# Together We Build

## The History of Kaiser Engineers

Edited
by
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# Together We Build

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# Foreword

Before there was the organization known as Kaiser Engineers, there was a group of Henry Kaiser's engineers who helped him build massive hydroelectric projects and his first industrial plants. By about 1938, the first group of Henry Kaiser's engineers to operate in a formal way was established in the Latham Square Building in Oakland, California, located at 16th Street and Telegraph Avenue. They were a small group assembled to design sand and gravel facilities and assist with the design of a new Portland cement plant. This group was headed by Fred Crocker, known as a genius with a slide rule. He was aided by George Havas, Lou Oppenheim, Jim Foster and a small drafting squad.

In August, 1941 the name Kaiser Engineers was established as a division of the Henry J. Kaiser Company. By 1942, Kaiser Engineers was an operating entity and had commenced its first project to design and build a steel mill near Fontana, California, that would manufacture steel for Henry Kaiser's wartime shipyards.

This is the true story about the important industrial and civil engineering projects that were built by Kaiser Engineers around the world. It involves the Company's projects over the years 1942 through 1986. It was written by the men that did the work.

While much has been written about the man who was Henry Kaiser, the works and accomplishments of Kaiser Engineers, his wholly owned engineering and construction company, have largely been ignored. Henry Kaiser built and operated basic industrial plants including steel, aluminum, cement and automobile manufacturing facilities, and shipyards. The public was led to believe that he had an anonymous, competent staff that assisted him in these undertakings. This is the story about how Kaiser Engineers built Henry Kaiser's plants, and then went on to build many plants for clients outside of the Kaiser empire.

The significant services that Kaiser Engineers provided to private industry, in addition to its work for the affiliated Kaiser companies, have also largely been ignored. In its glory years Kaiser Engineers provided engineering and construction services worldwide to a wide array of industries and built many significant industrial and civil engineering works. In 1965, the Company was ranked the #1 Engineer / Contractor, worldwide, by *Engineering News Record.*

The men who wrote and edited this book were active participants in the marketing, management, staffing and execution of these massive projects. They were not merely observers as were the authors of other works about the Kaiser empire. For the first time, the details about the Company, its methodology, its people and major projects undertaken are revealed. Because the authors were intimately involved with the numerous projects and participants mentioned, they are referred to by their familiar names. Kaiser Engineers is referred to simply as "Kaiser Engineers" (without reference to its many subsidiaries formed for legal reasons) or as "KE" or as "we". This applies also to its years under Raymond International ownership, when it was renamed "Raymond Kaiser Engineers".

This history of Kaiser Engineers is presented in four different ways. The *first* is a recital of the overall company history, its organization and how it did its work. The *second* way is a detailed description of the KE industry divisions, describing major projects and the people who did the work. The *third* way of describing KE's history is by inclusion of pictures of KE's projects with descriptive captions. Together, these form a synopsis of the history of the Company. And, finally, the *fourth* way consists of a number of oral histories in which various authors describe their personal experiences in their work for the Company. These stories parallel KE's history and give a more personal glimpse of our work and what happened along the way.

The company's success resulted from the great works accomplished by its people. The authors, relying on their memories in the absence of official records, tried to recognize and give credit to those that did the work and the book is dedicated to them. In all, about 1,500 names are cited, resulting from the combined memories of the authors. However, in order to recognize all of KE's people who were so important to its work, using a number of different documents, a carefully crafted roster of KE's personnel was prepared. More than 4,100 of KE's permanent staff have been recalled, including staff people, engineers and construction managers. The "string" listing of names on the cover of this book is taken from this roster.

This book stops its history of Kaiser Engineers in 1986, a time when its editors and nearly all of its authors and contributors had already retired. It is recognized, however, that its great works continued for a number of years afterwards, before being sold for a second time to other companies. The Afterword describes briefly the sequence of events and changes that occurred after 1986 until July, 2000, when Kaiser Engineers as an entity ceased to exist.

Chapter 1

# History

## Prelude to Establishment of Kaiser Engineers

This is the story of Kaiser Engineers after it became an independent entity. But there is a lot of history that preceded this event. This book would not be complete without reciting those events precedent.

We include information about Henry Kaiser himself, about his inner circle of confidants, and early key men; his ventures in building large dams; the beginnings of the Kaiser industrial empire; briefs about the affiliated companies; and milestones along the way.

All of this can be found in Chapter 18, "Antecedents," and "The Kaiser Story" in the Appendix.

## Kaiser Engineers Is Born

The exact date in 1941 when the name Kaiser Engineers first appeared is rather fuzzy. In practice, however, it is rather clear that the organizational framework, its methodology, and its people originated at the beginning of the design of the Fontana steel mill in 1942. It was in the 1944 to 1945 period when publicity about the organization, organization charts, and internal stationery appeared with the name Kaiser Engineers. It is reasonable to assume for our purposes that KE was born in 1942.

George Havas (George Havas and Lou Oppenheim were the first two heads of the firm, spanning a period of over 30 years) is given the credit for having mobilized staff and organized the company. In a book about Henry Kaiser *(Western Colossus* by Al Heiner, 1991), George Havas' role is defined:

> The vortex for all the swirling activity (initiating the Fontana steel mill) was the Oakland office of George Havas, chief engineer, in the Latham Square Building. Havas was a Hungarian engineer who had joined Kaiser in 1928 during the building of the Cuban Highway. He was so brilliant, so thorough, so hard-working, Kaiser would keep piling more and more responsibility upon him. By 1942, Havas, whom Kaiser called 'the little giant,' was ready to take on the challenge of directing the design for a whole new integrated steel mill, even though he had absolutely no previous experience along that line.
>
> It was a sight to behold, seeing the steady stream of engineers coming in and out of his office at all hours during the day and into the evening with bulging blueprints. He didn't take long to approve, or disapprove, or modify the drawings. With his European mannerisms, he sometimes seemed like a dictator, but often enough, his eyes would twinkle, and people could sense his warm human qualities. Rarely did Havas bother Kaiser with questions.

Lou Oppenheim recalls the early beginnings:

> Henry Kaiser always kept a few engineers on his payroll, and this included George Havas. This practice was probably more or less continuous from the date of 1914 when he started contracting in British Columbia, although I am not sure about the continuity. I joined the Kaiser Sand and Gravel Company at Pleasanton in May of 1938 and moved into Oakland to be a part of George Havas' group of five or six engineers in early 1939.

A later historical sketch defined Havas' role as follows:

> Havas brought engineering to the Kaiser company. From now on, bids would be the result of reports and studies, based on solid engineering rather than Henry Kaiser's experienced guess at what a job would cost.

This early group of engineers formed the nucleus of an organization, expanded by hiring steel mill experts to design Fontana. While engineering was at its height of intensity in early 1942 and 1943, construction crews were already digging holes at Fontana, and a separate crew was already organized to plan for operating the mill. Communication between Oakland and Fontana was constant. The story is often told about the almost nightly journey of Oakland engineers who acted as couriers to deliver partially completed designs, traveling overnight by the Southern Pacific Lark. It was overnight so that no productive time would be lost in preparing the designs.

Engineering was intense in obtaining designs of steel plant components from steel mills and in placing major orders for steel mill components. Kaiser's engineers were now in the forefront of a major undertaking, plowing new ground, new methodologies, and practicing the art in the Kaiser way.

It was because of this experience and its success that its methodologies were adopted as the norm for the company. KE became a premier engineering and construction company that provided an operating company with a single-responsibility type contract. Internally, it became obvious that the coordination of the design, the procurement, and the construction required centralizing control under one individual. This was the project engineer. It was he who also controlled the scheduling and monitored costs to see that the work was efficiently done.

Thus, in the period of 1942 to 1944, KE became a functioning independent entity.

## Milestones

There were a number of significant events in the company's growth along the way. As the postwar booming economy grew and as crises arose around the world, KE was there to participate in the marketing opportunities that arose.

| | |
|---|---|
| *1942* | Kaiser Engineers is organized. |
| *1943* | Fontana steel first blast furnace blown in. |
| *1945* | *World War II ends.* |
| | Fontana's first expansion program begins. |
| *1950* | *Korean War begins.* |
| *1951* | Construction of Hanford nuclear reactor begins. |
| | Construction of Chalmette Aluminum plants begin. |
| | Expansion of Fontana entrusted to KE. |
| | Jamaica Bauxite is first KE overseas project. |
| *1953* | Nuclear Engineering Division organized. |
| *1954* | Snowy Mountain hydroelectric facilities in Australia begin. |
| | U.S. License for L-D plants awarded. |
| *1956* | Award of major Tata Steel overseas project. |
| | Carmel strategy meeting outlines outside sales program. |
| *1957* | *Sputnik launched.* |
| *1958* | International division is formed. |
| | Quebec Cartier Project awarded. |
| *1961* | Heavy construction losses start to mount. |
| | KE awarded Houston Apollo Mission Control Center. |
| *1964* | Award of Armco 600 massive steel project. |
| *1965* | KE ranked as #1 Engineering Contractor by the *Engineering News Record.* |
| | *Vietnam War begins.* |
| | *Berlin Wall erected.* |
| *1967* | Rapid transit projects in Washington and Baltimore begin. |
| | Henry Kaiser dies at age 85. |
| *1969* | *U.S. lands on the moon.* |
| *1970* | Zimmer nuclear plant awarded. |
| *1973* | Great Plains Coal Gasification design commences. |
| | *OPEC causes oil crisis.* |
| *1977* | Kaiser Industries is dissolved. |
| | Kaiser Engineers sold to Raymond International. |
| *1980* | I-595 Expressway awarded. |
| *1981* | Construction of Great Plains begins. |
| | KE backlog reaches $2.3 billion. |
| *1986* | Most of KE's key staff have retired. We chose to end this book at this time. |
| *1988* | The banks force Raymond to sell KE. |

These historical milestones parallel the expansion of industry in the United States. There were periods of postwar pent-up demands and difficulties of high inflation of costs that ensued. There were wars and crises. We had nine different presidents of the U.S. and nine different administrations to contend with. And there were the boom times of the '70s and '80s.

# Postwar Boom

*1946 to 1955*

## Economy and Environment Around Us

The country had been completely mobilized for the intense war effort of 1941 through 1945. All factories had been converted from producing consumer products to production of war materiel with strict control vested in an agency called the War Production Board. To avoid profiteering and artificial price escalation while full production was directed to the war effort, a separate agency, the Office of Price Administration, enforced strict price controls.

As soon as the Japanese surrendered, all restrictions were released. Now factories could convert back to producing consumer products, price controls were lifted, and it was left to the free market to determine prices. At the same time, demobilization of the 16 million men under arms was rapidly undertaken. These events caused major disruptions to the economy and a severe shock to the system.

At that time, the U.S. had a population of 131 million, and it was anticipated that at full production we would have a work force of 60 million. The 16 million demobilized fighting force constituted a large part of that work force.

During the five years of the war, no one could buy an automobile, or a toaster, or any other consumer products. Since they could not spend their money, people had lots of money to buy products at the end of the war. But it took a long time to convert factories back to peacetime pursuits. So now factories were converting, hiring new workers, and retraining demobilized veterans to peacetime jobs. But a third factor was in play. There was such great demand for consumer products that all factories placed their outputs on allocation. Waiting times would extend for as much as a year to buy a new car.

Price escalation was a major consideration for contractors trying to build projects. From 1945 until 1948, construction prices increased by 50 percent as measured by the *Engineering News Record* index of building costs (242 versus 461). By 1950, the index had more than doubled.

In this period, we operated under three presidents: Roosevelt continuing from 1933 to 1945; Truman from 1945 to 1953; and Eisenhower from 1953 to 1961.

Military readiness continued in the decade following World War II. The Korean War from 1950 through 1953 required military facilities and large demands for basic materials like steel, aluminum, and cement. These were the materials that the affiliated companies produced and for which KE provided the facilities.

## KE Is Ready to Serve

Kaiser Engineers entered the postwar period with an on-going backlog of work, continuing its design and construction of the Fontana steel mill. It had a sizable staff in place still gainfully employed, and it was in a profitable position. It had an established modus operandi and could now stand on its own as an independent engineering and construction company. It knew how to contract on a cost-plus-a-fixed-fee basis rather than taking on risk by bidding in fixed prices in a highly inflationary environment. It had a well-established fixed responsibility delegated to project engineers who would control all aspects of the work and monitor project schedules and costs, and it had key staff available.

Concurrently, when other Kaiser projects or enterprises came to completion, the best, well-trained project managers and engineers migrated to Kaiser Engineers. Dam builders and shipbuilders came along with key staff from Fontana. Also during this first decade from time to time, key staff became available from the automobile plants of Kaiser-Frazer in Michigan and from wartime plants and from appliance and aircraft plants. The advantage to KE was that these managers and engineers were well indoctrinated into the Kaiser way of doing business. They had the can-do spirit and knew how to build well and to build fast. They constituted a rich heritage of tradition, principles, and dedicated people who became the foundation for the emergence of Kaiser Engineers as a separate entity within the family of Kaiser companies.

Another source of talent emerged in about the year 1950 when returning GIs took advantage of the GI Bill of Rights to study civil engineering. As KE's volume increased and the need for additional talent became obvious, KE recruited these veterans. Most remained with the company for the full period covered by this book, rising to positions of prominence in the company.

KE's growth began with this rich resource of experienced engineers, administrators, and managers who had cut their teeth with the Kaiser organizations during the dam building days, in the shipyards, or in the wartime construction of the Fontana steel mill. They became the corporate and administrative managers of the company and the key engineering and construction personnel responsible for undertaking the expansion programs and projects for the affiliated Kaiser companies. Most of these personnel remained with KE for the balance of their careers. Several of them have participated in writing this history.

## Chief Engineer's Staff

The war had ended, and Mr. Kaiser and his ongoing businesses were expanding rapidly to meet the demand for their products. Sand and gravel, cement, steel, and now aluminum were under large expansion programs. George Havas, being Mr. Kaiser's right-hand man on matters relating to new facilities, was given an additional assignment. He would be the chief engineer of all affiliated companies. If one reads Mr. Kaiser's history, one cannot but marvel at the many and varied things he did. He was a visionary man and an insatiable worker.

George Havas was likewise a marvel at the number of things that he accomplished. Mr. Kaiser kept piling more and more on him. He was now successfully running the emerging engineering firm, but when we speak of running it, one has to understand that he was totally immersed in running it. Then, he continued his role in charge of negotiating joint-venture agreements and estimating, staffing, and monitoring our continuing involvement with heavy construction projects. And now he was chief engineer for all the affiliated companies.

He and a small nucleus of engineers became known as the Chief Engineer's Staff. Their role was to evaluate expansion plans, write feasibility reports, and assist the companies in starting new expansion programs. Costs for these services were on a shared basis where the costs were allocated on the basis of the amount of services performed for each company. This provided a ready, capable staff at the time that each firm was rushing through expansion programs. It meant they, in turn, did not have to recruit, train, and maintain this kind of staff on their own payroll. In return for their sharing KE's costs, they were granted reduced rates on fees charged for the work when projects were entrusted to KE. In the early years it was almost automatic that KE would be awarded the affiliated companies' expansions.

This started as the postwar era began, with rampant demands for products and high inflation. In addition, excess profits taxes imposed during the war remained in effect. It was not unusual for corporations to be charged 70 to 80 percent income tax rates. Despite this, companies could still justify expanding, as prices escalated along with escalating costs.

An example of how KE assisted with the Chief Engineer's Staff occurred in 1949. Kaiser Cement was shipping bagged cement into Alaska during the war and continued to do so afterwards. Its sales department came up with the idea that good markets existed, and good prices could be obtained by shipping in bulk cement, installing a bagging plant in Anchorage, and selling some of the bulk directly. They asked KE to study it.

KE established concepts for an off-loading facility to handle the bulk cement shipped by barges which would be beached after the high tides of Alaska flowed out. This would save immensely on bag handling and transportation. The resulting feasibility study forecast that profits after taxes (as high as 70 percent) would be returned in 8 months. Armed with this report, the Board of Directors authorized immediate installation. KE designed and built the facilities, which performed as forecast in the study.

George Havas sat in on all Boards of Directors' meetings for all of the companies and rendered advice and assistance concerning all of their expansion plans. After the Board meetings, his staff would render any evaluation that the Board or the management wanted.

This Chief Engineer's Staff was in place for the full decade following the war, until each of the affiliated companies became mature enough to recruit permanent staff of their own.

## Kaiser Expansions

During the first part of the decade, KE was so busy with Kaiser affiliated company expansions that it didn't have time or resources to seek outside work. Nonetheless, planning for future expansion was continuously going on. The time for such outside work would come later.

The company was concerned mainly with continuation of its joint venture construction activities, with which it was familiar, and with building staff and capabilities to meet the engineering and construction requirements of the other Kaiser companies.

Fontana was in continuous expansion from its early beginnings of its first blast furnace. In rapid order. By 1948, it was expanding its open hearth furnaces and putting in blast furnace #2. Its tin mill came in 1950. Expansions continued throughout the decade. Since some of these projects were smaller, some of the large crew that built the original facilities became available for other projects.

Then in 1951, Kaiser Aluminum started its large expansion at Chalmette, helped by the good profits made in Mr. Kaiser's shipyards. (See Appendix 7, "The Kaiser Story.") Those profits went into a company that was now operating some of the yards. Its name was Permanente Metals Corporation. After the war when it acquired some excess aluminum facilities sold off by the government, its name was changed to Kaiser Aluminum. Now early in 1951, KE was given the job to start the first aluminum potlines at Chalmette, Louisiana. Work was not even finished when additions were authorized for expansion of the potlines. KE's job numbering system shows how rapidly expansion occurred. The first potlines were started with Job No. 5110, which was the 10th job in 1951. The expansion was numbered 5180, which was the 80th job in 1951.

These expansions were typical of Mr. Kaiser seeking a means to overcome critical bottlenecks. Louisiana was chosen because it had an abundant source of cheap natural gas. This could be used for generating electricity because aluminum potlines were large consumers of electrical energy. But the area chosen did not have electricity available. So in typical Kaiser fashion, new radial gas engines were purchased for generating power for the initial production until conventional steam power plants would come on line.

Likewise, Kaiser Cement expanded by adding its fifth kiln in 1950 and its sixth kiln in 1955.

Meanwhile, Kaiser-Frazer on its own started converting the Willow Run, Michigan, aircraft plant to produce automobiles. By 1946, they had conversions going on, and production initiated. KE's role was minimal as Kaiser-Frazer employed its own engineering and construction and operating staffs. Many were recruited from the Richmond, Vancouver, and Washington shipyards. Noteworthy for KE's history was that a large number of K-F's managers and engineers eventually migrated to KE and became key players in KE's history. (Chapter 18, "Antecedents" elaborates on these people as they became available.)

## Dam Projects

The rich heritage of Kaiser's involvement in heavy construction was not forgotten. KE inherited the know-how, staff, and following of joint-venture activities now that postwar was a major focus of Mr. Kaiser and his inner circle of confidants. George Havas was the central focus for maintaining contact with old-line joint-venture partners, negotiating joint-venture agreements, estimating costs, and approving bids, staffing, and monitoring the work. With his busy workload previously described, he found the time to manage this also.

By 1948, KE was already bidding on and winning Hungry Horse Dam and Detroit Dam, which we sponsored. This meant staffing and managing the work also. Soon thereafter, we were participants in several other large projects. In 1954, our first major overseas project was awarded at the Snowy Mountains in Australia. This started an Australian adventure that lasted for 30 years, including many industrial projects.

In a small way business development efforts started in 1950 when KE initiated efforts to obtain work from non-affiliated clients. The initial foray started when KE hired a sanitary engineer to seek projects from local municipalities close to the Oakland headquarters. Early assignments were studies of water treatment and sewage disposal plants, with the first real success the awarding in 1950 of a contract to design the major water treatment works for the City of Vallejo. This was the beginning of a 35-year relationship with the city.

## Hanford Projects

Capitalizing on its prior presence in the State of Washington, KE obtained its first large nuclear construction project in 1951 when it was awarded the 1,250-megawatt Plutonium Production Reactor at Hanford, Washington. This was the first of many such assignments that lasted for more than three decades of engineering and construction for the U.S. government and then followed later for private industry.

## Atomic Energy

Even as early as the early '50s, KE was looking for opportunities to enter the nuclear engineering field, hoping to capitalize on relationships built up with the Atomic Energy Commission on construction work at Hanford. KE had not been successful in trying to break into construction for fossil fuel plants because utilities had long-standing relationships with other architect-engineering firms. But those competitors did not yet have nuclear capability.

By 1953, KE established a nuclear engineering division and recruited experts in the field. By 1955, the first significant award was made for engineering on the Idaho Engineering Test Reactor. Soon thereafter KE won the award to build it.

## L-D Licensing

Still looking for new markets and new opportunities, KE's management took the aggressive step of obtaining the U.S. License for the new L-D process for producing steel using oxygen. It was called the Linz-Donawitz method, patented by an Austrian firm. By 1954, a small development department was in place to market the process. The first few years were spent in staffing the department and tracking worldwide developments as more and more plants came on line. KE became the industry source for such information and was often quoted in the technical press. This ploy gave KE a standing and reputation in the industry.

By 1956, it was awarded its first L-D plant to design and build for Jones and Laughlin Steel. It was followed by a large plant for Armco and established KE as a major player in the oxygen steel engineering and construction business.

## Jamaica Bauxite Facilities

One of KE's first offshore design and build projects occurred in 1951 with the award of Kaiser Aluminum's Jamaica Bauxite facilities. This required building a new mine, new railroad system, and a loadout dock for ocean-going vessels. The project was noteworthy for KE being able to marshal forces for an offshore facility but also for a unique construction procedure.

The railroad was required to move down an escarpment to the seashore, but the route required massive movement of earth. It appeared that this would be a bottleneck for early completion of the project. Early completion was a norm for all of Mr. Kaiser's projects. Enter Tom Price, Mr. Kaiser's most trusted mining and construction man and one of his first employees. Price suggested that the way to do the job fast was to plant massive amounts of explosives and by properly placing the charges, move the whole side of the mountain. On one day the big blast occurred, and the movement of earth was easily accomplished; the short schedule was maintained.

## Years of Growth and Expansion

*1956 to 1965*

The next decade had more challenges. Following Eisenhower, we had Kennedy from 1961 to 1963 and Johnson from 1962 to 1969. The missiles crisis during Kennedy's regime gave new meaning to military readiness. We were in constant competition with the Soviet Union, giving rise to a vast military build up. The Vietnam War started in 1965. The Berlin Wall went up in 1961.

The Space Age was launched with Sputnik in 1957, and we caught up with Alan Shepherd going to space in 1961. By 1969, we had a man on the moon.

## Markets and Workload

In 1956, the company's workload consisted mostly of projects for the other Kaiser companies. Major projects included design and construction of ore benefication facilities at Eagle Mountain and two major steelmaking expansion programs at Fontana for Kaiser Steel; and for Kaiser Aluminum an alumina plant at Gramercy, Louisiana, and an aluminum reduction plant and sheet mill at Ravenswood, West Virginia.

In 1954, KE obtained the U.S. license for the L-D steelmaking process and in 1956 obtained its first contract using the process for a turnkey design and construction program for Jones and Laughlin Steel.

Kaiser Engineers Overseas Corporation was incorporated in 1955 for construction of the Tata Steel Mill expansion in India, and Kaiser Engineers International, Inc. had been formed for design and construction of the Industrias Kaiser Argentina (IKA) Automobile Plant in Argentina. The Henry J. Kaiser Company (Canada), Ltd. was formed in 1954 with a contract for a feasibility study of an iron ore concentrator for Quebec Cartier Mining Company. (In 1941, Mr. Kaiser had registered the corporate name, "Henry J. Kaiser Company, Ltd." in Canada for his paving work in that country.) The Quebec Cartier contract was the first of many Canadian projects that were to follow.

As of 1956, with few exceptions, KE's basic capabilities were those related almost entirely to the technologies of the cement and gypsum, aluminum, and steelmaking industries of the other Kaiser companies, or to large joint-venture public works projects. At this time, it had become apparent to KE's management that the growth and expansion programs of the affiliated Kaiser companies would not continue at their current levels and that long-term growth and profitability of KE would require even more diversification of the company's market interests and engineering. Senior management of KE was convened in Carmel to discuss and plan the future of the company and to identify its market opportunities and objectives as well as the measures necessary to attain them.

## Strategic Plan for Outside Work

The outcome of the decisions made in the 1956 strategy meeting in Carmel was that Kaiser Engineers would expand its market interests in the industrial and public market sectors and would pursue engineering and construction work in the following industries:

- Government projects, mostly for defense work
- Nuclear engineering and construction projects
- Iron and steel projects
- Alumina and aluminum projects
- Thermal power, both fossil and nuclear fueled
- Petroleum projects
- Cement, gypsum, lime, refractories and related projects

- Ports and harbors and related works
- Rapid transit and related transportation works
- Mining and mineral industries projects

During the strategy meeting, decisions were made also to develop the organizational structure and acquire the resources and technical staff necessary to compete successfully in the company's expanded market. A "Development Department" was established within the company's organization, and Tim Bedford, a longtime Kaiser company veteran, was appointed to head it up. Various personnel with in-depth experience in each of the targeted markets were hired, and they, together with other KE personnel, became the staff of the Development Department.

Soon after the company's decision to expand its markets and offer its services to industry in general came the rude awakening that Kaiser Engineers was almost unknown as a design and construction firm in many of the industries selected to comprise the company's markets. Kaiser was a household name known for its dam building history and for building ships during World War II. On the West Coast, people knew about the air pollution caused by Kaiser Steel's Fontana steel mill and Kaiser's cement plant at Permanente near San Jose. And they knew about the shipyards of World War II. People knew about Kaiser aluminum foil from frequent advertisements on the television program "Maverick" with James Garner leading the billing.

But few could identify Kaiser Engineers as a separate company within the family of Kaiser companies nor the kind of business it was in. Few within Kaiser Engineers even knew who the competition was for mineral industry projects. They knew Bechtel from past joint ventures, but were unaware that Bechtel was very prominent in design and construction of mineral industry facilities such as those at Morenci, Arizona, for Phelps Dodge. Few had heard of Stearns-Rogers in Denver, the designers of many major copper, potash, and cement projects worldwide. Western Knapp Engineering Company of San Francisco had a worldwide reputation as designers of mineral industry projects, but to many Kaiser Engineers personnel they were thought to only be machinery vendors.

After a year of intensive sales efforts, a resurvey of industry showed that our recognition factor had doubled to 35 percent.

However, a business development handicap still existed in Kaiser Engineers' established market sectors for the cement, steel, and aluminum industries. Despite the level of experience and expertise possessed by the company's personnel in these technologies, difficulty was still being encountered in obtaining new business in these industries from other companies in the private sector. Concerns of the other Kaiser entities regarding possible exposure to liabilities related to KE's work for outside clients, and concerns by both the Kaiser company and potential outside clients regarding the possibilities for divulgence of proprietary technology know-how were found to be severe impediments to obtaining new outside business in these industries.

Despite these early concerns, later events proved that KE could overcome these possible difficulties, and the industry groups went on to accomplish numerous projects for outside clients.

## Tata Project

While KE was planning for expansion into new fields, an inquiry came in about a large steel mill complex to be built for Tata Iron and Steel in India. It was at the suggestion of Tom Price that if we really wanted the job, we needed to send a top-flight mission to India to sell it. As a result, the mission included most prominently George Havas and Lou Oppenheim. They came home with a signed contract.

This was KE's largest foray into international engineering and construction work after the work of the Snowy Mountains project in Australia. This was engineering and construction to be built under a single-responsibility contract in the record-breaking time of 30 months. It was actually completed under budget and within a few months of the target date, an unheard of accomplishment for that country.

## Iron Ore Projects in Canada

Soon thereafter in 1958, Quebec Cartier awarded KE its iron ore concentrator in a remote area of Canada, followed later in 1964 by the award of the Wabush Mines concentrator also located in a remote area of Canada. At the same time in 1964, KE was busy building the Hammersley iron ore facilities in Australia.

## Aluminum Overseas

Concurrently, opportunities arose for projects abroad. In rapid succession, awards came in for the aluminum smelters in Ghana, Australia, Wales, and New Zealand.

## Hydro Overseas

The source of power for the aluminum smelter in Ghana was the Akosombo Dam for which KE had just completed the design and supervision of contractors. Then followed the Bandama hydro development in the Ivory Coast and the Boa Esperanza Power House in Northeastern Brazil.

## Armco Projects

Our investment in acquiring the L-D process license for the U.S. led to the award by Armco Steel in 1962 of its oxygen steel plant in Kentucky. The project was so successful that it caught the attention of the Armco management. Little did we know at the time that it was a test project for them, for soon after KE was asked to handle a massive undertaking for them. It was their Project 600, so identified because it was a $600-million undertaking, in 1964 costs. Today that project would cost over $3 billion.

Project 600 involved facilities to be designed and built in Middletown, Ohio; Houston, Texas; and at their Butler facilities. The project is described in more detail in the steel industry chapter.

## Heavy Construction

While all the industrial projects were going full steam ahead, heavy construction continued apace. Work continued on the Snowy Mountains project in Australia, and now we were participating in military projects resulting from the military build up of the Cold War. We sponsored construction of Titan missile base projects and Atlas missile bases.

Then came the international hydro projects where KE sustained large losses. Losses included projects in Venezuela (Guri), Greece (Kremasta), Israel (Dead Sea Dikes), Pakistan (Links Canals), and on the American River in California.

## Space and Defense

With the launching of Sputnik in 1957 and our putting a man in space in 1961 and landing on the moon in 1969, there were many opportunities for our Advanced Technology experts to participate. President Kennedy's promise to put a man on the moon in ten years implied that there was much work to be done on the ground first. And there was, as we took advantage of those opportunities.

The original Nuclear Engineering division was expanded to Advanced Technology which included staff for space and defense projects. So by 1961, KE was designing launch complexes for the Air Force. In 1962, KE was awarded two plum projects by NASA: the Mission Control Center at Houston where control of all of the moon space missions was centered and the huge space propulsion test facility near Cleveland that would simulate the outer space environment.

## Additional Staffing

KE had a veteran staff comprised of engineers and managers who came from the dam projects, shipyards, automobile plants, and those recruited as experts for new technologies. KE management recognized that with the vast workload on hand and anticipated to come in, additional talent was going to be needed. In the early 1960s, KE developed a recruiting program to attract talented young engineers into a newly formed management training program. People recruited for this program were assigned to productive jobs, obtaining on-the-job training.

Fortunately at the same time, a number of engineering colleges instituted new disciplines in their civil engineering curricula where engineers took graduate courses in construction management. KE's recruiters selected the best for induction into our program. A measure of the success of those candidates was their popularity with project managers. Quite often on new projects a project manager requested a trainee he knew as his first selection in manning a new project.

These ex-trainees progressed rapidly in the company, most becoming project managers and key management personnel. Many spent their entire careers with KE, retiring about the time this history ends.

## Reorganizations

As more projects were undertaken in far-off places, management and administration became more complex. By 1958, it became obvious that our overseas involvement required a separate staff for marketing, management, and execution of projects.

It was a different environment than we had at home. Customs were different. Language was different. The kind of money involved was different. One had to be aware of local politics, local availability of materials and supplies, and we needed to know the capabilities of local hires. Often we were required to train local staff.

Consequently, at that time the company was split into two parts. One organization was devoted to domestic projects, and a separate one handled international projects. Internationally, we were organized by geographical areas. Each industry group and geographical group maintained separate profit centers so that management could measure the effectiveness of each group.

This mode of operation worked for a number of years, until in the period of 1961 to 1964 when the international group took on a number of heavy construction projects which lost money.

There were many reasons for the losses, but the most important reason was the failure to recognize that each overseas contracting agency had a different contractual language than KE had known when contracting in the U.S. with the Bureau of Reclamation of the Corps of Engineers. Now, in the overseas arena the contracting agency was ruled by the host country's laws. No longer would the law of equity govern where changed conditions would call for an equitable compensation to the contractor. Instead, the contract was read by strict interpretation under local laws, and local laws always favored the owner.

There was another practical problem. All of the governing agencies were funded for their original value of the projects undertaken. There were no additional funds to pay for extras. In other words, KE's contracts were treated more like an insurance policy for the owner. Our negotiations had no chance to obtain additional funding; thus, large losses occurred.

As a result of this bad experience on heavy construction projects abroad, management decided in 1965 to recombine the two divisions, domestic and international. Industrial projects were still profitable, and the same management was kept in place, except now an executive vice president was in charge of international projects but reporting to domestic top management.

At about the same time in 1964, the massive Armco Project 600 was awarded. This was so large, requiring large resources of engineering, construction, administrative, and management talent that it was decided to establish an entirely different group for this one project. A vice president was appointed full time to manage the projects. Key staff was detached from Oakland and from projects around the world to devote full time to the project. Key staff was assigned to Chicago for the design work, and others were assigned to Middletown, Ohio; Houston, Texas; and at the Armco Butler facilities. This staff was fully occupied for the next eight years.

## We're Number One

In this decade, KE had people in every continent of the world, working on hydro developments, iron ore projects, steel projects, aluminum, cement, and space and defense. KE personnel were everywhere and were dubbed by some as the "Amazing Kaiser Engineers." KE employed literally tens of thousands of engineers and craftsmen building these projects.

In 1965, these feats were recognized when the *Engineering News Record* named KE as the largest of 400 international contractors. The work volume for the year was $795 million which translated to today's costs would be a volume of about $4 billion.

All of the projects undertaken were large and complex.

## Changing of the Guard
*1966 to 1975*

By now we had two more presidential administrations to contend with. Johnson served until 1969 and Nixon until 1974 and then Ford finishing out Nixon's term.

*The Vietnam War covered the full period of 1965 to 1975.*

*Oil exporting companies, OPEC, shocked the world with their cartel arrangement when oil prices went from the range of $2 to $3 per barrel up to $25 or more, causing disruptions and shortages.*

## Reorganization
*1968 to 1975*

Until 1973, the company was run by George Havas and Lou Oppenheim, a period of 31 years out of the 45 years covered by this history. By 1974, Havas had retired, and Oppenheim was given other responsibilities. Jim McCloud, a veteran of a number of Kaiser operating companies, became president of KE and held that position for another 10 years. So these three executives were at the helm of KE for 41 of the 45 years covered.

An interesting sidelight: each of the three had different styles and different technical expertise. Yet they respected each other and were good personal friends. Each contributed greatly to KE's continuing success.

In 1974, Kaiser Industries had brought in for the first time a new president from outside the Kaiser organization. He insisted that KE needed to be more aggressive in marketing itself, so he brought in an executive vice president to lead the new marketing effort. This was a group that operated independent of the industry groups and international area groups. It is a mode of marketing often used by operating firms, although there are those who favor this mode and those who insist that each operating division can do a better selling job.

KE operated under this mode for several years, during which a number of large international projects were awarded. Then in another of its organizations KE reverted back to the older mode of having the operating divisions do their own marketing.

## Heavy Construction

Despite the losses sustained in the earlier period, KE continued to participate in joint-venture activities no longer as sponsor, but as a participant.

There were military facilities in Thailand and water projects in Los Angeles.

## Industrial Projects

Large projects in steel and aluminum continued to be awarded. Work on L-D oxygen steelmaking was especially active. By 1972, Armco Steel's large projects were coming to a close, and staff was now available to take on even more steel work.

Iron ore projects included the Tilden concentrator in Michigan and the Wabush Mines concentrator in Canada.

This period saw the success of the mining and minerals division in building cement projects for the whole segment of the industry.

## Coal Gasification

The entire nation was shocked by OPEC's actions in 1973. We had an energy crisis. KE was able to participate in the need to find new sources of energy.

In 1973, in association with the Lummus Corporation, KE was awarded the initial design of the massive Great Plains Coal Gasification Project, located in North Dakota. This $2.2 billion project would be activated for construction from 1981 to 1985.

## Nuclear Power

Again, addressing energy needs, KE was awarded the Zimmer Nuclear Plant in Ohio in 1970 and a larger nuclear station at Perry, Ohio, in 1974, a $5.2 billion project.

KE's reputation in Ohio was enhanced by the excellent work done for Armco at Middletown, Ohio steel works. When our nuclear capabilities were added to the competent, well-known staff already working in Ohio, the award was made to KE.

## Construction Management

By the early '70s, many owners became interested in having projects performed with fewer services than KE had been providing under the single-responsibility basis. The market for construction management grew. This is where KE would provide architect / engineer services and then provide a limited number of key construction managers. In some cases, for the food industry especially, KE had a separate staff, which did the construction management, even though KE did not do the design.

In some overseas environments owners wished to conserve on foreign exchange expenditures, so they would contract out construction services to local contractors who were willing to be paid in local currencies. In these cases, KE would provide a limited number of construction supervisors to monitor the local contractors' progress. In some cases, the KE function was advice and assistance only in construction matters.

The rationale for the foreign owners was that they were conserving on foreign exchange, but they were also willing to be somewhat less efficient in the construction while they were training their people in modern construction methods.

In the U.S. many of the cement plants were built under the construction management method.

## Advanced Technology

In this period the Space and Defense Department became most active with such projects as the Trident submarine bases, the $828-million U.S. Naval Shipyard modernization program, and the $4.5-billion modernization program of the U.S. Army's ammunition production plants.

In 1966, the Advanced Technology division was awarded the very extensive Bay Delta Water Quality Study. Services covered a period of two and a half years and provided a master plan for controlling water quality in San Francisco Bay and the Sacramento-San Joaquin River Delta region.

## Final Decade

*1976 to 1986*

*Now we had President Ford continuing his term and President Reagan from 1981 through 1989.*

*By the end of Mr. Reagan's term in 1989, the Berlin Wall had been torn down and soon thereafter in 1991 the USSR collapsed. We were beginning to see the lessening of the Cold War threat.*

*In 1977, Kaiser Industries was liquidated, and Kaiser Engineers was sold.*

### Liquidation of Kaiser Industries

Stock in Kaiser Industries was traded on the American Stock Exchange. Much of KI's assets were held in the stocks of the affiliated Kaiser companies, including the steel, aluminum, and cement companies, and Kaiser Jeep. Financially embarrassing to the management of KI was the fact that KI shares were worth less on the stock market than the sum of the worth and shares of its assets. KE was worth more dead than alive!

At the same time, revisions of the U.S. tax laws required that charitable foundations had to pay out a stipulated amount of their assets each year to protect their tax exempt status. The Kaiser Family Foundation owned Kaiser Industries stock, but it's dividends did not generate enough cash to permit the Foundation to comply with IRS requirements.

Another IRS liquidation ruling required that a corporation's wholly owned assets be sold. Faced with this requirement, the KI Board of Directors ordered the sale of KE and the other owned assets.

### Employees Try to Buy KE

When it became known that Kaiser Industries had to divest itself of all subsidiaries, a group of employees, led by Jim McCloud, signified its interest in forming an ESOP to buy it. An Employee Stock Ownership Plan would have used KE's fully funded employee benefit reserves, which were about $30 million at the time for payment for the purchase.

### Kaiser Engineers Sold

The employees' proposal to purchase KE was presented to Edgar Kaiser who rejected it. Instead, Kaiser Industries decided to sell KE to Raymond International, over the offers of several other firms, including Jacobs Engineering and a British company that had indicated interest in buying KE. The sales price was $30.5 million. Kaiser Industries favored the sale to Raymond as they had great respect for that firm from joint-venture activities dating back to the early beginnings of the Kaiser organization.

Later in this chapter, Jim McCloud describes in detail the circumstances underlying Kaiser Industries' decision to liquidate and to sell Kaiser Engineers and its other wholly owned assets. He describes also the unsuccessful efforts of KE's employees to buy the company.

### Raymond Years

Despite the change of ownership that occurred in 1977, KE staff, its work assignments, and backlog continued to flourish. By and large, the staff remained in place even as the new owners took over. It was still the same KE personnel who managed and performed the work.

Large projects started in the previous decade now accounted for a large part of the backlog. Coal gasification and the Perry Nuclear Power Plant contributed to the on-going profitability of the company. KE continued to serve its traditional clients in steel, aluminum, and cement. By now, many more projects were being undertaken in the construction management mode.

### Steel

During this period, KE mounted rescue efforts on three foreign steel mills that started without our help. Trouble was due to lack of proper management and large overruns. These were direct reduction iron and steel plants that started as the result of the OPEC cartel raising prices. The three countries that were part of the cartel were Venezuela, Iran, and Indonesia. Each was now earning more money than they ever could have conceived of and, at the same time, because they were pumping more oil, they had an abundant supply of gas which was being flared and wasted. They now wanted to use that gas to begin to industrialize.

They each contracted with equipment suppliers for design and construction of integrated steel mills. Unfortunately, they were ill conceived and poorly managed.

KE provided staff to help bail out the projects for Sidor in Venezuela, Ahwaz in Iran, and Krakatau in Indonesia. The Indonesian rescue mission was so successful and KE's reputation was such that the staff stayed there for future expansions lasting a total of 12 years.

## Cement

In the period of 1976 through 1983, a series of 12 different cement plants was designed by KE minerals group. Until about 1955, this group did work mostly for Kaiser Cement, but in the final 30 years, the group performed some $700 million of cement projects. In today's costs that is equivalent to $2.2 billion.

## Advanced Technology

The Space and Defense group continued to be awarded projects for the Army, Navy, and Air Force programs and the beginnings of more than 10 years of major projects for the U.S. Postal Service. The nuclear group performed services for Lawrence Livermore Laboratories starting in 1977 for the Shiva Nova High Energy Laser Facility. Services continued for several years, contributing large revenues to KE.

## Other KE Industry Groups

Entering the 1980s, major alumina and aluminum projects were underway in Australia, Bahrain, Brazil, Libya, and Indonesia. Major rapid transit projects were underway in Baltimore, Chicago, Florida, Los Angeles, and Vancouver. At this time, all of KE's industry groups were actively engaged in profitable work. Massive projects overseas were undertaken, including the Northwest Shelf LNG projects in Australia. KE was construction manager of Florida's $1.2-billion Highway I-595 expressway project.

## Leveraged Buyout

In 1983, five years after its purchase of Kaiser Engineers, Raymond International undertook a leveraged buyout of its public shareholders under the new name, Raymond Holdings, Inc. The shareholders received cash for their shares, and Raymond Holdings issued its own common and preferred stock, primarily to a newly formed Employee Stock Ownership Program (ESOP). About $180 million of financing was provided by a consortium of banks. About $30 million of excess funds in Kaiser Engineers employees' retirement plan was also used to fund the leveraged buyout.

## Markets Decline

The leveraged buyout and formation of the ESOP was undertaken in the face of economic weakness and declining markets for Raymond's capital intensive marine construction divisions and its drill rig fabrication operations. Additionally, these activities and other Raymond subsidiaries experienced continuing, significant operating losses and working capital shortfalls in the years following the buyout.

At the time of the leveraged buyout, Kaiser Engineers' traditional markets were also declining. The company's $2.33-billion backlog at the end of 1981 had fallen to $499 million by the end of 1983, the year of the leveraged buyout. KE's projects were profitable, but funds for new business development were limited because of the parent company's needs for cash.

## Losses and Reorganization

Raymond's financial condition continued to deteriorate, incurring a loss of $3.2 million in 1986. At the end of 1986, the company had a negative net worth of $46 million and an outstanding indebtedness of $191 million. Raymond reorganized in 1986, sold off some of its assets, and refinanced. The engineering groups, including Kaiser Engineers, were consolidated with the parent corporation, renamed Kaiser Engineers Group, Inc. and entered the year 1987 with a bank indebtedness of $110 million. Further declines in KE's market and its insufficient working capital caused its net loss in 1987 to increase to $7.7 million.

## Kaiser Engineers Sold Again

In October, 1987, Kaiser Engineers Group proposed to the banks a write-down and restructuring of its indebtedness. The banks rejected the proposal and decided to sell Kaiser Engineers. The circumstances leading to the bank's sale of KE and the demise of Raymond in 1988 are described further in the Afterword.

The events of the following years of Kaiser Engineers history, leading to its final demise in 2000, are described also in the Afterword.

## End of the Trail

From 1942 to 1986, KE was an active, viable, and profitable engineering and construction firm, performing projects in 12 selected industries, over all continents of the world, for most of the large basic industries, and for a wide range of governmental agencies.

In the period covered, just the projects named in this history had a constructed value if built today of approximately $250 billion.

KE built well and built big.

In 1965, KE was named the number one builder in the world.

By about 1980, most of the executives who grew up with the Kaiser facilities at Coulee, Bonneville, the shipyards, and automobile plants had retired. By 1986, veterans of World War II who joined KE after getting their degrees under the GI Bill of Rights also retired. And even those who joined in the 1960s as management trainees were now retiring also.

What was left were newer employees who had not grown up with the Kaiser tradition or imprint upon them.

A generation of men and women who had built great and important projects had come to an end.

## Sale of Kaiser Engineers to Raymond International

related by Jim McCloud

### Background

First, it would be helpful to relate some background on the formation of Kaiser Industries. In 1956, various financial advisors led by George Woods, president of First Boston Corporation and principal advisor to the Kaiser group of companies, recommended combining all assets of the Kaiser interests into one large publicly held holding company. This would include Kaiser Motors Corporation, the company that replaced Kaiser-Frazer. This is the company that had bought Willys-Overland, the manufacturer of the Jeep line of vehicles and for which Henry Kaiser made bank guarantees. Due to Kaiser-Frazer losses, the new company would have a tax loss carry-forward of approximately $76 million, which could be recuperated as a result of the new holding company's almost certain earning power.

Combining all the other assets of the Kaiser interests into one holding company had many advantages. The assets included 37 percent of the stock of Kaiser Cement, 37 percent of Kaiser Aluminum, 56 percent of Kaiser Steel, 77.5 percent of Kaiser Broadcasting, 50 percent of National Steel and Shipbuilding, and the wholly owned Kaiser Engineers, Kaiser Aerospace and Electronics, and Kaiser Sand and Gravel. Automobile shareholders who had suffered a loss in share values would exchange their automotive shares for the new holding company shares in an approximate ratio of four old for one new. But the new shares would have an earning power that emanated from various corporate entities involved in widely diversified and profitable industries. Kaiser Industries was organized, went into action, and provided its shareholders with a stable asset.

### Worth More Dead Than Alive

But years later, it became apparent and somewhat embarrassing to the management of Kaiser Industries that the company was worth more dead than alive. For years, Kaiser Industries stock had been selling for far less than the sum of its parts and in April, 1977, some 22 years after its organization, the liquidation (or dissolution, as some preferred to name it) of Kaiser Industries Corporation was approved by its shareholders. Many factors combined to bring this decision to the forefront. Kaiser had sold the Kaiser Jeep Corporation to American Motors Corporation in 1970 for 22 percent of AMC and then sold the AMC shares for $39 million, suffering a loss of about $10 million versus what the AMC shares were held in the Kaiser Industries books.

Another very important factor that contributed heavily to the decision to liquidate was a revision in U.S. tax law, brought about by the Tax Reform Act of 1967, that required charitable foundations to pay in a stipulated fraction of their assets annually to preserve their tax exempt status. This affected the Kaiser Family Foundation, the assets of which were concentrated in Kaiser Industries shares, but the dividends from Industries to the Foundation had never generated enough cash to meet the IRS requirements. As a result, it became evident that the Foundation was going to be forced to sell off some of its Industries shares to preserve its tax exempt status. The Foundation owned approximately 31 percent of Industries shares, was the largest single shareholder, and the liquidation of Industries would prove of tremendous financial benefit to it and allow it to follow the precepts of its founder, Henry Kaiser. The private shareholders would also benefit since the liquidation would bring them far more than the market prices of the shares if sold at prices existing prior to liquidation.

## Liquidation Formula

The IRS ruling that approved the liquidation allowed the distribution of its shareholdings in its publicly owned affiliates of Cement, Aluminum, and Steel directly to the Industries' shareholders, but required the sale of the wholly owned subsidiaries and joint-venture companies. The wholly owned subsidiaries to be sold were Kaiser Engineers, Kaiser Sand and Gravel, and Kaiser Aerospace and Electronics. Kaiser Industries' interest in joint-venture companies to be sold were National Steel and Shipbuilding and Kaiser Broadcasting. All of the income generated from these sales would be distributed to the shareholders. The disposition of Kaiser Industries' assets entitled the owner of 100 shares of Industries stock to 25.4 shares of Kaiser Aluminum, 13.6 shares of Kaiser Steel, and 7.8 shares of Kaiser Cement plus somewhere between $500 and $700 in cash resulting from the sale of the holding company's other properties.

When the dissolution was first proposed in May, 1976, Kaiser Industries shares were selling on the American Stock Exchange in the neighborhood of $10 and had risen somewhat to attain this level because of the announcement of the liquidation. When all the smoke cleared away about three years later, the shareholder had received well over twice the share value quoted on the day dissolution was first proposed. Needless to say, the liquidation was, from the point of view of the shareholder, a resounding success.

## Put on the Blocks

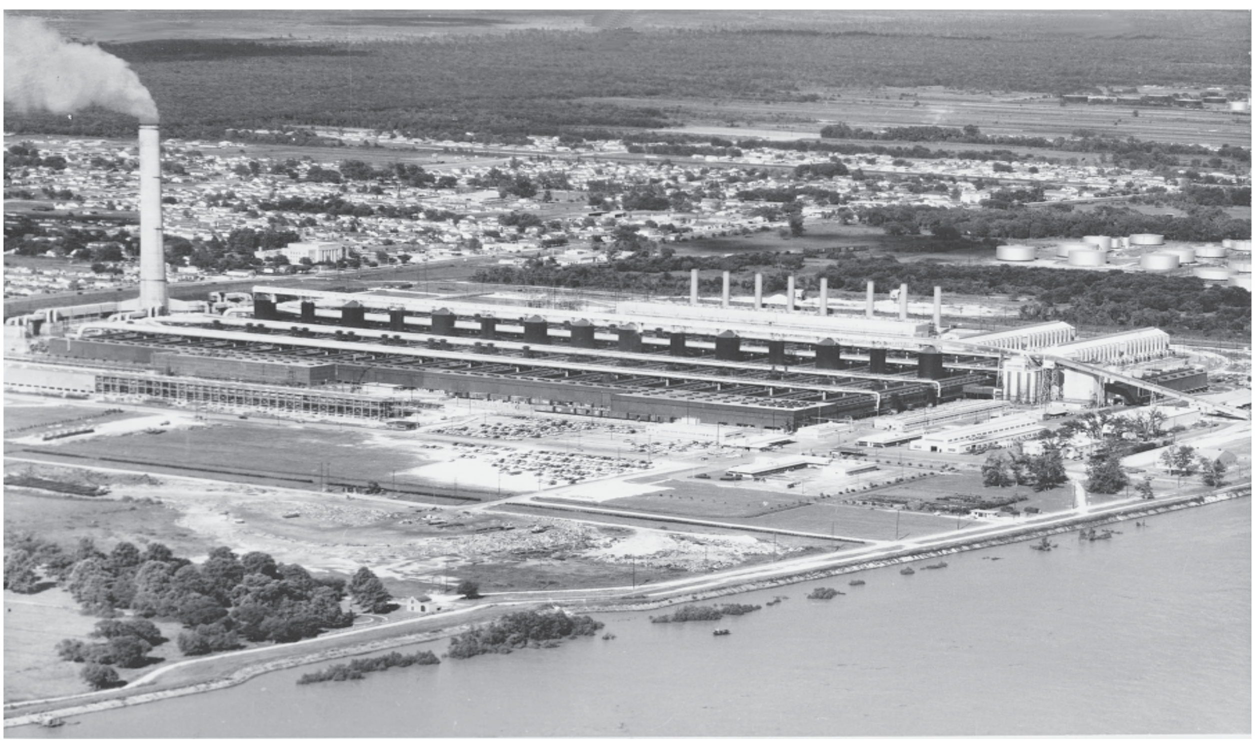
As previously stated, the IRS approval of the Industries liquidation plan required the sale of its wholly owned subsidiaries. Kaiser Engineers, Aerospace and Electronics, and Sand and Gravel were all literally "put on the blocks" immediately after the liquidation plan was approved. Kaiser Engineers, as did the other subsidiaries, received many expressions of interest. Among them, what appeared to be the most preferred by Kaiser Industries' management was the offer received from Raymond International with offices in New York City and Houston, Texas.

Raymond had worked on various jobs with Kaiser Engineers and was well regarded by Kaiser management. Raymond had diversified over the years, starting as a specialist in pile driving, and it had branched out and was involved in ports and harbor design and construction, test boring, pipe laying, structural fabrication, and other allied heavy construction endeavors. The match-up between Kaiser Engineers and Raymond was synergistic and was an important factor in management's decision to accept the Raymond offer of $30.5 million.

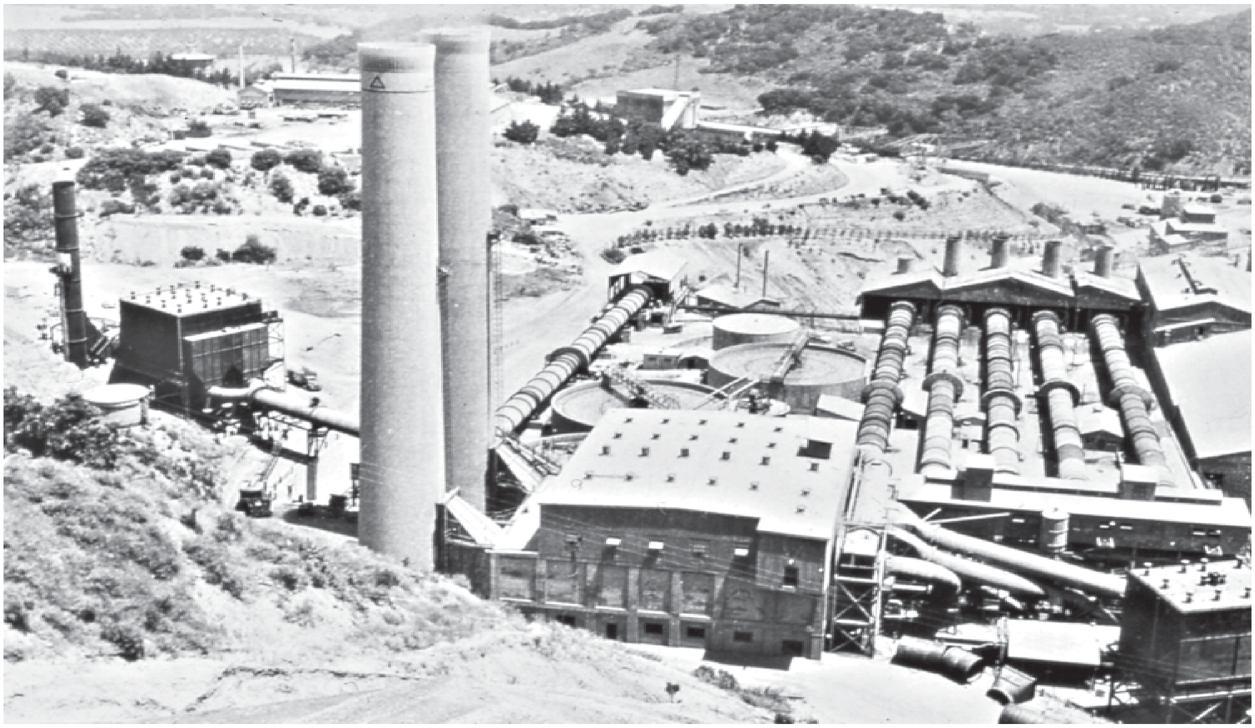
Prior to the final decision accepting the Raymond proposal, Kaiser Engineers' management studied the possibility of organizing an ESOP (Employee Stock Ownership Plan). Discussions were held with Louis Kelso, a prominent San Francisco attorney who had originated the plan. The ESOP involved using the Kaiser Engineers' fully-funded employee benefits reserves, which were in the area of $30 million, as payment for the purchase of KE and issuing ownership shares to each employee in proportion to his or her personal accrued benefit account. The Kelso Plan was very popular, and KE management favored it over the sale of the company to an outsider.

The Plan was presented to Edgar Kaiser for his consideration and, hopefully, his approval and presentation to the Board of Directors. But it was not to be, and on February 18, 1977, the decision to sell substantially all of Kaiser Engineers to Raymond International was announced. The pretax gain to Kaiser Industries was estimated at over $25 million.

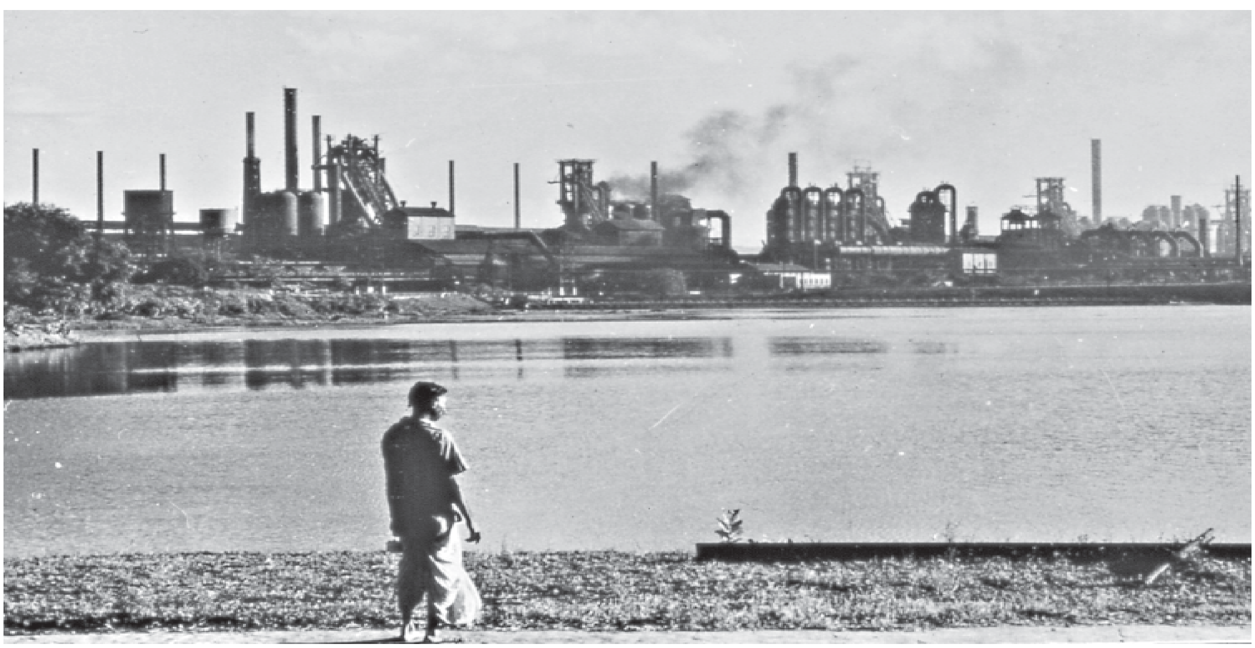
The next three photos depict KE's growth in capabilities over the years. It begins with the single project for which the company was formed in 1942…to build the Fontana Steel Plant for its affiliate, Kaiser Steel. In the background is the first blast furnace built in the record-breaking time of 9 months. It was named *Bess* in honor of Mrs. Henry Kaiser.



The Chalmette Aluminum Plant, built in Louisiana for Kaiser Aluminum in 1951, was also built in a hurry—in 11 months—to meet the market built up by the World War II aluminum market. To expedite construction, power generating facilities were split into two parts: conventional steam and Nordberg gas engines, which were faster to install but more expensive to operate. The plant was built next to the Mississippi, requiring all structures to have wood-piling foundations.

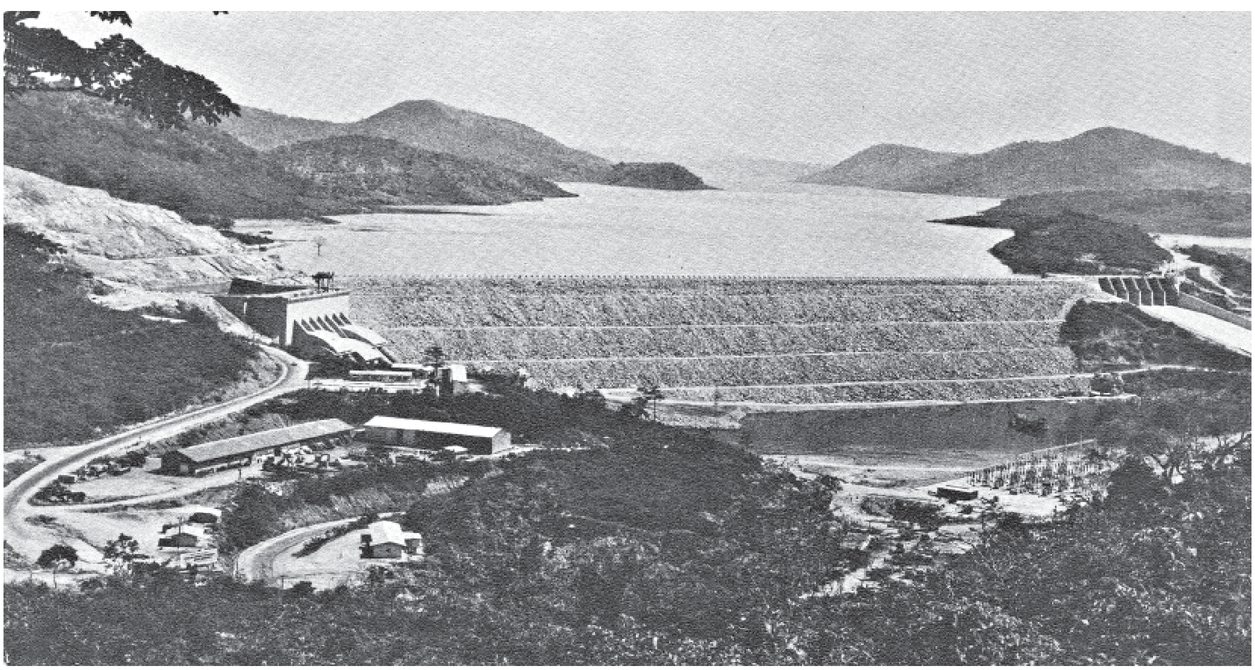


Until 1955, KE's cement activities were devoted to expanding Kaiser Cement's plant at Permanente. The fifth kiln was built in 1950, and the sixth kiln in 1955. As KE developed its cement expertise, it went on to become an important builder of cement plants for the U.S. cement industry with plants for Marquette, Medusa, Arkansas, Martin Marietta, and Lone Star cement companies to name a few. Early cement projects were undertaken as engineer/contractor. Later plants were designed by KE with field work performed as construction managers. Shown above is the Permanente plant following addition of its fifth and sixth kilns.

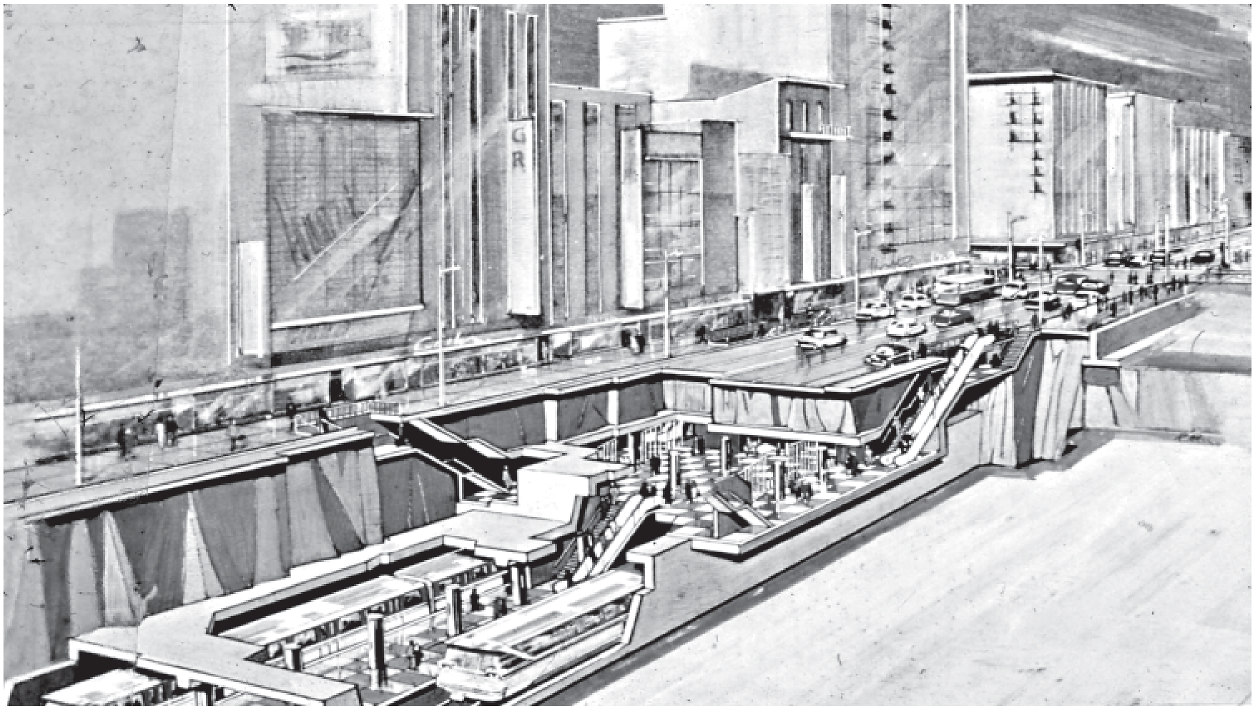


By the early 1950s, KE started to diversify and market its capabilities outside of the Kaiser family of companies. The first major overseas turnkey project awarded was the Tata Steel Project in India. Awarded in 1956, it was completed under a turnkey project in a record-breaking 36 months. KE had 100 of its key personnel in residence in India but employed some 20,000 people at the job site. This view shows the Tata plant in the background with an Indian worker in the foreground.

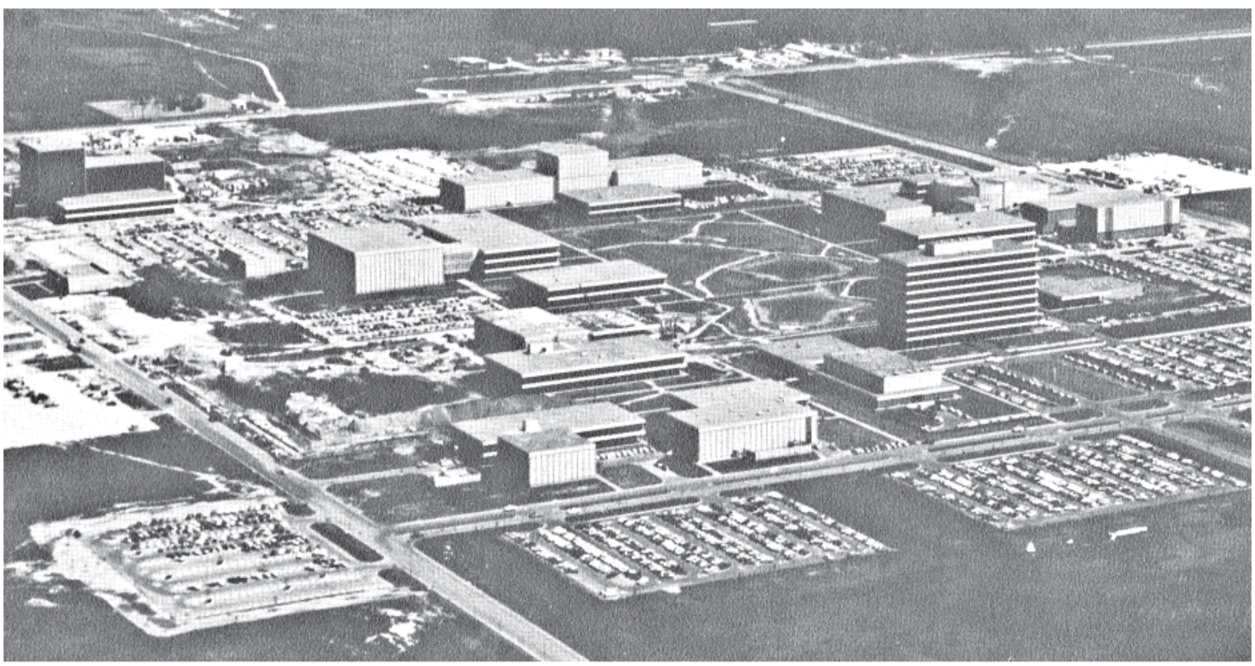
View of Valco Plant in Ghana. By 1963, KE embarked on an intensive overseas program, capitalizing on its aluminum and overseas know-how by building the Valco Aluminum Plant in Ghana. Power for this plant was provided by the Akosombo Hydro Project, also built by KE and started several years before for the Government of Ghana.



View of Akosombo in Ghana.



By the mid-1960s, KE embarked on another field of endeavor, building up its expertise in the transportation industry. It soon became known as one of the premier designers of rapid transit systems. In 1961, KE won the first contract for the Los Angeles system, and KE staff participated in its expansions for 27 years. Between 1966 and 1984, it participated in the design and construction of seven major systems in the cities of Miami, Baltimore, Pittsburgh, Boston, Long Beach, Chicago and Los Angeles. Shown above is a cut-away perspective of the Los Angeles Rapid Transit Station at Sixth Street and Broadway in downtown Los Angeles.



In 1952, KE began construction of the U.S. Atomic Energy Commission's $122-million New Production Reactor at Hanford, Washington, the beginning of many years of design and construction work for this agency. By the mid-1950s, KE was actively engaged in design and construction work for other federal agencies, including missile launch facilities for the Air Force. KE designed NASA's Apollo Mission Control Center in 1962. The Mission Control Center is shown here center-left in an aerial photo of NASA's Manned Space Flight Center, located near Houston, Texas.

KE's mining and minerals group designed and built numerous iron ore benefication plants and other industrial minerals facilities for copper, uranium, lead, zinc, and coal. The Wabush Iron Ore Concentrator (above) was built in Labrador in 1961.

One of the largest undertakings in the later part of KE's history was the ANG Coal Gasification Plant, built in North Dakota in 1984. It was a $2-billion undertaking. Overall view of the Great Plains project taken nearing completion of construction.

The worldwide headquarters of Kaiser Industries was also the site of KE's executive offices, located on the 18th floor. KE also occupied several more floors of space. Completed in 1960, it consolidated offices located throughout downtown Oakland. KE's first offices were located in the Latham Square Building at 17th Street and Telegraph Avenue in Oakland, California, followed by the first consolidation into the old Kaiser Building at 1924 Broadway, Oakland. KE's headquarters were on the 6th floor then. Soon thereafter the workload required renting office space for the design department.

By the time the Kaiser Center was built, KE occupied 17 different offices in the area, which were then consolidated into the Kaiser Center. In 1970, the Ordway Building was built adjacent to the Kaiser Center, and KE occupied a large block of that space.

KE's logos tell the story of KE's march of Progress. In keeping with modernization of the Kaiser Industries logo, KE maintained the slanted style, shown at the left, for a major portion of its history. Prior to that, the original logo shows a large 'K' with the name 'Kaiser' through the middle. KE's logo, above, was a circular 'e' with a large 'K' inside. The 'Together We Build" logo was used extensively to honor employees with multiple-year service awards, usually a pin.


DIRECTORY

KAISER COMPANIES & AFFILIATES

# Chapter 2
# Organization and Operations

## Overview

Our success in providing engineering and construction services to industry and governments worldwide can be attributed to several factors, including the legacy, inspiration, and the example set by our founding chairman, Henry J. Kaiser; the integrity, training and experience of a cracker-jack team; and a specialized methodology and system for performing our work. This chapter deals mainly with the third factor.

## Guiding Principles

From his early career in the business world, Henry Kaiser was by temperament a builder. He discovered early that hard work, intelligence, and attention to detail reaped benefits both for his clients and for his organization. Over the years his guidance, principles, and inspiration have been incorporated in the Kaiser Engineers policies, procedures, methodology, and style.

"Find a Need and Fill It" was one of his guiding principles and often expressed mottoes. Over the years Kaiser Engineers found needs to be filled in the market place of basic industry and governmental projects worldwide. From its beginnings, KE recognized the need for rapid construction of complex industrial projects. In the early years they were referred to as "turnkey" projects. Later, the term generally came to mean a lump sum package including supply of equipment. KE changed its terminology to "single responsibility" projects.

What this meant was that a client would have a single organization responsible for defining overall project concepts and process equipment needs, ordering equipment, performing design engineering for the overall project and its details, constructing the facilities and erecting the equipment.

"The difficult we do immediately. The impossible takes a little longer." A major part of Kaiser lore has to do with the speed with which the organization accomplished projects that were undertaken. It was not that we at Kaiser were smarter than the next guy, but we just worked hard at what we were doing.

Many of KE's key men were repeatedly detached for special duty, assisting Mr. Kaiser in developing his many new ventures. Without exception, these people came away from these assignments with new first-hand experiences gained from observing how the man worked and with new tales of how hard they worked. He said, "Hard work never hurt anybody." And, he added, accomplishment is "90 percent perspiration and 10 percent inspiration." But 20-hour days? These assignments gave us a new understanding of his genius.

"Don't tell me how not to do the job. Tell me how to do it" was frequent, strong "advice" to his associates. He was a great proponent of putting into practice some of his favorite sayings such as, "Give a man a job to do and let him do it." "One man. One job." "Don't do tomorrow what you can do today." "Time is money." To gain time, one always looked for ways to expedite a project. Overlapping of activities produced major benefits in the end. When the shipyards were being built in the early 1940s, while earthwork was going on, keels for ship production were being laid. Production was started months and perhaps years before completion of the shipyard facilities. The art of expediting equipment suppliers was developed early in the history of the Kaiser organizations based on the realization that the longest lead time was often not only the supply of the equipment, but also the information needed to tie it into the design of civil and other facilities.

It was Mr. Kaiser's interest in basic building materials production and later industrial minerals that led to the guiding marketing strategy under which Kaiser Engineers was to provide its expertise to such industries.

## People...Our Most Valuable Resource

Throughout our careers, we have heard Mr. Kaiser and his key associates say to us and to anyone interviewing them that people are our most valuable asset. As new projects were undertaken, new staff was recruited and integrated into the organization. A few key inner-circle men developed staffs to work on any number of construction or industrial projects. Civil construction projects were the first of the large undertakings, followed by cement plants, ordnance plants, shipyards, steel, aluminum, and hospitals.

After the first cement plant at Permanente and the Fontana steel plant were completed, a nucleus of key engineers became available to start a separate self-contained Kaiser Engineers organization, which over the years grew to employing tens of thousands of engineering and construction workers.

Many of these founding organizers spent their entire careers with KE. Its worldwide reputation was, to a major extent, developed by good people who worked hard, had integrity, acquired great experience, and developed a finely honed methodology.

## How We Did Our Work

With the guiding principles in place and with good people to perform its work, over a period of time, KE developed its own methodologies, systems, and procedures. Whether we were first to use these systems or one of the first is not an important issue for us. We know that we were early practitioners of the art.

One of the earliest principles for carrying on KE projects was the vesting of full power into the office of the "project engineer." This concept was different than practiced by most firms prior to the early 1940s. Before that, it was often the traditional practice to have engineering performed by an engineering firm and the construction separately by a different construction firm. Procurement of engineered equipment might have been done by the owner, the engineer, or the contractor. Under this scheme, there would be separate contracts but not one overall coordinator, unless done by the owner. If the separate contracts were fixed-price type contracts, then a major portion of the engineering had to be finished before the construction contractor could prepare its bid. Thus, valuable time was lost if the objective was an early start-up of production facilities.

With the large industrial expansion that followed World War II, the need for expedited early start of production became more pressing. The war years and the period following the war saw the growth of cost-plus-a-fixed-fee contracts where an organization such as KE would take on a single responsibility for execution of the project. (Note: This was different from the cost-plus contract of the first World War where, with the more "plus," the more the contractor got.)

With such a single-responsibility contract in place, KE's organizational focus was on how best to control all the activities of engineering, procurement, staff support, and construction. This became the role of the project engineer. He was the octopus that had a hand in everything. He coordinated all the activities and reported to top KE management and to the client on the execution of the work. Probably the one direct responsibility of the project engineer that other departments or staff only assisted with was the preparation of equipment specifications for the manufacturing processes.

On larger projects, groups of project engineers responsible for major segments reported to either a chief project engineer or a project manager.

In the careers of young engineers this concept was a sea-change from prior thinking because in KE's early years the prime recruiting ground for project engineers was from the design engineering department where detailed plans and construction specifications were prepared. As the expansions grew and new project engineers were needed, engineers were detached from supervising designs to positions responsible for the overall control of a project. One of the authors of this chapter recalls two newly appointed project engineers, who were known as stars in the design department, visiting his office with a question: "What the hell is a project engineer?" The simplistic answer given was that they should consider that they "owned" the project entrusted to them. A project engineer would coordinate all activities in the Oakland, California, headquarters office and keep track of costs and report periodically both to the client and company management on the progress of the work. Further, they were given one important admonition, in no event should they be caught preparing drawings again; others would be doing it for them. These men and others like them went on to become successful project managers and, some, vice presidents of the firm.

Flowing from the project engineer concept were a number of systems and methods. In the postwar era, a concept in vogue in industry was the "systems approach." This concept preached that in complex industrial organizations management needs to keep an eye on the overall purpose of the exercise. Each staff or department needs to determine whether that department's practices and concepts are compatible with the overall project's concept. While completing the engineering first and then soliciting fixed-price construction prices may lead to a cheaper and predictable outcome for construction, it may not be the cheapest approach overall when considering production requirements and financing factors.

It has been demonstrated to a number of clients that by expediting construction of a project, three months out of a 36-month schedule could be saved. This saves three months of interest cost during construction, three months of project management overhead, and production could start three months earlier, resulting in an increased revenue stream. All of these savings would often be many times more than any perceived inefficiency of not going out for fixed price construction bids based on completed drawings and specifications.

The single-responsibility contract permitted the overlapping of phases and a phased construction sequence. By preparing conceptual designs early in the project, one could prepare detailed cost estimates, schedules, and the "do early" planning for a project organization. Once concepts were established, major equipment components were defined and specified and placing of orders expedited. This recognized that the longest lead-time component was usually the process equipment, especially during times of rapid industrialization. During such times, getting a place in the equipment manufacturers' production schedule was a vital key to project completion in a timely manner. In addition, in order to design foundations and tie in utilities, it was important to obtain certified drawings from equipment suppliers, many of which took long periods of time. Thus, the single-responsibility concept with the overlapping of phases was an approach whose time had come.

## Some Techniques Used

To control progress of the work, project engineers had several control reports for their use. Detailed progress reports were issued monthly and showed progress of engineering and construction. During height of construction, detailed photographs illustrated field progress. More frequently, a *Status of Materials and Equipment on Order Report* would give detailed progress at manufacturers' plants, including ordering of castings, status of vendor engineering drawings, and status of manufacturing. This information was dovetailed into progress schedules and was vital for construction forces to know when equipment was expected to arrive at the construction site.

Monthly, accountants and estimators would prepare a cost and comparison to budget report in detail. This started with the preparation and updating of a detailed estimate of cost (the budget). The estimators' technique utilized files of data on similar projects and research into costs associated with the project, as well as estimates of cost of equipment and services. Monthly throughout the project, the accountants would record actual costs and commitments made (purchase orders) and compare them to the budget and amounts allocated for each line item in the budget. From these data, the project engineer could highlight problem areas and control costs.

Expediting of manufacturers was performed by an experienced staff of people who visited the manufacturers' shops regularly. As had been discovered earlier in expediting for shipyard activity, this function was of major assistance in the early completion of our projects.

As with Mr. Kaiser's modus operandi, good communications were maintained throughout the organization. Our telephone and telegraphic bills were high. But it was worth it, as we all believed that information was power. It was not strange as a young engineer to receive an assignment from a superior and then within the hour to receive a phone call asking for the answer. And it was not unusual to have a co-worker call to double-check on a fact or to end a conversation with, "When will you have the answer?" Nothing was left to chance. Facts were checked and double-checked.

Information is vital for proper decision making. Often, though, decisions had to be made with less than all the information one would have liked. Then it was necessary to use good judgment, often a painful event for some junior managers, leading to procrastination. One senior executive was often heard to say, when a manager was vacillating, "Let's go make a mistake." This was meant to hasten a decision and later to see whether it was correct.

Under the KE approach, with phased construction, some of the earliest activities were staffing of construction forces and early procurement of construction equipment, housing, and warehouse and office facilities. This way construction would proceed quickly and orderly. By the time engineered equipment arrived at the site, foundations were ready with anchor bolts in place for the equipment to be erected without need for long-time storage.

The discussions that follow describe in more detail the organization models used by KE over the years; more about its people, details on procedures followed by various departments, and more about project engineers and project management.

## Organization

This section describes the development and history of the KE management team as well as the project-level organizational structure. Taken together, they show how KE evolved and flourished for so long.

## Corporate Organization

The organizational structure changed over the years to meet greater and greater challenges and opportunities to serve the needs of industry. As the backlog grew, more and more diversified activities were undertaken. One of the first formal structures appeared in mid-1944 with a chart showing the organization of Kaiser Industries' Engineering Department, soon followed by a Master Organization Chart of the Kaiser Company, Inc., Iron and Steel Division. By November, 1945, Kaiser Engineers, Inc. was formed, and its organization chart showed that its prime purpose was the engineering and construction of the Fontana steel mill.

A record of many of the organization charts produced over the years still exists. It shows that for each of the first eight years a new chart was issued to reflect the current conditions. After 1957, organization charts dropped reference to KE being a "Division of" a separate corporate entity.

KE's organizations charts followed the classical pattern showing the chain of command, leading from the chief executive (vice president and general manager in early years) through line operation of project management, design engineering, construction, and various staff functions. Later, the title of the chief executive was upgraded to president in recognition of the company's growth and standing in the industry. For historical purposes, one of the early charts, for the year 1972, is reproduced on page 52 (Figure 2.1). It is not the purpose of this discussion to show each change in organizational structure, but rather to outline how, over time, changing needs changed the specific structure but not the concepts behind them.

## Our Leaders

Over its 35-year life span under the Kaiser auspices, KE had only five general managers (presidents). Their names and tenures follow:

| | |
|---|---|
| George Havas | 1942 to 1958 |
| L. H. Oppenheim | 1958 to 1973 |
| John Hallett (International) | 1958 to 1960 |
| Max Pearce | 1973 to 1974 |
| J. F. McCloud | 1974 to 1983 |
| G. W. Holman | 1983 to 1988 |

As will be noted in the listing above, throughout almost all of the period 1942-1977, when the company was owned by the Kaiser organization, most of the guidance of the company was by three chief executives: Havas, Oppenheim, and McCloud. While bringing different skills and styles to the position, each was an engineer and an outstanding leader who successfully presided over the organization's growth and development as times, technology, and conditions changed.

George Havas' inspiration, intelligence, and integrity gave the company its foundation, character, and standards. Known worldwide for his technical ability, he led the firm from its early development as an in-house engineering organization to its standing as a worldwide leader in the field of engineering and construction of complex process manufacturing plants.

The longest tenure was by Lou Oppenheim who started as assistant general manager under Havas and succeeded him as general manager. He was known and respected in engineering and construction circles for his organizational and leadership ability. Colleagues praise Oppenheim for his incisive analytical skills and his uncanny ability to spot potential weaknesses in engineering and other analyses. He pushed the organization to become one of the industry's leaders in the use of computers for both engineering and construction applications. His tenure as assistant general manager and general manager covered a 30-year span.

Long-time Kaiser company employee, Jim McCloud, came to KE in 1974 with chief executive experience at other Kaiser companies, including 12 years as head of Industrias Kaiser Argentina (IKA), the Kaiser automobile manufacturing company in Argentina. He brought a people-oriented approach to management and focused the organization on the importance of marketing and client relations just as the competitive marketplace demanded this focus.

Upon McCloud's retirement in 1983, Granville W. Holman was elected president. He was a veteran of more than 25 years with KE, rising from the Engineering Design Division through successive positions of corporate responsibility.

Later, economic events and changes to the parent organization (Kaiser Industries Corporation) led to several different organizational structures and finally to Kaiser Engineers' sale outside of the Kaiser family in 1977.

## Organizational Concepts

Starting as an in-house engineering arm during the World War II years, the prime mission of the company was building Kaiser Steel's Fontana steel mill on a green-field site in Southern California. With this single project, the organizational structure was less complex than later diversification dictated. However, the principles established and used successfully at Fontana were continued and were in general use for most projects since.

In the early years after Fontana was built, the KE organization was made available to perform staff engineering functions for the other affiliated Kaiser companies through what was called the Chief Engineer's Staff. George Havas carried the title of Chief Engineer for the steel company, the cement company, the aluminum company as well for Kaiser Engineers. The cost of this staff was shared by the affiliated companies. As the affiliates grew and could justify their own staffs, the Chief Engineer's Staff was phased out. Concurrently, KE's work for companies outside of the Kaiser family of companies grew, and KE became an independent and profitable entity.

Market conditions dictated changing organizational structures. The structure depended upon where the projects were located, the volume of activity, the type of services to be rendered, and the various kinds of talent needed. The biggest increase in activities occurred in the 1950s when KE was charged with handling major expansions for Kaiser Steel, Kaiser Aluminum, Kaiser Cement, and large outside clients. By the mid-1950s, the large Tata iron and steel mill expansion in India was entrusted to us on top of the work of an already busy staff. This was KE's first international turnkey project.

By this time, the company had been organized domestically along industry lines, with vesting of responsibility and authority in vice presidents who managed separate groups for aluminum, steel, minerals, heavy construction, and administration. In the early 1960s, the company's organization was expanded to add separate new industry classifications, including transportation, power generation, advanced technology (Nuclear, Space and Defense, Water and Waste Water, Environmental), commercial, institutional, and general industry, each headed by a vice president. Subsequently, groups were organized for projects in Latin America and, because of its large size and importance, for the Tata project in India. Later these groups would be combined into an international division. As it became vital to constantly add new projects to maintain and add to backlog, a marketing effort was mounted.

One organizational structure had the domestic industry divisions doing their own marketing with assistance from a central proposal preparation department. Internationally, marketing was done by each area vice president—Europe / Africa and the Middle East, Australia and the Far East, and Latin America.

For a brief period of time in the 1970s, a new model was instituted whereby all marketing was centralized under a Senior Vice President-Marketing. Under this approach, a company-wide marketing budget was established with the sales division staff purchasing services from the industry divisions for technical input into proposal preparation.

There were proponents of each model of marketing organization—centralized and decentralized. Many felt that the industry groups knew their markets best; conversely, there were marketing professionals who felt that only they knew best how to market the company's wares. Objectively, one can conclude that both methods were successful. It is a matter of judgment and preference as to which works best under a given set of circumstances. Basically, it's the people who make the difference. Good people can make either approach work well.

The organization by both industry and by area overseas was based on the concept of establishing a "franchise" for each vice president responsible for an industry or area. Each ran a profit center and was responsible for obtaining the business, staffing projects, executing them, and following through to final acceptance by the client.

Long-range planning was the responsibility of each area or discipline vice president. They prepared annual budgets and were held accountable for performance as compared to the budget. Planning was done annually to determine where markets were expected to go in the next five years. These were reviewed at annual management seminars held typically at Silverado, near Napa, California.

Maintaining staff during periods of slower activity was the constant purview of each of the vice presidents with an overriding major responsibility resting with the home-base engineering and construction departments. One scheme devised by the international division was to bring construction personnel home after completion of overseas projects and put them on a 50 percent pay standby arrangement. Under this approach, the high cost of providing a readiness-to-serve capability was minimized. These construction people were free to take other work, but would preserve their seniority with the company and would be obligated to return when recalled for a new job.

## International Presence…KE International

Another model that found proponents and detractors was the decision to organize a separate international group. As noted above, in the years 1958 to 1964 Kaiser Industries Corporation actually created a separate subsidiary division for international engineering-construction activities with its own senior personnel.

Other than during this period, KE had both industry and international divisions. When specialty industry groups such as steel, aluminum, and minerals were involved, the international division purchased technical services and split the profits with such industry groups. Inevitably, some disagreements arose over these profit splits and about who would manage the projects. Top management adjudicated these disputes which, fortunately, were very limited in number.

As the volume increased overseas, it became clear that KE needed to maintain a presence in many of the countries where we did business. As more and more projects were successfully completed, we needed to capitalize on the hard-won experience of working abroad. There was growing recognition that the complexities of doing work overseas—differences in legal systems, customs, language, political climate, local partner requirements, etc.—dictated separate organizations for international work.

Marketing overseas was many times more difficult than back in the States. One could not just pick up the telephone to find new leads; traveling 10,000 miles to determine what was needed for a new proposal didn't make economic sense.

It was important that the complexities and differences of international work be explained to those people who were to be detached from their domestic duties for an overseas assignment. Usually they were chosen because they were experts in a given field. However, there was much that needed to be passed on to them by way of indoctrination from people experienced in overseas work. Living abroad is different. The language is different. Customs are different. Living conditions are different. The money is different. Housing, schooling, and other family-related factors are very different. The available staff help is a minimum. And the definition of "know-how" that the expert is expected to pass on takes on new meaning. In this regard, he may be expected to do a measure of training of the client's staff also.

Procurement overseas was always an added challenge. One couldn't just go to the local supply store for equipment, parts, and supplies. Everything needed had to be anticipated far in advance as the lead times for procurement, manufacturing, and shipment were usually many months longer than in the States. Further, clients were often very close-fisted about authorizing expenditures for materials and equipment requiring foreign exchange. Our experts then became ingenious about making-do with what was available on the local market. And the engineering frequently had to be translated for work by untrained labor. This takes on a new meaning of American know-how. When entering the operating stage, our experts needed to assist in the early start-up phases of a plant.

Thus, the organization evolved to the stage where area vice presidents maintained staff, procedures, and methodologies to market, organize, and manage projects, and to train staff as they were detached for duties overseas.

## Project Organization

As time went on, the title "project manager" became the common term to designate the individual responsible for overall direction of all but the smaller projects. These individuals would have prime responsibility to KE management and to the client for the efficient execution of a project. The project organization as a task force was always tailored to the project and to the particular talents of the project manager or project engineer (for the smaller projects). Both authority and responsibility were delegated to project managers. For example, they might have authority to make commitments for up to $100,000 on large projects and $25,000 on smaller ones. Anything over these limits would require successive levels of higher authority approval. In this manner, management could monitor the work of the project leader.

When an appointed project manager was appointed, his initial responsibility would be to review the scope of the services required by contracts, establish an organization, prepare detailed procedures, and recruit staff. The initial productive work started with preparation of process design and development of flow sheets (if not provided by the owner), preparation of general arrangement drawings and outline specifications. Concurrently, the professional estimating staff commenced preparation of a detailed estimate of cost, relying heavily on historical data on similar projects. The project staff prepared a detailed construction schedule to target a completion date.

Then with the aid of the accountants, a chart of accounts was assembled and accounting for costs began. On very large projects the chart of accounts became the basis of "facility codes" for tracking all documentation such as original drawings, equipment specifications, and purchase orders. As examples, these codes might start with 1.0 as materials handling, 2.0 as blast furnace, etc. Armed with this initial effort, the project manager directed, monitored, and executed the project.

## Armco Steel Project 600

An interesting variation of a project organization occurred in the mid-1960s when Armco Steel Corporation entrusted Kaiser Engineers with its Project 600. This was one of the largest expansion programs of its era with a planned completion cost of $600 million. In equivalent costs of the decade of the '90s, this would be between a $2 and $3-billion project.

This project required rethinking of organizational structuring. Because of the size, complexity, and length of this project, the company relocated Bob Wolf, vice president in charge of steel projects, to the Chicago branch office where his prime corporate-level responsibility was the overall conduct of work for this tremendously important project. Further, with the client's concurrence, Don Daly was selected as the project manager assigned to the client's prime project site at Middletown, Ohio. He was a proven engineering manager, but without extensive years of steel mill experience. It was reasoned that the project's size and complexity, both in terms of dollars and manpower, required professional management of both people and resources. With the project manager and his staff at the project site, reporting directly to Vice President Wolf in Chicago, input from the home office was limited. Separate engineering staffs were detailed to the Chicago and Pittsburgh, Pennsylvania, offices where adequate supplies of steel design engineers were available. Frank Kast was detached from Oakland as engineering manager reporting to Wolf.

An innovation for this undertaking was the scheduling of formal, semi-annual state-of-the-project meetings with top management of both Armco and KE. That the project was successfully completed to the client's satisfaction and with great success to KE is in large measure due to the innovative organization systems and the good people detached to devote full time to this one large project.

In recognition of KE's good work, the American Society of Civil Engineers recognized the Middletown, Ohio, project (the largest of a number of projects included in Project 600) as "The Outstanding Civil Engineering Achievement of 1970." This was the first time in the 11-year history of the ASCE awards that a private undertaking was named to receive this prestigious award.

## Company Offices

As the volume of work increased, KE needed to establish a presence in numerous places around the world. Company offices were established either for a specific purpose such as the expediting office in Pittsburgh, Pennsylvania, or as a project office, or it might be a sales and development office.

Satellite offices required dispatching qualified personnel from the home office to satisfy discipline needs. Often they turned out to be supervisory personnel as new recruits were hired locally to satisfy demands for a project or a service. Maintaining such offices required focus and attention of department heads in the home office.

Typical of the number of offices maintained is the listing in back of the *Kaiser Builder* for October, 1970, which included the following offices:

| | |
|---|---|
| Washington, D.C. | Ghana |
| New York | Greece |
| Pittsburgh, PA | Israel |
| Chicago | Italy |
| Los Angeles | Sardinia |
| Montreal | Ivory Coast |
| Vancouver | Jamaica |
| Australia | Venezuela |
| Brazil | England |

## Subsidiary Companies

Throughout the 35 years of KE's history as part of the Kaiser family of companies, KE's corporate identity changed to keep up with legal and financial requirements. Since KE was a wholly owned subsidiary of either the Henry J. Kaiser Company or Kaiser Industries Corporation, corporate restrictions were enforced to protect the underlying assets of the parent companies. As these parent companies changed and grew, new corporate restrictions and demands were placed on their subsidiaries. In addition, over the years as KE expanded into new states and new countries, new subsidiaries of KE were organized to comply with local laws and regulations. In the discussions of this book, KE is identified as Kaiser Engineers or KE, without referring to the legal entity involved.

Typical of the subsidiaries active were those listed in the October, 1970 issue of the *Kaiser Builder*. They included the following:

| | |
|---|---|
| Kaiser Engineers Corporation | New York |
| Kaiser Engineers Pennsylvania, Inc. | Pittsburgh |
| Kaiser Engineers, Inc. | Chicago |
| Henry J. Kaiser Company (Canada) Ltd. | Montreal |
| Kaiser Engineers Division of Henry J. Kaiser Company (Canada) Ltd. | Vancouver |
| Kaiser Engineers and Constructors, Inc. | Australia |
| Kaiser Engenharia e Construcoes, Limitada | Brazil |
| Kaiser Engineers International, Inc. | England |
| Kaiser Engineers Limited | England |
| Kaiser Engineers International, Inc. | Ghana |
| Kaiser Engineers of Italy, Inc. | Italy |
| Kaiser Engineers America, Inc. | Jamaica |

## Marketing

### Overview

Marketing is selling. In the euphemism of the trade it is "Project Development." We operated under the principle that…nothing happens until someone sells something. To keep up the company's backlog, we had to make industry aware of our capabilities. There are many ways to do this, and we tried them all. Over the years marketing became a major effort, consuming much of the time of corporate officers and key staff. Someone once asked, "How important is selling in your company?" The answer was, "Not very important. Hell, it's everything."

We had organized programs for people to join trade organizations and foster friendship amongst the membership. We advertised. We had papers submitted to technical organizations for publication. And we maintained a sizable sales staff in the domestic, industry-focused, and international divisions.

Bona fide projects most often develop over a long period of time. Sales development started with industrial intelligence aimed at discovering a firm's interest in an expansion program. A plant staff engineer may have inquired about a similar facility we may have built; or requested a brochure on our experience; or asked for resumes of typical personnel whom we might assign to their project; or asked for preliminary estimating data; or for advice on some technical aspect of a potential project.

Leads came from trade conferences, from bankers who were alerted early to a possible expansion, from friends who had similar interests, or directly from the company that wished to expand or build a green-field plant. We subscribed to the theory that when information about the impending project is published in the trade press, it probably is too late to pursue it.

Another avenue to a job was through a formal request for proposal from the client, in which case several firms are competing for the project. Normally, for professional services such as ours, it was considered bad form to compete on price alone as this might lead to offering fewer services than would be optimum and possibly lead to a poor outcome.

### Affiliated Companies as a Market

Immediately after cessation of hostilities of World War II, there was a tremendous pent up demand for new facilities. Opportunities for engineering and construction were plentiful. Almost all work came in by word of mouth. Not much selling was required.

At that time KE was just being organized as an independent engineering and construction entity available to all companies and theoretically available to companies outside of the Kaiser empire. But much of the early work was actually done for affiliated companies. Marketing was done by top management through two convenient vehicles: the Chief Engineer's Staff and the Master Agreement. The Chief Engineer's Staff consisted of a cadre of technical and staff personnel who reported directly to George Havas. Havas, besides being General Manager of Kaiser Engineers, was also chief engineer for all the affiliated companies, including

Kaiser Steel, Permanente Cement, Sand and Gravel, and eventually Kaiser Aluminum. Cost of the Chief Engineer's Staff was prorated amongst all the companies. Its responsibilities included preparing technical analyses normally done by an industrial company's staff engineers and defining expansion plans for the companies.

When a project was defined, justified, and authorized by a company's Board of Directors, KE was assigned the job and instructed to build it rapidly. This was prearranged by terms of the Master Agreement, which spelled out the contractual conditions under which projects would be undertaken. Fees were spelled out according to a master fee schedule, which was a curve that measured the fee as a percentage of the cost of the project, the percentage decreasing with higher costs of a project. These fees were substantially below market rates charged by other firms. This discount was justified by recognizing that KE was avoiding the usual high cost of marketing its services. And the affiliated companies had the advantage of not needing to find and maintain such excellent engineering talent; when projects started, they knew they would have the best organization around and would have the Kaiser spirit of performing on an expedited basis. All Kaiser firms had the same philosophy of building a project fast so that they could immediately reach the market with their end product.

The Chief Engineer's Staff arrangement worked well into the 1960s until the affiliated companies got much larger and decided that they needed in-house staff engineers. However, the Master Agreement stayed in force for a much longer time as KE continued to build many of the large projects for the affiliated companies. The only exception was Kaiser Foundation Hospitals. KE built only a few selected hospitals, but not many. To this day, many of us think they missed out on a good thing.

## Early Marketing Efforts

As KE looked outside for work, it hired a few marketing specialists. One of the first was Larry Thackwell, a talented sanitary engineer. His assignment was to obtain sanitary engineering assignments in the Bay Area. His first success was with the City of Vallejo where we designed their water treatment plant.

After that, Thackwell maintained his relationship with the city and helped them develop the concepts for a sewage treatment plant. Then he prepared an engineering report including technical aspects and economic considerations. But he faced a difficult problem convincing the City Council. Here is how he described the next Board meeting to a staff engineer who helped him with his reports:

> The Vallejo City Council is now in session. Larry Thackwell is on the agenda for a presentation on why the city should build a water treatment plant. In walks Thackwell with a portable chemistry lab in one hand and a bucket of turbid raw water in the other. His first step is to clarify out and neutralize the solids. Then the filtrate is processed through a series of retorts and treated with various chemicals. After standing for a few minutes, the effluent is dripped into a beaker. Now, ever the showman, Thackwell holds the beaker up for all to see how clear and pure the water is. And with a great flourish he proceeds to drink the full beaker and to smack his lips.
>
> Great applause. We got the job!

The next professional salesman was Ralph Bates who was one of the first to try to get us into the mining business. It was about this time that the realization struck that business didn't just arrive at the front door. We had to learn to sell. We had to learn about the business of getting in early and helping to develop projects.

## Sales Organization

KE's organization always featured a task force basis or a project management team whereby a project engineer or project manager would be assigned to manage a project. When the company grew, it was reorganized by industry divisions domestically and by areas of the world internationally, but still with the task force as the prime organization mode. Vice presidents were assigned in charge of Steel, Aluminum, Mining and Minerals, Space and Government, and Rapid Transit in the United States; and to Europe and Africa, Asia and Latin America overseas.

The marketing management philosophy was that each vice president was in complete charge of his own area of expertise, including marketing as well as execution of the projects. They were responsible for maintaining full knowledge of markets for engineering and construction of their industry, flushing out new leads to new projects, developing the leads, preparing and submitting proposals, selling the projects, executing contracts, and executing the services. Each was a profit center. Each ran as a full business activity.

All projects for these divisions were major undertakings, requiring skilled marketing specialists in each division. At first glance, it was apparent that there was some overlapping and duplication of effort. A great deal of effort and thought was given to relieving each division of responsibility for those efforts that were common to all divisions. A central proposal preparation department was organized as well as a central brochure preparation staff. Advertising and public relations were by staff personnel. Legal activities were provided from the corporate legal offices for contract drafting and execution.

For most of KE's existence that was the management style practiced for marketing our services. There was a short period, however, in the mid-1970s when it changed. A new president was brought in to run Kaiser Industries, and he decided to change the way KE marketed its services in order to increase sales. He came from the steel industry and favored a more centralized marketing effort. This started with the employment of an Executive Vice President in Charge of Marketing.

Under this new model, a centralized marketing organization was assembled, partly with new professional marketing people and partly by centralizing marketing personnel from the internal divisions. It was like a consumer products firm that believed in individual product managers or one that believed that the corporate sales group could do a better job of selling.

Under this central marketing scheme, a great many leads were developed, documented, and followed. Each lead, for example, was assigned a number for tracking purposes, and follow-up was formalized. The central proposal department was enlarged with professional proposal editors (usually English majors) who were in charge of coordinating proposal preparation. By the nature of the proposals, many different people were involved preparing the marketing sections, technical sections, financial sections, and obtaining reviews and approvals. Editors were responsible for making the proposals sound like they were tailored to the client's wishes. They typically worked late into the night to meet deadlines because it seemed that all proposals had a deadline of Friday afternoon, in time to meet the weekend mails.

When a decision was made to pursue a project, the domestic industry division had the responsibility to provide technical input for the proposal. Marketing division provided overall management of the marketing campaign, including assigning fees and negotiating the contract.

Under central marketing, a great amount of company resources were expended for marketing. Costs were accumulated under what was termed as minimum overhead, meaning that only salaries and salary costs of the people working on marketing were charged. Assigning a pre-project job number for each prospect accumulated costs. No other overhead was assigned. Even so, in the mid-1970s such costs exceeded $6 million a year, which was more than the profit earned in those years.

Differences of opinion between industry / area vice presidents and marketing management were not subtle. The former argued that the previous industry / area full responsibility was better. Marketing management defended themselves by citing the greater number of successes they achieved. After about four years of operating with a central marketing mode, KE reverted back to its original style with full responsibility resting in each profit center.

In both modes of operation, KE ascribed to the notion that you had to go out and beat the bushes for new jobs. You could not rely on your reputation to attract new work.

## Philosophy of Marketing

To be successful, we believed, we had to have a proper philosophy and attitude about marketing. One basic philosophy was unwritten but understood. We would not be all things to all people. We stuck to our knitting, offering services for expertise that we had. To show the folly of deviating from this philosophy, take the case of a marketing specialist under the central marketing scheme who discovered a hot lead in Chicago.

This was at the time that KE was trying to find a way to do business behind the Iron Curtain, during the first détente period. There was this small engineering firm that had an inside track on a fine job in Poland. The lead was passed to KE's newly minted officer in charge of Russia and its satellite countries, and he was directed to look into it. It developed that the small specialty firm in Chicago knew how to design sausage factories. The Poles wanted a very large one and decreed that the Chicago firm was too small to handle their plant.

All that KE had to do was to build the sausage plant in Poland, using the Chicago firm's design, for a fixed price and to take payment with a part of the final product. The fact that we knew nothing whatsoever about sausage-making did not seem to enter the decision to take a second look. Needless, to say, a trip to Poland was wasted.

Normally, we would not waste our time chasing a project on which we did not have expertise in-house. On the other hand, sometimes we would attempt to enter a new field of endeavor by acquiring the know-how first. Such was the case with oxygen steel-making. When the L-D process became available from Austria, KE purchased the license rights for the United States and was eventually successful landing a number of jobs in that area. We also tried to do this, with mild success, in hiring specialists in the ports and harbor field. And the story of how we got into mining and minerals other than iron ore started with employment of experts in those other fields.

Many of our marketing people subscribed to the principle of "getting a foot in the door." This philosophy recognizes that clients often want to test a firm's ability before entrusting larger projects to them. This is not unlike the homeowner who hires a plumber for changing a washer on a leaky faucet. If he is satisfied, then when he wants to remodel his kitchen, he may remember the plumber and give him a much bigger job to do.

Similarly, some clients would entrust to KE a simple preliminary engineering job or a small expansion project. After they got to know about our resources, they would entrust us with their next larger project. Such was the case of Armco Steel where KE was given a small oxygen steel project to design out of our Chicago office. Since they were completely satisfied with the excellent performance, Armco proceeded to investigate us thoroughly. It culminated with their awarding us Project 600, which was one of the largest undertakings of the time.

"Foot in the door" worked in most cases, but not always. We performed a number of preliminary assessments and feasibility studies. We pursued them aggressively, as we believed that if we demonstrated our capabilities at the outset, they would entrust the full engineering and construction to us. One of our first major overseas projects worked the other way. That was the Tata project. We got the assignment even though preliminary engineering was done by Koppers.

On the Cosipa project, McKee did the preliminaries, and we got the follow-on work. But we did master planning for the Braden project in Chile. Bechtel got the engineering and construction follow-on work. Despite these exceptions, we aggressively explored invitations to participate in preliminary engineering studies and were successful on a number of them.

Top management strictly enforced another important philosophy. No one was permitted to participate in under-the-counter payments to anyone. It was difficult to compete in the overseas market, but despite these dictates, we were very successful in getting our fair share of projects without resorting to payola.

## Marketing Techniques

Often a client's own engineering staff defined an expansion program. While doing this, the staff might seek advice and assistance from our people. In some cases, the client's staff might never have had the responsibility for defining an expansion program. Our people, of course, were always involved with expansions. So we would help in defining a scope, phasing the project, and describing who was responsible for each part of the activities.

In developing this technique, our engineers and managers could define in some detail a structure of an organization to show how the client would interrelate and control the efforts of its staff and its consultants, engineers, and construction forces. In this, of course, we were defining how KE would do the job. That was selling at its best.

The gambit was successful on many jobs. Take the case of the Sheraton Hotels who were contemplating a major expansion of hotels worldwide. The staff architect in charge had no experience in such a vast undertaking and requested assistance from KE. Our architects and construction management team defined a worldwide program, complete with charts and graphs. Then to be sure it was understood, the staff architect was rehearsed in making the presentation. We were told later that he received a standing ovation, the project was approved, and we got the job. We did not get credit for the presentation. The staff architect did. We got the job of engineering and construction. One of our friends overseas explains this technique as "the translation of the idea."

In another case, we had been given a small job for Willys Overland do Brasil to assess whether to expand its automobile factory at its existing site or go to a new site where other U.S. automobile firms were locating. Our engineer completed his assignment (concluding that they should stay where they were) and was invited to sit in on negotiations with the Chrysler people who were proposing to joint venture on an expansion program. The proposition was for each firm to invest used equipment and tools and dies instead of buying new equipment. During several hours of discussion, no conclusions were reached, at which point our engineer was invited to make his observations. His observations were that each side had rather vague ideas about what equipment they could contribute but no solid definition of the facts. Without real facts, proper decisions could not be made. What was needed was a scoping report which would inventory and document who had what equipment to invest in the new venture, how the pieces would fit together (a design), and estimate how much it would cost.

They all thought the scoping report idea was great. But, do you know anybody who can do this? Yes, as a matter of fact, Kaiser Engineers does this. We got the job.

Later, on a second scoping report, when Willys decided to go it alone, we presented a proposal to do the engineering and construction management for this second project. We had difficulty selling the local staff on our substituting for them as they felt that they could do it alone while running the automobile manufacturing facilities. One day the President of Willys Overland do Brasil called from Washington, reminding us of our proposal, and he said, "You're hired!" Later, we discovered that while trying to get foreign funds from a Washington, D.C. bank, the bankers insisted they get outside engineering help and agreed that KE would be perfectly capable of handling the job.

## Marketing Governmental Agencies

Doing business with the U.S. Government presented slightly different challenges. While the principles of marketing are the same, the techniques are different. KE did business with the U.S. Government in the fields of nuclear, space, defense, housing, and the environment. Each required that we have expertise in their own fields of endeavor. We could gain such expertise by employing experts or by associating with specialty firms. In most cases, we opted to build our own staff which could market our wares and execute the work.

## Government Agency Market

Kaiser Engineers' federal government market for engineering and construction work consisted of various operating agencies, military construction organizations and defense industry contractors. The overall market was highly diverse with respect to how the individual agencies operated, the types of projects and services they contracted for, how their projects were funded, and their selection and contracting procedures. Because of this diversity, KE did not generally market its services to the overall government market in the broad sense of this term. Rather, it was necessary to study and track the market to learn of potential new business opportunities of interest to KE and then to individually tailor our business development activities to the selected new business targets and fit our approach to the contracting methods of their sponsoring agencies.

A common characteristic of the overall federal government market for engineering services was secrecy regarding pending new project procurement actions. The *Federal Procurement Regulations* and the *Armed Services Procurement Regulations* precluded dissemination of information or discussions with prospective contractors prior to advertising a project in the Department of Commerce's *Commerce Business Daily* publication. Agencies and their personnel were meticulous in avoiding situations in which a losing competitor could protest a contract award because of an apparent or actual unfair advantage had been given the winning contractor.

It was a fact of business life that if one first learned about a project upon its being advertised in the *Commerce Business Daily,* then it was most likely too late to successfully compete for it. This axiom was applicable to large planning projects sponsored by the major Washington, D.C. operating agencies such as the U.S. Naval Sea Systems Command or the U.S. Army Munitions Command. Subcontractor and consultant requirements for such projects had to be determined and agreements for them in place before the projects were first advertised in the *Commerce Business Daily.*

## Operating Agencies

Engineering projects contracted out by the operating agencies were generally for planning and / or preliminary design services. Three of KE's successfully won projects were:

> The master plan of the $4.5-billion U.S. Army Munitions Production Base Modernization Program, contracted out by the U.S. Army Munitions Command.

The master plan, conceptual design, and design specifications for the Trident Submarine Base at Kings Bay, Georgia, contracted out by the U.S. Naval Sea Systems Command.

Conceptual design of the Medium Volume Bulk Mail Centers, contracted out by the headquarters office of the U.S. Postal Service.

The successful participation in this segment of the federal government market required knowledge and understanding of major defense programs, the status of their legislation and funding, and how their sponsoring agencies planned to implement them. Business development knowledge and strategy was developed through informal engineer-to-engineer working level contacts with the sponsoring agency and membership and participation in quasi-professional societies, such as the American Defense Preparedness Association and the Society of American Military Engineers. Kaiser Industries' Washington Office personnel had limited availability to support our needs for information concerning specific programs and projects of defense and other federal agencies. However, Ward Humphreys, Wally Phair, or Jess Taylor would frequently invite KE personnel to have lunch with them at the Washington, D.C. Army-Navy Club and arrange for informal introductions to senior defense agency civilian and military personnel attending. Personnel and company name recognition obtained through such contacts was most valuable.

## Proposal Process

Requests for Proposals (RFPs) for major operating agency procurements would require comprehensive, 3-volume management, technical, and cost proposals. The RFP would usually define proposal evaluation criteria weighting percentages, i.e. 20%, 60%, and 20%, respectively. However, the best management and technical proposal would be a loser almost every time if the cost proposal was not relevant to the funds available for the project or the amount the client thought the project was worth. Advance knowledge of available funds was difficult to obtain because such information was not specifically set forth in the details of the federal budgets. Frequently, the money would be buried in the agency's operating budget, or it might be included in a "black" (classified) program account not specifically identified in the budget.

## Missile Silo Award

New business from the operating agencies could come about in some interesting ways. An Air Force advertisement in the *CBD* invited interested A-Es to submit technical proposals to conduct a conceptual design study of "hardened" (able to resist nuclear weapons effects) horizontal silos to house deployed MX intercontinental ballistic missiles. We submitted a qualifications proposal with the suggestion that the study include consideration of specially designed, but commercially available, large-diameter, pre-cast concrete pipe sections fitted together to form the silo enclosure. A manufacturer of such pipe was selected to assist in proposal preparation. We were short-listed and invited to make a technical presentation to the Air Force's selection board. John Gilcrest, along with an executive of the manufacturer, made the presentation. However, the Board selected another firm they were familiar with (from previous business relationships) for the project. A year later, KE was awarded a major contract by the Army Corps of Engineers to design a large operating facility for the MX missile program. It was learned subsequently that the Air Force Regional Civil Engineer had directed the Corps to select KE for this design project because of their interest in the novel silo concept we had previously suggested for the MX Missile Horizontal Silo Study.

## Military Construction Agency Projects

The U.S. Army Corps of Engineers and the U.S. Navy Facilities Engineering Command District Offices have responsibility for the design and construction of federal government installations and projects. Such projects were approved military construction (MILCON) projects, and generally are listed as line items in the annual federal budgets. In most instances, a MILCON project's design concept and criteria had been developed previously by the staff of the sponsoring operating agency or by a separate contractor selected by the agency. The Corps of Engineers generally handled the design and construction of Army, Air Force, and Postal Service projects. The Naval Facilities Engineering Command was responsible for Navy and U.S. Coast Guard projects and installations.

## Invitations to Propose

*Commerce Business Daily* advertisements prepared by the sponsoring MILCON agency would invite interested architect-engineer firms to submit qualification proposals for the projects based on descriptive information included in the CBD description of the project. The agency, selecting from the qualifications proposals received, would make a contractor selection outright, or for major or complex projects, prepare a short-list of qualified firms for further consideration. The short-listed firms would be invited to make a detailed technical and management proposal and presentation to the agency's contractor selection board, based on the project's scope of work. Special factors considered in the selection process could include proposed participation of minority subcontractors, the amount of government work the A-E previously and currently had (a political spread-the-work policy), the AE's geographic proximity to the project site, and a host of similar non-professional qualification factors.

## Space Shuttle Assembly Building

It was learned from experience that it was important to compete for some projects even when common sense strongly suggested that some of the non-professional qualification factors would weigh heavily against us. An example of this situation was our decision to compete for a major Corps of Engineers contract to design the Space Shuttle Assembly Building at Vandenberg Air Force Base, at a time when we had just completed a large design contract with this agency. We submitted our qualifications, were short-listed, and made a strong technical presentation to the selection board. John Gilcrest and Rich Nunes participated in the presentation, speaking in support of our project team. However, we were passed over, and Bechtel was awarded the design contract. Fifteen months later, the Corps requested qualifications proposals from interested firms for construction of the project. KE was short-listed, made a strong technical presentation, and was awarded a cost-plus-fixed-fee contract to build the project. The project was completed ahead of schedule and within its $49-million cost estimate. Commendations for KE's work were received from both the Corps of Engineers and the Air Force. We made far more money in building the project than we would have made in designing it. (See Dick Hulseman's description of the project in Chapter 17.)

## Pricing Federal Agency Contracts

Contracts for operating agency planning projects were frequently of the cost-plus-fixed-fee type, with fee limited to 10 percent of cost. Contracts for design of MILCON projects almost always were of the negotiated, fixed-price type, based on the owner's scope of work. Contract amounts were limited to a statutory maximum of 6 percent of the government's estimate of the project's estimate of construction cost which, often times was unrealistic. Pricing of contracts would be based on indirect cost rates established through annual audits of KE by federal administrative agencies. On all government work, firms such as KE were audited annually to establish its authorized overhead. This was the official rate that applied to all governmental projects.

## Our Fee Schedule

As we grew and had success in working with other affiliated companies, KE marketing personnel and management learned about competitive fees. Most of the early work was called "turnkey" by which we meant single responsibility of services. It was not turnkey in the sense of supplying equipment as well as services which is what some people meant by the term.

We were able to develop a confidential fee curve, which was established by management and closely guarded and monitored to guide all marketing personnel so that our fees would be consistent and competitive. It was intended to avoid over-eager sales people from taking on projects too cheap. It provided KE management a means of maintaining and controlling the kind of projects taken, and it forced a review by management and kept fees consistent for all clients.

Contrast the philosophy of pricing our services in a consistent manner with the environment today, several decades later. No one seems to worry in the airline industry, for example, if I fly to New York with a $280 ticket while my seatmate may have made a last-minute purchase for $560. Who worried in the era of Proposition 13 in California if my property taxes were frozen a decade ago, but my neighbor bought his home recently and paid double the taxes. And take rent control in Berkeley. A tenant under vacancy decontrol rents an apartment for $1200 a month where a grandfathered tenant pays one-third less.

It was much later in KE's existence that flexible pricing became popular.

## Multipliers

Later, as marketing for projects became more competitive, KE was forced to change the way we marketed our services. When competing for projects, especially overseas, we faced the competition of equipment suppliers who offered engineering services for free along with the supply of equipment. And we had the ever-mounting competition from local engineers. We could never compete with local firms that could work very cheaply and for local currency. And it was hard to compete with the suppliers until projects got into trouble because the suppliers did not provide objective, competent engineering, and the local people lacked proper engineering know-how.

Where we would enter the scene would be in providing expertise. This meant that we were selling top talent and not too many people in a supporting role. It meant that we had to price our product in a way to make it attractive to us and affordable to the client.

The same phenomenon occurred domestically with the advent of construction management services. We no longer were being asked to build a project, but to manage the enterprise acting as owner's representative. Again, the owner was obtaining from us key personnel without a cast of supporting craftsmen.

The multiplier on salaries was the means of pricing that prevailed in the late '70s and '80s. One executive used the term "optics" to define the creative pricing methods used to determine price. The main objective was to maximize the price charged. One of the favorite optical schemes was to charge a multiplier on salary costs. Salary costs were defined as actual salary paid plus costs for Social Security, worker's compensation, vacations, holidays, retirement benefits, etc. Salary additives, at the time, ran 40% of the salary paid. The multiplier was then a percentage of salary cost to cover our overhead. Favorite numbers were 75% and 100% of salary costs. To this, another percentage was added for profit. Overseas it was normally 25% and domestically 20%. This resulted in multipliers on salaries alone of between 2.5 to 3.5, which meant a good return for the effort. When looked at by the client, the cost for each individual looked very high. But overall, they bought our company name and know-how for not too high a cost to the overall project.

## Proposal Preparation

After receipt of a request for proposal or when the time is considered right for submitting an unsolicited proposal, a task force was assembled to prepare a proposal. This could be the effort of one person for small proposal efforts or a larger team for projects that were larger and / or more complex. The format of our proposals typically included the following elements:

- Our understanding of the scope of the facilities
- Outline of scope of services being offered
- Methodology to be followed in executing the services
- Estimated time to complete the work
- Our fee and terms of payment
- Qualifications of KE to do the work
- Resumes of key people who would be assigned to the job

Preparation of the proposal was by the marketing staff and assisted by the technical staff to delineate the scope of the work, scope of services, and methodology. A central proposal preparation department did editorial control and documentation. This group was responsible for preparing proposals in a standard and professional-looking format tailored to the client's needs. Legal review assured avoidance of legal problems; a final review by the responsible vice president assured conformance to company policies, procedures, fee structure, and availability of key staff.

## Waiting Game

After the proposal is submitted, there is a long period of time when the client decides which of several proposals he wants to accept. Sometimes it is negotiation time. Sometimes the decision is not clear to them. But the period of time while waiting for a decision is a trying time for the marketing manager.

Take the case of Cosipa. We were in final negotiations in New York when we enlisted the support of Edgar Kaiser to help close the deal. The marketing manager and Edgar went to the client's office at the appointed time, but were kept waiting for a long time. The marketing manager fidgeted and showed his exasperation for their wasting Edgar's time. Edgar spoke up and said, "Relax.

They're giving us the business. This is a negotiation ploy." And it was, and we got the job.

On another project in Mexico called Las Truchas, KE and Kaiser Steel proposed to help build and operate the steel mill. It was apparent that we had the best proposal, preferred by the staff, with whom we had very good relations. It was of sufficient interest to attract a visit to Mexico City by Gene Trefethen, president of Kaiser Industries, Jack Carlson, president of Kaiser Steel, and Lou Oppenheim, president of Kaiser Engineers. After they left Mexico, the marketing manager was left behind to babysit the proposal while the decision was being made. Our local partner was the largest construction contractor in Mexico, and he was able to feed us up-to-the-minute results of the evaluating committee's deliberations. This worked fine until one day he refused to take our phone calls. You know something is wrong when your partner won't talk to you.

We later learned through our U.S. Embassy in Mexico City that the job was awarded to British Steel and British consultants after the British government offered to donate a training center and to staff and train Mexican workers. They had bought the job out from under us.

## Corporate Help

On large important projects, KE would enlist the help of Edgar Kaiser in selling projects. Such was the case in Ghana, for example. However, KE's management was careful not to overdo it as he had other responsibilities besides KE. Such was not the case with the Bechtels. Their only business was the engineering and construction business, and they could marshal the man with the name on the door whenever a full court press was needed.

Seldom, if ever, was Henry Kaiser available to sell our services.

The use of the Kaiser name was helpful in selling projects, especially overseas. At the height of our activities, the name Kaiser meant know-how and expertise in a number of fields of building and in manufacturing. Most everyone knew of Kaiser's ships.

Where the name was not helpful was in some of the domestic new fields we tried to enter. A few times executives claimed that that they were afraid to allow us to gain their hard-earned expertise for fear that Henry Kaiser would take the information and enter the field himself. This was a mistaken impression, for it was never our intent to gain industrial intelligence, and there were no instances where this occurred. So, we had a double-edged sword.

And there was one instance with a self-imposed failure. Our Rapid Transit group was building its expertise at the time that Bart was just starting out. Our group had a great rapport with the Bart staff and was in a preferred position to be given the job. At the same time, Edgar Kaiser was very active in Oakland politics and very influential in getting the Oakland Coliseum built. He decided that it would be a conflict of interest for KE to design the Bart facilities. Here we are several decades later, and we still ask: Why didn't he just resign from the local politics and let us go on with our work? We would have had a very lucrative job, and it would have established us as a premier designer of rapid transit systems. So again, we had a double-edged sword.

## Staffing

### The 'Early Builders'

KE's staff came from many sources over the years. Initially, it was made up of some of Henry Kaiser's key men who worked on dams, hydroelectric developments, and roads, and then embarked with him on his journey into industrialization in the shipyards, steel, cement, aluminum, and automotive industries. They were builders who worked in a spirit of continuity of the professional and personal relationships during construction projects of the early days. They had a can-do attitude and spirit. There was a loyalty built up over many successful and gratifying jobs accomplished, even though each knew that signing on again meant long hours of hard work.

Many of the key men spent their entire careers of 30 to 40 years with the Kaiser organizations. As just an example, each of the five Kaiser Engineers chief executives during the 41 years under Kaiser auspices had one thing in common: They all spent their entire working careers with the Kaiser family of companies.

## Recruiting

But as the company grew and staffing needs increased, specialists in the fields of steel, aluminum, cement, hydroelectric, minerals and advanced technologies were recruited from outside sources. Many of those individuals also spent 30 to 40 years with the firm.

KE had a long-standing program of recruiting outstanding college graduates from local universities to participate in an on-the-job management-training program. These "nuggets" were highly successful in successive assignments in various departments and divisions. Many went on to become senior managers in Kaiser Engineers. As just one measure of the success of the program, it can be related that after a first tour of duty assignment of a management trainee, he would usually be the first person many project managers would request for a second assignment.

Individual initiative was encouraged throughout. The philosophy was Henry Kaiser's: "Give a man a job to do, and then get out of his way so he can do it."

## Project Staffing

Staffing of an engineering and construction project with its finite life span was always an exercise in building up a staff for a 2 to 3-year tour of duty, having it level off for about a year, and then demobilizing. Even on very large projects, the tour of duty was usually not over 3 to 4 years. Contrast this build-up and demobilization with any mature industrial establishment where staffing occurs once and operations go on for long periods of time with only replacement staffing requirements. Thus, the KE executives garnered a great deal of experience in fitting the right person to the right job—they were doing it constantly.

For the engineering, coordination, and management of major projects, the preferred model was the task force approach. Under this scheme, staff personnel were detached from their normal corporate division sponsor organization and reassembled into a group in a consolidated office location where communications were facilitated and where the staff's duties were fully devoted to the specific project. Experience showed that the dedicated task force working within the company's matrix organization resulted in superior project performance.

Industry vice presidents had no greater challenge than to manage their people, whether already assigned to a project, being demobilized, or in standby status waiting for a new assignment. One of the toughest jobs managers and other key personnel faced was finding useful work for personnel in between project assignments.

The best managers and project engineers were always in great demand by both the industry and international groups. Determining where such key men were to be assigned was a top management responsibility. The questions were: Who "owns" the man? Was it the last group to which he was posted? Or should it have been the division or the project that needed him the most? These questions were decided by top management by allocating the individual to the project they deemed best for the overall good of the company.

The management of people was a responsibility taken seriously by the top management. For the greater part of the 1950s, 1960s, and 1970s, the systems and procedures for allocating key personnel were developed and managed by Jack Hughes, who was Assistant General Manager of KE. It was his responsibility to adjudicate the differences of opinions of vice presidents and group vice presidents, each of whom wanted the most talented managers, some of whom thought they "owned" the personnel assigned to them. There was competition for such personnel, and Jack Hughes was known as a tactful and fair adjudicator of such differences.

He was directly responsible for all Oakland staff and departments, including establishing operating procedures and directing daily operations. He held this position until his retirement. As KE grew even larger, future reorganizations split his duties amongst several newly created executive vice president positions and the renaming of the top man as president.

Jack Hughes is fondly remembered for his humorous handling of the annual awards ceremonies where employees were honored for years of service to the company. He had a charming way of acting as master of ceremonies.

In a typical staffing session one executive was heard to make an impassioned plea for a particular indispensable project manager. No one else could do the job. After much discussion, he was told by his superior: "Remember, the graveyard is paved with the tombstone of that indispensable man." He found another project manager.

Another tough management problem was to determine which key people to maintain on stand-by status during periods of low work volume. People were frequently kept on standby even when the result was an increase in company overhead costs. But it was a necessary expense because when a project did break, and KE received the go-ahead, we needed these good people with experience in our methods who could hit the ground running.

People were our stock in trade. They were our most important assets. When we advertised that we had a readiness to serve, that meant we had a nucleus of key personnel available and were prepared to start recruiting fill-in staff immediately.

A different problem occurred when all key personnel were fully assigned and new projects were awarded. In these situations we needed to promote from within, often promoting a person to take over the duties of a key staff member on an existing project in order to move that mature staff person to start a new project.

Project managers and project engineers usually came from industry divisions. Construction personnel were "inventoried" in the construction division. A fertile source for new project engineers was always from the design engineering divisions in our headquarters and branch offices. These were always talented engineers who had demonstrated management skills as design supervisors and were ready to broaden their scope.

Staff personnel were also detached for larger projects. Estimators were assigned as cost controllers; purchasing agents handled large volumes of purchased equipment, and accountants kept track of costs.

For smaller projects, there was no need for moving personnel. Part-time use of staff personnel and design engineers, coordinated by a project engineer, was much more economical and effective.

## Project Management

### Overview

Like many other large organizations, Kaiser Engineers had its "book," as in "doing it by the book." As the organization matured, its policies, procedures, and practices were codified and published in what was called our *Project Management Manual.*

One early version still extant was published in August, 1967, before universities started to teach the subject of project management as part of their civil engineering curriculum. It was before the construction industry formalized the technique of professional construction management. Coincidentally, it was before the large scale use of computers as an aid to project control.

Note that within KE we commonly referred to the management of engineering and construction projects as "Project Management." At the universities where the same subject was later taught as part of the civil engineering curriculum, the universities called their classes "Construction Management." However, the two were essentially the same thing. (Note that within KE, we called direction of field construction by the name of construction management.)

Even so, the 2-inch thick 1967 KE manual identifies the many techniques used by the company and demonstrates how these techniques were developed over the years from an art into a profession. An impression one gains by rereading the document today is that KE projects were successful because the KE people paid strict attention to the many details involved. That fact really defines professionalism.

KE management believed that the *Project Management Manual* contained a great deal of proprietary information that was accumulated at a considerable cost. Therefore, the preface has a "Confidential" notification reading in part, "The contents of this report are for use only by Kaiser Engineers and must not be disclosed to others without expressed written approval."

Major sections of the manual are only abstracted here since it is not the intent of this KE history to be a how-to manual. An interesting summary checklist, however, is reproduced in its entirety in the Appendix since it serves not only as a table of contents, but also shows those operations and duties that were considered important.

In practice, the *Project Management Manual* was utilized by project managers mainly to indoctrinate newly recruited staff or personnel who had been promoted. The manual augmented the manager's instructions to the new staff. It is doubtful that any seasoned project manager had the need, time, or inclination to read the manual once a project was started. They were too busy for other than occasional reference to it. Since these veterans helped write the manual, they knew its contents firsthand.

### Abstract of the *Project Management Manual*

For convenience, the typical project has been envisioned as a $25-million domestic turnkey job. The work of project management is assumed to begin with actual work on the project after marketing activities are complete. Marketing was not a part of the scope of the manual.

A checklist of activities mentioned before runs to 8 pages of line items of work used as reminders for each project phase from initiation through execution and finally close out. It covers the management, engineering, procurement, construction, and administration activities. It is reproduced in its entirety in the Appendix.

The role of the project manager is defined as both line and staff operations, covering delegations of authority and working relationships. It is summarized in a "Typical Division of Project Work," which is in organization chart format and is reproduced as Figure 2.2.

The mechanics of the project operations section defines the role of project engineering, project construction, and project administration, which, under overall project management comprise Project Management. It outlines project criteria development, the design engineering function, equipment selection, procurement activities, vendor data, and project manual preparation.

A section on supporting services describes in detail support available and responsibilities of the following divisions:

- Contracts division–includes legal staff, claims, contracts preparation, and proposals.
- Design engineering prepares detail designs.
- Construction and estimating provides services and personnel to the project for estimating, cost control, and construction.
- Administration encompasses procurement, finance and accounting, industrial relations, technical reports, procedures, and office services.

## Administration, Support Services

### Overview

"The Project Manager has available a wide range of specialized services within Kaiser Engineers to assist him in the conduct of a project." Thus begins the second half of the *Project Management Manual*. Administration includes procurement, accounting, personnel and industrial relations, insurance, technical reports, budgeting, business relations, and office services. Support services are defined as design engineering, industrial construction support, industrial estimating, and preparation of contracts. While the reporting structure at one time may have included these support services, this book gives full chapter treatment to construction and estimating, and in this section it gives full subchapter headings to each of them. They are that important as the backbone of the company.

In actual practice, organizationally speaking, all administration was under the control of the Executive Vice-President for Administration. The first of these was R. E. (Bob) Bernard. Reporting to him were administrative support services as well as industrial relations, personnel administration, engineering design, construction, and estimating. Later, when Bernard moved to handle international activities, administration was under the supervision of Syd Whalen.

Whether staff was assigned to a task force group or remained a part of the headquarters pool, depended upon the size and location of a project. On very large projects administrative and support personnel were detached and assigned directly under the supervision of the project manager. On smaller projects, the project manager was provided their services from their regularly assigned offices.

### Procurement

Procurement includes purchasing, expediting, and traffic. For the initial two decades of KE's existence, procurement was identified with Joe Rowan. Joe was one of the original Kaiser employees who moved from Kaiser construction projects to KE. Lee Gillett followed Rowan until Gillett was moved to be in charge of the Australia and Far East area.

### Purchasing

Most of KE's projects involved purchasing of major equipment packages. On larger industrial projects like steel mills, aluminum plants, and minerals processing such equipment procurement could comprise as much as 50 to 60 percent of a project's cost. This demonstrates the reason why KE management placed so much emphasis on proper procurement management.

Close cooperation between project engineers and purchasing agents was required. Project engineers and process engineers defined the specifications of complex process equipment. Procurement issued invitations to bid, supervised the bidding, assisted the project engineer in bid evaluation, and negotiated final price and issues purchase orders.

Similarly, packages of supply, including installation, were sub-contracted. In this case, legal personnel cooperated with the purchasing agent and project engineer to complete final documentation. Evaluation of bids included comparison of prices, "equalization" of differences between bidders; analysis of technical adequacy (by project engineers); and analysis of financial terms (by project purchasing agent). Cost estimators evaluated the recommended bid to compare the price to estimated costs included in the project budget. A recommendation to purchase combined all of these evaluations, and it was submitted to KE management and to the client for review and approval prior to issuing a purchase order or subcontract.

## Expediting

For several decades, Hal Andresen was in charge of expediting. This followed his successful expediting for ships in the Richmond shipyards during the war. Expediting within KE was a major part of the procurement process and, in a large part, contributed to our reputation for doing projects rapidly and on schedule. KE maintained an East Coast presence with an expediting office in Pittsburgh, Pennsylvania, and elsewhere as volume of work dictated. On issuing purchase orders, KE expediters visited suppliers' offices and factories to obtain detail manufacturing schedules. Continuously, expediters revisited these facilities to follow up on progress of the manufacturing.

Initial requirements were to obtain vendors' drawings, which were vital for design engineers to proceed on an expedited basis to design tie-in facilities. It is necessary to obtain vendors' calculations of equipment weights for foundation design; utilities that pass through the foundations need to be identified; and location of boltholes is needed. These data allow design engineers time to complete foundation design early enough so that foundations can be poured in the field in time to meet delivery of equipment. It also allows field forces to level out their work schedule to avoid peak periods of concrete pours.

## Traffic

Traffic, also part of procurement, routed shipments to avoid interferences such as heavy loads crossing narrow or light bridges, and scheduling rail and water shipments. Traffic and expediting personnel insured that the vendor provided proper packaging of equipment. Such packaging is especially important on overseas shipments where the equipment can be exposed to the elements for periods of 3 to 4 months before arrival at the site.

All of this data was reported upon on one of three control reports that every project had. This one was called the *Status of Material and Equipment on Order* report. Project Management and field personnel used this report to plan the work. (The other control reports prepared by others were the *Progress Report* and the *Cost and Comparison to Estimate Report.)*

## Accounting

For the first two decades of KE's existence, Howard Tracy was KE's chief accountant. Howard's name was synonymous with accounting. Following his retirement, Frank Bilotti was the accountant. He was followed by Don Mielbeck.

Accounting services record, organize, and interpret the financial history of a project. Accounting is done in the home office and in the field.

Records are maintained for accounts payable, accounts receivable, cash requirements, and status of funds. Payroll accounting includes force reports, wage and salary reports, craft union contributions, tax reports, warehouse accounting, inventories, and receiving reports.

Cost accounting is detailed accounting which ties into a chart of accounts established for each project, as worked out in cooperation with the cost estimators. Information from cost accounting leads to the second control report, the *Cost and Comparison to Estimate Report.* It includes line item recording of costs incurred to date, tabulation of commitments made (as reported by the procurement department), and tabulation of the budgeted amount (as reported by the estimating department).

## Business Relations

Business relations handled contacts with the public, disseminated public information about the company, handled newspaper inquiries, helped with preparation of technical articles and the preparation of house organs such as the *Kaiser Builder* and KE news bulletins.

KE had an aggressive program for encouraging its technical staff to write interesting technical articles for technical journals. Such articles promoted interest in KE's expertise.

Business relations helped promote news articles and maintained good relations with the press. One especially noteworthy article appeared in the August 12, 1965, issue of the *Engineering News Record.* In it KE was rated as number one in the world in obtaining new contracts. We beat out our competitor from across the Bay.

Business relations cooperated with preparation of sales brochures, dedication programs, and sales presentations.

## Technical Reports

Technical reports department supported all engineering and construction divisions with preparation of graphics presentations, preparation of detail schedules, issuing monthly progress reports on projects, providing assistance in editing technical reports, and editing proposal preparation.

For many years, Bruno Franceshci ran the department. He was known throughout the company for his dedication to assisting project management and executives in making impressive presentations. To one who worked closely alongside him for many years, one remembers the many times Bruno stepped in to assist in meeting impossible deadlines. He was not one to look for glory. His whole career was devoted to being of assistance to others.

Not the least of his accomplishments was his ability to train junior engineers and then to find other positions for them. He was the initial training ground for a number of key people. Bob Tulk followed Bruno in heading up technical reports.

## Office Services

The office services department did things that many people never saw. One of its duties was to maintain offices. As KE grew, and especially before the Kaiser Center opened, we had offices all over downtown Oakland. Office services was charged with leasing and outfitting the space.

But what one remembers most were the almost weekly office moves made as KE opened new offices as new projects came up. Office moves were usually made on weekends to avoid wasting anyone's productive time. Moving vans moved in. Movers did their thing. And on Mondays the engineering crew was ready to go to work. It seemed effortless. But someone in office services did a lot of planning and a lot of overtime work.

## Legal and Contracts

KE's activities involved deployment of substantial resources of the company. Its rights and obligations under a number of state and federal laws needed protection. Starting with proposal preparation through the execution of formal contracts between the client and KE, KE's legal staff had major legal review authority.

Because KE was a division of Kaiser Industries, it was important to the Kaiser Industries management to maintain a purview over KE's activities to avoid any possible misinterpretation of KE's obligations and to avoid possible misinterpretation of implied guarantees that would need to be met by Kaiser Industries.

Consequently, all legal documentation between KE and its clients was reviewed by KE's legal counsel or by one of Kaiser Industries' legal staff. In fact, functionally, KE's legal department reported directly to Kaiser Industries' legal counsel, Bill Marks.

For the initial periods of KE's existence, legal work was performed by Marks' legal staff until the volume of work became so large that a full-time staff was warranted. After completing a tour of duty at Hanford, Hal Hunsaker became KE's in-house counsel. For complex international projects, staff attorneys were seconded from Kaiser Industries. These included Jim Parker, Tot Heffelfinger, and Art Shelton. Upon Hunsaker's retirement, Dick Bonitz became legal counsel.

All proposals submitted to clients were subject to legal review. In practice this proved to be useful as a check against overly aggressive selling, but it also served a useful purpose as a check on the language being used.

On successful awards of assignments, contracts were carefully crafted. It was the KE posture that we preferred to write the first draft of the contract for review by the client. That way, we controlled the timely execution of the contract and controlled the inclusion of chapters in the contract that were important to us, such as limiting our liability to include only the scope of services undertaken.

As projects became more complex, changes to the scope of services or scope of work were made by the client. Adjudicating changes in compensation led to claims for increased fees. Sometimes this required accumulating documentation and always involved legal review and legal presentations. Claims and counter claims made a significant part of the lawyer's activities, especially on governmental projects.

## Insurance and Risk Management

From the time KE became a separate operating entity of the Henry J. Kaiser group until the mid-1951 period, insurance to cover risks of loss was placed to cover each construction site under the control of construction site personnel, using the brokerage services of Underwriters Services, Inc. This was a wholly owned subsidiary of the Henry J. Kaiser Company. Overview was provided by KE's office engineer, Jack Hughes, at the time. Late in 1951, KE decided that in-house administration should be assigned to someone with supervisory responsibilities also. At that time, Delmar (Del) Young was employed. His tenure lasted until his retirement in 1985.

Young's responsibilities included evaluation of risks of financial loss due to KE's activities and its subsidiaries both domestically and internationally. Insurance would be a major method of accounting for such losses that might occur.

Of concern was the risk of financial loss because of potential liability for injury to persons or for damage to property of others resulting from our activities, and the cost of injury to employees in the course of employment as mandated by applicable workmen's compensation laws. There was also risk of loss or damage to KE's property or property for which KE was responsible. Monitoring these exposures and making sure these risks were accounted for by the purchase and maintenance of insurance became the responsibility of the newly established insurance department.

Cost of insurance premiums became an item of reimbursable cost in contracts that KE undertook. Losses that might occur would be paid for by the insurer rather than a job cost or a cost arising after a project had been completed and accounting records closed. This was especially needed on cost-plus-a-fixed-fee type project.

There were occasions in the 1970s and 1980s when a client proposed that it assume the risk of loss to a facility to be constructed, usually referred to as builder's risk. The client would provide physical loss insurance and purchase commercial insurance. When there was a loss, as did occur in a few instances, KE was made aware of the lack of understanding between the client's risk management people and its legal department as to the client's liability for the cost of repairing the loss. KE's insurance department made certain that the contractual agreements were specific in the assignment of consequential costs to the client in event of a loss.

Another case where a client insisted upon intervening in the management of risk or loss was to insist on self-insurance in the area of workmen's compensation for KE's construction employees. Injuries could result in substantial cost to the project, and the intent was for the effective safety program to keep injuries low. By law, KE was liable for payments for injuries to its employees. Wherever possible, KE's insurance department insisted that workmen's compensation insurance be purchased with injury payments after project completion to become the liability of the insurance company.

With respect to potential liability for injuries to persons or damage of property of others, KE always maintained insurance, being unwilling to risk future claims for which it could not be reimbursed. KE's liability insurance was continued even when clients insisted on using their own. KE's insurance was continued as excess insurance with the difference being a reimbursable cost.

Excess liability policies were maintained throughout, including errors and omissions policies covering professional liability. Values ran into the hundreds of millions of dollars, with changing environment and changing market conditions for the availability of such insurance.

## Project Financing and Economics Group

As our international work flourished, the three international area vice presidents became aware of the opportunities available to KE if it could provide financing assistance to its clients. At the annual management seminars held at Silverado in late 1969 and 1970, each of the vice presidents made impassioned pleas for KE to become staffed for that capability. Presentations were made by Earl Peacock, Sam Ruvkun, and Frank Davis, representing the three international areas.

Heeding this refrain, the KE management authorized the Executive Vice President-Administration, Bob Bernard, to recruit such a staff. Consequently, Bob Bernard recruited Don Rowlings to head up the group. Rowlings had just returned from an overseas trip and had just finished negotiating the sale of his former firm, Girdler Corporation, a few months earlier. He was looking for new opportunities in project finance.

## Project Deals Awaiting

As Rowlings took over, he discovered that there were already project deals requiring attention for possible project financing. In the Europe, Africa and Middle East area Earl Peacock was seeking to propose on a $150-million project at Taabo in the Ivory Coast. Rowlings arranged for about $75 million in favorable export credits. The Export-Import Bank financed KE's engineering costs and the cost of U.S. purchased equipment. France's COFACE funded the power plant; Italy's SACE financed the steel and civil works; and Belgium's DuCroire covered the transmission lines. To fill the balance, arrangements were made for a Eurodollar loan to the Ministry of Electricity of the Ivory Coast for an additional $75 million from Citibank. KE was awarded the project, and our financing program was fully utilized by the Ivory Coast government.

In the Asian area, Lee Gillett had by this time taken over for Frank Davis and was in the process of making a proposal to the City of Hong Kong for project management of the proposed new subway system. KE prepared a financial plan for the total project value of $800 million, utilizing multi-country export credits for the equipment and services, accompanied by long-term international bond issues for the civil works. The proposal was presented by Vic Cole, Lee Gillett, and Don Rowlings. After listening intently to KE's presentations, the local authority decided to undertake the project management function itself.

In the Latin America division, John Heffernan was now in charge, having taken over from Sam Ruvkun. A new $60-million lead plant for Peru required funding. At the time, Peru was experiencing difficult economic problems which made financing sources scarce. Through our good relations with the Export-Import Bank of Washington, we obtained financing for all of KE's engineering services and the major U.S. equipment supply. With that in hand, we were able to arrange a direct credit line from Banco del Peru for the domestic currency requirements for the rest of the project, including civil works and local costs. KE won the award.

Projects requiring financing kept growing, including power generation in South Korea, a cement plant in Jordan, tin plate and steel in Indonesia, coal in Mexico, and aluminum in Bahrain.

## Moving Targets

The focus of our work in project finance and economics shifted along with the movements in the international marketplace. Rising oil prices in the '70s created great demand for new developments in the Middle East and North Africa. We planned and financed the construction of an executive housing compound in Jeddah, Saudi Arabia, for the many incoming expatriate executives and their families. We managed the economic forecasting for the major Egyptian crude oil project and, at the same time, made analyses for steel and aluminum projects in Egypt, Bahrain, Saudi Arabia, and North Africa. A dual-train cement plant was financed and built in Jordan.

Energy projects took on increased importance in the United States. Coal, coal ports, coal gasification, and alternative energy projects were studied and analyzed for their economics. The immense multi-billion dollar Kaiparowitz coal mines and mine mouth power plants development, including a new city and infrastructure, were studied. Cogeneration of electrical energy and steam became the desired approach in many industries.

In the late 1970s ,the developing projects frontier shifted to the Peoples' Republic of China. We accomplished economic and financing assignments for iron ore mines and pelletization facilities along with a 10-year, $1-billion overall development program for the Meishan steel complex and coal gasification at Yuxion for the city of Beijing. Together with Chase Manhattan Bank, we collaborated on the development of the initial plans for the Beijing Foreign Trade Center to support the influx of new foreign businesses into China.

Our financing approaches to projects utilized advanced financing concepts and techniques. Financing which we arranged for the Rouge Steel coke battery rebuild utilized low rate interest (2%) in Japanese yen. These were converted to U.S. dollars internally hedged by a Japanese trading company. For Stanford University's cogeneration plant, we formed a finance / build / own / operate joint venture with General Electric, which then contracted with Stanford to purchase the power and steam produced by the campus power plant.

## People

The work involved in project finance involved conducting business in such diverse places as New York, London, Rome, and Tokyo. Much time was spent at project locations, including the 20-man bunkroom in the Jeddah Hotel annex (when the hotel was overbooked, as it frequently was in the early days). Time was spent in steamy hotels in Cairo, the Sinai, Lagos, Algiers, and frigid hotels in Bor, Yugoslavia, and northern China.

Personnel who contributed to the successful operation of the project finance group included Don Rowlings, David Arpi, Alfredo Caprile, Deanna Cheung, Hugo Daems, John Danielson, Joe Friedman, John Gurrad, George McMeans, Bill Morrison, and Don Neumann.

## Our Box Score

While not an official recording, conservatively it can be estimated that the volume of work financed by the Project Finance Group in the period 1971 through 1987 was $50 billion as measured in project studies, evaluations, and project value of analyses. Of this, $20 billion was project financing, actually and successfully planned and financed.

## Personnel Administration

### Overview

Personnel policies and functions vary from one industry to another in order to help the company remain competitive in its own field. Manufacturing and industrial firms normally have some kind of production line, and the plant remains in the same place so the job site doesn't change as it does in the engineering and construction industry. In those industrial firms almost the entire work force is unionized, and a work stoppage could shut down the plant or an entire industry.

In the engineering and construction industry the company is selling the skills and expertise of its employees. Much like a professional law firm, employees allocate their work time to various projects, and clients are billed based on these allocations. Probably the most important difference between an industrial establishment and a law firm is the constant movement and relocation of personnel from job site to job site, and the lack of a product for sale except the skills the people have and the high degree of mobility that they have. Unionization is primarily among the crafts in the field; very few engineering functions are organized so that, at worst, some project field work may be shut down, but not an entire company.

When the product for sale by the engineering company is the talent and skill of its employees, management must be vigilant to insure that the policies and programs are designed to provide a working environment that will attract and retain capable people, as well as maintain and improve employer / employee relationships. This is a reason why one of the Kaiser affiliated companies had a slogan which read, "People are our most important product."

### Functions and Morale

KE's personnel policy manual contained approximately 60 different policies pertaining to recruitment, employment procedures, vacations, sick leave, leaves of absence, medical and insurance benefits, salary administration, transfer and relocation, training and development, and foreign service. These policies developed after considerable research, some of which came from KE's participation in the National Constructors' Association, an organization of some 35 major engineering and construction companies. Committees shared information on salary levels, benefits, and personnel policies, care being taken to avoid any anti-trust implications.

### Breaks in Continuous Service

One of the most difficult problems affecting the maintenance of employee morale is the uncertain periods of employment, primarily with respect to field salaried personnel, but applicable to other salaried employees as well. The level of project activity can be uncertain, as on completion of a project there may not be an immediate follow-on assignment. In those cases, employees generally returned to their Oakland home department, but at a reduced workload in Oakland. If KE could not maintain such personnel, there was always the possibility of finding work with another engineering and construction firm.

As an early possible solution, KE began to use an informal leave of absence status during periods of non-employment. Leaves of absence were approved for three-month increments, which allowed continuation of medical and life insurance benefits. These personnel were constantly monitored so they could be available when needed.

For a while, the international division had an innovative program for key superintendents whereby they were given a leave of absence with 50 percent pay and when called for work, they were obligated to return. This gave the company a reduced payment for the employee's stand-by status and yet gave the employee a chance to earn extra pay by working elsewhere part time.

Occasionally, an employee would be unhappy with the administration of the leave of absence policy. Earl Peacock, who had worked for KE prior to World War II, went into military service, and after 20-plus years in the Army retired as a colonel and then rejoined KE as Vice President in charge of the Europe and Africa area. While Don Spiker was processing him for his re-employment, Peacock asked about his continuous service for the pension plan, but he was told that it would begin on the date of his rehire. Peacock insisted (with a twinkle in his eye) that he had only been on a military leave of absence and should have credit for those years. He never failed to take a jab at the personnel manager for not giving him such service credit…even at his last attendance at the KE retirees' luncheon.

## Service Awards

During most of the period of KE's existence, long service with the same company was thought to be desirable and evidence of a good relationship between the employee and the company. This concept has been changing in the decade of the '90s. Most companies had a program to recognize company service, and it usually included some outward symbol for the employee to wear or use, such as a brooch for the ladies, a wrist watch, a desk pen set, a brief case, or a standing desk clock.

The service emblem award in all the Kaiser companies was the same with a modest octagonal pin with clasped hands and a phrase that read, "Together We Build." Awards were presented to each employee in 5-year intervals, beginning with the fifth year of employment. A numeral on the pin reflected the number of years of service, and beginning with the 25th year, included a small diamond in the center. An additional diamond was added for each 5 years up to 5 diamonds for 45 years.

How this fits into the overall founder's philosophy was aptly stated in *The Kaiser Story*, published in 1968. "The idea of 'Together We Build' is at the heart of the Kaiser philosophy of labor relations, a philosophy hammered out under the floodlights at the dams, in the roar and clamor of the shipyards, through the tough days at Willow Run, and under the stress of a rapidly expanding organization."

At Kaiser Engineers, the service award for recipients of 20 years or more was a big deal. Management made it a formal dinner for recipients and spouses. Awards, presentations, and brief comments of praise came from the vice president and general manager. George Havas initiated the awards ceremonies, followed by each of his successors.

## Transfers and Relocations

All national and international companies move employees to different locations and assignments, but not as frequently or on as short notice as was practiced by KE and other engineering and construction firms. Management of these frequent transfers within the U.S. and to foreign locations required careful planning. Generally, the cost of such transfers was considered an item of reimbursable cost, so care needed to be exercised to be sure that all costs were reasonable and just. And the employees needed to have information on which items or expense would be covered in their move to a new location. Written travel instructions were prepared for each employee. Administration of the moves was handled by Herb Beasley.

KE's initial relocation policy was developed in the 1950s as a basis for reimbursement for the Hanford project in Washington. By 1960, the personnel department refined the policy to include transportation costs, food and hotel expense during travel, shipment of automobiles, the amount of household goods to be shipped, and food and lodging at the new location until permanent lodging could be obtained. Some field personnel owned mobile homes, which they used as a residence at the new location, so KE would move the trailer instead of providing for shipment of household goods.

Assigning and transferring employees to a foreign location required a far greater amount of company involvement even though many of the problems were similar but more complicated because of the distances and difficult communications involved. Employees and their families faced serious personal considerations, including deciding what to do with his owned residence, obtaining schooling for their children, determining adequate accommodations at a remote location, whether automobiles would be shipped or provided, what salary increases might be allowed, foreign and U.S. taxes involved, and many more. To assist in the decision of an employee of whether to accept an international job opportunity, the company provided photographs of the job site and written descriptions of the living conditions and the environment.

A comprehensive foreign compensation program was developed over a long period of time to deal with taxes, cost of living at the foreign location, schooling costs, housing costs, overseas premiums paid, hardship premium (if applicable), and other financial considerations. The purpose of the program was to establish the principle that the employee would not lose or gain on various costs, but the overseas premium was a clear net increase to his compensation and an incentive to take the position. Most engineering and construction firms had similar programs.

Because of the complex nature of the overseas assignment, all understandings between the employee and the company were formalized into an Employment Agreement. These were carefully crafted for each job location and had the prime purpose of avoiding disagreements concerning the terms and conditions of the assignment. Some concept of the complexity of foreign assignments can be inferred from the size of the KE *International Projects Manual.* A single manual issued in 1972 was three inches thick and was devoted entirely to the administration of industrial relations at foreign projects.

## Skills Inventory

As a new project got underway, a project manager would start to assemble his team, pulling technical staff from all areas of the company as needed. Generally, he would try to select people with experience in similar projects. Information about an employee's prior work experience frequently came from his resume submitted at time of hire and updated as more experience was gained.

A comprehensive questionnaire was provided to each employee to update his experience, including the type of project upon which he had worked, the skills obtained, and the length of assignment. An attempt was made to upgrade the resume every two years.

Maureen Fitzgerald had the full-time responsibility for this program. It was she who urged employees to update their files, and she became a diligent and dedicated saleswoman for the program.

## Hiring Process

The establishment of an employer-employee relationship is affected even before hiring by the way the employment process is handled. KE received a steady stream of unsolicited resumes in addition to applications for specific positions, which may have been advertised. Many companies do not respond to unsolicited resumes, but KE was an exception, responding to every one received. These were usually a form letter, with the last paragraph reading, "Unfortunately, we have no positions available." These became known as "unfort" letters. The applicant knew his resume had been received and reviewed.

If the applicant were to be offered a position, he was contacted by phone, advised of the salary offer, and the desired reporting date. Every verbal offer was followed up with a letter from the personnel department, confirming the job offer, the salary, reporting date, and, if relocation were involved, outlining the relocation expenses, which would be reimbursed. On the morning of arrival, after completing the hire-in process, Herb Beasley would escort the new hire to his department. All of these employment activities were designed to give the new employee a favorable impression of KE even before he started work.

## Pre-employment Physical Exams

Another element in the hiring process was the required pre-employment physical exam. The Kaiser companies were one of the few organizations offering and requiring a medical exam. The exams were conducted in the medical offices located on the mezzanine floor of the Kaiser Center originally under the direction of Dr. John Beatty. Later, Dr. Bernie DeHovitz became the company doctor. The exam provided the company with assurance that the new employee was physically capable of handling his job duties, but more important, the new hire had a free medical examination that occasionally turned up physical problems about which he was not aware. The medical office was also available for minor medical treatment at no cost to all employees who might become ill during the workday. They also performed annual physicals for executives to help ensure their continued good health.

## Medical Coverage

The affiliated Kaiser companies were one of the earliest to provide employees and dependents with medical coverage at no cost to the employee. KE was the only company amongst the 35 members of the National Constructors' Association that provided such coverage. In part, this stems from Henry Kaiser's long association with Dr. Sydney Garfield and his interest in making medical care available to employees, first at remote locations and later at the Kaiser Shipyards. Dr. Garfield is credited with being the founder of the Kaiser Medical Plans. KE employees were provided the alternative of choosing the Kaiser Health Plan or the New York Life Plan, with no employee premium cost. This was a generous benefit, which most employees realized at the time.

## Personnel Staff

During the ’60s and ’70s, the personnel department was staffed with some very competent people. The department included Paul Sibley, who became vice president of personnel in the late 1970s and early 1980s; Irv Skeoch was wage and salary supervisor; Dan McCormick handled the benefits program and later went into labor relations; Bea Bishop was in charge of personnel records; Evelyn Witkowski maintained security documentation; and Herb Beasley handled recruitment and transfers, as mentioned before.

## Training Program

At the peak of our activities, KE maintained a very active and successful training program for future project managers. KE’s personnel recruiters interviewed at top engineering schools for people interested in construction management. Most of those recruited came from schools of construction management (graduate course in civil engineering) from Stanford, UC Berkeley, or Purdue, for example.

Candidates came in for rigorous interviews by KE’s officers and department heads. Typically, we would offer positions to three or four candidates per year for a one-year training program. Trainees would spend an allotted period of time in each of the administrative offices and support staff offices where supervisors would use the trainees as they wished. In some cases, they did productive work. At other times, they observed and were trained as the supervisor wished. Purposely, no formal training manual was used. Instead, it was a program where the trainee learned by observing and by participating. By and large, trainees understood how the training was being done and approved of it. After a year, trainees were assigned to either project work, to support staff, or to construction projects.

One executive was so pleased with the results that he referred to the trainees as “our nuggets.” One observer noted that the success of the training program could be measured in two ways. First, there was little, if any, attrition amongst the people selected. They stayed with us. Second, when a new project was being staffed, one of the first people asked for by the project manager was the ex-trainee whom he knew from a past project. They were invaluable to the project manager in helping to manage a project. They were knowledgeable and flexible enough to fit into any of a number of roles. Today, years later, a number of ex-trainees are retired from KE, having completed successful careers as project managers.

## Counseling

Occasionally, a manager would request assistance from Personnel to counsel a supervisor because of some previous difficult experience with an employee, or maybe he didn’t know how to handle the matter diplomatically. Managers were encouraged to handle their own personnel problems; on occasion, Personnel would handle it for them. One instance concerned Howard Tracy who was Chief Accountant at the time. Tracy asked Don Spiker to intervene with an employee who wore distractingly short skirts to work. She got the office’s full attention every time she bent over to file.

During the discussion that followed with Spiker, the employee was most apologetic, didn’t realize it was a problem, and stated that she wanted to portray a public image that was satisfactory to KE. She agreed she wouldn’t wear those short skirts, and Spiker had accomplished his mission. The next morning Tracy called Spiker again to say that the counseling had not worked. Asked whether she was wearing a longer skirt, Tracy responded, “Yes. But she’s also wearing a see-through blouse without a bra.”

# Industrial Relations

## Overview

Kaiser Engineers’ labor relations policies were built on the foundation of Henry J. Kaiser’s own progressive, yet pragmatic approach to company-worker and company-union relations. He believed in the right of workers to organize, in a meaningful role for unions in the workplace, and in dealing openly and fairly with workers’ representatives. He always searched for a commonality of interests in company-union relationships. The constructive labor relations were always an important element in all the affiliated Kaiser companies’ spectrum of relationships with its employees.

## Henry Kaiser’s Philosophy

Quoting again from *The Kaiser Story* published in 1968, Henry Kaiser put his philosophy this way:

> Labor relations are no more than human relations. Man wants to be treated like a human being. He is jealous of his dignity and self-respect. He resents either being exploited or neglected. He wants to be heard on issues that affect his well-being. He wants to earn his way and to enjoy the fruits of his labor. He wants some say as to the conditions and terms under which he may live and work…

On early construction projects before KE began functioning as a division of the Henry J. Kaiser Company, union relationships and collective bargaining matters were handled by Mr. Kaiser himself, assisted by other members of his core management group. Principal among them was Harry Morton, who was considered to be and functioned as Mr. Kaiser's personal representative to organized labor. During this period, all labor relations were handled on a local project level. As more projects were undertaken, engineering and construction activity was organized and controlled by Kaiser Engineers, along with its own industrial relations staff.

## National Agreements

After the conclusion of World War II, the KE volume of construction work provided the incentive for the company to join with other related firms in a common front to deal with rampant radical unionism in the U.S. construction industry. The National Constructors' Association (NCA) was formed to provide a labor relations forum for industrial construction work apart from work covered by the Associated General Contractors. This was a national group of smaller, typically regional contracting firms. Originally the NCA consisted of major national contractors, predominantly engaged in industrial and heavy construction work, including Bechtel, Fluor, Stone and Webster, United Engineers, etc. An additional objective of the NCA members was to compete more effectively with major non-union contractors, which relied on few, if any, union agreements and were, in essence, anti-union.

This organization initiated an era of active participation of the Building Trades International Unions at the local level, and it started the application of uniform provisions to construction labor agreements. Now project agreements were negotiated with the International unions in an attempt to make national level agreements applicable to local sites and to enforce no-lockout, no-strike provisions. At the same time, however, jurisdictional work claims were aggressively being pursued by individual unions and rigorously resisted by others, creating a continuing atmosphere of union rivalry in the workplace.

In this political atmosphere, the reputation and personal relationships of principal union and contractor representatives became critical in efforts to keep projects working and/or getting them restarted. Another problem was that there were 12 to 15 national craft agreements with different expiration dates. Through the NCA, member companies began to bring a major measure of uniformity to the provisions of the several national craft agreements.

Early labor relations activities by KE as an entity were conducted by J. O. Murray and other key management personnel. In the 1948-49 period, attorney Jack Walling transferred from Kaiser Steel to head the company's industrial relations functions. Along with other NCA member operatives, he began to make significant improvements in the enforcement of national agreements in the face of repetitive work stoppages or prospects for stoppages. At the same time, the International unions began to accept the need for national level coordination. Several attempts were made to achieve a national agreement over a period of several years, but failed for lack of union commitment. National level bargaining became acceptable after Robert A. Georgine became president of the Building and Construction Trades Department of the AFL-CIO. A project labor committee of unions became the vehicle to initiate orderly national project level agreements on a case-by-case basis.

In 1976, Bob Fitzgerald, Walling's successor at KE, was elected president of the NCA and, with other NCA member representatives, initiated a joint NCA-union negotiation process directly with the International Union of General Presidents. Its purpose was to achieve a common national construction agreement for all NCA members' work. Under the agreement the International Union's responsibility was to prevent stoppages or order return to work if stoppages occurred. Each entity's responsibilities were subject to court enforcement.

## Non-union Work

The concurrent success of the non-union movement in the U.S. construction industry had a major effect on KE's and other large construction firms' labor relations efforts on behalf of their clients. A key contributing factor in the growth of the non-union movement was several decisions by the National Labor Relations Board (NLRB). One such decision required that once a union agreement was recognized at a construction site, all work of the affected craft at that site was determined to be "union covered" or commonly known as the "common situs" rule. Situs picketing for site recognition, coupled with growing jurisdictional claims, created frequent and severe disruptions of construction work. To avoid these problems, many contractors began internal restructuring to create both union and non-union contracting entities. They became known as being "double breasted." This seemed to satisfy widespread client dissatisfaction with the frustrations and added costs of unionized construction.

Kaiser Engineers was historically and principally a union construction firm. However, to satisfy customer requirements on some projects, KE created separate corporate entities to control the management and performance of both union and non-union work. Union construction was performed under the auspices of the National Agreements of the Henry J. Kaiser Company, one of several KE subsidiaries. Subcontracts for non-union construction at a common site were awarded to and managed directly by Kaiser Engineers as the parent company. While such arrangements were not common, several were notably successful. Some were projects for the U.S. Government in Arizona, Oklahoma City, Colorado Springs, and a project for Frito Lay in California.

### Experienced Staff

A critical element in KE's labor relations success during the '60s, '70s, and '80s was its practice of assigning talented, experienced personnel in residence at project sites to handle the labor relations function, interpreting, and enforcing union agreements. Notable amongst KE personnel were Al Gordon at Kaiser Aluminum, Ravenswood, Hanford, Armco Butler and Armco Middletown; Charlie Swain at Ravenswood, Hanford, Armco, Zimmer and Perry Reactors; Jack Lipner at Tata in India, Alpart in Jamaica, Tilden in Michigan; Dan McCormick at Butler, Tilden and Fontana; Jack Carter at Zimmer and Great Plains Coal Gasification; Steve Armknecht at Zimmer and Perry.

Perhaps the company's most significant project labor relations achievement was the construction of the Great Plains Coal Gasification Project. A tightly drawn "Project Stabilization Agreement" was completed in 1980 and utilized continuously until 1985. In that four-year period the project worked a total of 16.6 million craft man-hours of construction work without the loss of a single hour of work due to union stoppage. The project was completed early and substantially under budget with a peak unionized craft work force of about 5,000.

## Engineering Design Division

### Overview

The Engineering Design Division has been the backbone of the KE organization from its earliest beginnings. Before the war, Kaiser companies' construction activities included engineering activities, which were centralized in the design engineering department. There were no project engineers as such. After World War II, more complicated industrial projects were undertaken by the Kaiser organizations, and then the concept of a task force approach for each project emerged. It was then recognized that some 50% to 60% of the cost of a project was the cost of engineered equipment. With that, the concept evolved of placing a project engineer in charge of the concepts, specifying and ordering equipment and coordinating design and construction and coordinating all the work.

Even so, design engineering was the key source of talent for project engineers and project managers. A number of design section heads were reassigned from strictly design responsibility to project engineering roles. One notices the large number of KE project engineers and project managers who originally prepared detail designs in the design engineering division.

One of the early Chief Design Engineers was George Schumann. At management meetings George was a protector and advocate for his engineers. He was heard to complain at management meetings when someone referred to his shop in the old-fashioned terminology of "the drafting room." He insisted that it be called the "engineering office."

F. B. Tobias followed Schumann for many years. As projects became more numerous, larger and more complicated, his task of management became more complex. One remembers the difficult task he had of estimating the number of drawings required for a project and estimating the manpower requirements, recruiting new staff, and scheduling the work to completion. His design drawing schedules were constantly updated to meet job needs and were avidly reviewed by project engineers, schedulers, and field personnel in anticipation of receiving technical data on a timely basis.

He was constantly juggling staff. At the same time, as new jobs came up and new project engineers were needed, his best people were upgraded to project management roles. He was an advocate for promoting his best personnel, even at the expense of making his job more difficult. During its peak of activities, the Design Engineering Division had a roster of 1,400 engineers.

## Early Beginnings of Design Engineering

From road construction in Cuba, from dam building at Grand Coulee, Bonneville, and Shasta, from shipyards at Richmond and Portland, and from a dozen other projects, Henry Kaiser accumulated a corps of talented and hard-working design engineers. Some of these men later became key figures in Mr. Kaiser's industrial projects while others made up a part of that group of Kaiser Engineers now known as the Engineering Design Division.

Some of those talented engineers are famously known in the Kaiser Empire. They included Clay Bedford, Jim Foster, Fred Crocker, Ralph Knight, and others going back into the mid-1930s when they were recruited. They set standards for how we worked. Our engineers learned from them that we could do anything, no matter how difficult the task. And Mr. Kaiser taught them how to do things fast and in overlapping phases. They were a family of engineers who did great things during the war and during peace.

George Havas was the engineer hired while building the Cuba roadway project. He went on to found and become Chief Engineer of Kaiser Engineers, later becoming General Manager and then Vice President in charge (nominally now called President). This new group included a construction group and an engineering group, later to be counted as one of the foremost engineering and construction firms of the world.

For some time, all of the work was on Mr. Kaiser's varied projects where George Havas acted as the Chief Engineer for each of the affiliated companies. Soon KE began acquiring other clients other than the Kaiser companies. Ultimately, the workload became so heavy that the company was split into two parts, one domestic and one international, with Havas heading up both entities. L. H. Oppenheim became General Manager of the domestic division, and John Hallett became General Manager of the International Division. At the same time, George Schuman was appointed Chief Design Engineer for the domestic division. Since that appointment, there have been six other Chief Design Engineers for the company: F. B. Tobias, D. B. Mauser, G. H. Holman, W. B. Ball, W. H. Burstedt, and Rich Nunes.

## Growing Staff, More Offices

With the war grinding to a conclusion in 1945, Kaiser Engineers began a consolidation effort, linking the various groups that had been established to design the shipyards, Fontana Steel Mill, and other wartime projects. There were offices in a number of locations in Oakland, and although a headquarters had been established at 1924 Broadway, there were satellites in at least five locations operating semi-autonomously. Efforts to move all personnel into the Broadway office were thwarted by an increased workload and the need for more space. This condition persisted until completion of the Kaiser Center in the early '60s when all administrative and executive offices were moved to the Center along with a major portion of the Engineering Design Division. As more projects were awarded, more staff was required, and more offices were required to house them. The Engineering Design Division could not be housed entirely within the Kaiser Center, but several other buildings were leased for the expansion needs.

When the Ordway Building was completed in the early '70s, the Engineering Design Division moved in with all of its key personnel located under one roof, an improvement even though there were still satellite design offices elsewhere in Oakland. It was not until KE had been acquired by Raymond International that all design efforts could be housed under one roof in a newly constructed building at 1800 Harrison Street.

## Typical Design Organization

The Engineering Design Division organization followed a generally accepted pattern with occasional variations to accommodate project requirements. A chief design engineer supervised all engineering work through discipline supervisors in civil, mechanical, structural, electrical, architectural, piping, and instrumentation. Geology and soils mechanics were handled in two small sections responsible to the chief design engineer but often working directly with a project group. When the workload was heavy, a group of division chiefs was established to ensure high quality in the design process to see that all procedures were properly followed. Each of the chiefs might have under him several discipline supervisors in design groups located in satellite offices. The chiefs also acted as consultants when difficult or special design problems occurred.

During the period of 1945 to 1950 with offices scattered around Oakland, each engineering group operated under very general guidance from headquarters but set up its own detail design procedures. From 1950 through 1961, there was a refinement and consolidation of procedures so that by then every one was using the same calculation format, drawing size, drawing checking procedures, and other details, all of which improved communications and efficiency within the company.

Capabilities available within the organization mirrored the capabilities of the entire KE organization. KE's expertise ranged from automobile manufacturing, shipyard design, manufacture of railway cars, design of cement plants, design of aluminum and alumina plants, design of steel mills, nuclear facilities, postal handling facilities, space and defense projects, and a variety of mineral industries facilities.

The Engineering Design Division has always been able to provide personnel with the skills, talent, and knowledge to accommodate that diversity. Many of the personnel began their careers with field construction positions and later moved to the design office. Because they understood construction problems, they were able to avoid possible friction between the two groups. This experience gave KE an advantage not always shared by other engineering companies.

## Computerization

In the late 1960s, KE installed large main frame computers in the Kaiser Center and began developing applications for scheduling, design calculations, and drawing control. In time the use of workstations expanded throughout the company and provided faster and more complete communication between all divisions. The Engineering Design Divisions set up a small section to install and operate a computer controlled drawing machine. By 1970, this machine was in constant use, particularly for repetitive or standard details, which saved time for engineers to devote to more creative design. Word processing was also being used in preparation of specifications and operating manuals, saving much time of engineers and stenographers. As such, KE was a pioneer in the development of Computer Aided Design. By the late 1970s and 1980s, major portions of design work was being done by CAD.

By the early 1960s, the computer setup on the mezzanine floor of the Kaiser Center had a floor area of some 1,200 square feet and included a monster assembly of tape recorders, cabinets housing electronics, and printing devices. The processors were vacuum tube type and were cantankerous beasts requiring much attention and a great deal of patience. So much heat was generated that a false floor was provided to allow space beneath the machines for distribution of refrigerated cooling air.

After some success, many failures and much frustration, the system evolved into the present desktop satellite installation with communication to a central processor. Today, the slide rule has been largely replaced by computers, using software for most design problems. Draftsmen have been shoved aside by canned information and drawings are made under the stylus of a machine.

In a matter of 60 short years, we have come from hand-cranked calculating machines requiring 10-place log-trig tables to a hand-held, battery-operated computer. The former might take a week to do a job, which now can be done in an hour. KE

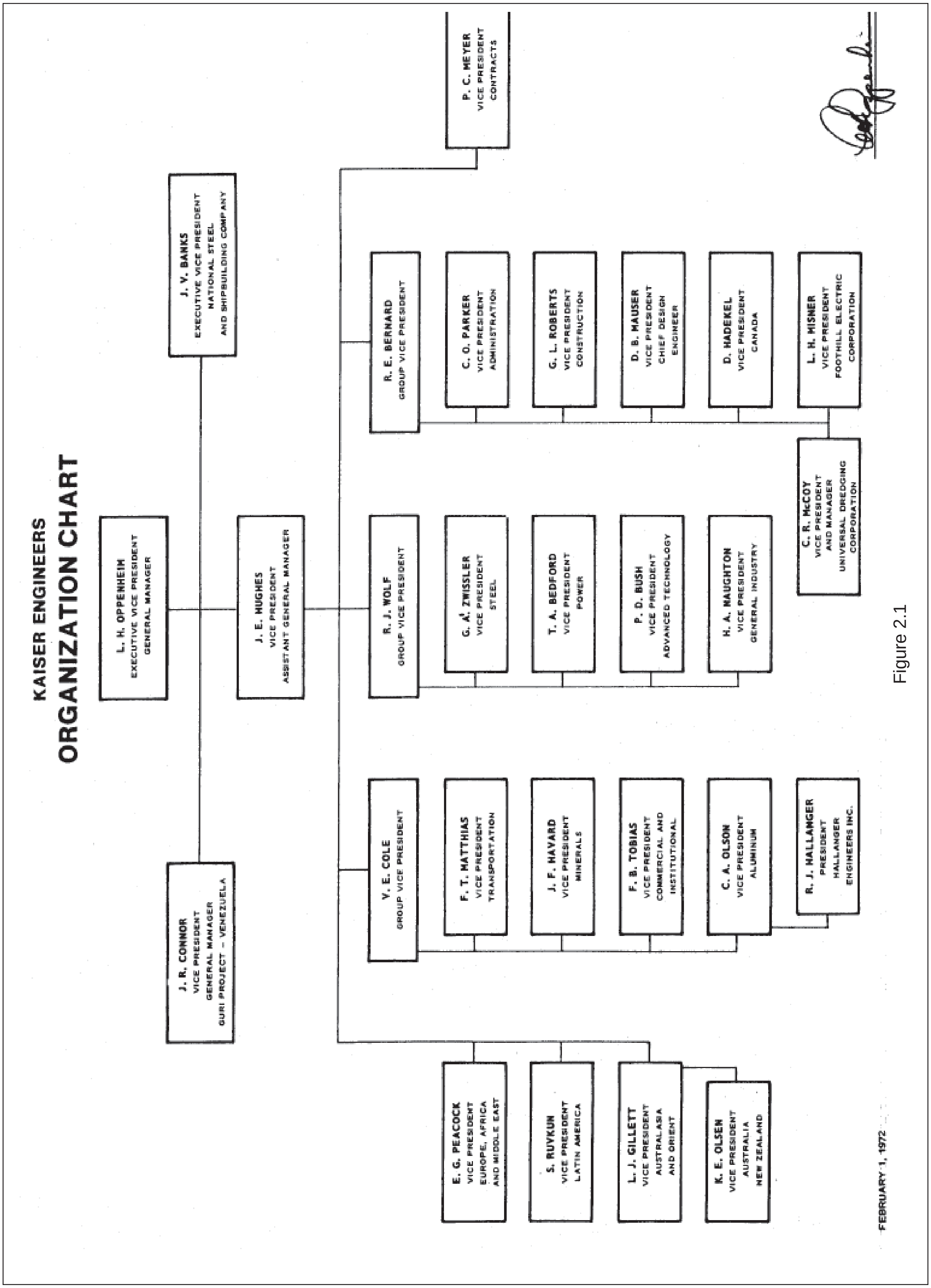

KAISER ENGINEERS
ORGANIZATION CHART
L. H. OPPENHEIM
EXECUTIVE VICE PRESIDENT
GENERAL MANAGER
J. V. BANKS
EXECUTIVE VICE PRESIDENT
NATIONAL STEEL
AND SHIPBUILDING COMPANY
J. R. CONNOR
VICE PRESIDENT
GENERAL MANAGER
GURI PROJECT – VENEZUELA
J. E. HUGHES
VICE PRESIDENT
ASSISTANT GENERAL MANAGER
P. C. MEYER
VICE PRESIDENT
CONTRACTS
R. E. BERNARD
GROUP VICE PRESIDENT
C. O. PARKER
VICE PRESIDENT
ADMINISTRATION
G. L. ROBERTS
VICE PRESIDENT
CONSTRUCTION
D. B. HAUSER
VICE PRESIDENT
CHIEF DESIGN
ENGINEER
D. HADEKEL
VICE PRESIDENT
CANADA
L. H. MISNER
VICE PRESIDENT
FOOTHILL ELECTRIC
CORPORATION
C. R. McCOY
VICE PRESIDENT
AND MANAGER
UNIVERSAL DREDGING
CORPORATION
R. J. WOLF
GROUP VICE PRESIDENT
G. A. ZWISSLER
VICE PRESIDENT
STEEL
T. A. BEDFORD
VICE PRESIDENT
POWER
P. D. BUSH
VICE PRESIDENT
ADVANCED TECHNOLOGY
H. A. NAUGHTON
VICE PRESIDENT
GENERAL INDUSTRY
V. E. COLE
GROUP VICE PRESIDENT
F. T. MATTHIAS
VICE PRESIDENT
TRANSPORTATION
J. F. HAVARD
VICE PRESIDENT
MINERALS
F. B. TOBIAS
VICE PRESIDENT
COMMERCIAL AND
INSTITUTIONAL
C. A. OLSON
VICE PRESIDENT
ALUMINUM
R. J. HALLANGER
PRESIDENT
HALLANGER
ENGINEERS INC.
E. G. PEACOCK
VICE PRESIDENT
EUROPE, AFRICA
AND MIDDLE EAST
S. RUVKUN
VICE PRESIDENT
LATIN AMERICA
L. J. GILLETT
VICE PRESIDENT
AUSTRALASIA
AND ORIENT
K. E. OLSEN
VICE PRESIDENT
AUSTRALIA
NEW ZEALAND
FEBRUARY 1, 1972

Figure 2.1

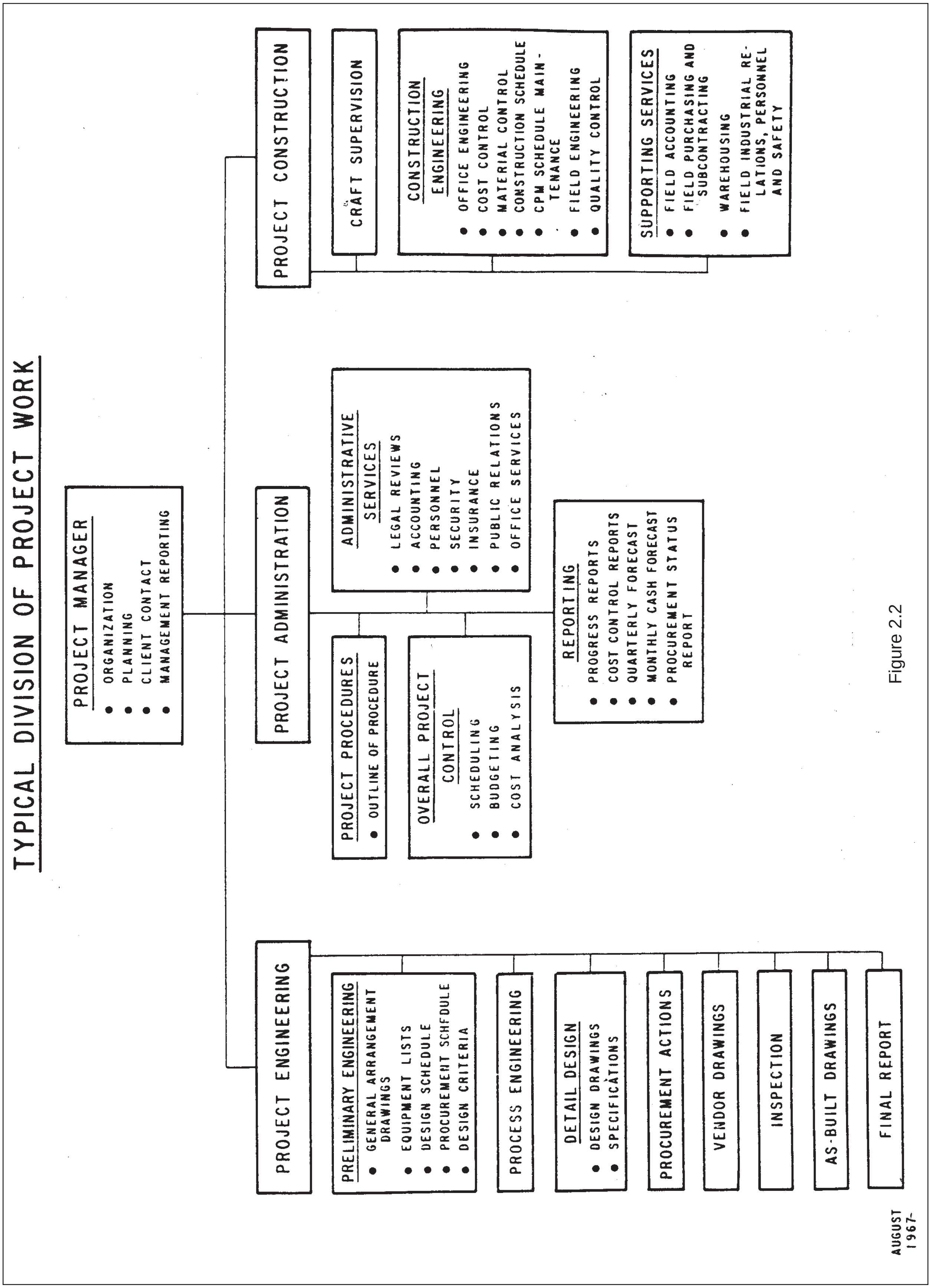

TYPICAL DIVISION OF PROJECT WORK
PROJECT MANAGER
ORGANIZATION
PLANNING
CLIENT CONTACT
MANAGEMENT REPORTING
PROJECT ENGINEERING
PRELIMINARY ENGINEERING
GENERAL ARRANGEMENT DRAWINGS
EQUIPMENT LISTS
DESIGN SCHEDULE
PROCUREMENT SCHEDULE
DESIGN CRITERIA
PROCESS ENGINEERING
DETAIL DESIGN
DESIGN DRAWINGS
SPECIFICATIONS
PROCUREMENT ACTIONS
VENDOR DRAWINGS
INSPECTION
AS-BUILT DRAWINGS
FINAL REPORT
PROJECT ADMINISTRATION
PROJECT PROCEDURES
OUTLINE OF PROCEDURE
OVERALL PROJECT CONTROL
SCHEDULING
BUDGETING
COST ANALYSIS
ADMINISTRATIVE SERVICES
LEGAL REVIEWS
ACCOUNTING
PERSONNEL
SECURITY
INSURANCE
PUBLIC RELATIONS
OFFICE SERVICES
REPORTING
PROGRESS REPORTS
COST CONTROL REPORTS
QUARTERLY FORECAST
MONTHLY CASH FORECAST
PROCUREMENT STATUS REPORT
PROJECT CONSTRUCTION
CRAFT SUPERVISION
CONSTRUCTION ENGINEERING
OFFICE ENGINEERING
COST CONTROL
MATERIAL CONTROL
CONSTRUCTION SCHEDULE
CPM SCHEDULE MAINTENANCE
FIELD ENGINEERING
QUALITY CONTROL
SUPPORTING SERVICES
FIELD ACCOUNTING
FIELD PURCHASING AND SUBCONTRACTING
WAREHOUSING
FIELD INDUSTRIAL RELATIONS, PERSONNEL AND SAFETY
AUGUST 1967

Figure 2.2

Havas (left) reviewing one of KE's designs with a friend.

**George Havas,** founder and the first of its vice presidents and general managers (later called president). His tenure lasted between 1942 and 1958. Known worldwide, he was especially recognized for his keen technical and organizational abilities. When organizing and initiating new projects, his intellect and knowledge of the subject became clear with his logical and concise directions to project managers.

First employed in 1928 while Kaiser was building highways in Cuba, Havas became Mr. Kaiser's expert on all technical matters, including construction matters. He was also an excellent estimator. He carried the title of Chief Engineer for all of the affiliated Kaiser companies. Even when acting as the head of KE, he was often called upon by Mr. Kaiser to advise on new ventures.

In his retirement, he consulted on the Oakland-Alameda County Coliseum complex, coordinating and directing the efforts of the architectural firm that successfully completed the difficult project.

In July, 1951, *Fortune* magazine featured an article about the 'arrival of Henry Kaiser.' One of the photographs described the engineering group of Kaiser Engineers, headed by George Havas. The photo is a typical session in Havas' office as he initiated a project. In this one, he is organizing the budget estimate for Chalmette. Prominent in the photo are Havas (second from the right) with Don Bird, estimator (to his right), then Paul Stafford, chief estimator with suspenders, E.C. Anderson, project manager, partially hidden, and Sam Ruvkun, assistant to George Havas, operating the Marchant calculator. The project was completed within the proscribed budget.

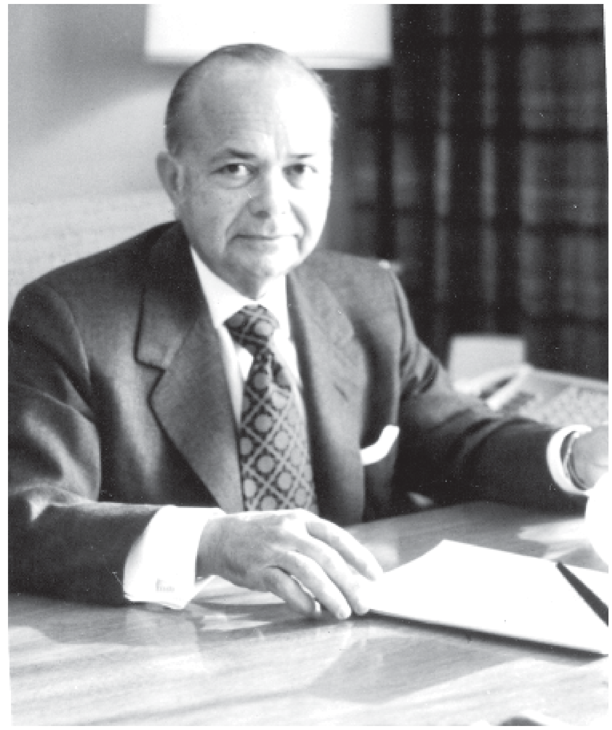
**L.H. (Lou) Oppenheim** headed KE for the period from 1958 through 1973 after having acted as assistant general manager to Havas for Havas' full tenure. As such, he knew the organization intimately. He oversaw the rapid growth of the company from an organization that did mostly in-house work for affiliated companies to an internationally-recognized architect/engineer/construction firm. He oversaw the opening of new markets for new industries located domestically and internationally.

Known for his superior administrative and managerial talents, he recruited key new personnel needed to staff new technologies undertaken. He continued Havas' tradition of running the company with strict controls, yet allowed freedom of action by subordinates to successfully pursue large and complex projects worldwide.

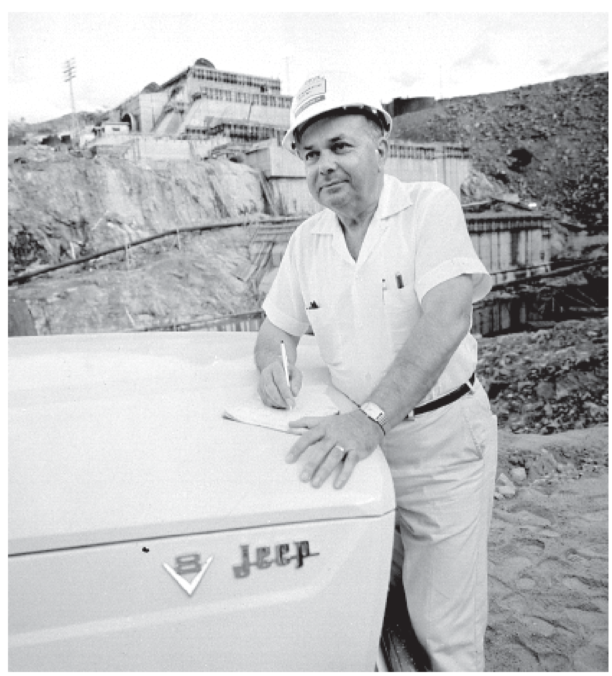
During his regime, KE rose to a position of prominence when in 1965 the *ENR* rated KE as the #1 builder in the world.

At retirement, Oppenheim volunteered his services to the engineering college of the University of California at Berkeley. He organized and headed its Berkeley Engineering Fund which raised private funds for the college. Starting with no such funds, he grew the organization to a steady flow of donations, reaching $40 million annually. This helped the college maintain its reputation as one of the top engineering schools in the nation. His reputation as a keen, inspirational manager followed him to the University of California.

Oppenheim graduated from Berkeley in Civil Engineering in 1938. He also had a degree in architecture from the University of Southern California.



**Oppenheim** on the job (right). Note his comments in the Oral History chapter. He felt strongly that an important role of management was to have frequent job site visits for its top executives. This gave a sense of discipline and importance to field personnel. It was a way for top management to interface with its clients and to assess progress of the work to avoid potential problems.



**J.F. (Jim) McCloud** was appointed president of KE in 1974 after a short tenure by Max Pearce. McCloud served for 10 years until 1984. Thus, the tenures of Havas, Oppenheim, and McCloud spanned most of the period covered by this history.

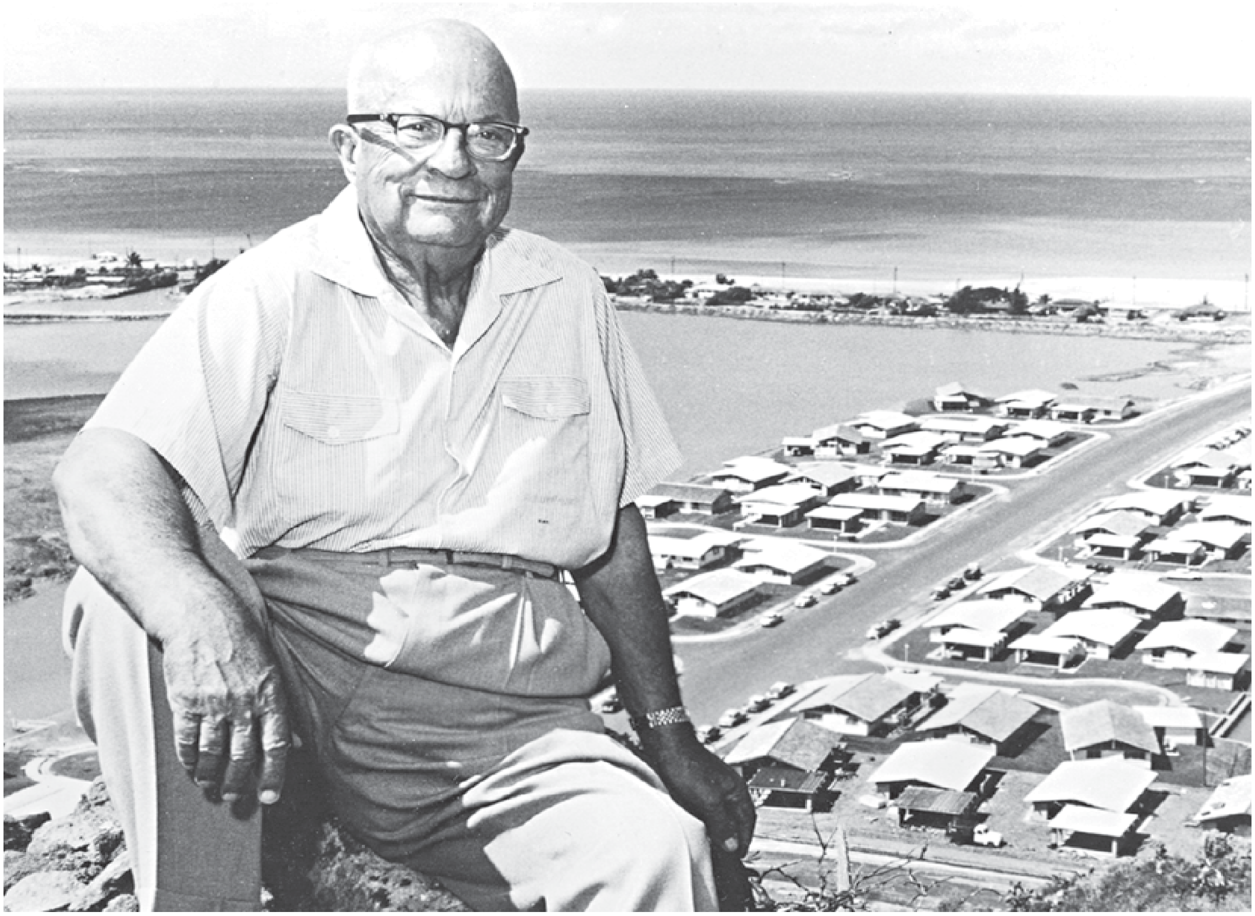
McCloud started his Kaiser career in 1941, moving up the ladder progressively from engineering, construction, and manufacturing executive positions. Prior to joining KE, he was group president for several Kaiser affiliated firms. For 15 years, he served as founder-president of Industrias Kaiser Argentina, building a facility in Argentina to manufacture the first Latin American fully-integrated automobile firm.

At KE, McCloud continued the Havas and Oppenheim tradition of providing an environment for key personnel to operate independently within proscribed limits to successfully build a number of engineering and construction projects. His experience as a successful manager of technical projects provided a successful formula for his KE responsibilities. He was sensitive to the people needs of his management staff. His organizational and marketing skills helped KE complete a variety of programs throughout the world.

Upon his retirement, McCloud took on a number of philanthropic activities, including helping to build a nursing home in Oakland and heading up the team which refurbished Franklin Roosevelt's yacht. Renamed the *Potomac,* the ship was rebuilt under his direction. It now serves as a tourist attraction for the Port of Oakland.

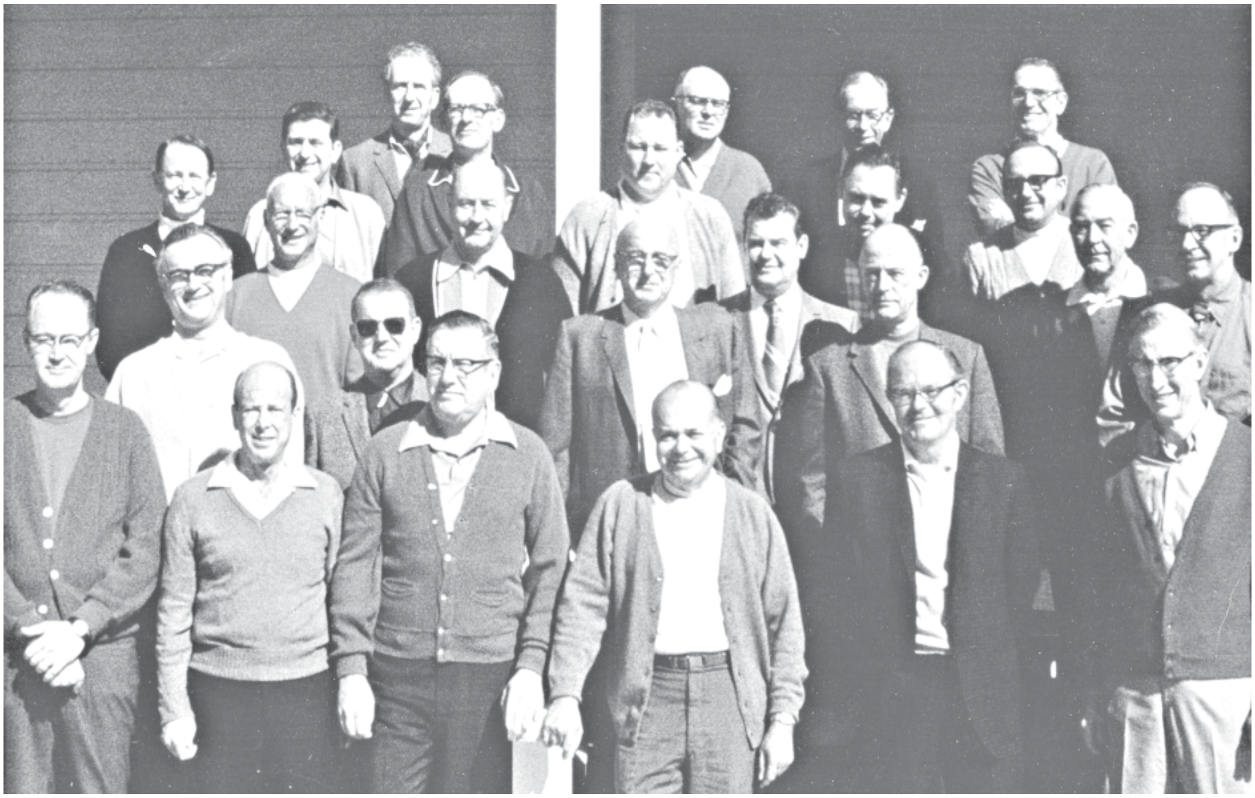
McCloud graduated in mechanical engineering from Stanford in 1941.


The *Engineering News Record* for June 5, 1975, featured Jim McCloud on its cover.



**Henry Kaiser,** the founder. Picture taken at age 80 as he overlooked his final project at Hawaii Kai.

**Edgar Kaiser** worked more closely with KE than did his father. Edgar helped in marketing. His most successful undertaking was to land the Valco and Akosombo Dam job in Ghana.



# Kaiser Engineers' Management Meeting Silverado, circa 1964

KE was managed by a key group who would gather for a 4-day review of their operations and plans for the future. Typical of the people who attended were the officers of the company as shown in the management meeting of 1964.
(Left to right, back to front) Fifth row: Dan Hadekel, Lee Misner, Edgar Kaiser, and Frank Bort.
Fourth row: Bob Bernard, Sam Ruvkun, Toby Tobias, Carl Olson, Paul Meyer, and Lee Gillett.
Third row: Jack Hughes, Vic Cole, Earl Peacock, Frank Matthias, and Bruno Franceschi.
Second row: Ken Olsen, Frank Davis, Gene Trefethen, and Bob Wolf.
First row: Don Mauser, Phil Bush, Gordon Zwissler, Lou Oppenheim, John Banks, and Tim Bedford.

# Chapter 3

# Construction

## Construction…KE's Heritage

Henry Kaiser's empire started in the construction business from its very beginnings in the 1930s. The large dams built in that period were the Kaiser companies' primary business. As World War II approached, Mr. Kaiser capitalized on the opportunities to become an industrial innovator and eventually a tycoon As he became more absorbed with industrialization, he had less time and interest to devote to construction. Thus, as Kaiser Engineers was formed in the early 1940s, it inherited the construction mantle for the Kaiser organization.

Beginning in the 1930s, as Kaiser moved from one large project to another, KE recruited and retained a pool of talented construction experts. Most of Mr. Kaiser's key management staff came from successful completion of his construction projects. Some of these dam builders went on to successful industrial careers, and many had engineering degrees.

When Kaiser Engineers was formed, many other of the dam builders were recruited as a nucleus of the newly formed engineering and construction company. While the name chosen emphasizes the engineering portion, in the trade KE was and is known as an outstanding engineering *and* construction firm.

The part of construction inherited from the early dam building era continued in KE and was known as heavy construction. It was heavy in the sense that it included massive amounts of earthmoving and heavy pours of concrete, for example. But KE was also charged with the assignment of designing and building industrial plants, too. This activity became known as industrial construction. Finally near the end of the 1970s, clients sought KE's expertise in managing other contractors, and this gave rise to our expertise as construction managers.

This chapter treats each of the three activities separately. The expertise involved lies strictly within the talents and training of the company's construction personnel. Administratively, heavy construction and industrial construction had different corporate vice presidents in charge. In practice, many of the construction personnel moved from one type of construction to another, and sometimes the vice president in charge was responsible for both heavy construction and for industrial construction projects. Because they involved the same people, the descriptions of each type of activity that follow sometimes combine some of the heavy and industrial construction activities.

When we entered the period favoring construction management, the same people who handled industrial construction now handled the management of construction. The difference was only in the contractual arrangements and the need to supervise other contractors rather than directly supervising construction personnel.

Heavy construction sponsorship by KE covered the period from 1945 through 1964.

Industrial construction was underway during the entire period covered by this book, 1945 through 1986.

Construction management became popular in the U.S. about 1970, and KE was actively engaged in it from then on.

## Overview

KE personnel tackled many large and diverse projects for a variety of clients in a number of different industries located around the world. Included in this chapter are tables of projects undertaken for each kind of construction activity which clearly show that diversity.

In all, the selected projects shown total $42 billion in contract values at the current prices of the time. When escalated to construction costs that prevailed in the period after the year 2000, they would aggregate projects whose constructed value is on the order of $150 billion, attesting to the reason why KE was known as the premier construction company of the decades of the '50s through the '80s.

## Heavy Construction

### Early Dam Builders

Beginning in the late 1930s, the U.S. Bureau of Reclamation initiated a number of flood control and power generating works on major rivers. While the projects had noteworthy beneficial effects for public use and protection, they were also prime public policy of make-work for the construction industry at the height of the Great Depression. All of the projects were massive by the standards of the day, and no one contractor had sufficient resources to accomplish a project individually. A useful strategy worked out at the time was the joint venture agreement, whereby several of the larger contractors would pool resources together and bid for the projects. That way the contractors could spread the risk over several partners.

This proved to be a viable vehicle for contracting services with the Bureau of Reclamation and later with the Corps of Engineers. It survived for a number of decades.

Mr. Kaiser's early construction involvement was with road building. When the Hoover Dam bid came up, he was intimately involved with the bidding process and became one of the participants in building this massive structure. Kaiser was a part of the Six Companies joint venture that successfully built the dam. Then followed construction of the Bonneville Dam and Coulee Dam in Washington where Kaiser was the sponsor. These were the early beginnings that gave rise to the definition of the construction staff as "the dam builders."

At completion of these two massive dams, the looming war clouds became apparent, and Mr. Kaiser saw an opportunity to build ships for the war effort. Thus began a period of industrialization. A nucleus of engineers and construction men was transferred from Coulee to start the shipyards. As a matter of fact, some of the massive "Whirley Cranes" used in dam building became key elements in lifting prefabricated ship sections and were given credit for early success in building ships rapidly.

## KE Takes Over Heavy Construction

After Kaiser Engineers was formed in 1945, it inherited responsibility for heavy construction work. George Havas had been one of Mr. Kaiser's key men in estimating and bidding jobs. As vice president and general manager of Kaiser Engineers, he also held prime responsibility for finding projects to bid on, negotiating joint-venture agreements, handling the bidding process, and supervising construction forces. In the earliest days he was assisted in this endeavor by another of Mr. Kaiser's key men, Mike Miller.

Heavy construction within KE was also known as joint-venture work. This work consisted of large civil works similar to Hoover Dam, Coulee Dam, and Bonneville Dam. While these works actually preceded the forming of Kaiser Engineers, the associations developed the procedures used, and many of the key construction people came to KE.

As an activity, heavy construction was managed and developed principally by the top management of KE, meaning the general manager's office. Very few key people were involved in estimating and managing these activities. On the other hand, this joint-venture activity involved the investment of far more of the company's funds than any industrial project. Industrial projects were practically always performed on a cost-plus-a-fixed-fee basis with very little risk of financial loss. Heavy construction involved great risk.

Most KE personnel, whether managing industrial projects or engineering or constructing them were not acquainted with heavy construction activities. One guess is that less than one percent of the staff knew about the bidding, negotiating, partnering, or execution of joint-venture activities. Their only knowledge came in the form of progress reports or hallway gossip.

It was no secret that while early heavy construction work was lucrative, later international heavy construction projects had many problems, not encountered domestically, leading to heavy losses. One writer of the Kaiser Empire's history reported erroneously on KE activities that KE never turned a profit. The fact is that KE was always profitable from industrial activities. As a matter of fact, KE's cash return to Kaiser Industries was a major source of Kaiser Industries' income.

## Finding Heavy Construction Projects

Joint-venture activities started whenever a large federal project was announced, typically along one of the major United States rivers. The Kaiser organization was known as experts on heavy construction projects. Projects were defined in federal legislation where either the Corps of Engineers or the Bureau of Reclamation would request appropriations from Congress. Kaiser Industries maintained an active Washington, D.C. office, and its government relations personnel kept abreast of all of these appropriations, giving KE early intelligence about projects coming up.

KE top management reserved for itself the responsibility of discussing with potential joint venture partners whether they would be interested in working with us. Companies such as Morrison-Knudsen, Perini, Walsh, Brown & Root, Raymond, and Pacific Bridge were in constant communication about whether to be a partner or a competitor.

Determining factors on who would sponsor a project depended upon who had the earliest intelligence, or who had personnel available, or who had construction equipment available, or who had experience in the particular type of project.

A sponsor was the company that took the lead position and actually ran it, staffed it, and had the majority share of the joint-venture partnership. Other partners had a financial interest in the project, dividing profits or losses in accordance with their agreed share of participation. Domestically, this arrangement worked very well. Such joint ventures were formalized with joint-venture agreements, but as future international events would reveal, the joint ventures were only as good as the partner's word and as good as a shake of hands. Such was not the case internationally.

In seeking out international projects in the early years, being invited to participate was an art in itself. Consider the case of the Tres Marias Dam in Brazil. Morrison-Knudsen had an inside track on this fee-based project until Jack Hughes, travelling the area, heard about Tres Marias and made a pitch for KE to run the project. While making his pitch, it became apparent that a joint venture would be most attractive to the client. We were invited to participate and were awarded the project with Morrison-Knudsen being the sponsor.

## Bid Estimate

An essential ingredient to successful joint-venture work is having a knowledgeable estimating staff. KE maintained a small staff of two estimators headed by Al Parker. Al Parker was successful in putting together winning bids on a number of joint-venture projects. He also authored a text on heavy construction work.

The process of preparing the bid started before bid documents were received. Early intelligence would give us an early start to visit the proposed site, size up labor availability, define strategy, and arrange for joint venture partners. This gave us a jump on being able to meet tight bidding deadlines.

When bid documents were received, the estimator prepared a "door knob" estimate which gave the management a feel for what was involved and gave adequate time to firm up partnerships, and arrange estimating assignments and meetings to firm up arrangements.

Each participant in the joint venture independently prepared a bidding estimate. At the appointed time all estimators and principals would meet to discuss in detail line items of estimates. After discussion of methodologies, equipment usage, productivity, and the like, estimators would come to an *agreed* estimate. It might take two long days to compare bid items. The result was an agreed estimate of the direct costs.

Then the principals would meet in a closed session to discuss below-the-line items to add to the agreed direct cost estimate. These included an assessment of future escalation, assessment of risk and contingencies needed, and profit. Strategy of bidding was also discussed, including such items as unbalancing the line items where different quantities were estimated than were indicated in the bid document.

If quantities did not match the bid document, the revenue to be received would be materially affected since bids were usually on a unit price basis. In later years, KE suffered several major setbacks when a young estimator was placed in charge and automated the last-minute effort of spreading overhead to bid items. There was an error in the computer program used, so instead of using our estimator's quantities, they used the bid document quantities. The result was an automatic under-payment for quantities of work accomplished. Several bids suffered from this mistake until it was discovered.

## Observing the Bid Process

Young engineers were sometimes invited to sit in on the pre-bid conferences to aid in note-taking and in working calculators. John Gilcrest remembers a bid for the Detroit Dam where the partners discussed who would sponsor the job. After a review of each partner's interests, it was decided that KE should be the sponsor because KE lost its shirt on the last phase.

Sam Ruvkun remembers a bid for the Broadway Low Level Tunnel. Discussion centered on the risk of hitting a water seam as one proceeded with tunneling. Jack Walsh of Walsh Construction, who would sponsor this project, thought everyone should know about his experience some years ago in tunneling in New York. He said, "We were making good progress when, all of a sudden, we hit this water course, with water pouring down all over us. At that point, I almost became an ex-tunnel contractor."

Phil Bush remembers a contractor who said, "We need less lawyering and more constructing."

## **Heavy Construction Activities**
## Early Projects

By 1946, KE was into bidding on dam projects and soon in 1948 became members of the joint-venture team that won the award of Davis Dam and then Hungry Horse Dam. The next year Kaiser won the bid for Detroit Dam on the Santiam River in Oregon, acting as sponsor. Russ Hoffman, an old time Kaiser hand, was project manager. Key positions on the project were held by Vince Palmer, Bert Provost, Ozzie Mikkleson, Don Bengston, and Park Savage.

By 1953, Mike Miller was named vice president of joint-venture activity, reporting to George Havas. Miller had been responsible for work in Canada and for the Garrison Dam powerhouse in North Dakota. Al Parker was appointed chief estimator reporting to Miller. Later, Parker reported to a succession of bosses as administrative responsibility changed.

## International Projects

International construction activity in the modern era began with the Snowy Mountains Project in Australia in 1954. (Mr. Kaiser's paving work in Cuba occurred a generation earlier.) Heavy construction estimating was handled by Al Parker, reviewed and approved by George Havas. The actual heavy construction division was formed in 1964. Prior to that, some key estimating assignments were handled by Mike Miller, one of the original Kaiser construction men. He had a good grasp of estimating large construction projects.

It was natural that interest was great in the huge Snowy Mountains Project, the largest civil construction project ever built by the Australian government. KE completed four contracts, totaling $118 million in value. The project began the KE presence in Australia that continued for the next four decades, performing a variety of engineering and construction projects in industries such as alumina, LNG process, railway, coal, and other mineral projects.

Following the bids for the Snowy Mountains projects in Australia, Kaiser participated in a continuing stream of joint-venture dam, tunnel, and other heavy construction projects through 1964.

Several projects undertaken in the period of 1961 through 1964 shaped the future of international work. These international projects were Guri Dam in Venezuela, the Pakistan Canals, Dead Sea Dikes in Israel, and Kremasta Dam in Greece. These projects were undertaken as part of the international division, led by Art Shelton, reporting to John Hallett. Shelton was not a construction man by training but was considered at the time a bright, innovative leader who could lead KE into a new era of interesting international construction work. His tenure lasted until 1963 when the bidding process for the Guri project was in question.

Along with the American River Project in California, these were financial failures for a variety of reasons. These projects and their effect on Kaiser Engineers' future are described in the story entitled "The Heavy Construction Losers."

## Domestic Work

One of Frank Bort's first large responsibilities was in the early '50s when KE sponsored a joint venture for building Garrison Dam powerhouse in North Dakota, headed by John Bargas. At that time, Bargas reported to Frank Bort who was then in charge of all construction personnel. (See the Bort Years in the Industrial Construction section). At completion of the project KE had several claims against the Corps of Engineers, which were eventually resolved—not entirely to our satisfaction—with the help of Jim Miller. While this is heavy construction, its staffing and responsibility was by Bort.

KE joint ventured with Morrison-Knudsen on Navajo Dam, Greer's Ferry, Wanapum, and Hansen Dams. There was more partnering with Morrison-Knudsen in 1961 on Yellowtail and Lower Monumental dams before the onset of the "problem projects."

The American River Project was started in 1963 as a $95-million hydroelectric project in the Sierra Nevada foothills. The KE-led joint venture was the only bidder on this star-crossed and controversial project that consisted of 5 dams, 4 powerhouses, and 22 miles of tunnel. As a heavy construction project, it was originally under Frank Mathias' management, but it was staffed mainly out of the general construction division headed by Frank Bort.

Don Barrie was assigned project manager assisted by Vince Palmer, Henry Boucher, Lachlean McBean (from a joint-venture partner), Sherrill McDonald, Earl Woodward, John Hester, Pat Bedford, Linc Grayson, Jim Taber, and a host of others. Disaster struck in December, 1964, when warm Hawaiian rains melted a big snow pack, creating the "flood of record" on the American River. The major rock-filled dam at Hell Hole was raised to its scheduled level but was unable to withstand this unprecedented flood. It was over-topped, failed, and caused major downstream damage. Lawsuits and countersuits followed. The joint venture filed a $40-million claim against the engineer for misrepresentation of tunnel conditions. His fee was contingent upon receiving a project bid below the guaranteed maximum price.

The owning agency also sued KE for alleged restraint of trade since only one bid had been received. Add to this a fatal spillway slide at Hell Hole and a concrete aggregate hauler who was a major Mafia figure being watched by the FBI, and there were enough ingredients for a fascinating movie. The hauler completed his contract acceptably, and the project was completed early enough to earn a bonus despite the disaster and other problems.

## Heavy Construction Project List

KE always maintained a perpetual job list for all projects undertaken, small and large. From that documentation, we have abstracted a list of major joint-venture work undertaken in the period of 1946 through 1970. The job listing is chronological with a four-digit format. The first two digits are always reserved for the year of project origination. Table 3.1, "Heavy Construction Projects List," follows the narrative section of this chapter. Note that job number 4601 refers to Davis Dam that began in 1946, with KE as a joint-venture participant and a project value of $31 million. Most of KE's activities covered the period through 1965, but there were three small additions for the State of California Department of Water Resources in the next five years where KE was a participant only.

These were all large projects. The total value of the projects at the contract prices of the time was more than $1.7 billion.

## Heavy Construction People

As Mr. Kaiser became more involved with steel, shipbuilding, and other wartime ventures, responsibility for heavy construction and joint-venture projects rested mainly with George Havas. Later when he retired, L. H. Oppenheim took charge. During a brief period when KE had a separate international division, John Hallett took charge of foreign projects assisted by Stan Kimball and Art Shelton.

In 1949, Kaiser sponsored the winning bid for Detroit Dam on the Santiam River in Oregon. Russ Hoffman was assigned project superintendent. Others who held key positions were Vince Palmer, Stan Kimball, and John Tacke.

Mike Miller was named vice president of joint-venture activity in 1953, reporting to George Havas. Miller was responsible for work in Canada and for the Garrison Dam Powerhouse in North Dakota. Al Parker was chief estimator reporting to Miller. But in 1954, Parker, still in charge of joint-venture estimating, reported to Frank Bort and Tom Price, and Miller reported to Havas.

One of the most successful of our joint ventures was the Clear Creek Tunnel Project in Northern California, sponsored by the Shea Construction Company. It was profitable because Shea had foreseen that much more tunnel steel would be required than the bid documents called for. This bid item was bid at a high unit price that yielded a profit in the job of $15 million on total revenues of $45 million. It was observed at the time that one of the reasons for successful completion of Shea projects was that one of the principals always acted as project manager, and they had constant surveillance of all project activities.

Sherrill McDonald, who was working for Col. Wendell Trower, recalls frantically hunting for Gil Shea in San Francisco one morning to get his signature on a joint-venture agreement at the last minute. Shea usually stayed at the Palace Hotel, but on that day he was not in his room. The bellhop suggested that McDonald check Shea's usual haunt, which was the bar across the street. Sure enough, he was there and came back to his room where he graciously signed the document, which was rushed back to Oakland.

In 1957, Stan Kimball was named vice president in charge of heavy construction, and Frank Bort headed industrial construction.

In 1958, Parker was again moved, reporting this time to Kimball. In 1964, Frank Mathias was named vice president of heavy construction and hydro division for domestic operations. Mathias had played an instrumental role in setting up the Hanford Works for the Corps of Engineers, where he served as Officer in Charge during the war. Al Parker now reported to Mathias, one of his many moves.

For a closer look at some of the construction personnel involved, we have included the next sub-chapter that describes the Snowy Mountains Project and the number of expatriates assigned and their roles. It is a recollection made by Vince Palmer some four decades later.

## Snowy Mountains Projects

The Snowy Mountains projects in Australia were the first international large-scale construction involvement by the company. KE sponsored these projects, the first of which was awarded in 1954. It was the largest civil works ever undertaken by the Australian government. KE's participation required recruiting and dispatching a large cadre of construction specialists, some of whom went on to manage other KE projects around the world. The project was of such significance that it is described in some detail.

The project was established to take advantage of the high annual snowfall and rainfall of the Snowy Mountains, together with the rapid drop in altitudes. Rivers were diverted to provide irrigation water for arid regions west of the mountains and to provide power for urban areas. KE's involvement involved the period from 1954 to 1958, but the project was not entirely completed until 1974.

John Tacke moved from Hanford to head the first Snowy project. Russ Hoffman, recently at Detroit Dam, was project superintendent, Vince Palmer was project estimator, and John Hester was tunnel superintendent. Kaiser's work on the Snowy was well respected by the Australians and led to an ever-growing excellent reputation in the engineering and construction field.

## Snowy Projects

The first part of the Kaiser-managed project was the Eucumbene-Tumut Tunnel and Tumut Pond Dam with a contract value of $54 million in 1954. By the turn of the century 2000, the project value would have been about a half billion dollars. Co-venturing with KE were Walsh Construction Company, Perini, Raymond Concrete Pile, and Arthur A. Johnson. The combine was known as Kaiser-Walsh-Perini-Raymond.

Adaminaby Dam was awarded to the combine, and it was completed in mid-1956 at a cost of $14 million at the time.

A third phase of work undertaken was the construction of a diversion dam, called T-2 Dam, Tunnel, and Powerhouse for a cost of $54 million. KE again sponsored the work. A special feature of the project was construction of the powerhouse 800 feet below ground level.

The next project was the Khancoban Dam and spillway, along with a power station and tailwater channel. Excavation of the power station required the open-cut excavation of 7 million cubic yards. Contract value was $4.5 million.

## Construction Personnel Assigned to Snowy

It is instructive to review how the projects were staffed. John Tacke who had been project manager at Hanford was assigned to run this project. After award of the project, Tacke arranged to open an office in Sydney. The first Australian national employed as secretary was Betty Thompson who remained in the office throughout the Snowy projects and remained in the office as KE's industrial activities expanded for other Australian jobs in the decades that followed.

The first construction staff to arrive at Cooma included Russ Hoffman, Vince Palmer, Ossie Mickelson, and Joe McNealy. The first day order of business was to obtain driver's licenses, after which they drove—on the left side as Australians do—from Sydney to Cooma, a distance of 270 miles. Housing was short so that expatriate personnel were assigned to temporary buildings and a hotel in Canberra until houses could be built.

KE took over a Snowy Authority pre-fab factory, which built pre-fab houses. This advance staff directed the immediate construction of an office building, a warehouse, and a machine shop. It immediately started employing Australian personnel.

The local work force consisted mostly of displaced persons from Europe. These were people actively recruited by Australia after the war. One estimate was that there were 70 nationalities represented on the project. About one-third of the workforce was Australian, which was a condition set by the government.

An Australian national, Greg Oates, was employed to be head of labor relations. Australians also held positions in management and in accounting.

The expatriate staffing for this first Snowy contract shows the positions that were needed to be able to manage the project. These were the positions of authority that formed a team with Kaiser construction know-how. The balance of the staffing was employed locally:

| Expatriate Name | Position |
|---|---|
| John Tacke | Project Manager |
| Russ Hoffman | Project Superintendent |
| Ken Neilson | Director of Purchasing |
| Don Jacobs | Chief Engineer |
| Vince Palmer | Estimating Engineer |
| Clyde Turner | Tunnel Superintendent |
| Ossie Mickelson | Master Mechanic |
| Bud Keating | Electrical Superintendent |
| Joe McNealy | Carpenter Superintendent |
| Elden Lents | Accounting Manager |
| John Hester | Eucumbene Portal |

| | |
|---|---|
| Bob Bills | Superintendent |
| Bunky Steff | Happy Jacks Portal Superintendent |
| | Tumut Portal Superintendent |
| Park Savage | Tumut Dam Superintendent |
| Norm Ginrat | Facilities Engineer |
| Don Bengston | Chief of Surveys |
| Ray Stiner | Field Superintendent |
| Butch Shuler | Accountant |
| 9 others | Tunnel Walkers |

When the T-2 Dam, Powerhouse, and Tunnels were added to our contract, the project was so large that it required a separate expatriate staff. This project was headed by Red Fulton with the following expatriate staff:

| **Expatriate Name** | **Position** |
|---|---|
| M. L. (Red) Fulton | Project Manager |
| Oakie Blehm | General Superintendent |
| Bob Miller | Project Engineer |
| Sammy Simons | Outside Superintendent |
| Doug Allen | Master Mechanic |
| Paul Pond | Dam Superintendent |
| Roy Fulton | Assistant Dam Superintendent |
| George Bender | Carpenter Superintendent |
| Jerry Jobe | Assistant Carpenter Superintendent |
| Q. Cooper | Aggregate Plant Superintendent |
| Boyd Clark | Rebar Superintendent |
| Linc Grayson | Construction Engineer |
| Mike Ruzilla | Electrical Superintendent |
| Leo Heath | Welding Superintendent |
| Blacky Belt | Tunnel Master Mechanic |
| Kenny Belt | Tunnel Master Mechanic |
| John Coppedge | Tunnel Master Mechanic |
| George Boone | Tunnel Superintendent |
| Jessie Wilson | Tunnel Superintendent |
| Ben Murray | Tunnel Superintendent |
| Whitey Walker | Tunnel Superintendent |
| J. D. Kimsey | Powerhouse Superintendent |
| Louis Lanning | Walking Boss |
| Bud Goodson | Walking Boss |
| Whitey Phelps | Walking Boss |
| Bud Morris | Walking Boss |
| Aud Weatherall | Walking Boss |
| Bob Blehm | Walking Boss |
| Berle Blehm | Walking Boss |
| Jack Lacey | Budget Director |
| George Howe | Warehouse Superintendent |
| Bud Wehle | Assistant Warehouse Superintendent |
| Gary Fenity | Management Trainee |

When the Khancoban Dam was added to the scope of the Snowy projects, Harold "Curly" Christmann was assigned as general superintendent. Most of his personnel were from the T-2 group of expatriates, or he was successful in recruiting a very capable group of Australians.

## Heavy Construction Losers

The period 1961 through 1964 was a disastrous period in the history of Kaiser's heavy construction work. In that brief period of time five separate projects were bid on fixed prices or unit prices, and each resulted in massive losses.

Much has been written about these losses in mostly international joint-venture work. How this happened is a lesson in losing focus. First, consider the environment the international found itself in. Where previously all bidding and project execution was done by key older-timers like George Havas, Al Parker, and key Kaiser project managers, the international staff was now comprised of new people. The Vice President for Heavy Construction was an attorney. The Chief Estimator was a young engineer, an ex-trainee. And the philosophy espoused for heavy construction work was: the way to make money on a construction project is to assign your best tunnel walker to the project and leave him alone.

What this philosophy ignored was that international work requires working with a different kind of local currency, different customs, different technical capability, untrained and ill-equipped craftsmen, different laws, and management in a remote location. One cannot just go to the local hardware store to get a part. You need to get it from home with a 3- to 4-month delivery time.

## Guri Dam

Different customs and standards of business conduct made fixed-price bidding treacherous. Consider Venezuela's Guri Dam. When the project was being bid, the vice president in charge was instructed not to sign a contract until it was reviewed in Oakland. After he submitted KE's bid, he telephoned urgently to explain what was going on and to appeal for immediate signing of the deal. His boss was John Hallett who was standing in the hallway where a number of his industrial staff was discussing other matters. Hallett fielded the call and, to the amazement of all listening, heard him say, “You didn’t sign anything, did you?” The answer indicated maybe he had. Concurrently, Hallett had received calls from our joint-venture partners asking what was going on as his man in Caracas was phoning partners, lobbying them to call Hallett to get permission to sign. Hallett decided to take an overnight to Caracas where he discovered, in fact, an agreement had been signed. The vice president was fired on the spot.

A major problem occurred with ordering the diversion gates. This is a one-time-use piece of equipment used to seal off the diversion tunnel after the dam is completed. The staff decided they could save some money by purchasing the gates from Germany from a supplier who had never built one before.

When it came time to close the gates, they failed, making it impossible to stop the diversion water. Someone had saved some tens of thousands of dollars to be sure. But as later events showed, the cost of closing the diversion tunnel from the outside came to millions of dollars and a great deal of delay. The story is often told of how Edgar Kaiser stood at the top of the dam as he supervised crews tossing railroad cars into the raging lake to try to stem the water flow.

When losses on the dam mounted, it was discovered that cores from drill holes for the dam foundation were actually not those for the site on which we were building the dam. Someone had changed the location of the axis of the dam without drilling new holes and without advising us. It developed that the new site was a very difficult one to excavate and seal.

This example attests to the different business ethics overseas. Domestically, no one would change conditions without a commensurate change in contract. In Venezuela, with Venezuelan laws at that time, KE could get no relief.

## Kremasta Dam

Another interesting event occurred on Kremasta Hydroelectric Project in Greece. KE’s work involved construction of a first-stage diversion tunnel for which our estimators planned two headings, one upstream and one downstream. It was a critical planning decision to have bought two headings of equipment and to have planned tunneling progress to complete diversion before high-water season. It was the client’s responsibility to build an access road at the downstream heading. When the client failed to build the road and after much delay, the Oakland staff became concerned and asked a disinterested party to intercede with the vice president in charge. Photographs showed an easy slope leading to the proposed heading site. A bulldozer trail could be built for not over $25,000.

When the VP in charge was told of this possibility, he said, “You don’t understand. I don’t want them to build the road. I’ve got a beautiful, lucrative claim for an extra coming up.” This was lawyer talk. What chance did he have under Greek law? None. Millions of dollars later, KE got sucked into bidding on the full dam project, losing even more money.

A lesson learned from these international projects was that the nature of joint venture work was different overseas than at home. As stated at the outset, joint ventures were only as good as the partners regardless of the terms of joint-venture agreements. When losses on the Guri Dam project mounted, calls for funds from European partners went unanswered. They did not feel morally, ethically, or legally obligated to contribute to losses. Kaiser swallowed its losses, too.

## American River Project

The American River Project in California was the last domestic joint venture undertaken. Encouraged by Kaiser Industries to take on the more risky heavy construction, KE decided to bid this job in 1963. At that time, it appeared that some very interesting projects were being handled by the international division, and top management did not want the domestic division to lose out. (The projects were interesting until the time the American River Project was bid, and then, during its construction, they all went sour.)

The American River Project in California was unusual in that it required the bidder to guarantee a maximum price since the client could not raise additional funds. The disastrous overtopping of Hell Hole Dam caused this project to be another loser.

## Dead Sea Dikes

The Dead Sea Dikes undertaken in Israel in 1964 was another project that suffered from improper estimating and lack of understanding of the difficulty of sealing the dikes from water intrusion.

Construction crews soon learned that fill material being used was too coarse to meet the inspection standards set by the Israeli authorities. There were claims and counter claims for the extra work entailed, causing the project to overrun the bid estimate.

## Pakistan Canals

The Links Canals near Lahore in West Pakistan were bid in 1961. This project was carried out in a remote location and for a client of an emerging nation, for which our estimators had not made proper allowances. This project also finished losing money.

## Lessons Learned

With 20/20 hindsight, one can clearly see why these projects ended as disasters. Here are some of the reasons:

1. Early bidding and management of heavy construction was done by professionals such as George Havas and Mike Miller. These were men with vast experience and know-how concerning the business. When a separate division was formed, new people inexperienced in this line of work were given the task of management. One was a lawyer by training and had never worked on a construction project. This alone was a formula for disaster. The Shea Company, by contrast, always had one of the owners managing their work which was always successful.
2. Until about 1960, joint-venture bids were estimated by Al Parker, an old pro in such estimating. His work was checked by George Havas. Beginning in 1961, such joint-venture estimating was assigned to a smart construction trainee. He lacked knowledge of the pitfalls of such projects and was not yet seasoned enough for the responsibility. And there was no one to check his work.
3. Until this time, bidding in the U.S. was for the Corps of Engineers and the Bureau of Reclamation. Any contract entered into was adjudicated in U.S. courts with impartial judges. The law of equity was always a fall-back position, protecting a contractor from unreasonable treatment by a contracting officer. Such was not the case in overseas work. They did not judge by the law of equity, and there was no credence given to "acts of god."
4. In overseas work one was governed by local laws. Our people relied upon the written *intent* of the contract, while the local laws took their own interpretation of what the words meant.
5. In all projects undertaken in the period of 1961 through 1963, including the American River Project, the budget established for each project was the only amount of money available for the project. Any overruns, if one could get a judgment, required going back to voters to get more money. There was little chance of voters approving such overruns. Thus, in that period of time, the clients were really looking for an insurance policy from us, the contractors. Our failure to understand this was a failure to understand the new environment upon which we had embarked.

## No Longer Dam Builders

The works undertaken in the short three years of 1961 through 1964 carried such severe losses to Kaiser Engineers and Kaiser Industries that Kaiser ceased to function in its traditional role as builder of dams. Losses on each of the losers ranged into the tens of millions of dollars or more. The American River Project loss of $22 million, together with the great losses on Guri Dam, were the main reasons KE management decided to no longer bid on fixed-price construction projects.

Probaby no other firm except one with the resources of Kaiser Industries could have withstood such losses without going bankrupt. It attests to the moral courage and loyalty of its principals that the Kaiser family paid off all its debts on these projects and still survived.

Because of the financial drains at the time of the losses, management decreed that no longer would KE bid on fixed-price work.

By 1969-1970, after 30 years as a dominant joint-venture participant that began with the Hoover Dam Project, Kaiser was no longer a player in dam building or other heavy construction works, both domestically and internationally.

## Industrial Construction

### Background (Origin and Roots)

In addition to the heavy construction division that participated in joint-venture activities, KE maintained a large cadre of construction personnel who made up the industrial construction division. As previously mentioned, many of these people were assigned interchangeably between heavy construction and industrial construction. But most construction personnel were assigned and remained in the industrial construction division exclusively.

Frank Bort was the vice president in charge of industrial construction for many years, succeeding Frank Backman, still remembered for his key role in building the Fontana Steel Mill. Frank Bort maintained a large following of loyal construction personnel from his offices in Oakland. At Bort's retirement after several decades at the helm, George Roberts succeeded him.

In a way, it seems strange to talk of a construction division since KE from its beginning was built on Henry J. Kaiser's construction experience. Prior to KE's formation in 1941, Kaiser's business was exclusively construction, starting as a paving contractor first, then as a general contractor, and then as a joint-venture partner in the building of Hoover Dam (Boulder) in 1933, with many others to follow.

Kaiser's early entry into industrial work, departing from solely construction, came in 1937 with the loss of the bid for Shasta Dam. While losing the construction contract for the dam, Kaiser realized the opportunity to supply cement for the project. This required a source, which became available from the limestone source at Permanente (near Cupertino, California) where the first cement plant was built. A plant was built in record time in 1939 using his same construction men to build it, and a contract for the supply of cement was entered into for Shasta Dam.

At the same time, Kaiser built a 9.6-mile long conveyor system to supply aggregates for the dam. This was an innovative way of supplying natural aggregates from riverbeds. Kaiser's industrial vision began to require more than construction savvy. It needed good engineering as well.

Kaiser Engineers, as a group, was formed in 1941 as the engineering department of the Kaiser company for the specific purpose of designing and building the Fontana Steel plant, the only integrated steel plant in the western United States. This venture and other wartime activities, most notably the huge shipbuilding projects on the West Coast, provided the project engineering background and resources for Henry Kaiser's later expansion into a widely diversified industrial empire.

## Industrial Engineering, Construction

Just as the Kaiser Empire entered a period of industrialization, so too did Kaiser Engineers. From its early beginnings in 1942 through the period of about 1965 to 1970, KE's main focus was on building "turnkey" projects. Turnkey in this context was a single responsibility for the execution of a project where KE would manage it, procure the process equipment, design the facilities, and construct the facilities using its own supervisory personnel and employing its own craftsmen. The industrial construction staff was an integral part of the project team.

During the war years of 1941 to 1945, most industrial construction had been curtailed in favor of wartime production facilities. Thus after the war, there was a large market for a concern such as Kaiser Engineers which could build new factories rapidly. Clients were eager to have an organization with know-how in constructing complicated factories to handle the entire project for them. Kaiser's reputation for speed in construction was acknowledged to be one of the hallmarks of Kaiser Engineers' capabilities, and selling opportunities opened up.

To be sure, the early turnkey projects were for Kaiser affiliated companies, including the steel, aluminum, and cement companies. Since they had a common owner in Henry Kaiser, they all knew the tremendous advantages available to them by having a single-responsibility contractor handle the work. The environment at the time, vintage 1946 to 1955, was that there were shortages of building materials, process equipment, and labor. Because of these shortages and the recently released wartime price controls, prices were erratic and difficult to define. Consequently, finding contractors to bid on fixed-price contracts was impossible. But more important to the managers of these affiliated industrial concerns was the need to build rapidly. The Kaiser methodology honed in on the Permanente Cement Plant, and Fontana was adopted as a normal means of executing a KE project.

This methodology made project managers, design engineers, and construction personnel a part of an integrated team. By preparing overall concepts early and placing orders for process equipment early, engineers could define the concepts and provide early infrastructure and foundation designs. Construction personnel could thus start field work many months earlier than waiting for designs to be completed. They could mobilize field forces, order construction equipment, and start earth moving literally only a few short months after design commenced. Then with overlapping engineering, procurement, and construction phases, the project could be finished in 3 to 6 months earlier than the competition could complete its plants.

KE had the flexibility to hire construction craftsmen directly or for specialty facilities it could subcontract the work. Projects proceeded on the basis of budgetary estimates which were updated frequently to gain a measure of cost control. Fortunately, most projects undertaken fell well within budget.

Projects undertaken in this 20-plus-year period were large industrial projects, covering KE's range of expertise in steel, aluminum, and cement. Later, KE expanded into other mining and minerals processing plants and other works.

## Division Start at Fontana

The first step into the world of engineering and industrial construction was the building of the Permanente Cement Plant in 1939 by Mr. Kaiser's own construction forces. In 1941, an engineering and construction group was assembled to design and build the Fontana Steel Mill. George Havas was appointed Chief Engineer and General Manager for the project with overall management and engineering responsibility. Construction was headed by Tom Price, one of Mr. Kaiser's most trusted and experienced managers, acting as construction manager. Frank Backman acted as the construction superintendent. Frank Bort was superintendent of the blast furnace construction. More about Bort in a subchapter that follows.

Ground was broken in April, 1942, and the blast furnace "Bess" (named after Mrs. Kaiser) was blown in on December 30, 1942. The first of six open hearths was tapped in May, 1943, and the first plate rolled from the steel mill in August, 1943, only 16 months from ground-breaking. This rapid construction attests to the construction know-how of Kaiser's construction men.

Other construction personnel involved were Joe Kroll, G. G. Wilson, R. C. Wilson, and Wright Price. By any standard, including those of today, this schedule performance is truly amazing. By late 1943, a real project team had been forged and an engineering division and a construction division organized. By 1946, Kaiser Engineers was officially open for business and available to affiliated companies as well as non-affiliates.

In 1949, Frank Backman was moved to Oakland and became general construction superintendent, and Frank Bort became construction manager at Newark, reporting to Backman. During this period, Kaiser acquired the Eagle Mountain iron ore mine and coal properties in Utah. Further expansion at Fontana in this early postwar period included a cold rolling strip mill, a seventh open-hearth furnace, a second blast furnace, and a hot rolled strip mill. These projects kept the KE team fully occupied until the huge expansion in 1955 for large-sized projects for the new Kaiser Aluminum and for others in other parts of the country.

## Hanford Construction Projects

In 1953, KE was awarded the construction of the "K" reactor for the Atomic Energy Commission at Hanford, near Richland, Washington. This was a very large construction project, requiring the mobilization and deployment of a large cadre of Kaiser construction experts. It was an exception to KE's normal role in that KE did not do the engineering design for the project. It was, however, a negotiated fee-based contract.

Heading the project team was John Tacke, resident manager, with Gayle Wilson as assistant manager and Red Fulton as general superintendent. By 1954, Stan Kimball replaced Tacke who was assigned to Australia on heavy construction work. Later, Red Fulton moved up to assistant, and Park Savage became general superintendent. Bob Hammersmith was the project engineer. The organization chart for this project shows a number of construction personnel who later rose to responsible positions in the organization. They included George Roberts, Harvey Hautala, Hugh Fulton, Vic Shaver, T. R. Gray, and Ray Ware.

In 1959, KE continued its presence at Hanford by winning the award for construction of the New Production Reactor (NPR), a $156-million dual-purpose, graphite-moderated, water-cooled reactor to produce power as well as plutonium. Construction was now headed by Hugh Fulton. It was started in 1960 and was completed in 1964. This was a direct-hire project for KE and Foothill Electric, consuming approximately 7.5 million man-hours. Some of the key staff included Don McSparrin, George Roberts, Don Sahlberg, and T. R. Gray.

Progress was not always smooth, so that for a 6-month period of time Frank Bort moved to Hanford to see the project through its trouble. This project also added to KE's growing legal knowledge about construction claims, with interesting claims by suppliers and subcontractors. On-site legal counsel was Hal Hunsaker who successfully negotiated claims with the AEC.

## The Bort Years

People are our most important asset. That is an often repeated statement by Kaiser Engineers in its approach to selling new projects. This section would not be complete without noting the many talented supervisory construction people who reported directly to Frank Bort to which they affectionately refer as "the Bort Years." They included construction managers, construction engineers, superintendents, and craft supervisory people who moved from job to job both domestically and internationally.

Most KE construction men closely identify themselves with Bort, who represented KE's construction department as its Vice President in Charge. The Bort Years covered the period from 1954 through 1971. Almost an entire generation of construction people grew up under his tutelage. Frank was not only steeped in field construction experience, but he was an excellent manager and related well to all who worked for him, no matter at what level. He often found the executive level frustrating for lack of the direct action he liked. Sherrill McDonald recalls walking into Bort's office one day when Frank had just finished one of many telephone calls that day to one of his field managers. He said, with an air of resigned displeasure, "Mac, I never do anything. All I do is talk on the telephone!" Well, that talk, that personality, and that leadership carried the KE industrial construction group through 16 years of astounding growth and accomplishment until his retirement in 1971.

Most of Bort's veteran staff remember the division's beginning in the headquarters at 1924 Broadway in Oakland, even though there were a number of satellite project offices around town. Then for a time, the construction division's home was in the Blue Cross Building, until the Kaiser Center was completed in 1960, and all KE divisions were consolidated. Foothill Electric, headed by Lee Misner, had separate headquarters in East Oakland.

After his work at Fontana, Frank moved to the Mead Aluminum Plant in 1950 as general superintendent, reporting to Frank Backman. By 1951, he reported directly to L. H. Oppenheim overseeing several projects as constuction manager of the General Construction Division. Art Fisher was the construction manager of the Steel Division, reporting to J. O. Foster.

In 1954, Bort was named general construction manager under Oppenheim and was also responsible for joint-venture estimating; chief estimator was Al Parker. In 1957, Bort was made vice president of industrial construction and in that capacity reported to Oppenheim until 1964. After that all executive positions were consolidated under Jack Hughes. Bort continued in that position until his retirement.

## Aluminum Projects

The year 1955 was a banner one for construction, as this was the year that saw the beginning of four huge projects that competed for attention in the next few years. They included a new aluminum rolling mill at Ravenswood, West Virginia; modernization and expansion of an aluminum refinery at Baton Rouge, Louisiana; an aluminum refinery at Chalmette, Louisiana; and the major expansions at Fontana. They continued well into 1959 and 1960.

These aluminum projects, built mainly for Kaiser Aluminum, were massive turnkey projects requiring experienced construction personnel to meet tight construction schedules. They were all large. Chalmette was budgeted at $148 million in 1951. Ravenswood projects started in 1954 were budgeted at $194 million.

## Steel Projects

In 1956, Kaiser Steel embarked upon another expansion entrusted to KE. It was budgeted at $209 million.

KE's presence abroad started in Australia in 1954 with the Snowy Mountains Project, described in the heavy construction section. Soon thereafter in 1956, came the Tata Steel Mill Project in India, bugeted at $156 million. At this point, a new division was formed for international work and led by John Hallett as vice president in charge. On the construction side, Art Fischer was resident manager for the Tata project; W. J. Smith was resident chief engineer, and C. W. Bingham was general construction superintendent. Dick Hart was senior piping engineer. Assistant superintendents included R. J. LeCount, Bill Teal, and Charlie Clifton. The Tata project was very successful despite the fact that much of the work had to be carried out using crude, labor-intensive methods.

## Armco Project 600

But nothing compares to the Armco Project 600 awarded in 1964. These were projects for expanding steel-making facilities at Middletown, Butler, and in Houston at a then estimated cost of $600 million. This project required a rethinking of how to manage it. Large numbers of key people, including construction staff, were mobilized from Oakland

and a number of other construction sites to manage construction of these projects. The project was large and important to the development of KE's image and reputation. It is treated separately in the chapter on steel engineering and construction.

## Titan Missile Bases

In 1959, KE bid for and won the construction of the Titan missile base near Boise, Idaho, in joint venture for a lump sum of $34 million. While this is joint-venture work, staffing for it and direct responsibility rested with Frank Bort, and it is covered as part of Industrial Construction. This was one of a number of similar bases in the country fueled by the Cold War.

Because of the many changes demanded by the government, all of the missile base projects had serious claims issues. Changes were changes in concept so numerous that they had an *impact* effect on the entire project. Claims work became a separate project of its own.

Major corporate executives from the various contractors, including Edgar Kaiser, testified before the U.S. Senate to help ease the way for settlement of the extra cost overruns. The KE-led joint venture settled with the Corps of Engineers for $59 million. Pat Bedford was the construction manager supported by Jim Miller, Uwe Clausen, Don Cardarelle, and Dan Blackwell. Despite the substantial increase in work and cost, the project was completed on the original schedule. This was KE's first encounter with the principle of "contract acceleration," and the impact effect of numerous changes, which caused a substantial increase in the volume of work without a commensurate increase in price.

## Noranda Aluminum Project

One of the last major projects of the Bort Years was a difficult, strife-ridden project, the aluminum smelter at New Madrid, Missouri, for Noranda Aluminum Company started in 1970. The pipefitters virtually ran the job despite valiant efforts by the KE staff. Don Barrie began as construction manager and was succeeded by Jim Miller. Strikes and jurisdictional disputes were rampant. This was the first aluminum smelter built in the area, and each union tried to carve out as much work for themselves as possible. Threats, fights, and even fire bombings were part of this unfortunate project. Both Noranda and KE finally joined in a lawsuit against the Millwrights. Noranda won the suit, getting damages assessed for $1 million. Some of the KE staff included Chuck English, Lou Fox, Gene Green, Roy Hamilton, Charlie Harman, Cal Nara, Dave Palmer, and Don Smith.

## Bort's Supporting Cast

Frank Bort had lots of good help during his tenure. Key construction personnel included Pat Bedford, Don Barrie, Hugh Fulton, Red Zilm, Jim Miller, Stu Simonson, Hal Meyer, John Bargas, and Clyde Gray. Assistance in the office consisted of his long-time secretary Doris Gatenby and engineers and estimators. They included Vince Palmer, Sherrill McDonald, Bob Phillips, Oscar Hanson, and a continuing but temporary stable of construction managers between assignments.

There were a lot more. Because they covered a wide range of projects and covered more than one project, they are listed without reference to any individual project:

| | |
|---|---|
| Harvey Hautala | Chuck English |
| Bill Crass | Hugh Fulton |
| Curly Christman | Red Fulton |
| Chuck Lindberg | Clyde Baker |
| Dick Hart | Bill Biebesheimer |
| George Humphrey | Bob Franklin |
| Bert James | Hal Brock |
| Cal Lutz | Al Sacchi |
| Peter Goldsmith | Frank Walker |
| Tony Speechley | John Nicetin |
| Geoff Rees | Rufus Chapman |
| Linc Grayson | |

All of the work took place in what the KE construction alumni call "the Bort Years." Here we are more than a quarter of a century after his retirement, and "his people" still remember him with affection, admiration, and respect.

## Successor Vice Presidents

Upon Bort's retirement, George Roberts was appointed to replace him as vice president in charge of industrial construction. Roberts had just completed a hugely successful role as project manager for Armco 600's projects at Middletown, Ohio. It was during his tenure that an additional series of large, innovative construction projects was undertaken. Roberts continued in this role until his untimely death in 1976.

Pat Bedford, who had been vice president of

Kaiser Canada in charge of construction of such projects as the Wabush Iron Ore project and STELCO in Canada, succeeded Roberts and served for two years until Kaiser Engineers was sold off to Raymond International in 1977. At this time Bedford took early retirement.

Don Sahlberg who had just returned from managing construction of the Zimmer Power Plant then assumed the vice presidency of the newly named Field Operations Division. Sahlberg served in that position until he left to participate in the newly won Hanford project for the Department of Energy. This was a 5-year, $500-million project started in 1982 where KE was architect-engineer-contractor.

Then Ken Willis, coming off the ANG project (described later) took over the construction division until 1988 when he became manager of the $4-billion Boston Harbor Project also described later in the construction management subchapter.

As the management baton was passed through the succession of vice presidents, KE's work assignments continued to flourish on three fronts: continuation of direct-hire industrial construction, construction management starting in about the 1970s, and providing construction assistance only for projects that KE designed. The later two fronts are covered under the subchapter of construction management. But during the reign of Messrs. Roberts, Bedford, Sahlberg, and Willis, a number of significant direct construction projects were undertaken, and they are described next.

## Tilden Iron Ore Concentrator

Begun in 1972 and completed in 1974, this $120-million iron ore concentrator was located in the Upper Peninsula of Michigan and was built for Cleveland Cliffs Iron Company. George Roberts played a key role in managing its construction. It had a number of early key personnel changes and late design coordination problems. Project manager was Jim Miller, supported by Sherrill McDonald, Earl Woodward, Don Willman, Dick Cranston, Ed Day, Jim Tabor, Gene Green, Mac Horowitz, Ray Dorr, and Floyd Eckols. Near the end of the job, Roberts spent a great deal of time on-site helping to renegotiate the electrical contract, which permitted the job to finish without a complicated claim problem.

## Zimmer and Perry Nuclear Plants

At about the same time KE landed two sizeable nuclear power plants to be built on a direct-hire basis. Zimmer was located in Cincinnati for Cincinnati Gas and Electric. Don Sahlberg and Clyde Gray led the construction team which included Don McSparrin. When Sahlberg left to return to Oakland to head up the construction division, Bob Marshall took over, followed by Mark Albertin, and finally Keith Dempsey. The project almost didn't get off the ground since there were strong protesting elements in the area against nuclear power. It had been stopped since 1971. Then the license for construction was granted in 1973. It was known that protesters were seeking a court order the first thing one morning, but if the construction had started, they would not have been able to prevail. A crew of operating engineers was held over past midnight in order to technically start work in accordance with the license.

The project was a full construction project with direct hire of employees and included work by Foothill Electric, led by Joe Farra. The project ran into so many problems that the owner stopped work on it as a nuclear power plant. It was later completed by others as a coal-fired plant.

There were hundreds of salaried employees living near this project, the Perry Project, and Armco's Middletown site. Some of the key people were Charlie Standfield, Charlie Clifton, Red Evans, Gene Moynihan, Ed Hallan, Mickey Ford, Jim Sandlin, Jim Short, Harry Christianson, Chuck Mandell, and Dave McMyler.

The Perry Nuclear Plant was built in Cleveland. There KE acted as an extension of the clients' project team. The setting of the reactor vessel dome required a specially built mobile derrick crane which moved the 880-ton dome about a quarter mile before setting it up. At the time, it was one of the heaviest lifts in the world. The project was completed on time and within budget and functioned very well. Hugh Fulton, Dave Fitzpatrick, and Mike Nofsinger helped manage the Perry construction.

## Roberts' Other Projects

Also under construction during Roberts' term were the Reserve Mining Project in Silver Bay, Minnesota (Hugh Fulton, Ken Schuerman, Don Cardarelle, the Uranium Ore Concentrator at Churchrock, New Mexico (Don Smith, Jim Roberts) and another expansion of the Fontana steel plant (Jack Straw, Uwe Clausen).

## Australia in the '80s

Because of the large amount of KE work performed in Australia for over three decades, beginning with the Snowy project, KE was able to develop and retain a cadre of competent Australian construction personnel. Thus, in the '80s much of the new work was undertaken by largely KE local staff. This included the Worsley alumina plant and the alumina refinery at Queensland.

## Diego Garcia

One of the largest and most demanding projects was inherited from Raymond after it acquired KE. It was a $600-million expansion of military infrastructure facilities at Diego Garcia Island in the Indian Ocean for the U.S. Navy. Don Montez was the initial project manager for KE. Bill Stevens led a KE team to complete the work. Chuck Lindberg handled administrative tasks in Houston.

## ANG Coal Gasification Project

During George Roberts' term as vice president in charge of industrial construction, extensive planning began for the landmark American Natural Gas Company's coal gasification project in Beulah, North Dakota. KE, with Lummus Corporation, won the project in a national competition, and Ken Willis was selected to head the project.

Started in 1981, this $2.2-billion project was completed in 1985. This was one of the largest and most successful projects undertaken by KE. Conceived during the oil crisis in the early '70s as an alternative energy source, the project was carried out as a joint venture between Lummus Engineering and Kaiser Engineers. Lummus did the process engineering, and KE did the infrastructure engineering and the construction. In the planning stages since 1973, the project finally won approval to proceed in 1981.

Because of the project's size and demanding requirements, many of the cream of KE's construction group was assigned there. Led by Ken Willis, the staff grew to a peak of about 600 and included such key people as Cliff Gambs, Ken Schuerman, Joe Sullivan, Ray Dorr, Doil Yocham, Dave McMyler, John Berentis, Gary Thronson, Kurt Kehler, and Dave Wilson.

There were many remarkable things about this project. It included 3 million engineering manhours by the two companies located 3,000 miles away from each other. Construction effort took 16 million manhours of which 78 percent was by Kaiser craft forces. Included were 120,000 cubic yards of concrete, 55,000 tons of structural steel, and 400 miles of piping. All work was done in a ferocious climate whose winters produced a record 48 straight days of below zero temperature, and on one memorable day the wind chill factor hit 109 degrees below zero. Despite all the challenges, the project was completed on time and below budget, yielding a bonus for the joint-venture partners. This was the last and perhaps the greatest private construction effort by Kaiser Engineers.

## Dredging Operations

In 1971, KE acquired Universal Dredging which had three operating dredges. By 1973, KE won the dredging work for the Honolulu Reef Runway for the new airport. Most of the work was completed under management by Vince Palmer in 1976. One of the dredges was the largest cutter-head dredge in the world, and it did the most difficult portion of the job—cutting through coral. Assistance to Palmer was provided from the industrial construction forces by Foster Sisson, Bill Sproule, and Bob Ray. Universal Dredging Company (UDC) was sold on completion of this project.

## Foothill Electric

In 1951, KE acquired an electrical contracting company in Oakland and renamed it Foothill Electric Company. This acquisition was required because of the demands of the electrical union, the IBEW, which would not supply tradesmen to a contractor that was not an NECA member (National Electrical Contractors' Association). Because Johnston Electric (predecessor of Foothill) had such a membership, KE would now be supplied electrical workmen. Lee Misner, an electrical engineer, became general manager of Foothill Electric.

KE management recognized that it could not provide electricians to its clients without acquiring an electrical contractor. George Sheer, KE's electrical consulting engineer, was given the assignment to find one. At the same time, Sam Ruvkun, who was assistant to George Havas, became aware of the need and, while perusing his *Wall Street Journal,* noticed an ad for the sale of an electrical contractor in Oakland. With the blessing of George Sheer and Lou Oppenheim, Ruvkun acted as "dummy" buyer of the company. The reason for having a dummy front was that if the seller knew how badly KE wanted the company, and if she knew the resources available, the price would escalate.

Within a short two-week period, Ruvkun determined that, in fact, Mrs. Johnson, the owner, had a valid IBEW agreement, and her asking price seemed reasonable. After a price had been agreed to, we then revealed who the true buyer was. At completion of the purchase, it was Ruvkun's suggestion that, since the Johnson Electric Shop was located on Foothill Boulevard in Oakland, a good name would be Foothill Electric. That name has endured.

### Non-union Affiliate

By the mid-'80s the trend in labor relations was to favor non-union construction work. KE adapted to this trend by acquiring a non-union arm. To do this, KE would place its union agreements in the name of the Henry J. Kaiser Company which would be the union arm of KE's construction efforts.

This group was then headed by Bob Fitzgerald as general manager, Gerry Abraham as vice president of construction, and a staff which included Dan McCormick, Bruce Allen, and Bill Probert. This organization was in place for two years until the HJK Company ended operations in 1985. The one project performed in this period was the Yuma project for the Air Force.

As to the non-union activities, KE was not successful in either acquiring a non-union arm nor in obtaining non-union work, although all the elements were in place to do so if opportunities arose.

### Work Volume

By 1976, KE had grown to a company with more than 2,500 professional, technical, and administrative personnel. It had a backlog of work totalling $2.3 billion and offices in ten countries. As the 1970s came to a close, new contracts awarded to KE, including both construction and construction management services, peaked at nearly $3 billion in 1980 then fell steadily each year to about $650 million in 1986.

Despite the heavy construction difficulties of the period 1961 to 1963, KE had many other successful industrial projects. The *Engineering News Record* ranked KE in 1965 as the number one contractor in the world, based on total domestic and international work done.

### Industrial Construction Projects List

KE maintained a perpetual chronological job listing. Job numbers were assigned to keep track of costs and income. From this perpetual list, we have abstracted those large industrial construction projects for which KE had direct construction responsibility in addition to the engineering and overall management of the projects. They are listed following the narrative pages of this chapter as Table 3.2, "Industrial Construction Projects List." The sequence used in coding the jobs was to assign the first two digits as the year the project began. Thus the job number 5110 begun in 1951 was the Chalmette Aluminum Smelter with an estimated project value of $148 million.

Note in the table that many of the projects listed were massive undertakings for the time. The Chalmette plant in today's costs would exceed $1 billion.

Also note how in the first page of the table the listings up to 1955 were predominantly for Kaiser affiliated companies. After that, projects were for a variety of industrial and mining firms whose projects were located in the industrial states of the United States and abroad.

KE's headquarters were in Oakland, but none of the projects listed were even close to Oakland. KE was better known in far-off places than it was at home. With projects located in remote places, it meant that KE's management and executives traveled a lot. One executive logged 2 million miles until he stopped keeping track of his mileage. That's like 80 trips around the globe.

The projects were large. The industrial projects listed have an aggregate contract value at costs prevailing at that time of $17 billion.

## Construction Management

### Prelude to Construction Management

Heavy construction was pursued as a business in itself in the prewar years. But during the Fontana years, the war years, and the postwar worldwide building boom, Kaiser Engineers' construction activity was a significant part of the single-responsibility package of design, procurement, and construction of industrial projects. The owners' emphasis at those times was on early completion of projects to permit early entry into markets for their products. Such projects were undertaken by KE on cost-plus-fee basis to permit fast-track overlapping of phases of the work.

KE's reputation for completing projects on time and within budget played a major role in winning new contracts. Most of the construction division's work in the early years was done for affiliated Kaiser companies. When that work declined, KE began to market itself successfully to outside companies, and the single-responsibility contracting approach continued to have wide appeal. KE used the project manager-task force approach for all projects. Construction operations organizationally were the responsibility of the project manager. Field construction activity was under the direction of a site construction manager who was nearly autonomous in the construction arena.

Usually, Frank Bort staffed construction people with the approval of the project manager. Functionally, construction people reported to Bort, but administratively to the project manager.

Until about 1970, domestic projects were largely on a direct-hire basis with KE management and superintendents directly managing hired union craft labor, stemming from heavy construction and wartime shipbuilding.

At the end of the postwar boom, some owners became disenchanted with large cost overruns on their own projects. They began to insist upon the construction management approach to projects or some lesser responsibility by our industrial construction forces. KE's role then came into three forms as follows:

- Construction Management as a part of KE's architect-engineer services.
- Construction Assistance and/or construction advice as an adjunct to other services.
- Don Barrie's Construction Management operating as a profit center.

These three roles are discussed in the next subchapters.

## Construction Management as Part of AE Services

By the mid-1970s, the phased construction approach began to appeal more and more to owners as they seemingly combined the best of two worlds: faster completion than their normal design-bid-build system and more cost effective than the faster single-responsibility cost-plus-fee basis. Under the newer approach, design was ideally completed in a natural sequential series of contract packages which were bid usually to local contractors on a fixed-price basis. KE provided the overall coordination and management of site construction, along with contract administration, quality control, and schedule management.

Outside the U.S., this was also the preferred contracting method. In a mature environment like Australia, fixed prices could be obtained.

The adoption of the CM method did not change KE's approach. It was still a totally managed product of design, procurement, and construction management, but KE personnel were now one step removed from direct construction craft personnel.

## Cement Projects

A series of 12 cement plants, designed by KE was performed this way during the years 1976 through 1983 when KE was recognized as the world leader of cement plant construction. The end of the '70s saw a continuation of new cement projects designed and constructed by KE. These included Calaveras Cement at Redding, California (Clyde Gray), Martin Marietta at Davenport, Iowa (Uwe Clausen), Marquette Cement at Cape Girardeau, Missouri (Earl Woodward), and the California Portland Cement plant at Mojave, California (Bill Stevens).

By the end of the decade other cement projects were built, including OKC Cement in Oklahoma (Bill Biebesheimer), Cibinong 2 in Indonesia (Hal Meyer), Coplay Cement in Nazareth, Pennsylvania (Bill Stevens), and Medusa Cement in Charlevoix, Michigan (Foster Sisson).

In the decade of the '80s, cement projects included one in Hong Kong (Bill Stevens) and an expansion at Cushenbury for Kaiser Cement (Foster Sisson).

## Other CM Projects

KE managed the Stanford Co-generation Project with Uwe Clausen, Bob Franklin, and Ron Blaj. The Stanford Linear Accelerator project was handled by Bill Sproule, Harvey Caesar, and Gerry Abraham. Then followed a large overland bauxite conveyor for Alpart in Jamaica handled by Pete Hanley. The Reef Runway job in Honolulu was completed under Pat Bedford's regime. Then followed Uranium Mills for Chevron at Panna Maria, Texas, handled by T. R. Gray and another for Union Oil in Sweetwater, Wyoming, by Rick Larson. For the Department of Energy there was the MHD Test Facility at Butte, Montana, handled by Al Orne. The Caraiba Copper Mine in Brazil had Dan Blackwood on its construction side. The largest zinc refinery at the time was in Clarksville, Tennessee, for JMZ, handled by Bill Stevens and Bob Miller.

## Other Notable Projects

KE kept busy during the '70s and '80s with a number of construction projects. Several notable projects included an aluminum smelter for Martin Marietta at Goldendale, Washington (Earl Schuerman); two semi-conductor plants for SEH America at Vancouver, Washington (Earl Woodward); the silo-hardening project for the U.S. Air Force at Yuma, Arizona (Dave McMyler and John Berentis); coke oven batteries for Republic Steel in Chicago (Ken Willis); Rouge Steel in Detroit (Joe Sullivan and Gary Thronson); casters for Armco at Ashland, Kentucky (Wilson Hoffman, Jim Short, and Rusty Kodet); casters for Wheeling Steel at Monesson, Pennsylvania (Al Lawrence); and Steubenville, Ohio (Walt Kitchen).

## Public and Government Projects

As the decade of the '80s moved on, KE was able to land transportation projects for the Metro North, Foster Sisson; and construction management assistance for the Los Angeles to Long Beach light rail line, Max Horowitz and Dick Pitney. Later the Taipei Rapid Transit Project in Taiwan was undertaken. Another government job was the rehabilitation of the mile-long aircraft maintenance facility at Tinker Air Force Base in Oklahoma, Ken Schuerman. Projects also included construction management for four bulk mail facilities for the U.S. Postal Service in Washington, D.C. (Pete Handley); Los Angeles (Cal Smith); Dallas (Walt Kitchen); and Springfield, Massachusetts (Al Lawrence).

## Mining Projects

In the latter '80s, KE did construction management for the heap-leach gold processing plant for Echo Bay Mines at Round Mountain, Nevada (Dave McMyler and John Berentis). Then followed the Neves-Corvo Copper Concentrator in Portugal (Dan Blackwell and Uwe Clausen).

## Boston Harbor

In 1988, KE was awarded a key role in the management of the huge Boston Harbor Project for the Massachusetts Water Resources Authority. This was a court-ordered clean up of the harbor for a project whose value was estimated at $4 billion. KE's role was program and construction manager. Ken Willis initiated the project when he moved from the Oakland headquarters, relinquishing his role as head of industrial construction. His successful tenure on the Boston Harbor Project still continued into the year 2000.

## Construction Assistance and/or Advice

Many of the projects for which KE was the architect-engineer required limited staff. This was especially true of overseas design of hydroelectric facilities in Brazil and some steel projects when owners felt they had competent construction contractors. KE's role on such projects was to provide possibly a single resident construction man who quite often was referred to as a construction engineer. The assignment was to provide advice and assistance on construction matters with limited coordinating responsibilities. The construction engineer typically provided a vehicle for the engineering staff to check against construction interferences and to provide a check on whether the contractor was adhering to design concepts.

On several steel projects internationally, KE provided engineering services and such limited services at Somisa in Argentina and Cosipa in Brazil. Uwe Clausen did field coordination at Somisa where the client employed the German firm Ferrostaal to do physical construction. At Cosipa Joe Vance provided construction advice and assistance. His introduction was a challenge. Cosipa's field construction manager was a civil engineer who was an expert on water supply. Feeling that he knew best, he ignored the KE design for site development and, instead, constructed a series of canal waterways for plant water supply. Needless to say, canals would interfere with railroad trackage and siting of permanent facilities such as blast furnaces and steel-making facilities. It was when this water expert was replaced that we proceeded to direct the filling-in of the canals.

## Foreign Steel Rescue Assignments

A series of steel projects began as a result of the 1973 oil crisis began in countries around the world in order to capitalize on the large income due to the increased oil prices and to find a way to use the flared natural gas. Projects began in Iran, Venezuela, and Indonesia. Eventually, each got into trouble, and they called for help from KE. Our assistance was offered on the basis of providing staff to fill in the owners' own construction staff. Thus, construction assistance was provided.

At Ahwaz in Iran, a crew was headed by Jim Miller and included Doil Yocham, George Boyde, Lyle Marsh, Gene Green, Ron Betz, and Chuck Whitford. The crew got caught in the Iranian revolution of 1978 when the Shah of Iran was overthrown. Fortunately, the crew was able to leave the incomplete project just a few days before other Americans were taken hostage.

At Sidor in Venezuela, Key Ryan and Don Cardarelle provided construction assistance. In addition, another construction leadership role for the infrastructure of the area of Ciudad Guiana, of which Sidor was a part, was conducted by Sherrill McDonald, Bob Miller, Lachlan McBean, and Frank Walker.

At Krakatau in Indonesia, KE had a more substantial role in overall management and in refining the concepts of this large steel manufacturing complex. In addition, construction assistance was provided. Bill Smith was in charge with construction assistance by Harvey Hautala, Curt Jensen, Key Ryan, and Doug Robbins. Additional assistance came from KE's Australian nationals.

## List of Construction Management and Construction Assistance Projects

Abstracted from KE's perpetual job list is a listing of large construction management projects undertaken by KE's industrial construction staff along with construction assistance assignments. This follows the narrative as Table 3.3. Note how the prevalence of construction management projects begun in the 1970s and by the decade of the '80s it was the preferred mode of construction.

The combined listing contains some very large projects, several involving billions of dollars. The total value of the projects listed at the cost of construction at the time was $24 billion.

## Don Barrie's Construction Management Division

### An Ad hoc CM Department Is Formed

While some owners opted to employ KE construction management services alone as previously described, a separate department was created within the construction division to handle smaller projects like this. From 1971 through 1986, a professional construction management group was organized and headed by Don Barrie. It was formed on an ad hoc basis without any formal budget for its development. Owners could use these services even if KE did not do the design of their facilities, but rather, used our construction management services only. The group was given department status by George Roberts in recognition of the good, profitable work performed by Don Barrie and his group. It was the construction division's own version of a "skunk works," similar to the well-known and fiercely independent "skunk works" of the Lockheed Company which produced some outstanding edge-of-the-envelope aircraft like the stealth fighter.

### Safeway Projects Begin the CM Department

As related by Barrie in an interview with Sherrill McDonald in 1996, it all began in late 1971 when KE was trying to get into engineering and / or construction for the food industry. Howard Naughton, who was handling marketing for general industries, brought George Pope, chief engineer of Safeway, to the Kaiser Center for lunch. George Roberts and Vince Palmer learned that Safeway had a small nonfood warehouse project about to start in Denver. It was Safeway's intent to commit it to a general contractor based upon Safeway's own architect's designs. They agreed to give us the plans to see if we could improve performance. Because it had lots of stores coming on line, they needed to complete the warehouse quickly. In the past when they had to fast-track a job, they negotiated with a general contractor, but it usually cost them 10 to 15 percent more.

Don Barrie was assigned to meet with Pope, and Barrie described the KE concept that would phase the design and contract packages. Construction could be performed on a fixed-price basis with a small contingency, and the project could be completed in 10 months from the start of design versus 13 months with a general contractor. Safeway found the concept attractive and agreed to the KE concept. Jim Gurecki was assigned to define the packages under Don Barrie who became project manager, working with a local architect, Leo Rosenthal, with whom KE had dealings before. They met with prospective contractors and pre-qualified them. KE had only one man on site acting as construction manager, Curt Jensen. Barrie's plan called for a good winter and, luckily, it was. The project was completed as scheduled and impressed Safeway so much that it led to a number of future jobs. A Denver bakery and a distribution center in El Paso followed. Bonelli was the architect on the last two and was responsible for the department obtaining more work in the food industry.

## CM Staff

In 1982, Barrie was made vice president and was given responsibility for Foothill Electric also. After Don retired, between 1984 and 1986, Gurecki headed the group that was renamed the General Facilities Division.

The department was never large with only about six people. Gurecki assisted Barrie until about 1974 when he headed the Motorola Project in Arizona, and Vince Palmer joined the group. It was about that same time that Don Sahlberg became vice president of construction, and he continued the support that had been given to the department. Some of the office personnel were Ted McManus, Omar Finsand, John Henri, Bruce Moen, George Morschouser, Steve Whitehead, and Jim Jackson. Some of them held field jobs as well. Other personnel included Bill Rutherford, Dave Corn, Glen Kaiser, Bill Linforth, and Brad Rintzer.

## CM Methodology

This led to a 3-party team consisting of the owner, the architect, and KE working closely together on a non-adversarial basis. The process was simple on the face of it. Develop the schedule with the owner, then work with the architect so that the design met the schedule, or in some cases, modifying the schedule to fit the architect's requirements. The last two jobs had about 10 to 12 packages each, and both were successful from a schedule and cost standpoint.

One of the innovations growing out of the department was the concept of "value engineering" as part of the construction process. For Barrie, it originated with a meat plant that Safeway wanted to build in Calgary. Safeway had a favorite architect there, and Barrie met with them to describe our concept. As Barrie explained it, "We took the preliminary plans by the architect and met for a half hour or so with the leading contractors, describing the scope of the work and asking for their suggestions as to how we could make the project better and more effective. This heightened their interest and resulted in a number of ideas about local methods. This technique was used on all jobs after that with great success. We collected these ideas from the pre-bid discussions and used many of them as alternates in the bid documents. We estimated the cost savings at about 5 percent. One year the Safeway chief engineer won an award for the innovative cost savings! Later, we let the contractor volunteer savings as part of the competitive bid process. The owner received the entire savings, and the contractor got the job. Some of these ideas we borrowed and used for other jobs in different parts of the country."

## Other Food Projects

The period 1972 to 1980 was a good time in the food industry. Everyone was expanding, and the department did seven projects for Safeway alone. Bonelli, the architect, brought Lucky Stores aboard, and three jobs for them followed. Other food projects included Ralph's, Zacky Farms, and United Grocers. Jim Gurecki sold the first job for Frito Lay, a snack food expansion in Mississippi. Three more projects were done for them in Washington, Kansas, and Arizona. Then in about 1980, this type of activity cooled. The last food projects were for Frito Lay in 1982 and 1984.

## Non-food Projects

There had been some non-food jobs during the peak years, including a semiconductor plant for Motorola in 1974, the MHD project for the Department of Energy in Butte, Montana, in 1976; the NOVA Laser facility at the Livermore Lab in 1977; and a synfuels project for Chevron in Richmond, California, in 1981. All these projects fit the model of requiring construction management services only. After 1980, only 3 of 10 jobs done by the department were in the food industry. The work done earlier on non-food projects and an excellent record of accomplishments on all projects made it possible to expand the work of the department into other areas.

This included the $45-million Shuttle Assembly Building at Vandenburg, handled by Dick Hulseman and Al Orne, and the semiconductor epitaxial wafer plants in Vancouver handled by Earl Woodward.

## I-595 Expressway

The grandest of all the construction management projects handled by the Barrie group was the I-595 project for the Florida Department of Transportation. This project had a project value of $1 billion but is listed on Barrie's own project list as $50 million. (It is also shown on KE's construction management list at full value.) First awarded in 1983, it lasted into the '90s and involved right-of-way acquisition and construction management. Jim Weir, former Navy captain, headed the project. Key KE employees assigned were Dick Curry, George Fraunces, Bill Rutherford, Lachlan McBean, Steve Huckins, and Jim Pardepoosh. This project established a firm presence for KE in Florida.

In the period 1971 to 1984, the construction management department completed 36 projects. Records maintained by Don Barrie show that in this period of time the department returned a gross margin (fee plus overhead) steadily increasing from $275,000 in 1972 to $2.5 million in 1984.

## Barrie's Construction Management Project List

Following this subchapter is a listing of the projects performed by the Barrie construction management staff. It is Table 3.4. The total contract value of these projects at the times of their performance was $705 million.

## Industrial Estimating

Originally, estimating and scheduling came under Frank Bort's sponsorship. Chief estimator in the early years was Paul Stafford followed by Ed Lowell. Gene Hoggatt headed the scheduling group assisted by Ed West on scheduling and estimating. Sabih Ustel was sent on special assignment to handle the complicated scheduling requirement for Armco's Project 600. Industrial Estimating was headquartered in Oakland. Ed Lowell is still remembered for his innovative estimating style and good humor.

This group maintained voluminous files of cost data from prior jobs and a cadre of well-trained conceptual estimators who could prepare estimates based on very little information, or they could prepare detailed estimates of costs for bidding purposes. They could prepare "door knob" estimates, "horseback" estimates, or order-of-magnitude estimates whenever called upon by management in order to plan projects. Classification of estimates was suggested by Jim Thompson and numbered 1 to 5. After much lobbying by Jim, Type 1, 2, 3, 4, or 5 estimates came to be well known. The door knob, for example, became Type 1.

One remembers a client who came to Oakland to participate in defining a multi-million-dollar mining program. One piece of the project involved a copper briquetting facility for which only pilot plant data was available, and they wanted a feel for likely cost of a plant. Ed Lowell was asked to come up with an estimate. After waving of arms and guessing how big the clarifier would be and vaguely describing the process equipment, Ed was asked to come back with some numbers. Thirty minutes later, Ed arrived with his usual green-lined paper full of numbers with a heading that read, "WAG estimate." The client asked, "What is that?" Ed: "A wild-assed guess." It was greeted with much good cheer and communicated the accuracy very well.

Later, he was given a little more data and was asked to come back with another try. He reported back within an hour and had a green sheet that was now headed "SWAG estimate." "What is that?" "Oh, since I had the luxury of another hour to think about it, it is now a scientific, wild-assed guess."

The industrial estimating department was charged with responsibility of estimating projects from inception to establish a budget, through monitoring estimates to complete the project. Once approved as a budget, all cost activities were monitored to maintain cost control. Monthly, estimators cooperated with accountants in preparing the *Cost and Comparison to Estimate Report*. It was one of the three control reports available to a project manager.

At inception of a project, because of their familiarity with the budget items, estimators defined a chart of accounts for the project, so that cost elements could be segregated and line items could be monitored.

The critical path method of controlling schedules became a management tool for controlling a project schedule. In the case of Armco's Project 600, controlling the schedule was deemed of such importance that a staff was detached to the project working full-time on CPM scheduling.

Likewise, for proper control of project costs, project estimators were detached and sent to project sites to constantly update estimates of cost to complete the project as they analyzed costs incurred.

**Table 3.1**
**Heavy Construction Project List**

| Job No.[1] | Project Name | Client | Location | Sponsor/ Participant | Project Value $xmillions |
|---|---|---|---|---|---|
| 4301 | Ross Dam | City of Seattle | Washington | Participant | 18 |
| 4601 | Davis Dam | Bureau of Reclamation | Arizona | Participant | 31 |
| 4802 | Hungry Horse Dam | Bureau of Reclamation | Montana | Participant | 48 |
| 4902 | E. Delaware Aqueduct | Board of Water Supply | New York City | Participant | 43 |
| 4928 | Detroit Dam | Corps of Engineers | Oregon | *Sponsor* | 26 |
| 5162 | Big Cliff Dam (Detroit) | Corps of Engineers | Oregon | Participant | 7 |
| 5187 | Sir Adam Beck Tunnels | Ontario Hydro | Ontario, Canada | Participant | 50 |
| 5211 | Chief Joseph Dam P.H. | Corps of Engineers | Washington | Participant | 46 |
| 5303 | Garrison Dam P.H. | Corps of Engineers | North Dakota | *Sponsor* | 13 |
| 5427 | Snowy Mountains | SM Hydro Authority | Australia | *Sponsor* | 54 |
| 5602 | Pittsburgh Sewer Tunnels | Allegheny Co. Sanitation | Pennsylvania | Participant | 12 |
| 5603 | Adaminably Dam | NSW Dept. of Public Wks | Australia | *Sponsor* | 14 |
| 5604 | Haas Tunnel & P.H. | Pacific, Gas & Electric | California | Participant | 11 |
| 5643 | Water Supply System[3] | Corposana | Paraguay | *Sponsor* | 11 |
| 5655 | Tres Marias Dam[4] | Brasil Power Authority | Brasil | Participant | 20 |
| 5701 | Military Garrisons | Corps of Engineers | Iran | Participant | 75 |
| 5702 | Tres Marias Dam | Cent. Elec. De Minas Ger | Brasil | Participant | 62 |
| 5720 | Hood Canal Floating Bridge | State of Washington | Washington | Participant | 16 |
| 5803 | Navajo Dam | Bureau of Reclamation | New Mexico | Participant | 26 |
| 5850 | T2 Diversion Dam | SM Hydro Authority | Australia | *Sponsor* | 48 |
| 5943 | Wanapum Dam | Grant Co. P.U. District | Washington | Participant | 101 |
| 5944 | Greers Ferry Dam | Corps of Engineers | Arkansas | Participant | 18 |
| 6003 | Atlas Launch Complex | Corps of Engineers | New Mexico | Participant | 24 |
| 6004 | Airport Runway, Terminal | Canada Dept of Transp. | British Columbia | *Sponsor* | 3 |
| 6017 | Titan Missile Bases | Corps of Engineers | Idaho | *Sponsor* | 34 |
| 6036 | Big Horn Dam | Bureau of Reclamation | Montana | Participant | 40 |
| 6056 | Atlas Missile Base | Corps of Engineers | New York | Participant | 27 |
| 6057 | Atlas Missile Base | Corps of Engineers | New Mexico | Participant | 24 |
| 6058 | Missile Fuel Plant | Thiokol | Utah | Participant | 12 |
| 6059 | Mount Isa Railway | Queensland Government | Australia | Participant | 5 |
| 6110 | Titan Misssile Bases | Martin Company | Idaho | *Sponsor* | 10 |
| 6150 | Irrigation Links Canals | WP Power Authority | West Pakistan | *Sponsor* | 28 |
| 6151 | Yellowtail Dam | Bureau of Reclamation | Montana | Participant | 43 |
| 6252 | Commonwealth Ave Bridge | Nat'l Capitol Dev. Co. | Australia | Participant | 3 |
| 6154 | Sirinumu Dam, Papua | Australia Dept of Pub Wks | New Guinea | Participant | 1 |
| 61509 | Diversion Tunnels | Public Power Corp. | Greece | *Sponsor* | 3 |
| 6260 | Netufa Canal Lining | Nekoroth Water Co. | Israel | Participant | 1 |
| 6241 | Peace River Diversion | B. C. Hydro | British Columbia | Participant | 18 |
| 6259 | McCloud River Tunnel | Pacific, Gas & Electric | California | Participant | 20 |
| 6311 | American River Project | American Riv. Constr. | California | *Sponsor* | 95 |
| 6325 | Lunalilo Freeway | Hawaii Dept of Transp. | Hawaii | *Sponsor* | 4 |
| 6323 | Berri Street Subway | City of Montreal | Canada | *Sponsor* | 3 |
| 6353 | Guri Hydroelectric Project | Consorcio Guri | Venezuela | *Sponsor* | 74 |
| 6358 | Wells Hydroelectric | Douglas Co. P. U. Dist. | Washington | Participant | 67 |
| 6359 | Mr. Isa Railroad Cont. 10 | Queensland Government | Australia | Participant | 5 |
| 6402 | De Montigny Subway | City of Montreal | Canada | *Sponsor* | 3 |
| 6404 | Beri Street Viger Subway | City of Montreal | Canada | *Sponsor* | 2 |
| 6405 | Subway, Underground Sta. | City of Montreal | Canada | *Sponsor* | 3 |
| 6492 | Kremasta Hydro Dam | Public Power Corp. | Greece | *Sponsor* | 82 |
| 6493 | Dead Sea Dikes | Dead Sea Works, Ltd. | Israel | *Sponsor* | 25 |
| 6504 | Navajo Irrig Tunnel #2 | Bureau of Reclamation | New Mexico | Participant | 9 |
| 6505 | Rapid Transit Tunnels | Bay Area Rapid Transit | California | Participant | 33 |



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**Table 3.1 con't**

| Job No.[1] | Project Name | Client | Location | Sponsor/ Participant | Project Value $xmillions |
|---|---|---|---|---|---|
| 6611 | Military Facilities | U. S. Navy | Thailand | Participant | 140 |
| 6651 | Angeles Tunnel | Dept of Water Resources | California | Participant | 106 |
| 6968 | Pyramid Dam, Init. Fac. | Dept of Water Resources | California | Participant | 3 |
| 7020 | Angeles Tunnel Intake | Dept of Water Resources | California | Participant | 5 |
| 7503 | Clear Creek Tunnel | Bureau of Reclamation | California | Participant | 44 |
| | | | | | 1,749 |

***Notes:***

[1] Numbering was chronological with the first two letters indicating year project was initiated, i.e., 4628, Detroit Dam, started in 1946.
[2] Heavy construction work was performed in joint venture with other contractors. Where KE sponsored the work, it is so indicated.
[3] Fee-based project. Kaiser construction. No partners.
[4] Fee-based project.

**Table 3.2**

## Industrial Construction Projects List

**Project where KE was both**
**Architect/Engineer and Constructor**

| Job No.[1] | Project Name | Client | Location | Project Value $ x millions |
|---|---|---|---|---|
| 4201 | Iron and Steel Plant | Kaiser Steel | Fontana, CA | 147 |
| 4401 | Shell Plant Facilities | Corps of Engineers | Fontana, CA | 16 |
| 4555 | Iron & Steel Facilities #4 | Kaiser Steel | Fontana, CA | 11 |
| 4750 | Eagle Mountain Mine | Kaiser Steel | Eagle Mountain | 5 |
| 4781 | Press Plant | Kaiser Fleetwings | Bristol, PA | 2 |
| 4811 | Ironton Blast Furnace | Kaiser-Frazer | Utah | 3 |
| 4828 | Aluminum Rod Mill | KaiserAluminum | Newark, OH | 2 |
| 4840 | Open Hearth Plant | Kaiser Steel | Fontana, CA | 14 |
| 4845 | Porcelain Enamel Plant | Kaiser Metal Products | Bristol, PA | 2 |
| 4850 | Blast Furnace #2 | Kaiser Steel | Fontana, CA | 28 |
| 4941 | Cabinet Facilities | Kaiser Metal Products | Bristol, PA | 2 |
| 5033 | Fifth Kiln | Kaiser Cement | Permanente | 4 |
| 5096 | Tin Mill & Auxiliary Facil. | Kaiser Steel | Fontana, CA | 28 |
| 5102 | Diatomacious Earth | Great Lakes Carbon | Lompoc, CA | 3 |
| 5110 | Aluminum Reduction | Kaiser Aluminum | Chalmette, LA | 148 |
| 5120 | Alumina Plant | Kaiser Aluminum | Baton Rouge, LA | 7 |
| 5121 | Bauxite Mining | Kaiser Aluminum | Jamaica | 10 |
| 5149 | N&S Ore Bodies | Kaiser Steel | Eagle Mountain | 4 |
| 5175 | Steel Plant Expansion | Kaiser Steel | Fontana, CA | 59 |
| 5186 | Carbon Baking Furnace | Kaiser Aluminum | Mead | 7 |
| 5191 | Alumina Plant Additions | Kaiser Aluminum | Baton Rouge, LA | 19 |
| 5193 | Steam Plant Additions | Kaiser Aluminum | Chalmette, LA | 55 |
| 5218 | Sunnyside Coal Mine | Kaiser Steel | Utah | 5 |
| 5234 | Plutonium Plant | Atomic Energy Commission | Hanford, WA | 120 |
| 5251 | Lighting Fixture Plant | Westinghouse | Mississippi | 3 |
| 5340 | Wallboard Plant Expans. | Kaiser Gypsum | Seattle, WA | 3 |
| 5357 | Wide Slab Facilities | Kaiser Steel | Fontana, CA | 5 |
| 5430 | Aluminum Rolling Mills | Kaiser Aluminum | Ravenswood, WV | 22 |
| 5503 | Wallboard Expansion | Kaiser Gypsum | Long Beach, CA | 3 |
| 5505 | Refractory Brick Plant | Kaiser Aluminum | Ohio | 5 |
| 5510 | Aluminum Reduction | Kaiser Aluminum | Ravenswood, WV | 82 |
| 5518 | Wallboard Plant | Kaiser Gypsum | Antioch | 6 |
| 5520 | Boiler Plant Additions | Kaiser Aluminum | Baton Rouge, LA | 5 |
| 5522 | Aluminum Rolling Mills | Kaiser Aluminum | Ravenswood, WV | 91 |
| 5529 | Sixth Kiln | Kaiser Cement | Permanente | 4 |
| 5530 | Cement Plant | Kaiser Cement | Cushenburry | 13 |
| 5549 | Fine Ore Beneficiation | Kaiser Steel | Eagle Mountain | 4 |
| 5543 | Aluminum Extrusion | Kaiser Aluminum | Maryland | 6 |
| 5544 | Engineering Test Reactor | Atomic Energy Commission | Idaho Falls, ID | 15 |
| 5559 | Cement Plant Additions | Marquette Cement | Missouri | 8 |
| 5560 | Gilsonite Refinery | American Gilsonite | Colorado | 4 |
| 5566 | Iron and Steel Plant | Tata Iron & Steel Company | India | 151 |
| 5592 | Alumina & Chlorine Plant | Kaiser Aluminum | Gramercy | 76 |
| 5603 | Steam Power Plant | St. Joseph’s Lead | Pennsylvania | 22 |
| 5605 | Ninth Potline | Kaiser Aluminum | Chalmette, LA | 14 |
| 5606 | L-D Oxygen Steel Adds. | Jones & Laughton | Pennsylvania | 9 |
| 5650 | Steel Plant Expansion | Kaiser Steel | Fontana, CA | 209 |
| 5666 | Platform Unit | Shell Oil | Wilmington | 6 |
| 5704 | Diatomacious Earth | Eagle Pitcher | Nevada | 2 |
| 5706 | Foreman Cement Plant | Arkansas Cement | Arkansas | 11 |
| 5711 | Circuit Breaker Plant | Westinghouse | Pennsylvania | 4 |
| 5818 | Heat Treat Facilities | Kaiser Aluminum | West Virginia | 8 |
| 5840 | Airfield Building | Defense Constructors, Ltd. | Canada | 4 |
| 5825 | Steam Electric Station | Puerto Rico Water Res. | Puerto Rico | 4 |



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**Table 3.2 con't**

| Job No.[1] | Project Name | Client | Location | Project Value $ x millions |
|---|---|---|---|---|
| 5836 | Iron Ore Concentrator | Quebec Cartier | Canada | 50 |
| 5844 | Secondary Crushing Fac. | Kaiser Steel | Eagle Mountain | 11 |
| 5919 | Cement Plant | Kaiser Cement | Hawaii | 11 |
| 5920 | Wallboard Plant Reloc. | Kaiser Gypsum | New Mexico | 2 |
| 5921 | New Production Reactor | Atomic Energy Commission | Hanford, WA | 154 |
| 5922 | Alumina Plant | Hindustan Aluminum | India | 32 |
| 6003 | Townsite | Quebec Cartier | Canada | 10 |
| 6005 | Solid Fuel Propellant | Thiokol Chemicals | Utah | 12 |
| 6012 | Wallboard Plant | Kaiser Gypsum | Florida | 6 |
| 6020 | Aluminum Smelter | Hindustan Aluminum | India | 32 |
| 6060 | Steel Rolling Mills | Pacific Steel | New Zealand | 7 |
| 6115 | Iron Ore Facilities | Wabush Mines, Ltd. | Canada | 68 |
| 6119 | Cement Plant | Kaiser Cement | Montana | 10 |
| 6121 | 3rd Kiln Expansion | Kaiser Cement | Cushenberry | 9 |
| 6136 | Iron Ore Beneficiation | Kaiser Steel | Eagle Mountain | 6 |
| 6227 | L-D Oxygen Steel Plant | Armco Steel | Kentucky | 22 |
| 6304 | Asbestos Stripping | Lake Asbestos | Quebec | 5 |
| 6305 | Liquid Hydrogen | Union Carbide | Sacramento, CA | 20 |
| 6326 | Tin Mill & Aux. Facilities | Kaiser Steel | Fontana, CA | 14 |
| 6351 | Aluminum Smelter | Valco | Ghana | 192 |
| 6401 | Iron Ore Beneficiation | Kaiser Steel | Fontana, CA | 19 |
| 6402 | Town for Remote Const. | Wabush Mines, Ltd. | Canada | 6 |
| 6416 | Wallboard Plant | Kaiser Gypsum | New Jersey | 7 |
| 6427 | Alumina Smelter | Valco | Ghana | 120 |
| 6428 | Electric Weld Pipe Mill | Kaiser Steel | Fontana, CA | 6 |
| 6435 | Queensland Alumina | Qualco | Australia | 94 |
| 6441 | Cement Plant Expansion | Arkansas Cement | Arkansas | 13 |
| 6474 | Middletown Steel Plant | Armco Steel | Middletown, OH | 432 |
| 6475 | Butler Plant Expansion | Armco Steel | Butler, PA | 145 |
| 6472 | Houston Plant Expansion | Armco Steel | Houston, TX | 22 |
| 6480 | Steel Plant Expansion | Kaiser Steel | Fontana, CA | 73 |
| 6545 | Iron Ore Pellet Plant | Hamersly Iron Ore | Australia | 46 |
| 6558 | Radium Aggregates | Kaiser Sand & Gravel | California | 12 |
| 6560 | L-D Oxygen Steel Plant | Alan Wood Steel | Pennsylvania | 27 |
| 6601 | Pellet Plant Pilot | Wabush Mines, Ltd. | Canada | 5 |
| 6603 | Magnesium Plant | See Mining Corp. | Canada | 4 |
| 6606 | L-D Oxygen Steel Plant | Youngstown Steel | Pennsylvania | 65 |
| 6620 | Lead Smelter | Asarco | Glover, MO | 34 |
| 6629 | Alumina Plant | Jamaica Alumina Partners | Jamaica | 146 |
| 6641 | 4th Potline | Kaiser Aluminum | Tacoma, WA | 20 |
| 6650 | Alumina Plant | Qualco | Australia | 41 |
| 6692 | Alumina Plant | Alpart | Jamaica | 146 |
| 6714 | Alumina Load Out | Kaiser Aluminum | Baton Rouge, LA | 5 |
| 6721 | Rolling Mill Expansion | Kaiser Aluminum | Ravenswood, WV | 42 |
| 6739 | Aluminum Reduction | National Southwire | Kentucky | 93 |
| 6746 | Caustic Chlorine | Kaiser Aluminum | Baton Rouge, LA | 25 |
| 6748 | Caustic Chlorine | Kaiser Aluminum | Gramercy | 25 |
| 6702 | Phosphorous Mfg. | Electric Rod Company | Canada | 40 |
| 6824 | Aluminum Reduction | Noranda Mines | New Madrid, MO | 81 |
| 6831 | Cold Rolled Sheet | Kaiser Steel | Fontana, CA | 19 |
| 6866 | East Intercourse Iron Ore | Hamersly Iron Ore | Australia | 110 |
| 6872 | Bluff Aluminum Reduct. | | New Zealand | 89 |
| 6873 | Alumina Plant | Qualco | Australia | 45 |
| 6902 | 4th Potline, Power Plant | National Southwire | Kentucky | 60 |
| 6908 | Cement Plant Expansion | Gifford-Hill | Texas | 6 |
| 6929 | Thermal Power Plant | City of New Madrid | Missouri | 36 |



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**Table 3.2 con't**

| Job No.[1] | Project Name | Client | Location | Project Value $ x millions |
|---|---|---|---|---|
| 6932 | Strontium Carbonate | Kaiser Aluminum | Nova Scotia | 13 |
| 6942 | Alumina Plant Expansion | Alpart | Jamaica | 62 |
| 6957 | Copper Crushing, Leach. | Asarco | Arizona | 9 |
| 6964 | Alumina Plant Expansion | Qualco | Australia | 114 |
| 6965 | Aluminum Plant | Euraluminum | Italy | 81 |
| 7018 | Aluminum Smelter | Valco | Ghana | 22 |
| 7034 | Crushed Aggregates | Gifford-Hill | Texas | 9 |
| 7041 | Fluoride Plant | Kaiser Aluminum | Louisiana | 5 |
| 7043 | Iron Ore Concentrator | Wabush Mines, Ltd. | Canada | 31 |
| 7044 | Iron Ore Pellet Plant | Wabush Mines, Ltd. | Canada | 42 |
| 7045 | Copper Concentrator | Gaspe Copper | Quebec | 57 |
| 7051 | Railroad Upgrade | Hammersly Iron Ore | Australia | 41 |
| 7054 | Uranium Ore Processing | Continental Oil | Texas | 7 |
| 7070 | Nuclear Power Station | Zimmer | Ohio | 360 |
| 7131 | Aluminum Reduction | Amax | Puerto Rico | 18 |
| 7127 | Iron Ore Conc. Pellet | Cleveland Cliffs, Tilden | Michigan | 120 |
| 7145 | Calcining Plant | Kaiser Cement | Long Beach, CA | 3 |
| 7218 | Empire Iron Mine | Cleveland Cliffs | Michigan | 27 |
| 73101 | Aluminum Potline Expan. | Noranda Mines | New Madrid, MO | 62 |
| 7366 | Kiln Replacement | Huron Cement | Michigan | 23 |
| 7381 | Coal Gasification Plant | Great Plaines Coal | North Dakota | 2,200 |
| 74047 | Steel Plant Expansion | Stelco | Canada | 490 |
| 74092 | Kaiser Steel Expansion | Kaiser Steel | Fontana, CA | 35 |
| 74104 | Nuclear Power Station | Perry | Ohio | 5,200 |
| 74202 | Zinc Refinery | Jersey Miniere | Tennessee | 136 |
| 74023 | Steel Plant Modifications | Kaiser Steel | Fontana, CA | 200 |
| 74106 | Integrated Steel Plant | Stelco | Canada | 490 |
| 74114 | Fume Collector, Scrap | Kaiser Steel | Fontana, CA | 12 |
| 74131 | Uranium Mill | United Nuclear | New Mexico | 27 |
| 74249 | Steel Scrap Cutting | Kaiser Steel | Fontana, CA | 9 |
| 75103 | Coke Oven Plant | Dominion Steel | Canada | 110 |
| 75083 | Iron Ore Plant | Reserve Mining | Minnesota | 345 |
| 75178 | Uranium Mill | United Nuclear | New Mexico | 27 |
| 76160 | Uranium Mill | Union Oil | Wyoming | 35 |
| 76163 | Uranium Mill | Chevron | Texas | 19 |
| 76198 | Coke Oven Emission | Kaiser Steel | Fontana, CA | 12 |
| 76199 | Coke Gas Desulfurization | Kaiser Steel | Fontana, CA | 225 |
| 78149 | Aluminum Plant | Kaiser Aluminum | Baton Rouge, LA | 66 |
| 78152 | Troy Silver/Copper Conc. | Asarco | Montana | 51 |
| 79185 | Goldendate Alum Smelter | Marin Marietta | Washington | 120 |
| 79719 | Mojave Cement Electrical | Calif. Portland Cement | Mojave, CA | 15 |
| 80103 | Worsley Aluminum | Worsley Aluminum Pty. | Australia | 800 |
| 81081 | Bloom Caster Complex | Armco Steel | Kentucky | 104 |
| 81092 | Military Facilities | U.S. Navy | Diego Garcia | 600 |
| 82056 | Gas Turbines, Cogenera. | Westinghouse | Boron, CA | 30 |
| 83230 | ICBM Silo Super Harden | U.S. Air Force | Arizona | 30 |
| 84046 | Topps Precision Load Out | Carter Mining | Wyoming | 5 |
| 85105 | Coal Gasification Plant | Great Plaines Coal | North Dakota | 20 |
| 86086 | Tinker AFB, Restore Bldg | U.S. Army | Oklahoma | 29 |
| 86150 | Boddington Gold | Worsley Alumina | Australia | 30 |
| 86153 | Hanford Construction | U.S. Dept. of Energy | Washington | 501 |
| | | | | 17,424 |

***Notes:***

[1] Numbering was chronological with the first two letters indicating year project was initiated; i.e., #5110 was Chalmette, started in 1951.

**Table 3.3**
**Construction Management Projects**
**& Construction Assistance Projects**

Projects where KE was
Architect/Engineer
*but* did more limited construction services

| Job No.[1] | Project Name | Client | Location | Project Value $x millions |
|---|---|---|---|---|
| | ***Construction Management Projects*** | | | |
| 5508 | Automobile Plant | Industrias Kaiser Argentina | Argentina | 42 |
| 58510 | Automobile Plant | Willys Overland do Brasil | Brazil | 41 |
| 6059 | Mt. Isa Railroad | Queensland Government | Australia | 5 |
| 6111 | Copper Production Facilities | Soc. Minera el Teniente | Chile | 7 |
| 6345 | Auto Parts Foundry | Kelsey-Hayes | Michigan | 7 |
| 6359 | Mt. Isa Railroad #10 | Queensland Government | Australia | 5 |
| 6442 | Smelter Modifications | Kennecott Copper | Utah | 25 |
| 6808 | Hospital Constr Supervision | Kaiser Hospitals | Los Angeles | 24 |
| 6869 | Aluminum Smelter | Angelsley | Wales | 92 |
| 6872 | Aluminum Smelter | New Zealand Constructors | Bluff, NZ | 89 |
| 7037 | Elkview Coal Prep Plant | Westar Mining | Canada | 11 |
| 7038 | South Hills Transit | Port Authority Allegheny | Pennsylvania | 235 |
| 7045 | Copper Concentrator | Gaspe Copper | Canada | 57 |
| 7201 | Cement Plant | P.T. Semen Cibinong | Indonesia | 42 |
| 7228 | Cement Plant Modernization | Medusa Cement Co. | Georgia | 12 |
| 7242 | Waste Water Treatment | Vallejo Flood Control | California | 13 |
| 7246 | Reno Sparks Water Supply | Sierra Pacific | Nevada | 5 |
| 7301 | Dalhousie Wharf | National Docks & Harbors | Canada | 5 |
| 7318 | Cement Plant Expansion | Whitehall Cement | Pennsylvania | 11 |
| 7362 | Long Horn Cement Exp. | Kaiser Cement | Texas | 11 |
| 7397 | Glendale Water Supply | Sierra Pacific | Nevada | 5 |
| 74076 | Columbium Flotation | Niobec, Inc. | Canada | 10 |
| 74134 | Coal Prep Plant | Gregg River Resources | Canada | 20 |
| 74244 | Cement Plant | P.T. Semen Cibinong | Indonesia | 71 |
| 74257 | American Canyon Wastewater | Napa Sanitation | California | 13 |
| 75012 | Lead Sinter Plant | Empressa Minero Centro | Peru | 18 |
| 75054 | Cement Plant | Messinia Cement | Greece | 94 |
| 75115 | Glendale Water Treatment | Sierra Pacific | Nevada | 5 |
| 75149 | Elkview Plant Expansion | Westar Mining | Canada | 4 |
| 75160 | Coal Dewatering Facilities | Westar Mining | Canada | 20 |
| 75190 | Swan Brewery | Swan Brewery | Australia | 70 |
| 76069 | Steel Plant | Asil Celik Sonyi | Turkey | 150 |
| 76077 | Cement Plant Modernization | Coplay Cement | Pennsylvania | 52 |
| 76119 | Dade County Transit System | Dade County | Florida | 1,050 |
| 76128 | Positron Electron Storage Ring | Stanford Linear Accelerator | Stanford, CA | 33 |
| 76138 | Zinc Concentrator | Jersey-Miniere | Tennessee | 19 |
| 76176 | Copper Mine | Caraiba Metais | Brazil | 325 |
| 76199 | Coke Gas Desulfurization | Kaiser Steel | Fontana | 225 |
| 77125 | Pellet Plant | Eveleth Taconite | Minnesota | 105 |
| 77127 | Marquette Cement Plant | Marquette Cement Company | Missouri | 95 |
| 77128 | Medusa Cement Plant | Medusa Cement Company | Michigan | 57 |
| 77174 | Cement Plant Expansion | OKC Corp. | Oklahoma | 23 |
| 78040 | Mojave Cement Plant | California Portland Cement | California | 110 |
| 78108 | Calaveras Cement Expan. | Genstar Corp. | Redding, CA | 40 |
| 78110 | South Trend Mine | Mobil Oil | New Mexico | 30 |



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**Table 3.3 con't**

| Job No.[1] | Project Name | Client | Location | Project Value $x millions |
|---|---|---|---|---|
| | ***Construction Management Projects*** | | | |
| 78114 | Finishing Mills | California Portland Cement | California | 6 |
| j78125 | Cement Plant | Martin Marietta | Iowa | 85 |
| 78148 | Coke Oven Battery | Republic Steel | Illinois | 68 |
| 79054 | Steel Rail & Beam Expan. | Wheeling-Pittsburgh Steel | Pennsylvania | 99 |
| 79064 | Coke Oven Battery | Republic Steel | Illinois | 137 |
| 79068 | Rashadiya Cement | Kingdom of Jordan | Jordan | 185 |
| 79069 | SF Resource Center | Sanitary Fill Company | San Francisco, CA | 70 |
| 79087 | Calcium Carbide | White Martina | Brazil | 80 |
| 79089 | Aluminum Smelter | Aluminum Bahrain | Bahrain | 66 |
| 79127 | Laser Fusion Research Lab | Lawrence Livermore | California | 225 |
| 79167 | Coal Conveyor | Minas Carbon, Escondido | Mexico | 25 |
| 79185 | Goldenville Aluminum | Martin Marietta | Washington | 140 |
| 80014 | Cement Plant Conversion | Lone Star | Florida | 11 |
| 80051 | Kalimantan Bauxite/Alumina | Worsley Alumina | Australia | 956 |
| 80054 | Centromin Lead Sinter | Empressa Minero Centro | Peru | 41 |
| 80060 | Cushenbury Cement Plant | Kaiser Cement | California | 131 |
| 80070 | Hong Kong Cement | China Cement | Hong Kong | 350 |
| 80086 | Capricorn Smelter | Alcan | Australia | 430 |
| 80097 | AC Transit Facilities | AC Transit | Oakland, CA | 100 |
| 80152 | Uranium Rehab | Union Oil | Sweetwater, WY | 40 |
| 81014 | Houston Transit Improvements | Harris County Transit | Texas | 235 |
| 81039 | BART Professional Services | BART | San Francisco, CA | 20 |
| 81052 | Zwara Aluminum | Libya Aluminum | Libya | 1,000 |
| 81080 | Continuous Bloom Caster | Armco Steel | Kentucky | 104 |
| 81102 | Bullmoose Coal Mine | Tech Corp. | Canada | 99 |
| 81120 | Bloom Caster | Wheeling-Pittsburgh Steel | Pennsylvania | 48 |
| 81121 | Continuous Slab Caster | Wheeling-Pittsburgh Steel | Ohio | 95 |
| 81145 | Alumina, Bauxite | Alumina Partners, Jamaica | Jamaica | 115 |
| 81171 | Glendall Coal | Raymond Engineers | Australia | 58 |
| 81191 | Conversion to Coal | Puerto Rico Cement | Puerto Rico | 14 |
| 81192 | Coal Export Terminal | Dominion Terminal | Virginia | 76 |
| 82001 | Research Facilities | Arco | Texas | 25 |
| 82003 | Steel Plant Expansion | Babcock & Wilcox | Pennsylvania | 90 |
| 82015 | Copper Concentrate | Empress Minero Centro | Peru | 300 |
| 82024 | Aluminum Rolling Mill | Gulf Aluminum | Bahrain | 102 |
| 82070 | Coal Gasification/Methanol | TVA | Alabama | 1,000 |
| 82080 | LNG Northwest Shelf | Woodside LNG | Australia | 3,061 |
| 82084 | LNG Northwest Shelf | Woodside LNG | Australia | 550 |
| 83120 | Space Shuttle Assembly Bldg. | NASA | California | 44 |
| 83168 | Highway I-595 Expressway | Florida Dept. of Transportation | Florida | 1,200 |
| 83183 | Windmaster Wind Turbines | Windmaster Corp. | Byron, CA | 15 |
| 83196 | Nickel Laterite | California Nickel | California | 6 |
| 84089 | Chicago SW Transit | City of Chicago | Chicago, IL | 496 |
| 84116 | Tri-City Waste to Energy | California Recovery Systems | Alameda Co., CA | 45 |
| 84143 | Merritt Hospital Cogeneration | Medical Cogeneration | Oakland, CA | 6 |
| 84147 | Talc Grinding | Nicor Mineral | Montana | 9 |
| 84149 | Coke Oven Rebuild | Rouge Steel | Michigan | 57 |
| 84192 | Jack London Square Paving | Amphion Env. Corp. | Oakland, CA | 25 |

con't

**Table 3.3 con't**

| Job No.[1] | Project Name | Client | Location | Project Value $x millions |
|---|---|---|---|---|
| | ***Construction Management Projects*** | | | |
| 84193 | Jack London Sq. Food Prov. | CHNMB Associates | Oakland, CA | 20 |
| 84194 | Electric Furnace "D" | Lukens Steel | Pennsylvania | 100 |
| 84216 | ICBM Silo Superhardening | Dept of Defense | Arizona | 75 |
| 85045 | Waste Water Treatment | City of Orlando PUC | Florida | 36 |
| 85057 | Cogeneration Plant | Stanford University | California | 60 |
| 85107 | Miami Beach Convention Ctr | City of Miami Beach | Florida | 57 |
| 85109 | Aluminum Rolling Mill | Gulf Aluminum | Bahrain | 48 |
| 85112 | Ritchie Parkway | City of Rockville | Maryland | 6 |
| 85116 | Minerals Port | Government of Gabon | Gabon | 150 |
| 85124 | LNG Northwest Shelf | Woodside LNG | Australia | 1,873 |
| 85131 | Pierce Transit Base | Pierce County Public Transit | Washington | 19 |
| 85138 | Traction Power Substation | Metro North Commuter RR | New York | 55 |
| 85153 | Path Exchange Improvements | Port Authority of New York | New York | 36 |
| 86018 | Marion Street Transit | Hillsborough Reional Transit | Florida | 7 |
| 86048 | Automated Skyway | Jacksonville Transit Authority | Florida | 30 |
| 86066 | Neves-Corvo Copper | Soc. Min. de Neves-Corvo | Portugal | 108 |
| 86148 | EBMUD Network | East Bay Municipal Utility District | California | |
| | *Construction Management Only – no design* | | | |
| 86062 | Greek Alumina Refinery | Hellenic Alumina | Greece | 850 |
| 86073 | Track & Bridge Rehabilitation | Connecticut Dept of Transp. | Connecticut | 6 |
| 86084 | Piti Power Plant | U.S. Navy | Guam | 2 |
| 86110 | Path Station Improvements | Port Authority of Trans-Hudson | New Jersey | 6 |
| 86120 | O'Hare Transit System | City of Chicago | Illinois | 111 |
| 86155 | Central Plant | Arizona State University | Arizona | 3 |
| | *Construction Assistance Projects* | | | |
| 5842[2] | Integrated Steel Mill | Cosipa | Brazil | 215 |
| 6131 | Medical Office | Kaiser Hospitals | Oakland, CA | 4 |
| 6508 | Boa Esperanza Power House | Cohebe | Brazil | 72 |
| 6515 | Hospital Expansion | Kaiser Hospitals | Santa Clara, CA | 4 |
| 6519 | Hospital | Kaiser Hospitals | Sacramento, CA | 4 |
| 6617 | Hospital Tower | Kaiser Hospitals | Oakland, CA | 7 |
| 6732 | Hospital and Clinic | Kaiser Hospitals | Sacramento, CA | 10 |
| 6742 | Hospital East Wing | Kaiser Hospitals | Santa Clara, CA | 4 |
| 6808 | Hospital Construction Superv | Kaiser Hospitals | Los Angeles, CA | 24 |
| 6809 | Hospital and Clinic | Kaiser Hospitals | Bellflower, CA | 7 |
| 6823 | Bandama River Hydro Proj | Ivory Coast Republic | Ivory Coast | 84 |
| 6810 | Steel Mill Expansion | Somisa | Argentina | 300 |
| 6866 | East Intercourse Island Port | Hamersley | Australia | 110 |
| 6914 | Hotel Development | Sheraton Hotels | Portugal | 9 |
| 6927 | Salto Osorio Hydro Plant | Electrosul | Brazil | 100 |
| 7038 | South Hills Transit System | Port Authority Alegheny Co. | Pittsburgh, PA | 233 |
| 73118 | Bandama River Hydro Proj | Ivory Coast Republic | Ivory Coast | 130 |
| 74202 | Zinc Refinery | Jersey-Miniere Zinc | Tennessee | 136 |
| 75045 | Pahlavi Steel Plant, Ahwaz | Government of Iran | Iran | 250 |
| 75081 | Krakatau Steel Plant | Government of Indonesia | Indonesia | 1,000 |
| 76013 | Integrated Steel Mill | Sidor | Venezuela | 3,500 |
| | | | | 25,453 |

***Notes:***

1 Numbering is chronological with the first two numbers indicating the year the project was initiated.

2 Cosipa is an example of construction limited services. KE performed consulting services, process equipment procurement, and overall consulting and advisory services. In the field, Joe Vance was the Chief Field Engineer and the only KE representative.

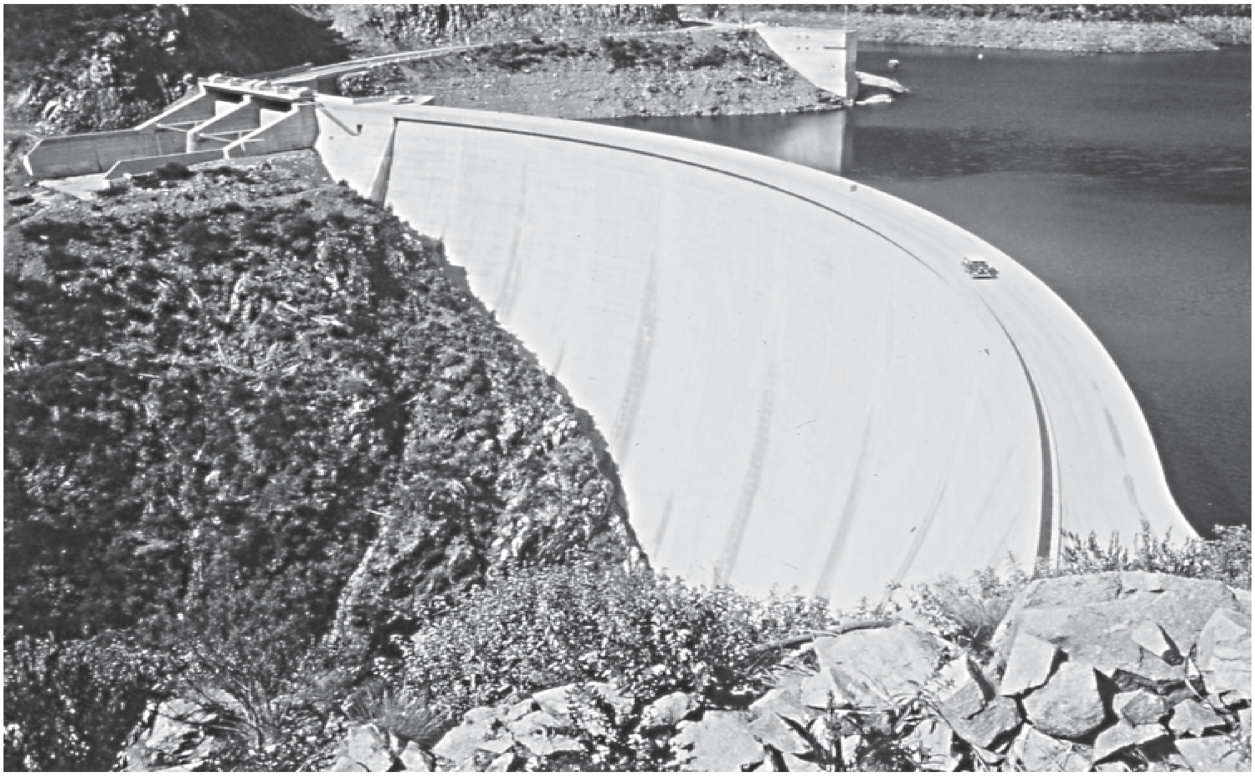
**Table 3.4**
**Barrie's Construction Management Projects**

*CM only; KE did not do the engineering*

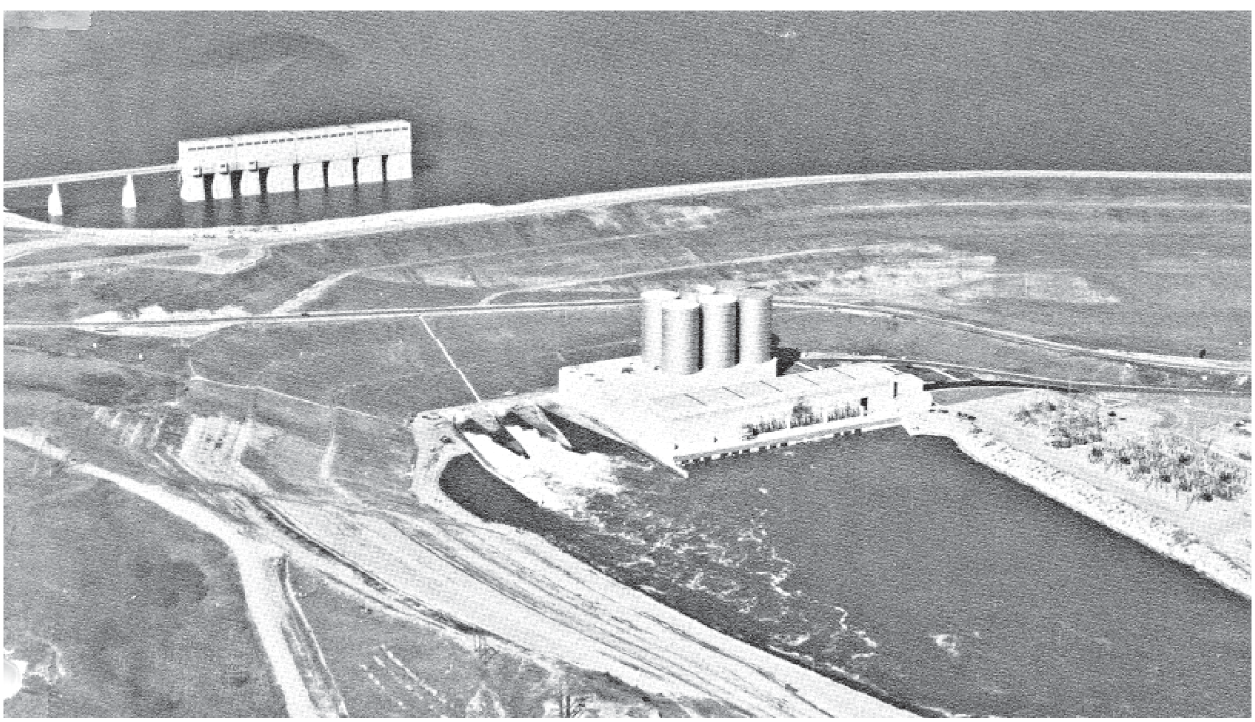
| Job No.[1] | Project Name | Client | Location | Project Value $x millions |
|---|---|---|---|---|
| 7147 | Denver Non-foods | Safeway | Denver, CO | 2 |
| 7156 | El Paso Distribution Center | Safeway | El Paso, TX | 8 |
| 7221 | Denver Bakery | Safeway | Denver, CO | 8 |
| 7220 | Calgary Meat Plant | Safeway | Calgary | 5 |
| 7222 | Tulsa Distribution Center | Safeway | Tulsa, OK | 5 |
| 7374 | Witchita Meat Plant | Safeway | Witchita, KS | 13 |
| 7394 | Denver Distribution Center | Safeway | Denver, CO | 9 |
| 74049 | Tempe Semi-conductor Plant | Motorola | Tempe, AZ | 33 |
| 74123 | Phoenix Semi-conductors | Motorola | Phoenix, AZ | 4 |
| 74250 | Fume Control | Corning Glass Co. | Pascagula | 4 |
| 75059 | Compton Meat Plant | Ralph's | Compton, CA | 13 |
| 75115 | Water Treatment Plant | Sierra Pacific Power | Reno, NV | 6 |
| 75174 | Texas Mine Development | Kaiser-Weirco | Texas | 60 |
| 76064 | Distribution Center | Lucky | Vacaville, CA | 20 |
| 76129 | Milk Plant | Safeway | Utah | 8 |
| 76155 | Montana MHD-CDIF | U.S. ERDA | Butte, MT | 35 |
| 77162 | Nova Laser Facility | U.S. Dept. of Energy | Livermore, CA | 25 |
| 78055 | Zacky Farms Plants | Zacky Farms | United States | 7 |
| 78094 | Distribution Center | Lucky | Houston, TX | 15 |
| 78158 | Amax | Lead Smelter | Missouri | 6 |
| 79018 | Chip Plant | Frito Lay | Mississippi | 6 |
| 79026 | Grocery Distribution | Lucky | Irvine | 38 |
| 80001 | Frito Lay | Chip Plant | Washington | 6 |
| 80136 | Distribution Center | United Grocers | Sacramento, CA | 14 |
| 81051 | Pilot Plant | Chevron | Richmond, CA | 60 |
| 82001 | Arco Plant | Arco | Plano, TX | 25 |
| 82045 | Frito Lay | Chip Plant | Arizona | 35 |
| 82070 | Synfuels | TVA | Alabama | 2 |
| 82100 | Chip Plant | Frito Lay | Kansas | 29 |
| 83110 | Silicon Wafer Plant | SEH America | Vancouver | 25 |
| 83120 | Shuttle Assembly Building | NASA | Vandenburg AFB | 45 |
| 83168 | I-595 Expressway | Florida Dept of Transp. | Florida | 50 |
| 84019 | Epitaxial Wafer Plant | SEH America | Vancouver | 25 |
| 84043 | Snack Foods Preparation | Frito Lay | California | 59 |
| | | | | 705 |

***Notes:***

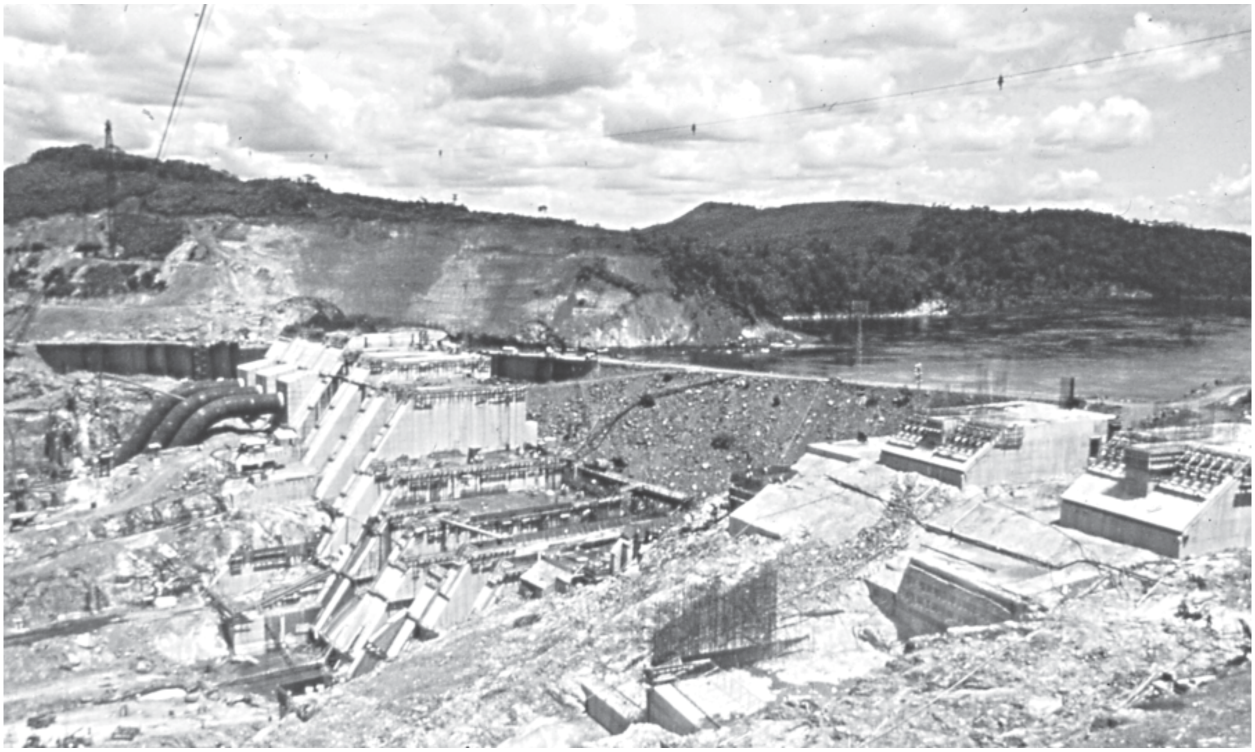
[1] Numbering is chronological with the first two numbers indicating the year the project was initiated.



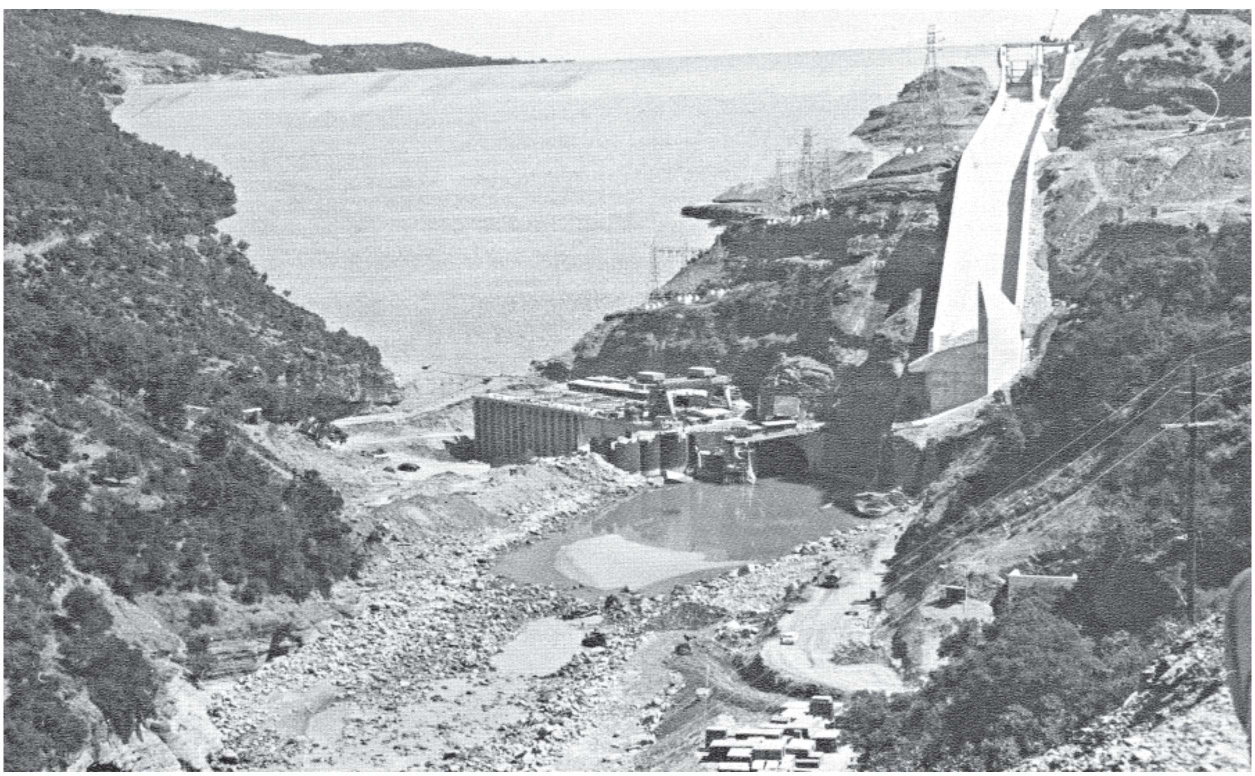
Snowy Mountain Project, Australia. Started in 1954, KE was the sponsor. Shown is Tumut Pond Dam, a concrete arch dam with a crest length of 715 feet and height of 290 feet. This dam was part of the vast Snowy Mountain Project design to redirect the waters of the Snowy Mountains into the arid central plains of Southwestern Australia. This project included construction of the 14-mile, 21-foot diameter Eucumbene-Tumut Tunnel, a junction diversion dam and a 1-1/2-mile concrete pressure tunnel. This was one of the first international projects built by KE. This kind of joint venture construction job was commonly called “Heavy Construction” by KE.



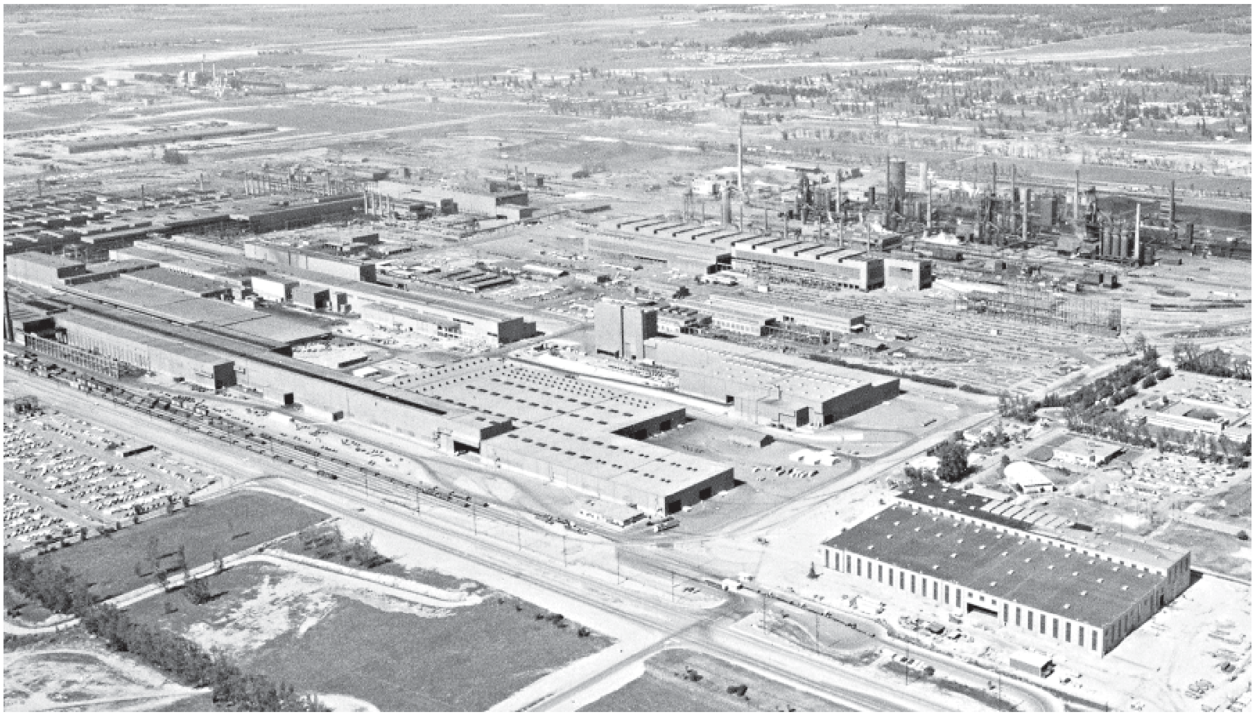
Garrison Dam Powerhouse, sponsored by KE’s construction division, was initiated in 1953.



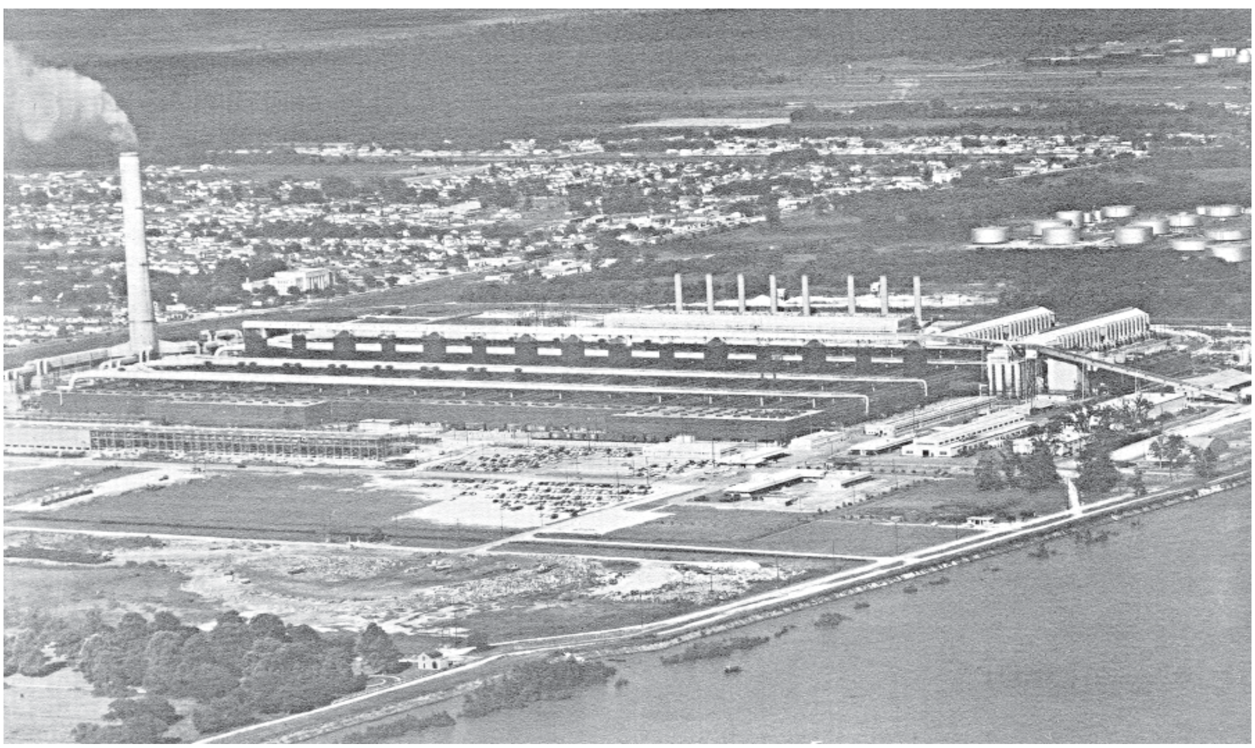
Guri Project in Venezuela was a joint venture undertaken in 1963. It was one of KE's losers. Despite all the problems it had, it was successfully completed. Photo taken during construction.



King Paul Dam on the Akheloos River, Kremasta, Greece. This joint venture began in 1961 as a simple diversion project. The power intake structure was flooded, causing major project delays. KE then undertook to salvage the project by building the dam proper.

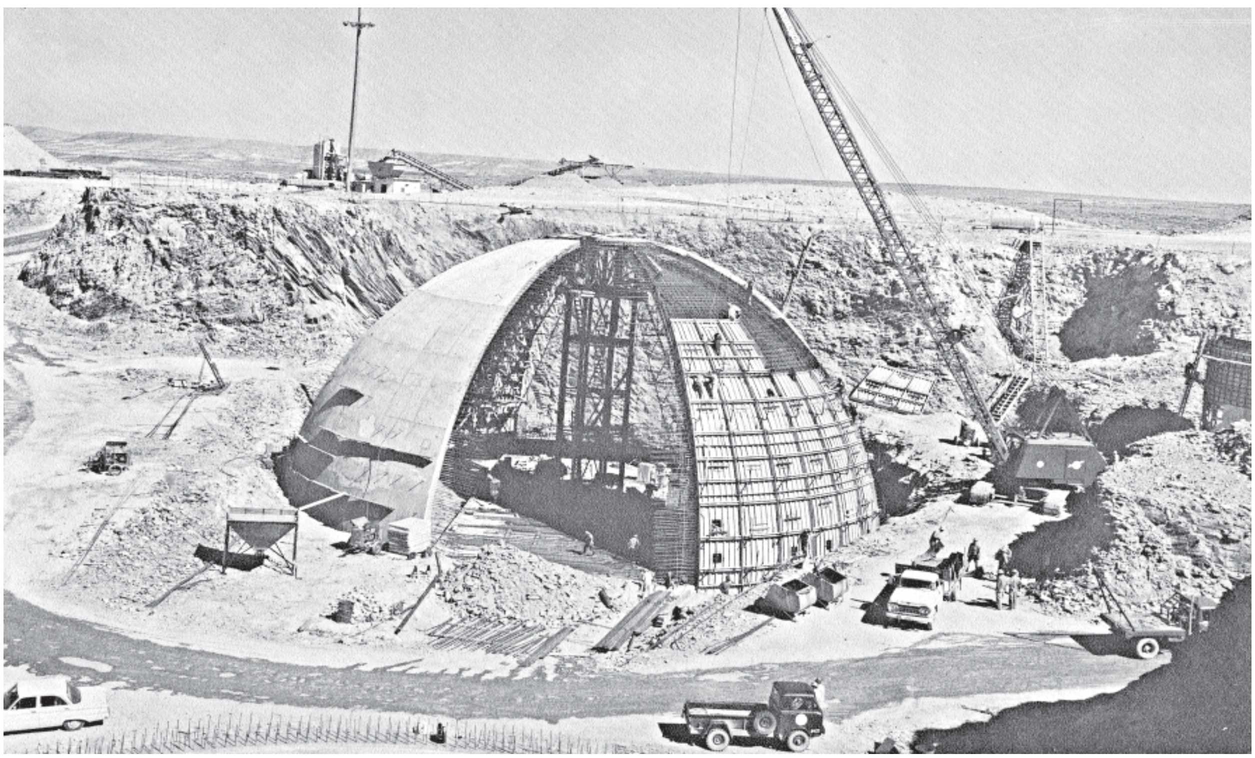


KE started its first project, design, and construction of the Fontana Steel Mill in 1942. The plant had an initial production capacity of 600,000 tons per year of finished steel. Over the next 35 years, KE handled all of the plant's modernization and expansion programs, raising its annual production capacity to 3,400,000 tons of steel products.

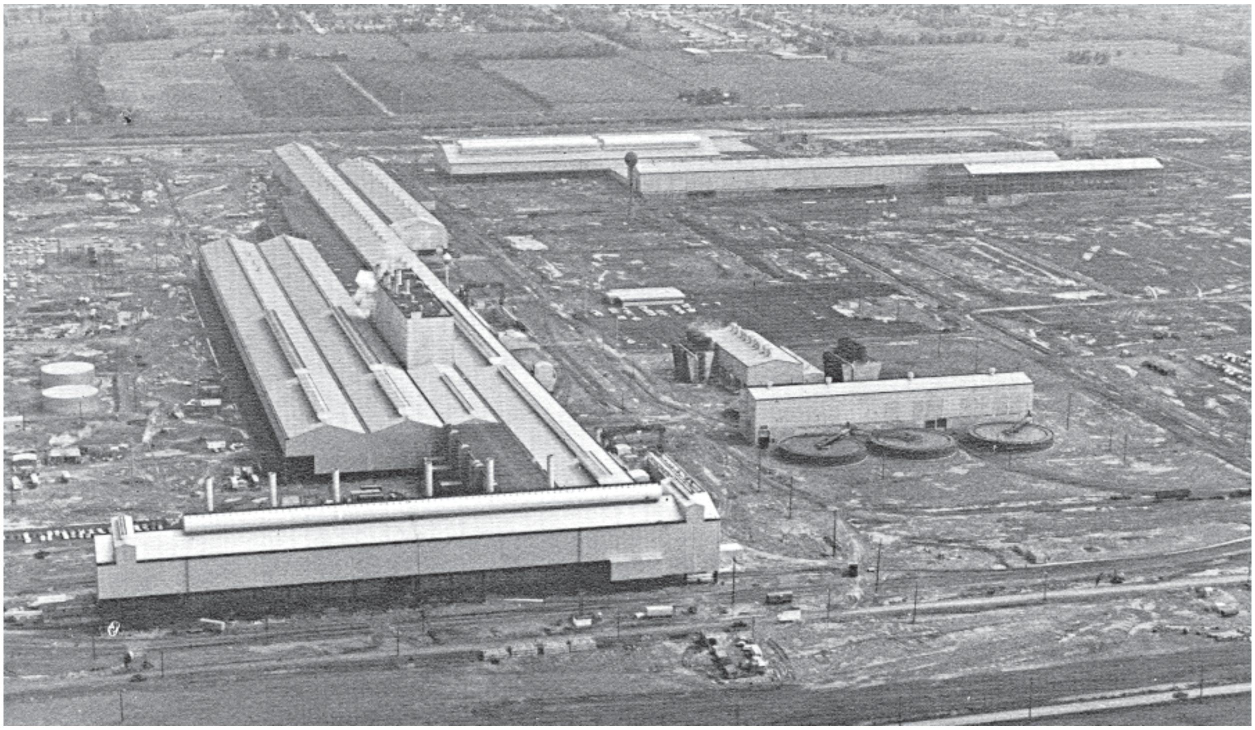


Chalmette Aluminum Plant, started in 1951, was KE's first aluminum project. Located on a green-field site on the banks of the Mississippi River, it required all structures to be founded on wood piles. KE built the potlines and power facilities also. Power was split into two modes to accelerate early start of production. Half of the power was provided by gas-fired Nordberg reciprocating engine-driven generators, and the other half by a conventional steam plant. The Nordbergs could be built faster, allowing for production of aluminum in 11 months from the first pile driving.

In 1952, KE landed its first fee-based construction work for the Atomic Energy Commission at its Hanford site. KE had personnel at this site for several decades and even after the company was sold, personnel were still active there. Shown is the New Production Reactor, located on the Columbia River. Completed in three years, it would be a $1-billion project if built in 2001.

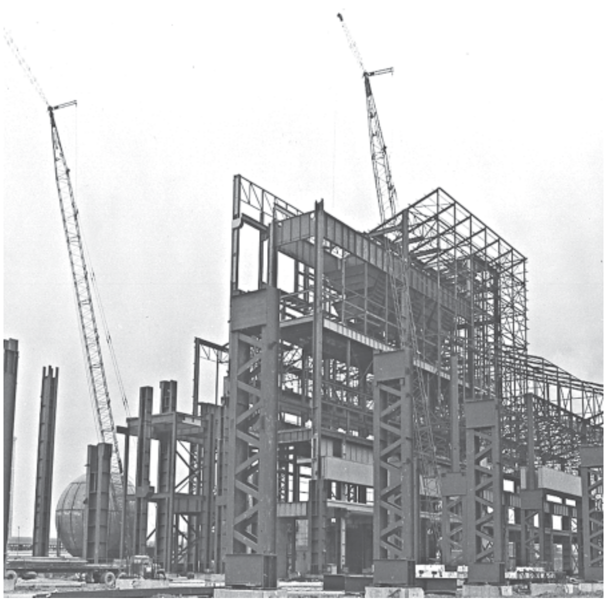


Kaiser Engineers constructed three Titan Intercontinental Ballistic Missile launch complexes near Mountain Home Air Force Base. Each complex consisted of missile silos, equipment terminals, propellant terminals, antenna silos, a control center, a powerhouse, a portal silo, filtration structure, and connecting tunnels, all built underground. The complexes were “hardened” to withstand nuclear weapons effects. Shown is the powerhouse under construction.

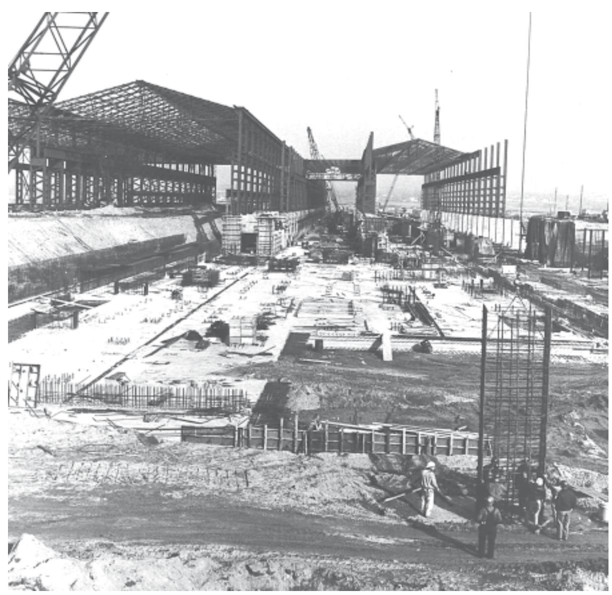


Armco Project 600 was landed in 1964. This was a milestone undertaking estimated to cost $600 million at that time. In today's costs it was a $3.1-billion undertaking. Completed in 1972, it required an entirely new project organizational structure to integrate staff split off from the home office, along with new hires and Armco personnel. It was a large and complex undertaking, including a wholly new hot strip mill with computerized controls. The project won numerous awards for outstanding engineering and construction. Photo shows the massive hot strip mill at Middletown, Ohio.

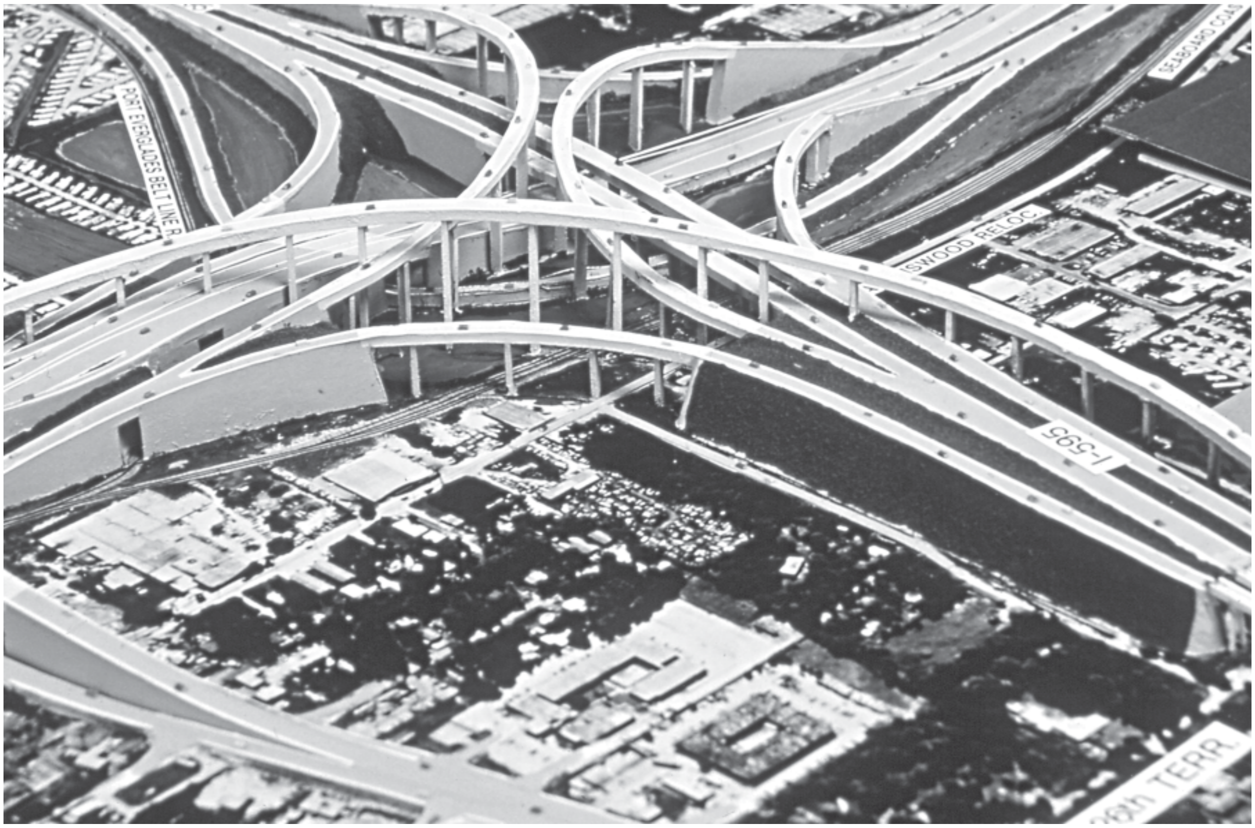
*Note:* The Chalmette, Fontana, and Armco projects are representative of projects for which KE acted as general contractor responsible for both designs and construction. Refer to the narratives and the photos in the industry chapters for additional representative projects.



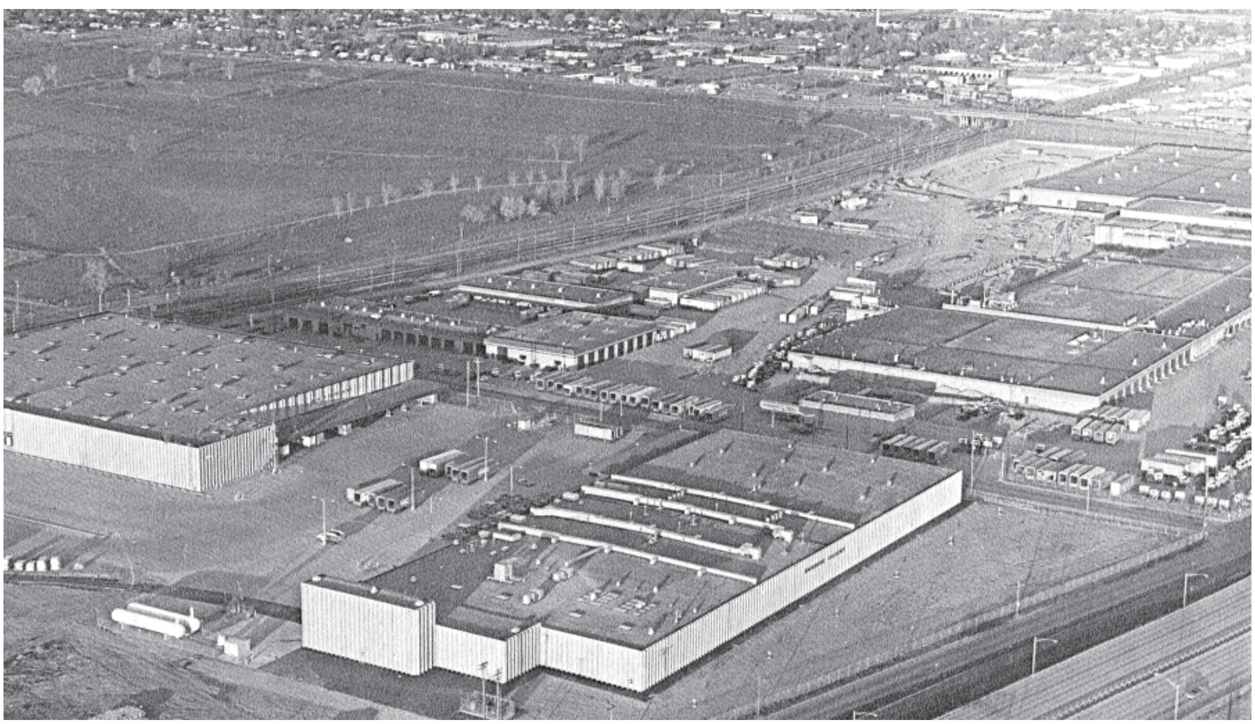
The Middletown L-D plant during construction.



The Middletown hot strip mill during construction.




In 1983, the Florida Department of Transportation awarded the massive $1-billion I-595 construction management project to KE. An aerial view of the interchange is shown above. KE provided services for the I-595 program lasting into the 1990s.



With a limited budget, Don Barrie founded a successful and profitable construction management group which performed a number of small CM projects where KE was not the designer. Typical is Denver Distribution Center, including bakery, frozen food, and meat plant built for Safeway in 1973.

Chapter 4

# Steel

## Overview

To describe Kaiser Engineer's Steel Industry involvement is to describe the history of Kaiser Engineers. KE marked its formal entry into the engineering and construction business in 1942 when it began the design and construction of Kaiser Steel's Fontana Steel Works. Preceding this, the key KE staff acted as the engineering staff of Kaiser Steel and was headed by its Chief Engineer, George Havas. Havas went on to become General Manager of KE and because of his genius as an innovator and excellent engineer became known as one of the premier designers of steel mills.

As KE grew over time, it continued to handle all steel expansions for Kaiser Steel and became available to outside steel firms. Steel projects became a major part of KE's backlog of work. KE continued to handle Fontana expansions from 1942 through 1956 and beyond. In 1955, a significant change occurred when KE was awarded the Tata project in India. At that time, the construction manager for the Fontana works for the previous 14 years, Art Fisher, was transferred to handle construction at the Tata Jamshedpur, India steel works.

The Tata project was so large and logistics so complex that a separate task force group was organized by selecting engineering and construction staff from other steel projects. This group was headed by a corporate vice president, John Hallett.

Concurrently, KE's steel plant expertise and reputation grew so that to take advantage of opportunities available, a new division was established as the Steel Group, headed by another vice president, R. J. Wolf. Since the center of activities for steel projects was in the Midwest and eastern part of the United States, offices were established in Chicago and Pittsburgh to service the industry. The number of projects awarded from these offices attested to the growing reputation of the company as one of the premier engineer-contractors to the steel industry. By 1964, KE was awarded the massive Armco project. These three projects defined KE as a potent force in architect-engineer-constructon for the steel industry.

## Steel Industry Gave KE Its Start

In many areas of the world, Kaiser Engineers became known as one of the premier steel plant designers and constructors. Its roots started with the design and construction of Kaiser Steel's Fontana plant. The Kaiser Steel story that follows illustrates how that came about.

With a foothold in the steel industry with the Fontana works design, KE now had experience and a large staff of competent steel mill engineers to market its wares. Its first large outside company success was the award of the Tata project in India in 1955. By the time it was completed, a steel marketing group was hard at work developing domestic steel mill leads. The highlight of the steel group's marketing effort was the award in 1964 of one of the largest steel plant undertakings of the day—the Armco Project 600. This was a $600 million undertaking (which in the decade of the year 2000 costs would be a $3-billion project.)

These three steel projects defined KE as an independent engineering firm and as specialists to the steel industry. Their time frame covered the following overlapping periods.

| | |
|---|---|
| Kaiser Steel at Fontana | 1942-1958 and beyond |
| Tata project in India | 1955-1959 |
| Armco Project 600 | 1964-1972 |

Thus, in some 30 years KE had risen to a predominant position as a steel mill designer and builder. Many other projects were undertaken. The next subchapter describes them, followed by descriptions of several international steel projects, which had unique characteristics and some interesting aspects to relate.

In order to advance its standing in the steel industry, KE also obtained license agreements from Linz-Donewitz of Austria for the then new process of steel making, which became known as Oxygen Steel Making. Originally, it was called the L-D process. A separate group administered the license agreements, maintained the company source of know-how on the process, and developed new enhancements to the process. KE became a leader in knowledge about the extent to which the Oxygen Steel Making process was being utilized in the United States and was often quoted in the technical and financial literature as the source of information about the process. This helped in marketing those projects also.

## Steel Project List

KE maintained a perpetual project list by job numbers, client, project name, and estimated project cost. Job numbers were assigned for accumulating costs and for identifying documentation for each project. We have abstracted from that perpetual list a number of the larger steel projects undertaken around the world, shown following the narrative as Table 4.1, entitled "Steel Projects List."

The list is impressive in showing the wide range of projects including the current project costs of the time. In most cases, KE was the engineer of record. On some it acted as architect / engineer / constructor and others as architect / engineer / construction manager. On some of the international projects KE helped rescue them by providing technical assistance, mostly on construction.

They were all large projects as attested to by noting the aggregate construction value at the time they were built at $10 billion. Today such projects would cost over $25 billion.

## Project Descriptions

In the pages which follow we present some of the major projects around the world to show the range of services offered. Projects for Kaiser Steel, Tata, and Armco are featured and lead off the discussion because they set the stage for the company's steel plant expertise and because they were large projects. Following them, there is a discussion and presentation of evidence of KE's substantial involvement in a number of projects. The discussion concludes with several other international projects, which are interesting because of their large scale, the political climate involved in each one, and the international know-how that we provided in addition to steel plant technology.

The Krakatau story in Indonesia is dealt with briefly in the text. A more detailed, very interesting account of the story as seen through the eyes of Bill Smith is reproduced in the chapter on Oral Histories. In it, he describes the politics of the country; the difficult working conditions when working with equipment suppliers who also provide financing; the difficulty of working with local staff who need training in basic principles of project management; and finally the assistance provided in operating the facilities. Many of these aspects are not encountered in a domestic project. Bill Smith tells an interesting story.

## **Kaiser Steel**
### Background

The Fontana steel mill projects, started in 1942, were where KE got its start in the designing and building of steel projects. As a matter of fact, it is where KE got its start as an independent architect / engineer / constructor. But first a little background.

Fontana is the name of a small town in San Bernadino County, located along what is now interstate highway 10. Upon decision to proceed with the project, Kaiser Engineers was assigned the responsibility to design and build it, using a nucleus of engineers who had been with Mr. Kaiser for years building dams, the Permanente Cement Plant, and other Kaiser works. George Havas was Mr. Kaiser's chief engineer who headed up the project.

To manage this large undertaking, a new and separate company was organized. This required recruiting staff, defining procedures, and a methodology for executing the project in a hurry. Thus, KE's method of operations was established.

It was a sea change in the manner of executing projects. While many large non-industrial projects employed separate design engineers and separate contractors to do the building, this steel project was undertaken on a single-responsibility basis. KE had its own staff of engineers, procurement people, and construction people. The fact that the first blast furnace was built in 9 months attested to the wisdom of this method of operations.

## Steel Plant

The year was 1942 when the war effort for World War II was at full steam. Henry Kaiser was having trouble getting steel plates for his West Coast shipyards where his legendary ships were being built. It is an often told story of how he convinced the authorities to allow him to build a West Coast steel mill. But they insisted that it be built away from the Pacific Ocean so that it would not be vulnerable to possible attack from the sea. So the plant was located inland without access to economical shipment of iron ore and coal. Even so, it was located in a site with lots of land available.

The plant was located 50 miles inland from the Pacific Coast, on a 1300-acre site near the small community of Fontana, California. The Kaiser Company, Inc., Iron and Steel Division (which later became Kaiser Steel Corporation) was formed and authorized the start of work for the new plant on

March 19, 1942. The first blast furnace was blown in on December 30, 1942, a mere nine months later. This demonstrated the can-do spirit of the KE staff. The blow-in was done to a great deal of fanfare as the first blast was recorded by photographers from all over. In truth, the flash that they saw was the ignition of magnesium flares.

To encourage loyal participation of key employees, it became a KE company practice to hold commemorative dinners and to give away momentos. When the blast furnace actually produced metal, the first pig iron was molded into miniature paperweights that looked like little pigs. These were properly inscribed with the date of the blow-in and the participants' names. It was appropriate that they were in the form of little piglets because the site of the steel mill was actually an abandoned pig farm.

Detail design, procurement, and construction for the plant were provided for the initial steel plant and all subsequent expansions, covering a span of over 40 years, until the plant was shut down because it could no longer compete in international markets for steel.

Engineering responsibility was assigned to individual project engineers who were in charge of all aspects of each plant facility, such as the coke ovens, the blast furnace, the steel-making facilities, individual rolling mills, etc. For specialty facilities such as the coke ovens and the blast furnace turnkey contracts were issued. McKee had the contract for the blast furnace, and Koppers built the coke ovens, for example.

Overall design engineering and design of materials handling and tie-in facilities was done by KE in the Oakland office and rushed to Fontana overnight. Daily shipments were made using the Lark, Southern Pacific Railroad night train from Oakland to Los Angles. KE personnel made frequent visits to the site, travelling by the Lark. Noteworthy is the engineers traveled first-class with individual staterooms. That way, they did not waste any time at night and were ready to work the next day.

And because of the rush to complete, communication costs ran high. Phone calls to the site were frequent. Telegrams were sent for urgent messages. (That was before Telex and before the Internet).

The initial plant had a capacity of 600,000 tons per year of finished steel and included: a 90-ton oven by-product coke plant, a 1200-ton blast furnace, six 185-ton open hearth furnaces, one 10-ton electric furnace, twelve soaking pits, a two strand tandem plate mill, a 36-inch breakdown mill, and a 29-inch structural mill. Supporting facilities included: 34 miles of in-plant railroads, diesel electric locomotives, seven oil-fired boilers for in-plant steam, water supply and reclamation facilities, utilities, administrative offices, and a hospital.

Immediately following World War II, Kaiser Engineers completed studies, concepts, detail design, engineering, and construction for expansion of the plant to 2,000,000 tons per year of finished steel. The additional facilities included 45 additional coke ovens, a second blast furnace, number seven open hearth, two more soaking pits, and additions to the structural mill and bar mill. New products were added to Kaiser Steel's market by the addition of a new large-diameter pipe mill, electric weld pipe mill, a seamless tube mill, an 84-inch hot strip mill, and a cold mill. This major expansion elevated Kaiser Steel to the rank of seventh largest steel producer in the United States.

Increased demand for steel during the 1950s in the rapidly growing western area of the United States resulted in continuous additions to the Fontana plant. KE again increased the capacity to 3,000,000 tons per year. New facilities included an additional blast furnace, soaking pits, coke ovens, open hearths, and a new Basic Oxygen Steel Making plant (L-D plant), along with rolling and finishing facilities. The new L-D plant was significant since the oxygen steel making process has since supplanted open-hearth furnaces as a means of making steel. New product producing facilities included a tin plate mill, welded wide flange beam facilities, and quality improvement such as continuous strip pickling.

During the 1960s, a leveling-off of expansion took place, and the plant reached its maximum capacity of 3,400,000 tons. A double-reduced tin plate mill and galvanizing line were added to the Fontana plant, and improvements were made to increase efficiency and quality.

In the early 1970s the steel industry in the United States suffered from foreign steel imports. Kaiser Steel was no exception and made every effort to improve its operations in order to compete with the cheap imports. KE studied new methods and procedures, prepared concepts of recommended ones, and upon approval made plant changes with a new L-D plant, continuous casting, blast furnace improvements, coal pulverizing facilities and coke oven desulfurization, and new scrap cutting yard. All of these improved facilities improved operating costs. However, with the decline in steel consumption and increased foreign competition and more stringent environmental demands (the plant was located in the Los Angeles basin where strict controls were enforced), the plant was closed in 1984 after over 40 years of successful operation. Today, the only reminder the steel plant existed is a very large stockpile of iron ore slag that is clearly visible from Highway I-10.

## Innovations

Several innovations and successes, originally achieved at Fontana, gave KE good marketability. Its original layout was planned with great vision of need to constantly update and modernize the steel-making facilities. The plant design won many kudos from steel plant designers for its master planning which provided adequate space and proper material handling for all major expansions that followed. When Fontana was originally conceived, the KE engineers, headed by George Havas, determined that they would have a good advantage over the steel mills in areas like Pittsburgh. In Pittsburgh, the industry was built up over the prior 50 years with continuous expansions as steel markets expanded. Because of their economic success, these plants were surrounded by satellite industries and new housing developments. This resulted in the plants being hemmed-in with the lack of adequate property for expansion projects. Expansions were thus accomplished in cramped space. This impeded proper layout of facilities and impeded material flow patterns and resulted in rail traffic congestion in many Eastern steel mills. Such would not be a limitation at Fontana which had abundant land so that KE engineers could provide ample room for expansion and could provide for the free flow of traffic.

Another innovation at Fontana was proper preparation of feed stock by bedding and blending of ores. Materials handling facilities for iron ore, coal and limestone were carefully designed to allow for proper bedding and efficient handling of the materials. Proper bedding led to proper blending of blast furnace feed which led to efficiency of operation and increased quality control. This made it possible for blast furnace operators to have uniform feed stock and permitted predictable operating practices

Because the Los Angeles Basin in which the plant is located had the most stringent environmental protection regulations in the nation, KE had to implement the most advanced pollution techniques to satisfy these regulations. We pioneered the use of electrostatic precipitators for open-hearth fume control. We applied the latest baghouse dust collection methods in the sinter plant. And we employed water conservation systems that gained recognition throughout the steel industry. The systems solved the extreme water shortage problem and the problem of disposing of effluent.

One of KE's mechanical engineers, Fred Greyson, designed a new type of sinter cooling machine. The normal method used was to build a long flight of conveyors, allowing time for the sinter to cool. This required lots of space and interfered with production at the blast furnace area. Instead, Greyson invented a rotary system where sinter would be stacked but by rotating it and moving it with a special plow, he could achieve good cooling in a compact machine and with better performance. He won a patent for the machine.

## Key People

Added to these innovations was KE's ability to mount the project with trained staff of steel plant engineers and construction supervision to build the facilities in record-breaking time. Many of KE's engineers, managers, and construction staff got their start at Fontana. When the first blast furnace was completed, a program celebrating the event, entitled "Blowing in the Bess," listed the following KE personnel as contributors to the progress at Fontana:

**Managers and Project Engineers**

| | |
|---|---|
| George Havas | Lou Oppenheim |
| Jim Foster | Bill Vogt |
| George Scheer | George Vreeland |
| Ray Fullerton | E. C. Anderson |
| Fred Greyson | Earl Akerlow |
| Ernie Putman | Art White |

**Design Engineers**

| | |
|---|---|
| George Schuman | F. B. Tobias |
| Bill Bertwell | Don Mauser |
| Clay Schwalen | Frank Kast |
| John Hart | Gene Blymer |
| Ken Olson | W. Van Vleck |
| Dick Hart | |

**Construction People**

| | |
|---|---|
| Frank Backman | Burr Tupper |
| Frank Bort | Ralph Bates |
| Art Fisher | Phil Bush |
| Joe Vance | Joe Kroll |
| G. G. Wilson | R. C. Wilson |

**Staff People**

| | |
|---|---|
| Del Brown | Joe Rowan |
| Bruno Francheschi | Howard Tracy |
| Jack Walling | Giff Randall |

The list reads like a "Who's Who of Kaiser Engineers." Several key people started at Fontana but did not pursue a career in the steel industry. They included Phil Bush, Earl Peacock, Wright Price and Burr Tupper. All went on to distinguish themselves as key executives within KE, serving other industries.

## Tata Steel

### Background

After more than a decade of work in developing and expanding the Fontana works, KE had developed a reputation in the steel industry and had accumulated a sizeable staff of experts in steel mill construction and could make a foray into performing similar services for companies outside of the affiliated Kaiser companies. When we heard of the Tata's interests, we were able to capitalize on their needs.

The Government of India's economic development plan for 1955 called for developing three new steel plants and expanding three existing plants to quadruple its steel-making capacity by 1961. Tata Iron and Steel was India's oldest and largest steel manufacturer, begun in Jamshedpur in 1908. It was authorized to expand its capacity to 2,000,000 tons per year from 1,300,000 tons on an urgent and expedited basis.

Tata invited Kaiser Engineers to review the project and advise whether it could build it on an expedited schedule. A top level KE team headed by George Havas reviewed the project in November, 1955, and promised to build it in 30 months or by May, 1958. Because of the urgency of the program, it was proposed that KE provide a single responsibility (turnkey) contract which would take advantage of KE's know-how on steel mills, its know-how on expediting overlapping phases of such a program, and its ability to coordinate such a complex project. Services included full responsibility for procurement of large amounts of foreign equipment, complex logistical support, and integration of foreign staff and resources with Indian resources. The project was so urgent to Mr. Tata and he had such faith in the Kaiser organization to perform as promised that he accepted the offer.

### Summary

The Two Million-Ton Plan (labeled TMP for ease of identification on documentation) called for increasing output from all major production facilities, without interrupting existing operations. KE proposed further that as individual components were completed, they would be turned over to operations for revenue production.

KE's proposal for a single-responsibility contract was accepted, and a contract was signed in December, 1955, and field work began a few months later in the spring of 1956. All major facilities were completed by the first quarter of 1959, only a few months later than originally proposed. This tight schedule was mostly kept despite delays due to obtaining import licenses into India, additional facilities were added to the project, and shipping and clearing problems at the docks.

By the time the TMP was completed, the other Indian steel mills being built were still many months and years away from completion. The Tata organization was elated with their fast start. KE prepared some 4,500 original engineering drawings and procured and installed 100,000 tons of imported equipment. KE's design, procurement, and construction work force in India reached a peak of 20,000 of whom only 90 were Americans. Design, procurement, and liaison forces in Oakland reached a peak of 190 employees who were assisted by six staff from Tata's operating division from India.

### Project Description

The project included the following major facilities:

- coke plant and by-products plant additions
- ore crushing, screening, and sintering plant
- a 28-foot diameter blast furnace
- steel-melting shop additions, including 2 200-ton open-hearth furnaces and new Bessemer furnaces (to expedite the project it was decided not to innovate and to put off for the future the new technology of oxygen steel making)
- soaking pits
- new blooming mill
- new billet mill
- medium and light structural mill
- revamping of 28 miles of railroad tracks
- new boiler and power house

- power distribution facilities revamping
- gas cleaning facilities

The project had several complexities that made it a challenging and ambitious undertaking. This project was started before previous expansion had been completed. Some portions of the prior program were added to our scope to avoid some added conflicts, but there were interferences nonetheless. Adding to the complexity, was the essential need to keep existing steel mill operations going, making scheduling of construction difficult. Then procurement had to be coordinated among European countries, Japan, the United States and within India, and standards from each country had to be integrated.

To limit foreign exchange expenditures, maximum use of Indian suppliers and manpower had to be utilized. This required assessing capability of local suppliers to provide the quality and quantity of supplies needed within our expedited time frame.

We undertook to accomplish this seemingly impossible schedule with a limited foreign staff and the maximum use of Indian nationals. We successfully accomplished our goal.

## Task Force Staffing

Early on, KE management recognized the difficulties that this project would face and the difficult coordination required. So it was decided that a special task force team would execute this project. KE selected a seasoned senior veteran from other Kaiser projects and assigned the responsibility of selecting a staff and executing the project. He was John Hallett who was appointed as its vice president and project manager. Art Fisher, veteran of steel plant construction, headed all field efforts; Bill Vogt was chief project engineer in Oakland; Bill Bertwell was chief design engineer in Oakland; and Sam Ruvkun was executive engineer in charge of logistical support, administration and coordination of procurement, progress and schedule control, accounting and liaison with the client's representative.

To permit good communications and to assure the full time devotion of the entire staff to this one project, the entire group set up operations in a separate office within Oakland.

## Key Staff

Key staff was recruited from within Kaiser Engineers and from outside the company.

Availability of required experts in some fields was very limited because of the large workload KE was already carrying for projects for Kaiser Steel and Kaiser Aluminum. Still it was possible to release some key project engineers and construction personnel from the Fontana project.

Following were key staff personnel:

**Project Engineers and Managers**

| | |
|---|---|
| John Hallett | Bill Vogt |
| Frank Mayer | L. Katroba |
| Ray Fullerton | George Vreeland |
| A. Palsak | Sam Ruvkun |
| Art White | George Scheer |

**Design Engineers**

| | |
|---|---|
| Bill Bertwell | Jim Ellis |
| Tony Witkowski | Clay Schwalen |
| Bill Smith in India | |

**Construction People**

| | |
|---|---|
| Art Fisher | Joe Vance |
| Sid Stewart | Sam Banks |
| O. Ballheim | |

Due note should be taken that our staffing was done at a time when KE's work volume was at its peak, with major projects being underway for Kaiser Aluminum and Kaiser Steel also.

## Logistics

Paper work was voluminous. The client required documentation for approval and to obtain import licenses for all procurement, and they reviewed all drawings and documentation as they were prepared. The operating staff and engineering staff in India also had review authority, which gave rise to many telegraphic queries for technical data and justification, requiring investigation in Oakland and then preparation of telegraphic responses.

Keeping track of the telegrams, telexes, letters, memos to the field, and documentation required setting up a documents control desk, whereby all such documents were numbered, logged, and backed up with second confirmation copies to assure that all messages arrived in India. Over 25,000 pieces of mail were logged, with a peak of some 450 in one week.

Engineering drawings, approved vendors' drawings, control reports, and procurement data were packaged together and shipped as package mail (a forerunner of the now common overseas air package handlers). By 1957, some 7,600 pounds of air shipments had been recorded at a fraction of the cost that would have been possible by other means. And by alerting our staff in India, they knew what was coming, could clear customs, and expedite shipments to the field.

At the height of project activity in 1957, PanAm Flight No. 5, carrying one of our packages, went down in the Pacific Ocean. The next day we identified what was aboard it, reproduced the documents, and a new shipment was on the way. This alone justified the expense and effort of tagging the documents.

## Construction Equipment

To expedite construction, KE recommended and Tata approved the early procurement of construction equipment needed to erect the heavy millstands and structures to arrive from foreign sources. Such equipment included a number of crawler cranes, shovels, and special low-boy and deep-well railroad cars. It was necessary to augment the Indian port authorities' equipment for off-loading heavy equipment, and to help the railroads carry the equipment as their rail cars were inadequate.

## Project Costs

Final project costs came in at the equivalent of \$148,000,000 (equivalent to \$900 million in costs prevailing in the year 2000). KE's services totaled \$9,250,000 of which \$3,000,000 was the fixed fee.

## Observations from the Jobsite

An interesting documentation of the project was jointly authored by KE staff and the TATA engineers and was published in the *TISCO Journal* (Tata Iron and Steel Company) for January, 1959. Due credit was given to KE's efforts for a job well done. Some of the reminders of note are as follows:

The job proceeded well even given the several monsoon seasons encountered. "There is a 10,000-mile gulf between Oakland and Jamshedpur." The facility of communication and degree of cooperation were extraordinary.

John Hallett traveled 200,000 miles in the execution of the TMP work. The early completion gave TISCO the maximum return on capital invested. To assist the local economy and make work for the poor people of the area, work was assigned to manual labor even though modern machine methods were more efficient. It was in the nature of the Tata organization to recognize their social responsibility that they fostered such make-work schemes.

A particular example was in early earth moving out of congested areas; earth was excavated by hand, with the men lifting the earth in baskets onto women's' heads. Then a column of women would carry it to a dump site. The Americans referred to it as their flexible conveyor...it could move up, move down, to the left, or to the right.

Another perspective of the project can be seen in the report from one of the KE staff who was in residence at the site. He reports:

> The project involved worldwide procurement and extremely tight scheduling of deliveries through complex supply systems. Calcutta served as the transfer point for ship unloading, warehousing, and loading onto rail cars. The scheduling burdens imposed by the Suez Canal crisis were overcome by integrated worldwide expediting. Most of the plant and equipment had to be imported, cleared through the busy port of Calcutta, and transported 160 miles west of Calcutta over a heavily traveled railway line.
>
> At the plant site, housing was constructed for both American and Indian personnel, and personnel recruitment and training programs were established for a force that reached 20,000. Kaiser Engineers also assisted in training Indian operating personnel and provided operations and maintenance consulting services to Tata management.

The Tata Steel plant expansion was one of the largest design and construction contracts entrusted to a single firm. The following figures convey some idea of the breadth and scope of the project:

- 1,800,000 cubic yards of earth and rock excavated and backfilled
- 17,000 tons of reinforcing steel placed
- 268,000 cubic yards of concrete placed
- 46,000 tons of structural steel erected
- 2,000,000 square feet of sheet roofing and siding
- 60,000 tons of refractories used in production facilities

The program was completed within 36 months with the procurement and erection of over 100,000 tons of materials and equipment obtained from worldwide sources. Most production facilities were in operation in 30 months or less. The work was carried out sequentially in line with the product flow so that profitable use could be made of the products as soon as each of the facilities was completed.

The new facilities had to be built around the existing plant, with minimum interference in current production. Indian workers had to be trained. The project was plagued by strikes, labor disturbances, an influenza epidemic, and the aforementioned Suez Canal closure.

## Armco Project 600

No project or group of projects had so profound an effect upon the KE organization, as did the Armco 600 Project. While the Kaiser Steel project in 1942 got us into the steel industry, the Armco projects started in 1964 gave us stature as a major player in designing and building steel plants.

Today, the Armco 600 project (a $600-million project) would cost close to $ 3 billion. It was large by any measure. It required assigning many of our key people and defining an organization that could be responsive to the client's needs by integrating our people into the Middletown, Ohio, environment. KE and its people were active on this "project" (really a series of projects) for the next eight years at the site and on an as-needed basis after that.

In early planning for the project, both Armco and KE management recognized the enormity of the undertaking and agreed that a completely new organization had to be mobilized. The entire venture was assigned to KE's senior vice president for steel activities, R. J. Wolf. Wolf would spend most of his time for the next eight years devoted to Armco projects.

## Key Staff

Key staff assigned to Bob Wolf were a vice president of engineering, Frank Kast, and a senior project manager at the site, Don Daly. Kast organized and recruited staff that was headquartered in Chicago, which was the center of steel mill designers. This location was chosen since it was recognized that there would be a need for many such experts, and we would be in competition with others for recruiting them.

Middletown, Ohio, was the site of most of the proposed expansion. Don Daly was selected to head up this activity. It was recognized by both managements that a professional construction management team was needed to control the heavy interference with production. While, at the time, Daly did not have steel mill expertise, he was an acknowledged expert in managing large complex projects.

George Roberts was assigned as Construction Manager at Armco.

Frank Sparks was Project Manager at the Butler site.

Key project engineers assigned to Armco projects were Jay Irvin, Earl Denner, Frank Brauns, and Key Ryan.

Rich Nunes and Wally Hick handled key design supervisory roles, and eventually both succeeded Kast as chief of design in Chicago.

Because of the complex nature of the projects, a complete critical path scheduling operation was installed. Sabih Ustel, an expert in such programming, was detached from Oakland and supervised the scheduling until completion of the project.

## Prior Work for Armco

In 1958, KE opened an engineering office in downtown Chicago to service major steel companies located in the eastern part of the United States. Services were provided to most of the major steel companies along Lake Michigan in subsequent years.

One of the early clients was Armco Steel Corporation, headquartered in Middletown, Ohio. In 1959, KE was engaged to provide a full range of detail design services for a new Basic Oxygen Steel-making plant for its Ashland, Kentucky, plant. Facilities included two 150-ton LD furnaces and electrostatic precipitators. Studies were made to recommend the location and orientation in their existing facilities.

When general arrangement drawings, equipment specifications, and estimates were approved, detail design was authorized to proceed. Portions of the detail design dependent on input from major equipment suppliers was left incomplete until procurement and construction services were authorized several years later in 1962. The plant was rapidly completed and placed in operation in October, 1963, ahead of schedule and substantially under budget.

It was because of KE's excellent performance on these prior works for Armco that we were selected to head their Armco 600 project.

## Armco Steel Plants

KE's assignment for Project 600 began in 1964 and was completed in 1972, providing program management, master planning, engineering, detail design, construction, and construction management services. The program encompassed the Middletown works in Ohio, the Butler works in Pennsylvania, and the Houston works in Texas.

The program for the Middletown works, the largest of Armco's seven steelmaking plants called for a BOF plant, vacuum degassing and continuous casting facilities, soaking pits, a slabbing mill, a hot strip mill, pickling lines, a tandem cold mill, coating lines, and annealing furnaces. For the Butler plant, the program featured an electric furnace plant, vacuum degassing and continuous casting facilities, extensive additions to cold rolling and finishing facilities, major expansion of high-grade electric steel production facilities, relocation of rolling facilities, and a central maintenance shop. At the Houston works the program included an electric furnace plant and master planning for the next phase of expansion.

The largest element of the program, the Middletown works, was selected by the American Society of Civil Engineers as the "Outstanding Civil Engineering Achievement of 1970." This was the first privately financed project to win the award. Before winning the ASCE award, the new facilities had already received statewide recognition by being named one of the "Seven Engineering Wonders of Ohio" by the Ohio Society of Professional Engineers. The air and water pollution control program for the new facilities also received recognition when the National Society of Professional Engineers named it as "one of the outstanding engineering achievements of 1969."

The magnitude and complexity of this turnkey project and the dispersal of construction sites necessitated the use of advanced production, instrumentation, and control technology, including many new concepts previously untried in the United States. Virtually every detail of the entire project was programmed for efficiency through application of highly sophisticated critical path method of scheduling. The Critical Path network proved especially helpful in projecting potential problems and possible delays and in finding alternative solutions.

## Planning

The success of the overall program is attributed in large part to the major planning and scheduling effort that preceded each element of work. Procedures were established for the preparation of a substantial engineering report for each new facility. General arrangement drawings, major equipment specifications, detail design schedules, construction schedules, and capital cost estimates were carefully prepared, reviewed, and approved by all levels of management prior to beginning detail design, procurement and construction. Working in a task-force mode with extensive input from Armco Steel department heads and operating and maintenance personnel, allowed Armco management to authorize expenditures for each facility with confidence in the eventual outcome. The scope of the work was fixed before capital expenditures were made.

The initial phase of the Middletown expansion part of Project 600 was based on a product mix established by Armco's sales department. The master planning for the ultimate capacity of the steel plant was based on the ultimate capacity of the hot strip mill that was installed in the initial phase.

Material flow diagrams were prepared based on existing plant production rates and projected rates from newly installed facilities. From these production flow diagrams equipment was selected to meet production objectives. With such equipment selection, outline designs were prepared to show equipment locations so that engineering studies could be initiated as follows:

- Energy studies: plant-wide heat balance, plant steam balance, and power plant power distribution.
- Plant water system development
- Plant oxygen requirement
- Plant rail and road traffic

The results of these studies constituted a Master Plan, which was issued initially in November, 1964, and revised in June, 1967. The reports included descriptions of existing and proposed facilities, basic process criteria, and preliminary schedules for each facility.

Project 600 provided Armco Steel with greatly reduced operating costs, and each facility was put into operation ahead of schedule and substantially under budget allowing Armco to produce prime steel products.Shortages of craftsmen occurred in mechanical, piping and electrical trades. A large-scale recruitment program in Canada, supported by local unions, overcame the shortages, and was instrumental in helping to complete the project on time. The on-time completion of the project and the smooth startup of the facilities are a testament to the effectiveness of KE's master planning capabilities.

The project staff successfully sequenced and coordinated hundreds of simultaneous activities involving 20 major subcontractors. The procurement group efficiently handled and coordinated all procurement functions including purchasing packages, shipping, receiving and warehousing. A computerized procurement status report summarized the activities.

## Middletown Facilities

New facilities at Middletown included 900,000 square feet of new structures. Included were the following facilities:

- an expandable melt shop with two initial 200-ton basic oxygen furnaces;
- vacuum degassing and continuous casting facilities;
- 50 soaking pits;
- slabbing mill; two slab yards; three reheating furnaces;
- a hot strip mill which included a scale breaker, three two-high and three four-high roughing stands and a four-high seven-strand finishing train producing about 240,000 tons per month of 80-inch wide strip up to 1/2-inch thick;
- three coilers for up to 44-ton coils;
- pickling line;
- coating lines;
- cold reduction mill;
- heat treatment processes;
- auxiliary support facilities such as waste heat utilization; 100,000 gallon per minute industrial water system; deep well waste acid disposal system;
- extensive pollution control systems for water and air.
- computer control system for full process control with features including automatic roll changing; strip width and thickness electronic controls; controls for compensating strip temperature with table speed; and "zoom" rolling and inter stand tension compensating controls.

The computer control system was unique as described by Earl Denner: In the early and mid-1960s a number of computer-controlled hot strip mills were constructed for other steel mills in the United States. All failed their scheduled start-up dates. Many months and even a year or more were spent in finding design errors and omissions and correcting them, adding millions of dollars of unbudgeted costs to the projects.

In contrast, the Armco continuous hot strip mill achieved start-up by computer control on schedule! The third coil and those that followed were quality products! The *Wall Street Journal* made particular note of this achievement by stating, "The first computer-controlled mill to come on line on schedule." This was followed up with the comment that Congress should hire Kaiser Engineers to straighten up the government mess. Soon after the mill started up, we were told by the Armco Board of Directors that in anticipation of possible start-up problems as experienced by the earlier hot strip mills, it had budgeted $15 million for extra costs that they now did not have to spend.

## Major Design and Construction Effort

The design effort required a peak staff of 340 engineers and resulted in preparation of 14,000 design drawings. Structural design work alone required a peak of 85 engineers and draftsmen, producing 3,600 drawings.

KE construction personnel numbered about 3,600 at peak in mid-1967 at Middletown and another 900 at Butler by April, 1969.

Activities included installation of 94,000 cubic yards of concrete; 6,100 tons of reinforcing steel, and 25,000 tons of structural steel.

## Follow-on Armco Work

The KE Project Management office in Middletown was closed in June, 1972, after 8 years of continuous activity. During the next 18 years continuing work for Armco was handled from Kaiser Engineers' permanent office in Chicago. These continuous services included design and construction management for a continuous bloom caster complex at Ashland, Kentucky, and inspection services for coke oven batteries at Middletown and Ashland. Subsequently on the international scene, KE's international groups cooperated with Armco in providing services to SOMISA in Argentina and to Krakatau in Indonesia.

## Steel Capabilities

For the reader to gain a fuller feel for the extent of the steel mill experience the company had, we have reproduced portions of excellent group "dot charts" of steel plant activities taken from a 1976 steel plant brochure, Table 4.2. This was carefully crafted by Mike Janner to show the many and varied number of clients, the different types of steel-making facilities undertaken, and a breakdown of the types of services rendered, from preliminary engineering through final construction. The table gives a concise picture of the company's experience.

This document was extensively used by marketing personnel as a concise compendium of KE's steel capabilities. A potential client could readily identify projects similar to his own and have a sense that KE had the capabilities to assist him.

Each chart shows for each project which of ten different roles KE had played in executing the project. The role could have been preliminary engineering, or detail design or construction, or any other responsibility. Individual charts are shown for steel-making, iron-making, L-D plants, rolling mills and even specific kinds of rolling mills, water utilization, pollution control, steel yards, and utilities, warehousing, and direct reduction processes, pelletizing plant, and iron ore projects.

Referring to the black dots, one can easily discern KE's role. For example on the first sheet for major steel production facilities, KE's role covered all ten responsibilities for Kaiser Steel's projects, for the Tata project, and for Armco's plant. But for Stelco KE had a more limited role consisting of engineering and construction management.

By any measure, the dot charts describe the extensive expertise KE had accumulated. Marketing efforts were simplified by this concise presentation.

Noteworthy here is the section on L-D plants. Because of the know-how acquired in this process, KE was able to market this process successfully. Most of the projects and steel companies in the United States were clients. Projects are included for Acme Steel, Alan Wood through Armco, International Harvester, Jones and Laughlin, Youngstown Sheet and Tube, Great Lakes Steel, McClouth Steel, Republic Steel, and U.S. Steel Corporation. In fact, most of the United States steel companies are listed as clients. KE had emerged as a premier purveyor of knowledge of the steel industry.

## International Projects

Meanwhile, the KE international group was active in building steel projects. Following the Tata project described as one of the three major efforts of KE's early career, KE landed the Cosipa Steel project in Brazil. It occurred at just the time that engineering for Tata was completing and, fortunately, a key group of engineers could be spun off and transferred to that project. Cosipa was a fully integrated green-field project. Interesting aspects of this project are reviewed below.

Following the Cosipa Project and while the domestic division was working with Armco, we were successful in negotiating the Somisa project in Argentina in association with Armco. This project is also reviewed below. Then after the 1974 oil crisis three countries embarked on direct reduction steel-making projects. Several years later when they became mired in construction problems, KE stepped in to assist them with rescue missions. That story is told below also. And the international group sponsored a number of major studies for steel projects abroad. These included Al Jubail in Saudi Arabia, Uninsa in Spain, projects in Argentina, Brazil, and Mexico.

## **Cosipa, Brazil**
### Background

As the Tata project began to wind down, our interest in Latin America increased with opportunities to participate in industrialization that was obviously coming. We first heard about the Cosipa steel project in Brazil early in 1957 from a financial adviser to Edgar Kaiser who suggested that we get involved at an early date as the project was in the early phases of trying to obtain financing. In order to determine whether the project was viable and whether it was worthwhile for us to devote a substantial effort in pursuing it, he volunteered to have KE prepare a feasibility study of the project at our own expense.

KE's report, completed in August, 1957, concluded that the project was viable. The report was released by the client to their friends in the industry, and it soon found its way in the trade as suppliers of equipment liked its thoroughness and the results that it predicted. Suppliers who often were the first to assist owners with advice concerning how to build a steel mill had previously seen many projects proposed without any definition or any justification.

Seeking confirmation of our findings, Cosipa engaged the Koppers Company to make studies of markets and to make preliminary layouts and conceptual specifications for the plant. This report was completed in May, 1958. Soon thereafter, Cosipa solicited fixed-price quotations from KE, Koppers, and McKee, the three traditional competitors, on a limited scope of services. Our proposal complied with the request but went further to limit any obligation to perform services beyond the limited scope and beyond the 44 months specified for project completion in the Koppers report.

This proposal was a complete change in scope of services in which KE had previously offered its services. We were used to providing cost-plus-a-fixed-fee type contracts with single responsibility for the entire works. But in Latin America there was no way they would permit such "turnkey" operations because of lack of dollars to pay for them and because they wanted local firms to do as much work as possible in order to save foreign exchange and in order to educate their Brazilian technical personnel.

We agreed to participate in this limited effort because our steel forces on the Tata project were becoming available, and new turnkey work on the horizon was limited. The project required the investment of a few key people including a project manager, a construction manager, and key steel mill project engineers. The scope limited our obligations to just what was specified, and the payments to us were mainly in dollar obligations. With a very detailed estimate of cost and proper monitoring of our obligations, we were able to meet our financial projections. The project returned a profit of over $1,250,000, which was substantial for the time. The mark-up on costs was 50 percent.

## Cosipa Steel Mill

Cosipa is an abbreviation for the name of the founding company, Companhia Siderurgica Paulista, SA. It is located on a green-field site at an abandoned banana orchard at Piacaguera, Brazil. This is south of Sao Paulo, Brazil, at the foot of an escarpment and has water access for raw material shipments.

Work commenced in November, 1958, with initial long-range planning and master planning services conducted in our Oakland offices. Ultimate planning was for a facility to produce 2,500,000 metric tons of ingots annually. When the master planning was completed, work was initiated in Oakland on the conceptual design and preparation of general arrangement drawings and specifications for the initial 500,000 ingot ton authorized. Major facility bid packages were defined for procurement of turnkey supply of the blast furnace, coke ovens, oxygen steel plant, and major rolling mills. Complete bid packages were assembled, and suppliers were solicited for proposals. Proposals were analyzed in detail in Oakland, and recommendations for purchase were submitted to Cosipa for approval. Bid packages were unusual in that suppliers were requested to offer financing terms along with the supply of equipment. Responses came from Europe and Japan. The review process was done in two steps. Review of technical proposals was performed by KE staff who prepared recommendations to purchase, comparing technical and cost data. Cosipa management compared financing terms and made final decisions.

The second phase of work started at completion of the Oakland phase with the dispatch to Sao Paulo, Brazil, of a key nucleus of project engineers and one field supervisor. Work continued in Brazil with preparing additional specifications for the remaining packages of supply and in assisting Cosipa in reviewing, analyzing, and placing the remaining orders. General arrangement drawing work was completed in Brazil. Detail design drawings and tie-in with information furnished by suppliers was reserved for preparation by a Brazilian design staff that had participated on another Brazilian steel mill at another location. KE's responsibility was to review and comment upon those designs.

At the site, field work was handled by other Brazilian contractors and managed by Cosipa personnel. KE's field responsibility was to review construction inspection and to assist on an as-needed basis and when requested by the Cosipa staff.

The major plant facilities included under this 500,000 ingot ton program were: coal, iron ore and limestone handling and preparation; sinter plant; 62 coke ovens by-product plant; 28-foot blast furnace; two 60-ton vessel L-D plant; six 2-hole soaking pits; 44 x 114-inch, 2-inch hi reversing slabbing mill; two 100-ton slab heating furnaces; 36 and 54 x 110-inch, 4-hi reversing plate mill; 5-stand, 4-hi 25 and 47 x 66-inch semi-continuous hot strip mill; 2-hi 32 x 66-inch hot skin pass mill; 60-inch hot shearing line; 4-hi continuous 66-inch cold reducing mill; 3-stand, 4-hi 21-inch and 45 x 66-inch cold temper mill; annealing furnaces, blower and powerhouse, and water system. The rolling facilities were designed to produce 300,000 tons of finished products annually.

KE contracts were completed in September, 1962. By that time we estimated that the project was 62 percent complete. Detail design was not yet completed. Brazil in general and Cosipa in particular were undergoing a severe shortage of foreign exchange. Thus, they opted to attempt to complete the work using only local talent where payments could be made in local currency, the cruceiro at the time. The result of this decision was that personnel employed were not as trained in modern engineering and construction practices, and the project completion was delayed until the end of 1960s and early 1970s. It should be noted that the Cosipa management and directors underwent five complete changes during the life of our contract, usually occurring after each major election or political crisis in the Brazilian government.

Despite the delays, the plant, when completed, was a modern well-designed facility that provided adequate opportunity for further expansion as a result of our master planning work.

We estimated that the cost of the facilities would be $207 million of which 55 percent would be in local exchange. Estimating was difficult for Brazilian conditions because during the life of our project inflation was rampant, and the exchange rate from dollars to cruceiros varied from 137 to 487, a factor of 3 1/2.

Key staff included E. C. Anderson, project manager; project engineers, Rudy Fink, Werner Hahne, Dick Hart, Dave Knall, Clay Schwalen, Art White, and R. W. Hart; Don Robinson was office engineer; Tex Hathcoat, estimator; Ralph McNamara, procurement advisor; and Joe Vance, resident engineer. Work was under the supervision of Sam Ruvkun, vice president for Latin America.

## Somisa, Argentina

### Background

In the period 1966-1968, the KE Latin American division concentrated its marketing efforts in Argentina on expansion plans for its steel mill located at San Nicolas on the Parana River some 150 miles upstream from Buenos Aires. SOMISA (Sociedad Mixta Siderurgica Argentina) had plans to increase its steel-making capacity from 1.1 million tons to 2.5 million metric tons of ingots annually.

Good relations were maintained with key Somisa staff to gain early intelligence and to allow us to prepare a proposal for our services after financing was obtained by them. It became evident that four firms would be considered: McGee, Koppers, Armco, and KE. Armco had a long-standing relationship with Somisa by providing operating know-how.

Marketing considerations dictated that the best chance of success would be for KE to join with Armco since we already had a good relationship built by KE's work of the domestic steel division at Middletown, Ohio. The problem was how to integrate KE's Latin America division, Armco's international division, KE's steel group, and Armco's Middletown staff.

The result of negotiation was a contract whereby Armco was to be Somisa's technical consultant, and KE would provide engineering and construction management services under a subcontract to Armco.

### Somisa Steel Plant

In March, 1968, Somisa and Armco entered into a contract to expand Somisa in an orderly manner. Kaiser Engineers entered into a subcontract with Armco.

The first phase of work consisted of preliminary engineering and preparation of a detailed master plan to establish a basis for the orderly scheduling of the work. By April, 1969, the master plan was completed in Chicago and partial financing completed with the Export-Import Bank of the United States. The goal was to raise production capacity to 2,500,000 tons by 1973. The ultimate plant capacity foreseen by the master plan was 4,700,000 ingot tons.

The 2,500,000-ton plan was accomplished in three phases:

**Phase I:**
a new sinter plant and modifications of rolling mills

**Phase II:**
oxygen steel-making facilities; continuous casting; calcining; oxygen generation

**Phase III:**
a new blast furnace, coke ovens, materials handling, dock facilities.

Field forces took up residence in Argentina early in 1969 and completed contractual obligations by

1973. The project was estimated to cost $300 million in 1969 costs (over $1 billion in year 2000 costs).

The project included the following production facilities:

- a new sinter plant
- a blooming and slabbing mill
- hot and cold mill modifications
- temper mills
- new basic oxygen steel-making for 1,900,000 tons
- continuous casting
- oxygen generating plant
- calcining plant
- new coke plant
- new 32-foot blast furnace
- materials handling

The steel mill is unique in that both iron ore and coal are imported into Argentina. For financing reasons, much of the equipment was purchased internationally with financing provided by the suppliers. Construction activities were handled by the German construction affiliate of Ferrostaal.

Engineering reports were prepared by the KE staffs in Middletown and Chicago after which competitive international proposals were solicited and evaluated.

For each of the production facilities, suppliers offered turnkey contracts to supply designs, equipment supply, and erection. Supplies came from seven different countries in Europe, Japan, and the United States. The challenge was to coordinate different languages, customs, currencies, terminology, and steel practices.

## Key Staff

During early planning and field staff stages, U.S. activities were managed by Jay Irvin. When activities were fully implemented, the project was managed by Frank Kast in the U.S. Resident manager at San Nicolas was Wes Driver with Frank Brauns being the resident engineering manager. Detail design was handled out of the Chicago steel design office. Coordination of all activities was by the Latin American division under Sam Ruvkun. Field construction coordination was handled by a small staff of construction managers led by Uwe Clausen.

## Direct Reduction Plants, Rescue Missions

In 1974, the world saw an oil crisis as the OPEC nations of oil-producing countries decided that they would no longer sell oil at $2.50 per barrel. As oil reached $20 per barrel and beyond, OPEC countries became rich with dollars. They and their financial advisors laid out plans for investing the new-found riches with the avowed purpose of benefiting their own citizens.

Planning presumed that by industrialization they could create good jobs for their people, and they would also obtain a good rate of return on their investment. They were concerned also that if the the high prices for oil at the time did not prevail, industrialization would help the economy at a later date. Also there was some concern they might run out of oil.

Planners soon discovered that as they pumped more oil, they were flaring off a great deal of natural gas. They searched for a way to use this wasted gas in their industrialization plans. Fortunately for them, at the same time, a new process of steel production known as direct reduction of iron ore became available with a single production plant being very successful in Mexico. This new plant did not require coking coal, nor a coke plant, nor a blast furnace.

So, the OPEC countries bought into the new direct reduction process as a means of using their excess natural gas as a reductant. It turned out, though, that people who owned the rights to the process and had the know-how and thus promoted the process were European equipment manufacturers and suppliers. They succeeded in selling turnkey packages of engineering and equipment for plants in Iran, Indonesia, and Venezuela. Other European suppliers, sometimes affiliated with the direct reduction plant suppliers, offered turnkey packages for steel-making facilities and rolling mills.

At the time, each of the three plants—at Ahwaz, Iran; Krakatau, Indonesia; and Sidor, Venezuela—was about a quarter completed, each owner discovered that they were in real trouble. Budgets were being overrun, completion schedules were not realistically known, tie-in facilities for which the owners were responsible were not being built, and relationships between the owners and suppliers had deteriorated.

KE's international group had been watching each of the three projects since their inception.

When the owners called for assistance, we were able to match their needs to mount efforts to rescue the projects. We had steel plant know- how and a good reputation which they all acknowledged. We had a great deal of experience in working in the underdeveloped countries and knew how to work with their particular work practices. And we had personnel, which we were willing to send in to augment the clients' own staffs in managing and coordinating the projects.

## Ahwaz, Iran

Our first foray into rescuing these projects occurred in Iran. At the time, Iran was under the leadership of the Shah, and Americans were on good terms with members of the elite who ran the country. The project at Ahwaz in the interior of Iran was undertaken with an all-Iranian leadership group, supervising a number of foreign turnkey equipment suppliers. In this sense turnkey meant supplying engineering, equipment, materials, and labor to erect an entire facility.

The plant consisted of a number of large packages which needed coordination and assistance in providing tie-in facilities. KE was retained to provide services in a very complex contract, which required integration of our people with the Ahwaz people. KE did not provide engineering services.

## Ahwaz Key Staff

Personnel seconded to Iran included Wes Driver as project manager, Jim Miller as construction manager assisted by Doil Yockum, George Boyde, Lyle Marsh, Gene Green, Ron Betz, and Chuck Whitford. The work was under the direction of Dick Lowell vice president for Europe, Africa, and the Middle East. Contract negotiations in the final phases were handled by Bob Wolf. To satisfy the client's requests, our accounting system and charging method had to be reworked, requiring Wolf's attention to innovating our usual billing methods.

In 1979, just before the Shah was overthrown, Dick Lowell became seriously ill. Sam Ruvkun was in Iran starting a new steel mill at Bandar Abbas when he was asked to substitute for Lowell. As his work on Bandar Abbas concluded, he made plans for his initial visit to Ahwaz and had been in communication with Wes Driver about the trip. Ruvkun and Driver had a long-standing relationship starting with the Braden projects and the Somisa project. But before he could embark, the U.S. embassy urged him not to go. They said that Ahwaz was the hot bed for the anticipated uprising. Ruvkun returned home and agreed with Driver to keep in contact about the situation over the upcoming long holiday weekend in the U.S.

See Ruvkun's Oral History in which he relates how the crew escaped from Iran. In fact, there was an insurrection, and the embassy that thought the hot spot was in Ahwaz found itself overrun, and the embassy staff was taken hostage, much to the consternation of Presidents Jimmy Carter and Ronald Reagan.

## Sidor, Venezuela

Likewise, Venezuela wanted to get into a good thing. It was an oil-producing country with lots of flared gas also. But it had more grandiose plans. Along with wanting a steel mill, it had great plans to industrialize the Orinoco River area by building a new town site, alumina and aluminum plants, and the new steel mill. The steel mill was named Sidor, short for Siderurgica de Orinoco.

KE's history with Venezuela started with construction of Guri Dam which is near the area for industrialization and for which Guri supplied electric power. In following the execution of the Sidor plant, our marketing people discovered many similarities with the Ahwaz project. Sidor had also awarded turnkey packages to suppliers who promised more than they could deliver. And each package reserved certain tie-in facilities, utilities, and material handling for the owner to perform. When the project was far along, it became apparent that Sidor needed help, and they solicited help from several engineering firms including KE. Our services were to integrate our people within the Sidor organization. It was quite similar to the Ahwaz contract, but KE was also assigned some utility design projects handled by the Chicago office.

Staff assigned was headed by Key Ryan assisted by construction supervisory personnel including Don Cardarelle. Ryan's position was especially difficult as he was a key consultant to the Sidor staff as well as project manager for KE. However, Sidor would not allow him to have an administrative assistant to handle the paper work involved with managing the work. So he worked day and night.

At the same time that Sidor was going on, the president of the organization for industrialization of the Orinoco Valley called for help. This agency went by the acronym of CVG, which is short for Compania Vale de Orinoco. The call for help went to the then president of Kaiser Industies, Bill Roesch.

KE was successful in defining a program of assistance to CVG. The staff headquartered in both Caracas and Ciudad, Guiana, was headed by Wes Driver, with assistance from Sherrill MacDonald, Bob Miller, Lachlan McBean, and Frank Walker in the field and housing and management experts in Caracas. This effort was headed by Sam Ruvkun.

## Krakatau, Indonesia Background

While we were into our rescue missions at Sidor and Ahwaz and were well underway in mid-1975, we received an inquiry for assistance from Krakatau in Indonesia, developed by Jesse Taylor operating out of Australia. It came in the form of a cablegram requesting an immediate response.

We had very little intelligence about the project in Oakland. However, building on our knowledge of the problems at Sidor and Ahwaz and assuming that the Indonesians had similar problems and restraints on funds, we assembled an 11-page telex response. The next day our proposal was accepted, and we were requested to send technical personnel to Amsterdam for high level discussions. (See the article by Sam Ruvkun in Oral Histories, entitled “How We Got the Krakatau Job.”)

We proposed that a limited number of project and management staff be seconded to them and that we be reimbursed on a per diem basis. We obtained our highest multipliers on salaries and were able to return a fine profit for several years.

As a sidebar, we later learned that when McKee got the inquiry, they responded that it would take a month to make a proposal; Koppers said they wanted to visit. Only we responded to what we perceived to be an urgent call for help. And it was.

## Krakatau Steel

P. T. Krakatau Steel was organized in 1970 to develop an integrated steel mill located in the Sunda Straits about 120 km west of Jakarta, adjacent to a highway and a railroad and at a reasonable economic distance from the main steel consuming areas of Indonesia. The project proceeded on a joint-venture basis with Ferrostaal of Germany. Ferrostaal developed a plan to produce 1,500,000 tons of steel annually, capable of expansion to 6,000,000 tons. By mid-1974, contracts had been entered into for the supply of equipment and erection services aggregating the equivalent of U.S. $1.8 billion.

Terms and conditions of the contracts were heavily in favor of the sellers with no provision for termination, or owner review of design or construction, no performance test details, and no financing arrangements. Not surprisingly, this huge and hastily assembled project began to falter and by late 1974 payments became delinquent. By early 1975, the authorities called for an urgent review of the project. By May, 1975, Kaiser Engineers had submitted its proposal which was accepted.

After initial meetings to determine how to best serve the clients needs, it became apparent that Krakatau Steel would also need management and operating know-how. Armco Steel personnel had been in discussions with the Krakatau people as we had. Because of the excellent relations developed over the years at Armco Project 600 and later at the Somisa project, an arrangement was made whereby KE and Armco would perform the needed activities in association. Subsequently, all work was done jointly. Armco provided liaison, management, and operating know-how, and KE provided the technical support.

The first assignment was a reassessment report to decide how to cut back the program, and that was followed by the preparation of a master plan for the project. This initial assessment was undertaken on an urgent basis by assigning executives from the Oakland office while a staff was being mobilized for on-going services. The initial assessment was handled by a team composed of Sam Ruvkun, Jack Hughes, Dick Kuhl, and Harry Bernat, assisted by the Oakland estimating department.

Meanwhile, a team was mobilized to handle consulting for Phase I activities, which was construction assistance on already authorized projects. This activity proceeded from 1975 through 1979 and was headed by Dick Hart as project manager. His staff included Edgar Abreu, Mike Anderson, Grove Fox, Peter Goldsmith, Bruce Grube, Harvey Hautala, Dick Kuhl, Curt Jensen, Carl Mertens, Dick Milford, Doug Robbins, and John Rosten.

Then in 1979, Krakatau expanded with a new hot strip mill. This Phase II was also entrusted to KE to oversee, and a new team was dispatched. This team was headed by Bill Smith as project manager. His staff included Jim Allen, Mike Anderson, Elmer Barthel, George Botting, Fred Brunner, Earl Denner, Peter Goldsmith, Ebby Johnson, Dick Kuhl, Carl Mertens, Duke Milford, Doug Robbins, Key Ryan, and Bill Stolmack. KE’s involvement continued on for 12 1/2 years until 1987, overseeing the plant construction and initial operations.

A more detailed and interesting account of the Krakatau story as seen through the eyes of Bill Smith is reproduced in the "Oral History" chapter. In it he describes the politics of the country, the difficult working conditions when working with equipment suppliers who defined their own packages of supply, the difficulty of working with local staff who needed training in basic principles of project management, and finally the assistance provided in operating the facilities. Many of these aspects were not encountered in domestic projects.

**Table 4.1**
**Steel Projects List**

| Job No.1 | Project Name | Client | Location | Project Value $ x millions |
|---|---|---|---|---|
| | | *Projects where KE was both Architect/Engineer and Constructor* | | |
| 4201 | Iron and Steel Plant | Kaiser Steel | Fontana, CA | 147 |
| 4401 | Shell Plant Facilities | Corps of Engineers | Fontana, CA | 16 |
| 4555 | Iron & Steel Facilities #4 | Kaiser Steel | Fontana, CA | 11 |
| 4750 | Eagle Mountain Mine | Kaiser Steel | Eagle Mountain | 5 |
| 4811 | Ironton Blast Furnace Rehab | Kaiser-Frazer | Utah | 3 |
| 4840 | Open Hearth Plant | Kaiser Steel | Fontana, CA | 14 |
| 4850 | Blast Furnace #2 | Kaiser Steel | Fontana, CA | 14 |
| 5096 | Tin Mill & Auxiliary Facilities | Kaiser Steel | Fontana, CA | 28 |
| 5149 | N & S Ore Bodies | Kaiser Steel | Eagle Mountain | 4 |
| 5175 | Steel Plant Expansion | Kaiser Steel | Fontana, CA | 59 |
| 5218 | Sunnyside Coal Mine Adds | Kaiser Steel | Utah | 5 |
| 5357 | Wide Slab Facilities | Kaiser Steel | Fontana, CA | 5 |
| 5549 | Fine Ore Beneficiation | Kaiser Steel | Eagle Mountain | 4 |
| 5566 | Iron and Steel Plant | Tata Iron & Steel Co. | India | 151 |
| 5606 | L-D Oxygen Steel Addtions | Jones & Laughton | Pennsylvania | 9 |
| 5650 | Steel Plant Expansion | Kaiser Steel | Fontana, CA | 209 |
| 5844 | Secondary Crushing Facility | Kaiser Steel | Eagle Mountain | 11 |
| 6060 | Steel Rolling Mills | Pacific Steel | New Zealand | 7 |
| 6136 | Iron Ore Beneficiation | Kaiser Steel | Eagle Mountain | 11 |
| 6227 | L-D Oxygen Steel Plant | Armco Steel | Kentucky | 22 |
| 6326 | Tin Mill & Auxiliary Facilities | Kaiser Steel | Fontana, CA | 14 |
| 6401 | Iron Ore Beneficiation | Kaiser Steel | Fontana, CA | 19 |
| 6428 | Electric Weld Pipe Mill | Kaiser Steel | Fontana, CA | 6 |
| 6474 | Middletown Steel Plant | Armco Steel | Middletown, OH | 432 |
| 6475 | Butler Plant Expansion | Armco Steel | Butler, PA | 145 |
| 6472 | Houston Plant Expansion | Armco Steel | Houston, TX | 22 |
| 6480 | Steel Plant Expansion | Kaiser Steel | Fontana, CA | 73 |
| 6560 | L-D Oxygen Steel Plant | Alan Wood Steel | Pennsylvania | 27 |
| 6606 | L-D Oxygen Steel Plant | Youngstown Steel | Pennsylvania | 65 |
| 6831 | Cold Rolled Sheet | Kaiser Steel | Fontana, CA | 19 |
| 74047 | Steel Plant Expansion | Stelco | Canada | 490 |
| 74092 | Kaiser Steel Expansion | Kaiser Steel | Fontana, CA | 35 |
| 74023 | Steel Plant Modifications | Kaiser Steel | Fontana, CA | 200 |
| 74106 | Integrated Steel Plant | Stelco | Canada | 490 |
| 74114 | Fume Collector, Scrap Cutting | Kaiser Steel | Fontana, CA | 12 |
| 74249 | Steel Scrap Cutting | Kaiser Steel | Fontana, CA | 9 |
| 75103 | Coke Oven Plant | Dominion Steel | Canada | 110 |
| 76198 | Coke Oven Emission Control | Kaiser Steel | Fontana, CA | 12 |
| 76199 | Coke Gas Desulfurization | Kaiser Steel | Fontana, CA | 225 |
| 81081 | Bloom Caster Complex | Armco Steel | Kentucky | 104 |
| | | *Construction Management Projects* | | |
| 6345 | Auto Parts Foundry | Kelsey-Hayes | Michigan | 7 |
| 76069 | Steel Plant | Asil Celik Sonyi | Turkey | 150 |
| 76199 | Coke Gas Desulfurization | Kaiser Steel | Fontana, CA | 225 |
| 78148 | Coke Oven Battery | Republic Steel | Illinois | 68 |
| 79054 | Steel Rail & Beam Expansion | Wheeling-Pittsburgh Steel | Pennsylvania | 99 |
| 79064 | Coke Oven Battery | Republic Steel | Illinois | 137 |
| 81080 | Continuous Bloom Caster | Armco Steel | Kentucky | 104 |
| 81120 | Bloom Caster | Wheeling-Pittsburgh Steel | Pennsylvania | 48 |
| 81121 | Continuous Slab Caster | Wheeling-Pittsburgh Steel | Ohio | 95 |



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**Table 4.1 cont**

| Job No.[1] | Project Name | Client | Location | Project Value $ x millions |
|---|---|---|---|---|
| | | *Construction Management Projects* | | |
| 82003 | Steel Plant Expansion | Babcock & Wilcox | Pennsylvania | 90 |
| 82015 | Copper Concentrate | Empressa Minero Centro | Peru | 300 |
| 84149 | Coke Oven Rebuild | Rough Steel | Michigan | 57 |
| 84194 | Electric Furnace "D" | Lukens Steel | Pennsylvania | 100 |
| | | *Construction Assistance Projects* | | |
| 5842 | Integrated Steel Mill[2] | Cosipa | Brazil | 215 |
| 6810 | Steel Mill Expansion | Somisa | Argentina | 300 |
| 75045 | Pahlavi Steel Plant, Ahwaz[3] | Government of Iran | Iran | 250 |
| 75081 | Krakatau Steel Plant | Government of Indonesia | Indonesia | 1,000 |
| 76013 | Integrated Steel Mill[4] | Sidor | Venezuela | 3,500 |
| | | | | 9,984 |

***Notes:***

[1] Numbering is chronological with the first two numbers indicating the year the project was initiated.

[2] Cosipa is an example of construction limited services. KE performed consulting services, process equipment procurement, and overall consulting and advisory services. In the field, Joe Vance was the Chief Field Engineer and the only KE representative.

[3] At Ahwaz, KE *did not* perform engineering services.

[4] KE performed limited design services for Sidor.

# A Word About 'Dot Charts'

## Extensive Steel Capabilities

During the course of its history, KE acquired extensive steel plant design and construction capabilities. It would take volumes of text to describe this experience. In order to simplify its ability to market this information, KE prepared a concise "dot chart" of its steel plant experience. It was included in a steel plants sales brochure in 1976. Selected pages of this carefully crafted chart are reproduced next in Table 4.2 entitled, "Steel Capabilities."

The table shows the varied number of clients served, the different types of steel-making facilities undertaken, and a breakdown by type of services rendered, from preliminary engineering through complete design and finally construction. It is a concise picture of the company's experience in the steel industry.

With this dot chart, a potential client could readily identify projects similar to his own and feel assured that KE had done work similar to what he needed.

## Table 4.2
## Steel Capabilities

**from a Steel Brochure**
**published by Kaiser Engineers - 1976**

### major steel production complexes

| client and location | Engineering-Economic Studies | Preliminary Engineering | Definition of Criteria and Concepts | Master Planning | Engineering | Procurement and Expediting | Detail Design | A-E Field Engineering | Construction Management | Construction | description |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Altos Hornos de Mexico, S.A. Monclova, Mexico | ● | ● | | ● | | | | | | | Production and traffic analyses; and selection of locations for future ironmaking, steelmaking and rolling facilities |
| Armco Steel Corp. Butler, Pa. | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | Integrated steel plant expansion program |
| Armco Steel Corp. Houston, Texas | ● | ● | ● | ● | | | | | | | Integrated steel plant expansion program |
| Armco Steel Corp. Middletown, Ohio | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | Integrated steel plant expansion program |
| Cia. Fundidora de Fierro y Acero de Monterrey, S.A. Mexico | ● | ● | ● | ● | | | | | | | Development of a preliminary master plan for expansion of an integrated steel plant |
| Companhia Siderurgica Paulista Piacaguera, Brazil | ● | ● | ● | ● | ● | ● | | ● | | | Integrated steel plant |
| CRA/Hamersley Steel & Iron Division Australia | ● | | ● | ● | | | | | | | Integrated steel plant |
| Empire-Detroit Steel Division of Cyclops Corporation Portsmouth, Ohio | ● | ● | | | | | | | | | Integrated steel plant |
| Hamersley Iron Pty., Limited Various Locations | ● | ● | ● | | | | | | | | Operational and facility concepts for steel plants utilizing prereduced ore |
| International Finance Corporation | ● | | | | | | | | | | Consulting services in connection with the expansion of Belgo Mineira integrated steel plant in Brazil |
| National Iranian Steel Industries Company Ahwaz, Iran | | | | | | ● | | | ● | | Integrated steel plant |
| Kaiser Steel Corp. Fontana, Calif. | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | Integrated steel plant and expansions through 1955 |
| | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | 1956 - 1970 expansion programs |
| | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | 1970 - 1985 expansion programs |
| Marsteel—Government of Saudi Arabia Saudi Arabia | ● | ● | ● | ● | | ● | | | | | Direct ore reduction and steel plant |
| P.T. Krakatau—Government of Indonesia Cilegon, West Java | ● | ● | ● | ● | | ● | | ● | ● | | Existing and planned steel facilities |
| Siderurgie du Quebec - Canada (SIDBEC) Becancour, Quebec, Canada | ● | ● | ● | ● | | | | | | | New integrated steel plant |
| Siderurgica del Orinoco, C.A. (SIDOR) Caracas, Venezuela | ● | | | | ● | ● | ● | ● | ● | | Integrated steel plant expansion |
| Sociedad Mixta Siderurgia (SOMISA) San Nicolas, Argentina | ● | ● | ● | ● | ● | ● | | ● | ● | | 2.5-million ton program |
| Steel Company of Canada, Ltd. (STELCO) Lake Erie Development Ontario, Canada | | | | | ● | | | | ● | | Steel plant development and project assistance |
| The Tata Iron and Steel Company, Limited Jamshedpur, India | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | 2-million ton program |
| Union de Siderurgicas Asturianas, S.A. (UNINSA) | ● | ● | ● | ● | | | | | | | Integrated steel plant |
| Youngstown Sheet & Tube Company East Chicago, Indiana | ● | ● | ● | | | | | | | | Profit improvement study of integrated steel plant |

**Table 4.2**

## L-D plants

| client and location | Consulting | Engineering-Economic Studies | Preliminary Engineering | Master Planning | Engineering | Procurement and Expediting | Detail Design | A-E Field Engineering | Construction Management | Construction | description |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Acme Steel Co.<br>Chicago, Ill. | ● | | | | | | | | | | L-D plant |
| Alan Wood Steel Co.<br>Conshohocken, Pa. | ● | ● | ● | ● | ● | ● | ● | ● | ● | | L-D plant |
| Allegheny Ludlum Steel Corp.<br>Brackenridge, Pa. | ● | ● | ● | ● | | | | | | | L-D plant |
| Armco Steel Corp.<br>Ashland, Ky. | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | L-D plant |
| Armco Steel Corp.<br>Middletown, Ohio | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | L-D plant vacuum degassing |
| CAPASA<br>Rosario, Argentina | ● | ● | ● | ● | | | | | | | L-D plant |
| Cominco, Ltd.<br>Kimberley, B.C., Canada | ● | ● | ● | ● | ● | | ● | | | | L-D plant |
| COSIPA<br>Piacaguera, Brazil | ● | ● | ● | ● | ● | ● | | ● | | | L-D plant |
| Ford Motor Co.<br>Dearborn, Mich. | ● | ● | ● | ● | ● | | ● | ● | | | L-D plant |
| Great Lakes Steel Div.,<br>National Steel Corp.<br>Ecorse, Mich. | ●<br>● | ●<br>● | ●<br>● | ●<br>● | ● | | | | | | L-D plant<br>No. 2 L-D plant |
| Jones & Laughlin Steel Corp.<br>Aliquippa, Pa. | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | L-D plant |
| Kaiser Steel Corp.<br>Fontana, Calif. | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | L-D plants |
| McLouth Steel Corp.<br>Detroit, Mich. | ● | ● | | | | | | | | | L-D plant |
| Pittsburgh Steel Co.<br>Monessen, Pa. | ● | ● | ● | ● | | | | | | | L-D plants |
| Republic Steel Corp.<br>Cleveland, Ohio | ● | ● | ● | ● | | | | | | | L-D plants |
| SIDBEC<br>Becancour, Quebec, Canada | ● | ● | ● | ● | | | | | | | L-D plant |
| SOMISA<br>San Nicolas, Argentina | ● | ● | ● | ● | ● | ● | | ● | ● | | L-D plant |
| STELCO Lake Erie Development<br>Hamilton, Ontario, Canada | ● | ● | ● | | ● | ● | ● | | ● | | L-D plant |
| UNINSA<br>Gijon, Spain | ● | ● | ● | ● | | | | | | | L-D plant |
| United States Steel Corp.<br>Gary, Ind. | ● | ● | ● | ● | ● | | ● | | | | L-D plant |
| Wisconsin Steel Div.<br>International Harvester Co.,<br>Chicago, Ill. | ● | ● | ● | ● | | | | | | | L-D plant |
| Youngstown Sheet & Tube Co.<br>East Chicago, Ind. | ● | ● | ● | ● | ● | | ● | | | | L-D plant |

**Table 4.2**

## electric furnace plants

| client and location | Consulting | Engineering-Economic Studies | Preliminary Engineering | Master Planning | Engineering | Procurement and Expediting | Detail Design | A-E Field Engineering | Construction Management | Construction | description |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Armco Steel Corp. Butler, Pa. | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | Electric furnace shop; vacuum degassing |
| Armco Steel Corp. Houston, Texas | ● | ● | ● | ● | ● | ● | ● | ● | ● | | Electric furnace shop |
| CAPASA Rosario, Argentina | ● | ● | ● | ● | | | | | | | Electric furnace shop |
| Hamersley Iron Pty., Limited Melbourne, Australia | ● | | | | | | | | | | Continuous feed electric furnace process tests |
| Hamersley Iron Pty., Limited Various Locations, S.E. Asia | ● | ● | ● | ● | | | | | | | Electric furnace shop |
| Kaiser Steel Corp. Fontana, Calif. | ● | ● | ● | ● | | | | | | | Electric furnace shop |
| National Iron & Steel Mills, Ltd. Singapore | ● | | ● | ● | | | | | | | Electric furnace shop |
| Steel Corporation of Iran Tehran, Iran | ● | ● | ● | | | | | | | | Electric furnace shop |
| Steel Corporation of Taiwan Kaohsiung, Taiwan | ● | ● | ● | | | | | | | | Electric furnace shop |
| Washington Steel Corp. Washington, Pa. | ● | ● | ● | ● | | | | | | | Electric furnace shop |

## open hearth shops

| client and location | Consulting | Engineering-Economic Studies | Preliminary Engineering | Master Planning | Engineering | Procurement and Expediting | Detail Design | A-E Field Engineering | Construction Management | Construction | description |
|---|---|---|---|---|---|---|---|---|---|---|---|
| C. F. & I. Steel Corp. Claymont, Del. | ● | ● | | | | | | | | | Open hearth shop |
| Kaiser Steel Corp. Fontana, Calif. | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | Open hearth shop |
| The Tata Iron & Steel Co., Ltd. Jamshedpur, India | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | Open hearth shop |

**Table 4.2**

## direct reduction projects

| client and location | Consulting | Engineering-Economic Studies | Preliminary Engineering | Master Planning | Engineering | Procurement and Expediting | Detail Design | A-E Field Engineering | Construction Management | Construction | project description |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Companhia Vale do Rio Doce<br>Tubarao, Brazil | ● | ● | ● | | | | | | | | SL/RN process plant |
| Esso Research<br>Madison, N.J. | ● | ● | ● | | | | | | | | Direct reduction facilities |
| Great Lakes Steel Div.,<br>National Steel Corp.<br>Ecorse, Michigan | ● | ● | | | | | | | | | Direct reduction plant |
| Hamersley Iron Pty., Limited<br>Various Locations | ● | ● | ● | ● | | | | | | | Direct reduction studies and tests |
| | ● | ● | ● | ● | | | | | | | Electric furnace "HImet" utilization practice and tests |
| | ● | ● | ● | ● | | | | | | | "HImet" production complex |
| National Iranian Steel Industries Company<br>Ahwaz, Iran | ● | | | | ● | | | | ● | | Direct reduction facilities |
| Kaiser Steel Corporation<br>Northern California | ● | | ● | ● | | | | | | | Direct reduction plant |
| Marsteel - Government of Saudi Arabia<br>Saudi Arabia | ● | ● | ● | | | | | | | | Direct reduction facilities |
| P.T. Krakatau - Government of Indonesia<br>Cilegon, West Java | | ● | ● | ● | | ● | | | ● | | Direct reduction plant |
| SIDBEC - Dosco<br>Contrecoeur, Quebec, Canada | ● | ● | | | | | | | | | Direct reduction facilities - steel mill wastes |
| Utah International, Inc.<br>Magma, Utah | | ● | | | ● | | | | | | Kawasaki direct reduction process |

**Table 4.2**

## ironmaking facilities

| client and location | Consulting | Engineering-Economic Studies | Preliminary Engineering | Master Planning | Definition of Criteria and Concepts | Review of Vendor's Engineering | Procurement and Expediting | Detail Design | A-E Field Engineering | Construction Management | description |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Allegheny Ludlum Steel Corp. Brackenridge, Pa. | ● | ● | ● | ● | | | | | | | Cupola |
| Alan Wood Steel Co. Conshohocken, Pa. | ● | ● | ● | ● | | | | | | | Cupola |
| Armco Steel Corp. Houston, Texas | ● | | ● | ● | | | | | | | Blast furnace |
| Birla Gwalior Private Ltd. Chandil, Bihar, India | ● | ● | ● | ● | | | | | | | Pig iron production facilities |
| CAPASA Rosario, Argentina | ● | ● | ● | ● | | | | | | | Blast furnaces |
| Cia. Metalurgica Barbara Barra Mansa, Brazil | ● | | | | | | | | | | Blast furnace expansion |
| COSIPA Piacaguera, Brazil | ● | ● | ● | ● | ● | ● | ● | | ● | | Blast furnace |
| CRA/Hamersley Iron & Steel Division Australia | | | ● | ● | ● | | | | | | Blast furnace |
| Kaiser Steel Corp. Fontana, Calif. | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | Blast furnaces |
| | ● | ● | | ● | ● | | | | | | Blast furnace slag for cement production |
| SIDBEC Becancour, Quebec, Canada | ● | ● | ● | ● | ● | | | | | | Blast furnaces |
| SOMISA San Nicolas, Argentina | ● | ● | ● | ● | ● | ● | ● | | ● | ● | Blast furnace |
| Sumitomo Metals Industries, Ltd. Osaka, Japan | ● | ● | | | | | | | | | Blast furnace |
| The Tata Iron & Steel Co., Ltd. Jamshedpur, India | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | Blast furnace |
| UNINSA Gijon, Spain | ● | ● | ● | ● | ● | | | | | | Blast furnaces |
| Wheeling Steel Corp. Steubenville, Ohio | | | | | | ● | | ● | ● | ● | Blast furnace modernization |

**Table 4.2**

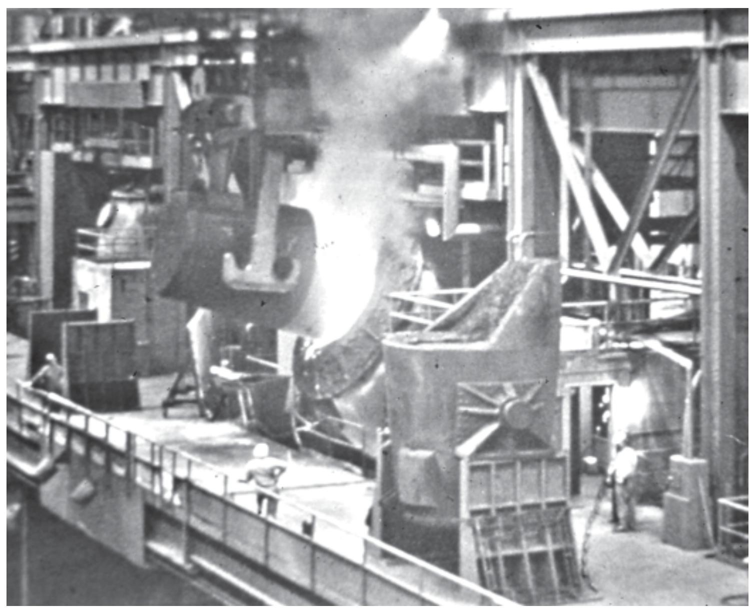
## continuous casting plants

| client and location | Consulting | Engineering-Economic Studies | Preliminary Engineering | Master Planning | Engineering | Procurement and Expediting | Detail Design | A-E Field Engineering | Construction Management | Construction | description |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Armco Steel Corp.<br>Butler, Pa. | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | Continuous casting |
| Armco Steel Corp.<br>Middletown, Ohio | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | Continuous casting |
| Great Lakes Steel Div.<br>National Steel Corp.<br>Ecorse, Mich. | | | ● | | | | ● | ● | | | Continuous slab caster and slab handling facility |
| Hamersley Iron Pty., Limited<br>Melbourne, Australia | ● | | | | | | | | | | Continuous feed electric furnace process tests |
| Hamersley Iron Pty., Limited<br>Various Locations, S.E. Asia | ● | ● | ● | ● | | | | | | | Continuous bloom and billet casting facilities |
| Inland Steel Company<br>East Chicago, Ind. | ● | ● | ● | ● | | | | | | | Continuous slab casting facilities |
| Kaiser Steel Corp.<br>Fontana, Calif. | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | Continuous casting |
| SIDBEC<br>Becancour, Quebec, Canada | ● | ● | ● | ● | | | | | | | Continuous casting |
| SOMISA<br>San Nicolas, Argentina | ● | ● | ● | ● | ● | ● | | ● | ● | | Continuous bloom casting machines |
| STELCO Lake Erie Development<br>Hamilton, Ontario, Canada | ● | ● | ● | | ● | ● | ● | | ● | | Continuous slab casting facility |
| UNINSA<br>Gijon, Spain | | | | | | | | | | | Continuous casting |

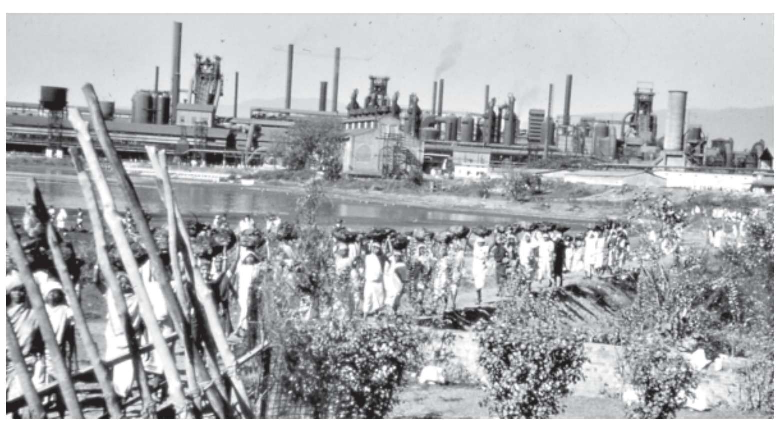

The Fontana plant of Kaiser Steel (above) was built inland for wartime security reasons. It was KE's first project and was the reason why KE was formed in the first place as an independent engineering and construction company. Many of KE's operating systems and procedures were developed on this project.

This was an entirely green-field site with plenty of room for expansion. Liberal allowance was made for adequate process centers. Allowance was made for adequate storage of production in process stages and for future expansion to eliminate shut-downs during construction.

The four blast furnaces show how KE built the plant in stages over a period of years.



Charging the L-D furnace at Fontana's oxygen steel plant (right center). KE designed and built this plant, one of the earliest in the U.S.



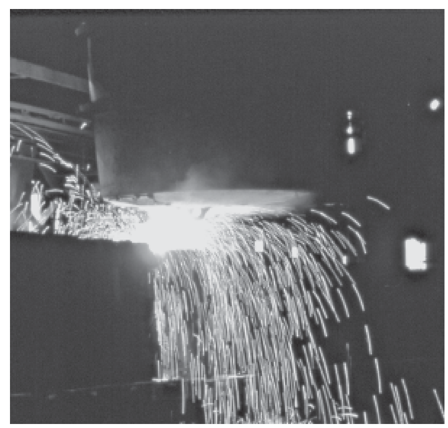
Tata Steel in India. The first large engineering project was undertaken by KE in 1955 to help India achieve its plan to become self-sufficient in steel production. It was undertaken to be completed under three years, an unheard of rapid pace. It was actually completed within budget and within schedule despite numerous weather and logistical delays.

At peak, KE employed 100 expatriates at Jamshedpur, India. Peak construction crews numbered over 20,000.

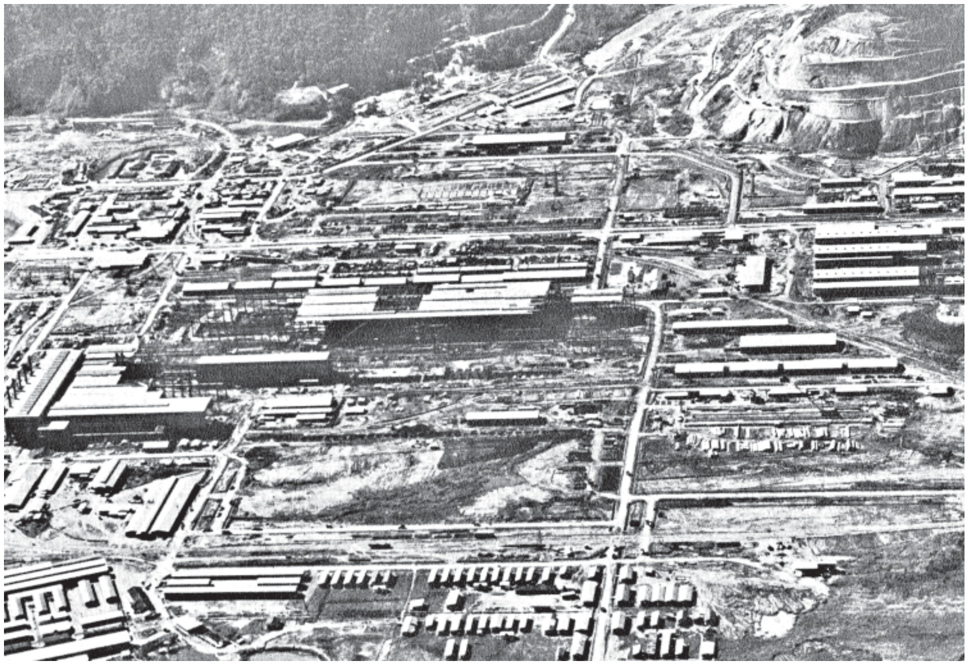
Photo shows the steel mill in the background. Note the line of women in the foreground carrying baskets of aggregates. They were called the flexible conveyor as they could traverse up, down, to the left, and to the right.

Armco, Middletown plant. Above, the Middletown, Ohio, steel plant was the largest of the Project 600 expansion projects. This included a new 86-inch hot strip mill and 900,000 square feet of new structures. At current costs, the project(s) would have a constructed value of $3 billion. Projects were built at Armco plants in Middletown, Ohio, Houston, Texas, and Butler, Pennsylvania.
The project received the ASCE Award for the Outstanding Civil Engineering Project for 1970. Above, Milldletown Basic Oxygen plant with 200-ton oxygen furnaces. Designed and built by KE.

Pouring steel at Ashland, Kentucky, where KE designed and built this 1,400,000-ton capacity plant.



Armco's Butler works where KE built this 150-ton electric furnace melt shop.



Cosipa in Brazil was the first steel project undertaken with less than full turnkey responsibility. It was undertaken at the client's request (to meet market conditions) to maximize on Brazilian input of technical personnel and local supplies. Thus, KE's responsibility was to provide a small nucleus of steel experts to take up residence in Brazil for a period of 44 months. This time period was required to limit KE's exposure to possible delays in completion of the project by others.

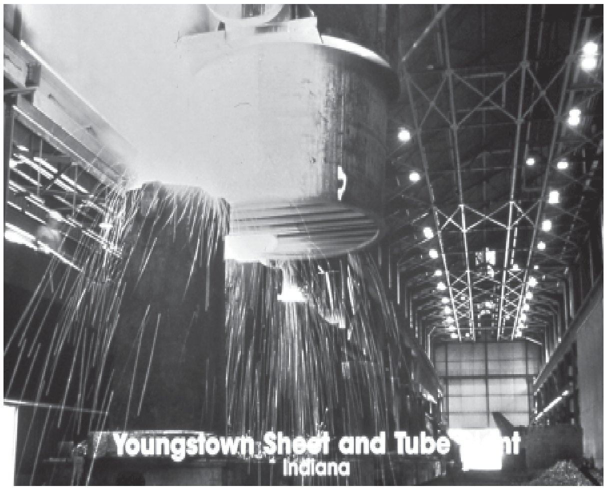
KE started its work in 1958 and satisfied its contractual obligations, netting a substantial profit of 50% over its costs. Actual completion of project facilities was delayed for a decade as political leaders changed project administration and struggled with obtaining needed financing. Eventually, the project was completed, essentially as planned by KE. The plant produced quality steel and then went on to expand several times, in keeping with the KE master plan.

Photo (above) shows the plant, located on a filled banana orchard at the base of a hill, that provided materials for filling in the site.

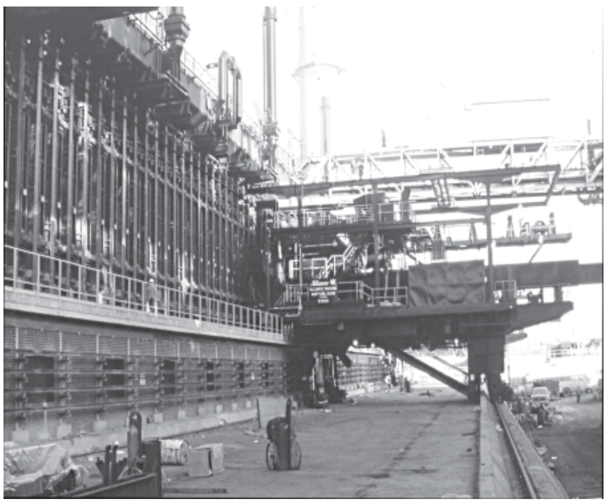
In 1975, KE started to participate in rescue missions for steel mills in Venezuela, Iran, and Indonesia that got into trouble by relying upon equipment suppliers to build integrated steel plants. These were all direct reduction steelmaking process plants that capitalized on the use of excess natural gas as a reductant in steelmaking. This gas became available with the OPEC cartel oil crisis in 1974.

KE provided technical assistance to the plants known as Sidor in Venezuela, Ahwaz in Iran, and Krakatau in Indonesia. Sidor and Krakatau were successfully completed . Ahwaz suffered from the Iranian revolution of 1979 when all foreigners were forced out of the country.

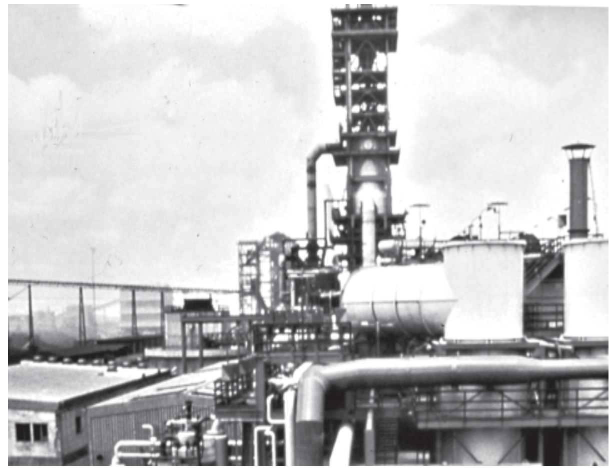
Krakatau Steel Mill (above). KE provided services for expansions lasting over a 12-year period.




Youngstown Sheeet and Tube L-D plant built in Indiana in 1966.



Krakatau (above). KE provided services for expansions lasting over a 12-year period.



The Sidor plant located on the Orinoco River in Venezuela. KE provided technical assistance from Chicago and at the site. The plant was eventually completed by the client's staff.

KE became one of the world's leading steel mill engineer/contractors. It had the requisite know-how in master planning, process and steel metalurgy, detail design, specifying and procuring major process machinery, and in logistical support (the latter is especially important) on overseas projects.

In 1975, KE started to participate in rescue missions for steel mills in Venezuela, Iran, and Indonesia that got into trouble by relying upon equipment suppliers to build integrated steel plants. These were all direct reduction steelmaking process plants that capitalized on the use of excess natural gas as a reductant in steelmaking. This gas became available with the OPEC cartel oil crisis of 1974. KE provided technical assistance to the plants known as Sidor in Venezuela, Ahwaz in Iran, and Krakatau in Indonesia. Sidor and Krakatau were successfully completed. Ahwaz suffered from the Iranian revolution of 1979 when all foreigners were forced out of the country.

Dofasco, Canada, coke oven battery, 1975.

Stelco, Canada, steel plant, 1974.

Chapter 5

# Aluminum

## Overview

This chapter covers Kaiser Engineers' activities in the production of aluminum, alumina, and bauxite. It is presented in the reverse order of production because that is the way KE became involved in the industry. Aluminum reduction to produce aluminum as a metal and shaping it in rolling mills was handled by a separate dedicated group of engineers. The production of alumina, by chemical processing and extraction from the bauxite ore, was handled by another dedicated group of engineers. And the extraction of bauxite was a mining process, requiring mining engineers and process people.

The chapter is organized to describe the various processes, followed by specific project descriptions.

Aluminum, that silvery, formable, non-corrosive, lightweight metal, coming in many alloys and hardnesses was to become one of Kaiser Engineers' most important sources of revenue from 1950 until 1980. At the height of the great expansion push of the industry we were doing about one-third of the world's aluminum reduction plant design and even more of alumina. KE was responsible for the design of 7.5 million tons of alumina annual production capacity and 1.3 million tons of aluminum metal production capacity.

Of the world's 17.7 million tons of aluminum production annually, the United States accounts for some 22 percent of the total.

Suddenly in the '80s, expansion came to a shuddering halt. Programs were canceled, designs were mothballed, and the bloom came off the rose. The lessening of Cold War tensions, a widespread economic depression, due in part to space and military de-emphasis, had a chilling effect on the demand for the wonder metal. From that time until today, virtually nothing has stirred in the industry, and the capacity achieved during the boom period has been more than enough to satisfy the world's appetite for aluminum.

## Henry Kaiser's Entry into the Aluminum Industry

To set the stage for our entry into the aluminum business, it is necessary to go back to 1941. With the war in Europe gaining our government's attention, President Roosevelt called for 50,000 warplanes to be constructed to aid the beleaguered English and to bolster our own outdated and flimsy air force. This announcement caught the attention of Henry Kaiser, and he immediately, with Chad Calhoun, descended upon Washington, D.C. with proposals to build aluminum plants in the Pacific Northwest where there was plenty of low-cost power. Electric power accounts for approximately 80 percent of the cost of producing each pound of metal. In spite of Kaiser's efforts, the proposals fell on deaf ears and, ultimately, two experienced metals producers, ALCOA and Olin, were given the go ahead on two reduction plants and a huge rolling mill. In retrospect the decision was right. These plants, financed by the government, contributed mightily to the war effort but, at the cessation of hostilities, were shut down and mothballed.

After the war, it was assumed aluminum would be in surplus, but Henry Kaiser, his urge to get into the business still undampened, signed a lease for the Trentwood, Washington, rolling mill in 1946. He followed that shortly by leasing both the Mead and Tacoma reduction plants, also located in Washington. The job of rejuvenating these facilities fell to personnel who had become available from ALCOA and Olin at the shutdown and whom Kaiser had recruited as soon as he had secured the facilities. Even though his engineers were available, there was little they needed to do on the re-starts, and with a contract from ALCOA to supply alumina, the feed stock for reduction plants, Kaiser was suddenly head over heels in the aluminum business.

Much to everyone's surprise, the Northwest acquisitions quickly became profitable, and the pressure to build more capacity was on. At this point, Kaiser's engineers had coalesced into Kaiser Engineers. Suddenly, Chalmette, near New Orleans, was chosen as the site of the first expansion plant. It would be the start for KE in the aluminum business and the beginning of the assembly of a project staff devoted to this industry alone.

## Aluminum Reduction and Rolling

### Aluminum Production Process

First, however, it will be helpful to introduce the reader to the process of producing aluminum and the terms used in the following descriptions.

The starting point is the mining of bauxite, a reddish earth, named for the town in France where it was discovered, LeBaux, France. This material is then refined into alumina, a white, granular substance looking like sugar or salt. Chemically, it is aluminum oxide, and any home craftsman will recognize it as that superior abrasive used to make sandpaper. While bauxite and alumina come first in the overall process, we got into the business at the back end—the reduction process.

Aluminum is, in fact, the most common metallic element in the earth's crust. It is also light, strong, and an excellent conductor of electricity. It is so chemically stable that it doesn't react with most foods, making it a natural choice for food and beverage containers and cookware. And it is endlessly versatile. It can be rolled, cast, forged, cut, extruded, drawn, even whittled into every shape imaginable from foil to wire, to beverage cans to transmission cable, to house siding to automobile parts, to ship hulls to space shuttles. It is virtually immortal. When exposed to air it oxidizes slightly and then stops after acquiring a powdery coating of "rust" which seals it off against further corrosion. This long life allows beverage cans and other scrap products to be endlessly recycled to the aluminum-making process, saving 95 percent of the energy needed to make new metal from scratch.

The ideal location of aluminum processing plants is a plentiful supply of bauxite and a cheap source of power. A few countries actually have this. Brazil has bauxite and a virtually unlimited supply of hydroelectric potential. Australia has vast supplies of bauxite and coal. Most other nations have one or the other, but not both. Canada has hydropower but no bauxite. The Middle East has oil and gas but few other raw materials. Jamaica, one of the largest producers of bauxite in the world, has limited supplies of electrical power. It must, therefore, export its bauxite. The U.S. imports 90 percent of the bauxite it requires from Jamaica.

## Aluminum Reduction Process

We begin this discussion with that third stage which takes place in an electrolytic cell called a pot. The method is known as the Hall Process for its inventor in the United States in 1886. In that same year, Paul Heroult discovered the process in France. Simply stated, alumina is introduced into a bath of molten cryolite contained in a steel tub lined with carbon (the cathode) over which a structure suspends carbon anodes into the molten bath. An electric current is passed through the pot, and oxygen is liberated from the alumina assisted by the catalytic bath of cryolite. Pots are arranged in a line with electrical conductors, called bus bars, connecting them in series. A potline may consist of two pot rooms with a rectifier building, supplying direct current power at one end and the bus bars making a U-turn at the other and returning to the rectifier building. Aluminum reduction is a power intensive process, and each potline requires formidable amounts of electrical energy. Depending upon size of potline and design of cell, a current of from 75,000 to 150,000 amperes will be coursing through the bus bars, causing a voltage drop of from 300 to 1200 for each line.

There are two basic pots: pre-bake and Soderberg, and there are major differences in plant arrangement depending upon the cell selected. Essentially, all electrode material in a pre-bake has been formed and volatiles removed by a heating process carried out elsewhere before installation in the cell. With Soderberg all anode electrode material is taken to the cell in a pourable or paste-like state, and the heat being generated by the cell drives out the volatiles. Today, almost all plants use pre-bake because fume emissions from Soderberg cells are extremely difficult to control. Emissions in the form of fluorides from early plants were the problem. They damaged plants, penetrated milk supplies, and showed up in the form of spotted teeth in some people exposed to the contaminant. Collection of the emissions from Soderberg systems was very difficult, and for that reason plants of that type are no longer built. Collection from pre-bake systems is much simpler, but it was not until the middle '60s when ALCOA developed the method of passing effluents through a fluid bed of alumina that reduction plants became environmentally acceptable.

Molten aluminum is tapped from the pots into a crucible by a vacuum process and taken to a metal service building where it is poured into a holding furnace, cast into bathtub-like molds called sows, cast into 50-pound shapes (pigs), or cast into a vertical mold (ingot). Other facilities include anode preparation plant, called paste plant for Soderberg and carbon plant for pre-bake. From the paste plant, the gooey mixture goes directly to the potline, and from the carbon plant, it goes to the press plant where the anodes are formed under heavy pressure and then taken to an underground baking furnace where the volatiles are removed and the anode hardened.

## Alumina Process

Bauxite is the red dirt that is excavated from open-pit mines; it is shipped to adjacent or overseas plants where it then is refined to pure aluminum oxide, called alumina. Processing the alumina with caustic soda, flocculation, and filtering finally results in a product looking much like table salt or sugar.

## KE's Involvement in the Aluminum Industry

For Kaiser Engineers the two words, alumina and aluminum, meant big business beginning in the '50s and continuing all the way into the '80s. Nearly one-third of the world's new plants during that period were designed and constructed under the supervision of our company. It all began when Henry Kaiser, following World War II, made the great bargain basement purchase of surplus aluminum plants in the Pacific Northwest. The need for a dependable supply of alumina soon led to the purchase and expansion of facilities in Baton Rouge, Louisiana, and the work for Kaiser Engineers never stopped until world aluminum supplies reached a saturation point in the early '80s.

Our involvement in the alumina/aluminum business has taken us on a global tour to such places as Ghana, Africa, Wales in the United Kingdom, Australia, Jamaica, Algeria, Canada, Bahrain, Trinidad-Tobago, and Libya. Our human resources department maintained a complete file of customs and traditions of each host country so that our overseas personnel could move into each job area with full attention to the job effort and still be sensitive to the customs and practices of the local people.

During this time, separate divisions were established for the two production disciplines of alumina and aluminum, and engineers who had no previous experience in the business became acknowledged experts. We do credit Kaiser Aluminum's acquired staff for their patient help during our learning years as they sat at our elbows explaining such things as carbon plants, digesters, caustic plants, baking furnaces, and the many other esoterics of the aluminum business. Above all, we credit Henry Kaiser with his foresight as he acquired the surplus plants to become a major new player in the entrenched bright metal industry.

KE managed a variety of aluminum and alumina projects. A synopsis of the larger projects handled was abstracted from KE's perpetual job list. Table 5.1 entitled, "Aluminum Projects List," follows this narrative section. (Editor's Note: Project values shown are those preliminary estimates available at the time when job numbers were assigned. Job numbers are 4-digit codes, with the first two digits signifying the year the project started.)

The authors have assembled their own record of the aluminum reduction projects they designed and built, adding up to about 1.3 million tons of capacity as follows:

| **Job Nos.** | **Project** | **Annual Capacity (short tons)** |
|---|---|---|
| 55100 | Ravenswood | 126,000 |
| 5110 | | |
| 5180 | Chalmette | 110,000 |
| 5605 | | |
| 6351 | | |
| 6958 | Valco | 202,600 |
| 74011 | | |
| 6641 | Tacoma | 40,000 |
| 6739 | | |
| 6902 | Southwire | 180,000 |
| 6824 | | |
| 73001 | Noranda | 140,000 |
| 6869 | Angelsley | 114,000 |
| 6872 | Bluff | 125,500 |
| 6899 | Voerde | 71,000 |
| 75019 | Amax | 187,000 |
| | Total | 1,296,100 |

## The People

The first large aluminum reduction project undertaken in 1951 was the design and construction of Chalmette. Overall responsibility was vested in KE's vice president, general manager, and chief engineer George Havas. Havas had the unique ability to be able to satisfy Henry Kaiser's impatience at getting jobs done at an unusually rapid pace. How Chalmette was built in 11 months is described later. Day-to-day project management, under Havas' guidance, was by E. C. Anderson. Anderson was assisted by George Scheer, KE's consultant for large electrical installations, and by key design supervisors working under George Schumann, who was in charge of all engineering design.

As KE gained more experience and it became clear that there was a growing market for aluminum and alumina plants, a separate aluminum division was organized. Responsibility for aluminum (and alumina) projects was placed under Carl Olson, who reported to Vic Cole. Specific responsibility for aluminum reduction plants was vested in Bill Ball who ran the projects for most of the period covered. Bill Fisher had specific responsibility for alumina projects. International projects had dual management responsibilities to account for peculiarities of local customs, practices, and remote management needs. On foreign projects Frank Davis, vice president for Asian projects, was quite active on Australian and New Zealand projects. Earl Peacock, vice president for Europe and Africa, played a key role in managing projects in England and in Ghana.

## Alumina Process Description

Alumina is a major component of high-temperature refractories and grinding compounds. It is also used in antacids and other pharmaceuticals, as a filter aid for liquids, as activated alumina for catalysts, and primarily as a feedstock for metallic aluminum production.

The aluminum industry moved forward slowly with the establishment of Pechiney in France and Aluminum Company of America ( ALCOA), originally known as Pittsburgh Reduction Company in the United States. The Hall-Heroult electrolytic process discovery was followed in a few years by the development of the Bayer Process to produce alumina from bauxite ore. The process was patented in 1894 by Karl Josef Bayer. The Bayer Process is still used with minor variations depending on the type and quality of ore.

## Bayer Process Description

Bauxite is mixed with a caustic leach solution and then pumped to digestion vessels where the pressure and temperature are increased in order to dissolve the alumina. Undissolved impurities are removed from the solution, and alumina trihydrate is precipitated by seeding the solution with fine trihydrate crystals. The trihydrate crystals are separated from the solution and calcined to produce the final alumina product. The basic Bayer Process has been modified in the digestion and solid-liquid separation sections to adapt the process to different bauxite feeds.

Bauxite occurs typically in a wet state, usually containing 15 percent of the dry components as moisture. Composition of a hypothetical and typical bauxite, measured on a dry basis, is as follows:

| **Component** | **% by weight** |
|---|---|
| $Al_2O_3$ | 49.0 |
| $Fe_2O_3$ | 20.0 |
| $SiO_2$ | 2.5 |
| $TiO_2$ | 2.5 |
| Loss on Ignition | 25.0 |
| Other | 1.0 |
| Total | 100.0 |

## Kaiser Engineers Enters the Industry

In 1946, Henry Kaiser outbid ALCOA and Reynolds Metals for the leases on two aluminum smelters and the Baton Rouge, Louisiana, alumina plant from the War Assets Administration. Baton Rouge had been operated by ALCOA during the war years, and when the plant was taken over by the newly formed Permanente Metals Corporation, it was discovered that many design drawings for the plant had been lost or possibly destroyed. It became necessary for Kaiser Engineers' personnel to physically measure all of the pipe sizes and elevations and prepare a set of "as-built" drawings. Kaiser Engineers also redesigned the material handling system to accommodate Jamaican bauxite, which was to be supplied by a newly formed subsidiary called Kaiser Bauxite of Jamaica.

The beginning of the Korean War brought on a period of unprecedented growth. The company name had changed to Kaiser Aluminum and Chemical Corporation, reflecting its increasing diversity.

Kaiser Engineers' background, experience, and expertise in the engineering and construction of alumina plants were and still are unsurpassed in the industry. Over a span of a quarter of a century, KE has designed and built alumina plants with a total capacity of over 7 million tons per year. Among those are the largest initial capacity plant built to date—ALPART in Jamaica—and the largest ultimate capacity plant in the world—Queensland Alumina Limited in Australia. At the other end of the scale, KE designed and built an alumina plant with an initial capacity of only 60,000 tons per year—Hindustan Aluminum in Uttar Pradesh, India. The designs covered the unloading, conveying, storing, and processing of a wide variety of bauxite, ranging from Australian to rocky Indian and South American ores to soft dirt-like Jamaican ore.

Kaiser Engineers designed and built plants using both batch and continuous precipitation (decomposer systems). Selection of system type was and still is dictated by process conditions such as holding time, particle size, and caustic concentration. The majority of the plant designs was based on producing a coarse, sandy alumina. However, the Eurallumina plant in Sardinia, Italy, was designed to be capable of producing either coarse sandy or floury alumina. Kaiser Engineers helped pioneer high-temperature, high-pressure digestion systems for economical recovery of a high percentage of monohydrate alumina along with the more easily extracted trihydrate alumina. We were also instrumental in the development of designs for slurry regrinding, valves, slurry control valves, and slurry pumps in the size, pressure ratings, metals, and configuration demanded in this severe service. Our metallurgists worked out techniques, application procedures, and inspection standards for the nickel lining of wetted steel surfaces of pipe, valves, and fittings in the high-temperature caustic liquor piping systems

KE has built many alumina plants in remote or isolated areas of the world and was especially proud of successful plants for QAL in Queensland of Australia; ALPART in Jamaica of the West Indies; Hindalco in Uttar Pradesh, India; Eurallumina in Sardinia, Italy, and Worsley in Western Australia. These plants were engineered and constructed under Kaiser Engineers' project and construction management control, with a minimum force of American expatriates and making maximum use of local constructors and engineers. These plants had excellent startup and were up to rated capacity within a very short time.

### KE People Prior to 1970

The new Kaiser Aluminum and Chemical Corporation assembled a cadre of chemists and chemical engineers drawn from ALCOA and from Kaiser's magnesium producer, Kaiser Light Metals Company. This group would oversee process design for all Kaiser Aluminum plant designs. Some of the key personnel in this group were Winston Cundiff, John Holeman, and Alan Donaldson. Owners' representatives in the engineering offices and in the field included W. O. Hansen, John Nutt, R. C. Miller, and Hans Zimmerman.

Kaiser Engineers' key management personnel during the 1950s through the 1970s concerned with this industry included E. C. Anderson, C. H. Case, R. W. Fisher, F. W. Tobias, and Lee Gillett. After this period, a formal aluminum division was formed, and Bill Fisher was placed in charge of all alumina projects. He was followed by Bill Deeths.

## Bauxite Mining

### KE's Bauxite Activities

Bauxite is the raw ore from which alumina is produced. It ultimately becomes aluminum. The ores of aluminum make up 7 percent of the earth's crust, but it was rarely found in a metallic state. As recently as the mid-19th century, it rivaled gold and silver in value and was prized by kings and emperors for use in jewelry.

The primary ore of aluminum was first discovered at Le Baux, France, and gave the ore its name "bauxite." Starting with the red dirt called bauxite, it is excavated from open-pit mines and shipped to adjacent or overseas plants where it is refined to form aluminum oxide called alumina.

### Jamaica Bauxite Mine, 1952

This project was one of the first overseas engineering and construction ventures undertaken by the new Kaiser Engineers after its postwar organization. The Jamaica project consisted of 15 miles of railroad trackage, an 1,100-foot deep-water pier, a rotary car dumper, raw bauxite storage, and a rotary kiln. A large dry storage building had draw-down pits and a covered conveyor system to ship loading facilities on the pier. This storage building was one of the first and largest geodesic *aluminum* domes built at that time.

Harry Bernat started as project engineer in charge in Oakland with Burr Tupper handling field construction in Jamaica. Later, when Tupper was transferred to handle an electric lighting plant for Westinghouse in Mississippi, Bernat moved to Jamaica and became project manager until completion of the project.

The mining plan was handled by Kaiser Aluminum's resident staff. It was a unique plan to excavate the red dirt that occurred near the surface, with just several feet of topsoil and vegetation covering it. The first step was to remove the vegetation and topsoil and stock pile it for future reuse. Then the ore was extracted using conventional earth-moving equipment. After the deposits were depleted, the topsoil was replaced and the surface planted with native vegetation, preserving the environment. The only evidence of mining activity was the deep depressions observed in the rolling terrain. Those depressions were where the ore had been.

## Construction

The pier was contracted out and constructed by Horace E. Williams Company from New Orleans. Chicago Bridge and Iron from Chicago constructed the water towers. Karl Hicks of Williams was the pier construction superintendent. The pier was built from a large LST that was moved about by a sea-going tug. Native Jamaican women set up food preparation facilities along the beach to serve the Jamaican workmen. Two fresh water wells were drilled to sea level. Before the wells were drilled and water was delivered to our homes in Mandeville, we had to be satisfied with water from the cistern, which contained run-off rainwater from gutters on the roof.

In addition to railroad, mining sites, and plant and pier at Little Pedro Point (later changed to Port Kaiser), we constructed a cookhouse and housing at a place called Duff House. At Spur Tree outside of Mandeville on the way to Alligator Pond and Port Kaiser we built housing, administrative office, laboratory, and garage repair facilities. The crew was a hard-working and dedicated crew, working in tough conditions.

One unique construction feature occurred on this project. The railroad access to the pier required traversing a sharp escarpment, requiring a very large amount of excavation. Normal construction activities would have been time consuming. Instead, Tom Price, one of Henry Kaiser's most trusted inner-circle engineers, came up with the idea of removing the hill with a single large blast of dynamite. The day of the big blast everyone stood offshore for a good picture of the events about to unfold. As it turned out, the blast performed just as planned, and the hill simply slid down the slope. Dozers pushed the remaining debris over the precipice. The result was a saving of a great deal of time for the tight schedule and also saved a lot of money.

## ALPART Bauxite *(1966, 1969)*

The huge bauxite deposits of the region have concentrated much of the world's alumina-making activity in the Caribbean. In Jamaica, we designed and built the refinery operated by Alumina Partners of Jamaica (ALPART) in 1966 and expanded it in 1969.

## Worsley Bauxite Mine, 1980

The Worsley project in Western Australia came about much later. It included a bauxite mine along with an alumina plant. Worsley is located 140 kilometers south of Perth. Approximately 3 million dry tons per year of bauxite are mined from reserves near Mount Saddleback in the Darling Ranges. Crushed to conveyor sizes at the mine site, it is moved 52 kilometers to the refinery on the longest cable belt conveying system in the world.

Construction was tightly scheduled around a season of heavy rains, which begin in April and continue well into November. Special care was taken to protect the environment since the initial mining operation, a large part of the conveyor system and the refinery, are located in the state forest area. Construction is limited by the life cycle of the fungus known as Yarrah Dieback.

The conveyor system, moving bauxite from the mine, travels 360 meters per minute, crosses 30 roads and several transmission lines on a 52-kilometer route to the refinery. The bauxite conveyor system contract was in the amount of $52 million in 1980 dollars.

## World's Source of Bauxite

As previously discussed, the ideal location of aluminum processing plants has a plentiful supply of bauxite and a cheap source of power. Few countries actually have this. Brazil has bauxite and a virtually unlimited supply of hydroelectric potential. Australia has vast supplies of bauxite and coal. Jamaica, one of the largest producers of bauxite in the world, has limited supplies of electrical power. It must, therefore, export its bauxite. The U.S. imports 90 percent of the bauxite it requires from Jamaica.

Another leading source of the world's bauxite is Indonesia, where vast reserves have kindled the country's ambitious plans to develop a modern aluminum industry. Working with P.T. Aneka Tambang on behalf of the Ministry of Mines of the Republic of Indonesia, Kaiser Engineers prepared the engineering and economic planning for development of the deposits on Bintan Island, south of Singapore, and for a 600,000-ton-per-year alumina refinery. As part of our work, we also performed world market studies of bauxite, alumina, and aluminum.

## Aluminum Reduction Projects
### Chalmette, 1951
### The 11-month Schedule

Chalmette, with its unbelievable schedule of 11 months, was the first aluminum plant built by Kaiser Engineers and the first new one for Kaiser Aluminum. Nevertheless, a gala opening ceremony was held right on the promised date. Both participants had much to learn, and there were mistakes on the way, but these were corrected and chalked up as the learning process. The beehive of design activity was carried out at 1924 Broadway, the old Kaiser Building, and in the old *Post Enquirer* newspaper building near 17th and Franklin Streets in Oakland, California.

Apart from a minor involvement in the cleanup of the surplus plants in the Pacific Northwest, we think of the reduction plant in Chalmette, (just outside of New Orleans) as the job where we cut our aluminum teeth. In the normal sensible project you have a look at the size of the plant you are to build and then make a preliminary schedule. This one appeared to be about a two-year effort. But wait! Henry Kaiser had promised to make the first pour of metal in 11 months. Eleven months! That's insane. Not possible with a group of engineers, none of whom had ever seen an aluminum plant much less designed one! But it was done, much as the Lord created the earth on the seventh day. The plant, located in a swamp seemingly without bottom, built during the rainy season, buildings supported on pilings was accomplished by a team of learn-as-you-go neophytes. Half the plant was to be powered by huge Nordberg natural gas, radial engines driving electric generators, while the other half was fed from conventional gas-fired boilers, delivering steam to turbines driving generators. The Nordbergs were chosen because their short delivery made the schedule possible.

Now, switch the scene back to Oakland early in 1951. George Havas was then vice president, general manager, and chief engineer of Kaiser Engineers. It was to him that Henry Kaiser entrusted the seemingly impossible task. Havas was one of the few inner circle engineers who worked closely with Mr. Kaiser over the years and knew how to construct Mr. Kaiser's impossible dreams. The description that follows was recalled by Sam Ruvkun who, at the time, was Havas' assistant and was present at all of the discussions that took place.

George Havas was known amongst his subordinates as a master of organization, logic, and clear thinking. In the early days of Kaiser Engineers, all major projects started with lengthy technical meetings, convened around his conference table in his office on the sixth floor of the old Kaiser Building at 1924 Broadway. For this project, it was clear that the meetings would be long and detailed, lasting late into the evenings and covering several days.

Havas had around him all of his key men. Andy Anderson was the project manager. Frank Backman handled construction. George Schumann handled detail design. George Scheer was the electrical expert. Staff members were called in for specific expertise or to implement decisions made. There was Joe Rowan of purchasing, Paul Stafford of estimating, and Bruno Francheschi for scheduling. Ruvkun was there to assist and to follow through on decisions made and assisted with formulating the scope of the work. Lou Oppenheim was called in on occasion; otherwise, he was left to run the rest of the company.

George Havas orchestrated the pace of the meetings. It was he who decided what topics to discuss, and he led all discussions. Other participants watched, listened, and fed him information as required. It was he who addressed construction techniques that needed to be carried on. They needed to preorder many wood piles. Orders were placed by Rowan by telegraphic means. The schedule was tight, so a construction manager was dispatched to the site in the first month.

A long-term contract for gas at 10 cents a thousand had been negotiated by Kaiser Aluminum. So analyses were made as between obtaining power from Nordberg engines known to be readily available or from conventional steam generators. Nordbergs would cost more to generate power. After detailed discussions and analyses made on the spot, Havas made the decision to split the order 50 percent by Nordbergs and 50 percent by conventional steam generators. Immediately, Joe Rowan was given the specifications and placed telegraphic orders for the Nordbergs; soon thereafter, he negotiated terms for the steam plant.

In like manner, he undertook to analyze and specify the obtaining of steel and fabrication of the pots and potline structures. Orders were placed. The aluminum bus bars would be a delivery problem. The aluminum required and the welding process were specified so they could be ordered.

By the time these four days were over, all major decisions had been made and major orders placed. Now he dictated a very logical and orderly scope of the project, which served as a guideline for everyone to follow. At the same time, he analyzed and scheduled events to show how and when they would occur. Then he directed the preparation of a detailed estimate of cost and establishment of a chart of cost accounts. Finally, he dictated an operating procedure, including split of responsibility as well as an organization chart.

What might have taken weeks or months to prepare was now available in four days. Anderson now had his marching orders.

## Quagmire Site

The chosen site alongside the Mississippi River offered a fine location for receiving and shipping of raw materials and products but was a quagmire with a high water table fed by the river. It was located adjacent to a cheap source of natural gas, needed for obtaining power. Something like 20,000 pilings were driven through the mud to support structures, and millions of oyster shells formed roads and paths around the plant. Most of the construction and operating people were from the West and Northwest, and the customs of the South required some changes in lifestyle, particularly for the wives and children at home. In due time, however, everyone adjusted and became part of the community.

Roads and parking areas in that quagmire required some form of base to carry the load of traffic. Without ready access to rock in the great alluvial deposits of the mighty Mississippi River, oyster shells were selected as the medium to build a base. Up to 15 feet of shells were needed in some locations, and they were hauled out each day from New Orleans. There was a steady stream of trucks carrying those shells to the plant. It didn't seem possible that the sea could produce that quantity, nor that the citizens of the city could munch down that many unlucky little bi-valves.

At one corner of the site there was a Civil War battlefield memorial. The commemorative plaque and a couple of oak trees rested on sacred ground and were not to be disturbed. This was the site where a famed commander, General Packingham, fought, and the oaks were named for him. Red Fulton was project manager. He found it necessary to remove one of the oaks and then managed to cut it up methodically, making souvenir bookends. Sam Ruvkun still has a set on his bookshelf, a set presented to him on the occasion of a visit to the site during pile-driving operations. Red also was the proud possessor of another relic of the Civil War. During excavation, they found a 6- inch cannon ball.

## Construction of the Plant

In view of later schedules of two to three years for a similar sized plant, the 11 months to completion at Chalmette makes it appear a minor miracle—and it was—but at a cost. The learning curve was steep, and mistakes were inevitable. Much midnight oil was burned in the engineering offices, equipment and materials orders were heavily expedited, and Delta Airlines wore a groove in the Southern skies as engineers shuttled back and forth from Oakland.

Problems were in plentiful supply. Roads would sink out of sight in a few days, fabricating the heavy aluminum slabs into the bus bars required new techniques, lack of experience handling highly abrasive anthracite coal saw us repairing and revising chutes and replacing fan blades which wore out like paper.

Bill Ball recalls this vivid episode that unfurled as he was on top of the paste plant, about 125 feet up investigating a problem with a dust collector and replacing one of its worn fans. It was then that he heard the "Great Blast," as it was later to be known. It seems that a construction crew had completed installations in the Nordberg room and was starting a test on the No. 1 unit. The thing refused to start, and the men continued to rotate it and feed fuel for some 20 minutes until someone realized the timing system had not been properly adjusted. Without being aware of it, the operators had allowed gas to accumulate in the engine and the big muffler outside the building while they continued vainly trying to start that dead engine. At the first spark from the adjusted ignition, the engine started, and all that gas in the exhaust was ignited with a roar heard all over the job site. As we looked to identify the source of the explosion, smoke came pouring out of the big muffler followed by a series of smoke rings.

As we watched, fascinated by the beauty of those 25-foot rings, stage two of the circus unfolded. Workmen, frightened by the explosion, began running from the building. Wooden planks had been laid over the mud from the building exit to a roadway about 50 feet away, and with the mud and rain, they were slippery. It was a Keystone Cops scene with men sliding off into mud, scrambling to regain footing, and plowing through the slop to reach the road and safety. As the noise subsided and the panic cooled, you could almost feel the sheepish looks exchanged by the knot of muddy figures even from our distant viewpoint. Stage three took another 10 minutes as vehicles assembled from all over the job to see the destruction. Amazingly, there was no damage except for a lot of muddy work clothes and some badly shaken nerves. The only damage was to the dignity of a group of very muddy workmen.

Cause of all this? The timing system of the engine had not been properly set, and while the big engine continued to be rotated, fuel was fed without ignition, and gas accumulated in the huge muffler. Realizing the problem, the workmen reset the timing and turned over the engine. At the first ignition, the whole trapped volume of gas went off with it!

## Project Scope

The first phase of the project included four potlines, two of which were supplied power by Nordberg engines with the second pair using conventional steam-driven turbines turning electric generators. Natural gas, plentiful in the area, was fuel for engines and boilers. Those engines are worthy of a comment or two. They were vertical-shaft machines with 11 cylinders in a radial configuration, about 25 feet in diameter, and they sat on top of a generator. Each potline required a number of engines, and inside the room where they were housed the clattering and banging was deafening. Steam turbine power would have been preferred, but the long delivery of them made it necessary to start with the Nordbergs. Plant capacity was set at about 50,000 tons per year, but as the operators gained in expertise, in later years that number was often exceeded.

## Tight Schedule

Perhaps a comment about how we made the schedule is in order since it illustrates the relation between field construction and office engineering. Typically these two groups work for different firms, but in our case we all worked for Henry Kaiser so there was a closer association. We had the same target, but there was a competition to see how we got to the end point as scheduled. The competition manifested itself, for example, when foundation drawings were needed for the field forces to keep busy. The technique employed in the field was to say they were starting to excavate the foundation for some area or other and must have the drawings. This put pressure on the engineers, and the drawings were often hand-carried on the next flight out to New Orleans. We all knew the game, but it worked very well as attested to by the regularity with which we met schedules.

A major problem threatened our schedule. In a storage area at the plant lay 1,100 pot hood sections, fabricated at a local metal shop. They were comfortably ahead of schedule, stacked in neat rows, awaiting the time for installation. The day arrived, and placement of the pots began, but there was a problem. Some of the hoods didn't fit! Why? There were to be 550 right-hand and 550 left-hand units, but the manufacturer had misread the drawing. All of those beautifully built hoods stacked out there ahead of time were right-handers! Clearly, some major expediting became a high priority, and the fabricator, to his everlasting credit, put on extra crews, went on a 24-hour-seven-day-a-week effort and got the revised hoods out on a tight but acceptable schedule.

Many other problems were encountered, but with the cooperation of suppliers and shippers, the great day of the first pour of metal arrived on schedule. With Henry Kaiser at the controls, the first ladle of molten aluminum was hoisted and poured into a mold. The metal was cooling rapidly and had that pour been made 15 minutes later, the molten stream would have turned to a bright icicle of solid metal hanging in mid air!

## Pollution Control

Aluminum plants are polluters. They smoke, and they spew large quantities of fluorides into the air. The smoke, containing carbon and tar particles, lays a pall over nearby areas, and the housewife hanging out the family wash is justly angered. Fluorides damage crops; your prize gladiolas will die, and teeth develop spots. With heavy exposure, when combined with water, hydrofluoric acid results. This acid is corrosive to almost everything. We used to refer to it as the universal solvent. So Kaiser, wanting to be a good neighbor, decided to do something about those emissions.

Engaging Stanford Research Institute to act as our consultant, a system was designed to clean up the air. Tunnels were provided beneath the pots, and large fans pulled air into ducts where it was sent into the courtyards between pot buildings. From there, it was directed into the bottom of 15-foot diameter redwood towers. Inside the 40-foot tall towers a series of high-pressure spray nozzles delivered a fine spray of water to the upward moving air with its burden of dirt and fluorides. Not enough particulates were collected, but those that were caused an unholy mess. Some of the acids formed (when water spray hit the air stream) were carried away in the exiting vapor to corrode whatever it landed on, and that which remained required chemical treatment. In short, the beautiful idea didn't work worth a darn, and the system ultimately was dismantled and other solutions tried. Kaiser was not alone with this problem, and it was not until 1970 when ALCOA made available to the industry its breakthrough in emission control that the problem was finally conquered.

It is worth noting that in the interim period most plants collected the emissions and discharged them into chimneys 500 feet in height, hoping they would float off in the upper air and disappear. Much time and money has gone into research, and gradually we learned to be kinder to the planet. We can be criticized for lack of knowledge, but it must be noted that doctors lost many patients before acquiring the knowledge of bacteria and antiseptics.

## The People

As previously discussed, George Havas had the prime overall responsibility. E. C. "Andy" Anderson was project manager with Red Fulton in charge of construction. This project was performed in a period before KE had an aluminum division. Anderson relied on technical assistance from wherever he could get it. The largest source of good technical help was in George Schumann's design engineering division. He drew heavily on support from design supervisors like Bill Ball, Lee Misner, Bill Fisher, and Bud Olds. And he had George Scheer also. In construction, he had Frank Backman supervising Red Fulton.

## **Ravenswood**
*(1955-1957)*
## Reduction Plant

Ravenswood was a project that followed completion of Chalmette. From KE's standpoint, the organization, methods, and staffing moved over to handle this as a follow-on project.

Located in West Virginia, it was the site of Kaiser Aluminum's next expansion, but it started as a rolling mill project. Before the mill had been completed, however, there was every indication that the market for the silvery metal had not yet been satisfied, and the decision to proceed with a smelter had been made. Here Kaiser, profiting from the experience in Chalmette, approached the local people and offered assistance in planning for the influx of workers, the extra load on schools, and the increase in traffic. This effort mitigated the impact of dropping such a huge facility into what had been a small, quiet community. Lessons learned both in Ravenswood and Chalmette were to benefit Kaiser on many future projects, particularly on the Volta aluminum plant in 1963 on the continent of Africa.

Begun in 1956, the Ravenswood smelter included new features for both KA and KE. It was the first pre-bake installation for both. Plant capacity was pegged at 120,000 tons per year, and raw materials were to be delivered both by rail and by barge from the Ohio River. Because of the pre-bake system, the technology applied at Chalmette was not applicable, and both engineer and owner embarked upon this new program in a joint learning effort.

As a two-potline plant capable of producing the 120,000 tons per year, this project included a green carbon plant, an anode press plant, a baking furnace, a rodding room, and the first emission control system employing a 500-foot chimney. Each of the above items being different from Chalmette, offered new challenges and, in the heat of an accelerated schedule, tensions arose between engineer and owner which were to have a long-term effect on relations between the two. In spite of the difficulties, the job was completed, although behind schedule and somewhat over budget. A smooth start up, well-designed facilities, and low-cost power made Ravenswood a profitable unit in Kaiser Aluminum's new industry and boosted them into second place on the American scene.

With the work at Ravenswood, KA began a program of research delving into the many aspects of producing aluminum and ultimately constructed a major facility for that purpose at Pleasanton in the Bay Area. Reduction cell structure, cell magnetics, bus design, carbon electrode composition, anode attachment, and many other things were studied and made a part of Kaiser's growing influence in the industry.

## Rolling Mills

The rolling mills had a capacity to produce 167,000 tons per year, including a 168-inch reversing hot mill, the largest in the industry. It also had a 110-inch reversing and 100-inch five-stand mill plus sheet and foil mills, annealing furnaces, stretchers, and slitters.

## The People

Essentially, the same KE staff who built Chalmette built Ravenswood. Andy Anderson was project manager.

## Volta Aluminium

*(1963-1965)*

### Background

Note the British spelling of the word "aluminium." This project ended the competition, and cooling of relations between KA and KE that existed for a few years following construction of Chalmette and Ravenswood. Some of us felt that this was because a plant to be built in Ghana, Africa, would provide a showcase for the talents of both organizations. Here we were, back working together on a major project. To the everlasting credit of the KA project team, the support provided to KE was outstanding. Joint procedures were established for transfer of technology and other criteria to avoid misunderstandings and to prevent cost and schedule overruns. The result: a major project 10,000 miles from home completed ahead of schedule and under budget.

Some background is necessary to fully appreciate this project. To begin the story, Kaiser Engineers had been interested in a proposed dam on the Volta River some 50 miles inland from the coast of Ghana, and Edgar Kaiser took a special interest in the proposals for the work. A British firm had already prepared preliminary plans for a dam on the river, but Edgar, with great tact and skill, negotiated with Kwame Nkrumah, then President of Ghana, a better program.

Since the current demand for power in Ghana was much less than the capacity of a reasonable sized hydroelectric complex, the economics of such a system were not favorable. This condition gave Edgar the opening he needed, and he proposed to build, along with the dam, an aluminum plant, which with its voracious appetite for power, would then make the whole venture an economic success. The obvious benefit to Kaiser was low-cost production of aluminum. The benefits to Ghana were enormous; low-cost hydro power to replace the expensive and not always reliable diesel-powered electrical system, jobs for Ghanaians at the dam and at the aluminum plant, substantial tax revenue for the state treasury, and power available for future industrial expansion.

Here again is another example of Kaiser's willingness to work with people wherever in the world they may be. First, it was Henry Kaiser moving his automobile business to Argentina, and then it was Edgar creating the Ghana program. It is true that in both cases the advantages and profits to Kaiser were great, but the advantages to the host country were far greater. It must also be pointed out that in each venture a revolution changed the government, but the Kaiser forces came through the storms without change. Oh, there were some midnight marches through deserted streets, hearing bombs fall on the Casa Rosada in Argentina, frayed nerves after looking down the barrel of a machine pistol after being stopped on the road between Tema and Accra, but those events fade into the background of those magnificent projects. (Editor's Note: Bill Ball witnessed these events in both countries.)

Tema, the site of the reduction plant, began life as a sleepy fishing village located on a small indentation of the Atlantic Coast where it runs east and west after the horn of Africa. By the time we arrived in 1963, the fishing village had been relocated, a sizeable port was under construction, apartment complexes were sprouting, a hotel was rising on the hill above the harbor, and large fishing boats plied the waters offshore bringing their catch to a cannery and freezing plant. The colonizing British had been invited to leave in 1961, and when we needed information on land ownership to stake out the plant site, we were introduced to the confusion of that change in administration. During those first days, we learned patience, and we learned to appreciate the problems of a people suddenly transformed from servant to master.

### The Project

The Volta Aluminum Company Limited reduction plant (VALCO) was built near the old fishing village of Tema in Ghana, Africa. In part, the location was chosen to utilize power from the Volta River dam and power station, also designed by Kaiser Engineers, and also to take advantage of low wages prevalent in Ghana. Edgar Kaiser, now holding the reins of Kaiser Industries, had established a good working relationship with Kwame Nkrumah, then president of Ghana, who could see that both the dam and reduction plant were to be of great benefit to the nation. Unfortunately, Nkrumah was deposed during the later stage of the reduction plant construction and was not around to see the benefits to his former country.

Although experiencing the turmoil of the revolution, including roadblock searches and alighting from a long flight from the U.S. to face a line of sandbags and machine guns, we completed the project on schedule and under budget. The experiences of our people at the job would make a book worth reading by itself, and the dedication of those men and women as they instructed the local workers in the skills needed to build the complex plant merits a word of praise in this book.

Reynolds Aluminum was a minority partner in the venture with a 10 percent interest. The project featured a new, larger reduction cell just designed by Kaiser Aluminum.

Edgar Kaiser had concluded that it would be necessary to provide a facility to attend to the health of the project people and, accordingly, the first order of business was construction of a hospital. Constructed of pre-fab elements, the hospital was a first-class unit, including x-ray, operating room, ambulance, outpatient area and a 20-bed ward. Access was without charge to our personnel and families as well as to the Ghanaian workers, carrying on the tradition of Henry's traditional Kaiser Permanente Health Program.

The facilities of the project are less important and less interesting than the people working on them, but a brief description is in order. The main plant was two miles from the port and included all of the processing facilities, personnel offices, and a beautiful administration building. Adjacent to the port, a raw materials storage area included a dome for alumina and silos for carbon electrode materials. At the port, a wharf and ship unloading machinery were provided, and a conveyor and truck transport transferred all materials to their respective points of storage. The port facilities had been under construction when we arrived on the scene. Credit must be given to the British firm of Parkinson-Howard for their cooperation and assistance as they allowed us use of their design for the type of wharf to be built and introduced us to the proper Ghanaian authorities to get things done without spinning our wheels. The only fee for all this help was that we had to drink gallons of tea heavily laden with sugar and milk during the many meetings we attended.

Three potlines were constructed in the first phase for a capacity of 120,000 tons per year, and subsequent additions increased the output to 202,600 tons per year. The pots used were a new, larger design developed by KA. The cell bottoms, fabricated in the States, were filled with various parts and shipped to the job. Of course, all material and equipment had to be shipped to the job site, and a computer program was developed for control of that rather formidable task. All purchasing, expediting, shipping, and inventory were monitored, and that program is still in use today.

In the baking furnace area a special crane was developed by a French firm to do a dual-purpose job. It could handle green and baked anodes into and out of the furnace pits and could also vacuum the carbon packing material from the pits and replace new material for the next cycle. New machines were also developed in the rodding room where spent anodes were stripped from the bars, which would later attach them to the pot superstructure. A pot room control system was developed to assist operators in the monitoring and control of pot functions. Much of the innovation came about as a result of research being carried on by KA, and this effort was to bear fruit on projects yet to come.

Emission control remained as a problem yet to be conquered, so it was once more back to the 500-foot chimney where effluents would be dispersed over an area wide enough to mitigate the deleterious effects.

A hospital was given first priority by KA, and the excellent facility previously described was constructed. Doctors and nurses were employed, and the unit went into service in the first six months of the job, complete with ambulance and driver. After much argument, we were able to convince the owner that a school, a commissary, and liquor store were necessary additions, and finally excellent provision was made for those items. Staffing came mainly from construction personnel wives. Of particular note was the Olympic-size swimming pool with its adjacent clubhouse, including movie projection screen, cooking and serving area, and music equipment. No one on the job will ever forget the dinners where at least 10 nationalities were represented by food and costume in an evening of glorious feasting.

## Relations with Ghanaians

Our relations with the local Ghanaians were excellent because they were a friendly and interested people. Of course, it took some time for us to get used to their customs and way of thinking. We must cite two examples to give the reader a feel for their logic and inventiveness. First the logic. As the surveyors staked out the area of the reservoir, which would be created by the Akosombo Dam (the dam was part of the Volta River Project which provided power to VALCO), they explained to the tribal chiefs that those stakes indicated the level to which water would rise when the dam was completed. When clearing the brush and trees from the reservoir, the crews found stakes scattered all over the place, all of them lower than seemed reasonable. After some investigation it was found that the chiefs, knowing that water would come to the level of the stakes, had simply moved them lower to avoid losing some of their land. Our surveyors, realizing their original explanation was subject to interpretation, tried again, restaked the waterline, and no further trouble was experienced.

Now the inventiveness. KA, wanting to demonstrate the use of their product, asked that the fence around the plant be made from aluminum posts and wire. It was, in fact, beautiful. It sparkled in the sun and would resist the corrosive effects of that warm, damp climate. A few months after the plant had been completed, it was noticed that the fence was sagging a bit, so a crew went out to tighten up the wire. Not long after, more sag. This time it was found that the local "recycling group" had cut every other post and after the first tightening had done it a second time. Each time, they had carefully covered the cut stump, which was encased in concrete, with dirt so it wouldn't be noticed. A fence patrol stopped the depredations, but for some time after the ubiquitous traders were offering valuable "antique" swords and daggers with cast aluminum handles, and there were also a few cast pots and griddles until the supply of raw materials dried up.

## The People

It is important to recognize the participation of the many people who contributed so greatly to the success of that job. As many as 80 employees for the owner and the engineer served as supervisors and managers, and it is doubtful that anyone ever worked just a five-day week or an eight-hour day. Overseas, away from family and friends, transplanted into a completely different cultural environment and a different climate than they were used to. They were magnificent! Not only were people doing more than the job for which they were hired but they were teaching and working with the local people helping to bring 5,000 Ghanaians up to a skill level, which in many respects exceeded work done in the States. Sure, they were well paid for their work, but in dedication and devotion to the job and to the Ghanaian people, they should have received a gold medal—wives and children included!

The KE staff who did the work for VALCO worked in association with the staff who was doing the hydro facilities. KE's Europe and Africa Division maintained overall responsibility for both projects from contract negotiation and preliminary assessment of the work through staffing of the project, project coordination, and even in sharing of the technical supervision with the Domestic Aluminum division supervisory staff. As the project began, the vice president in charge was Jim Boyce. When he moved to Kaiser Cement, Earl Peacock took charge. In later stages of the work Dick Lowell was in charge.

The Domestic Aluminum division, as it did in all international projects, had the prime responsibility for providing technical know-how and supervision. As such, the project was supervised by Carl Olson and his staff. Project manager at the site was Ray Ware. The following people had significant technical input: Dick Stuckgold, Bud Olds, Clay Schwalen, Glenn Wilson, Paul Martin, Jack Munro, Wynn King, Russ Monson, Sabih Ustel, Ed Baldinelli, Bill Smith, and Paul Sibley.

## National Southwire Aluminum Company

*(1968-1970)*

## The Owner

The owner of National Southwire (NSA) was our primary contact. The leader of the venture was Roy Richards, a remarkable, self-made entrepreneur who had built a successful wire-making plant in Carrollton, Georgia. He began his career by stringing wire for power company distribution systems. In the early years of his career, he was cash-starved, and in order to economize, he would buy a truck with only an engine, chassis, and running gear, making a bed out of scrap lumber and a seat from an apple crate. Success was not long in coming, and he soon decided that the cost of buying wire from outside suppliers was too high. Thus, he built the plant to draw his own wire and to form cable. By so doing, he could lower his costs and be assured of more reliable delivery. The next step was to have a plant to supply his own metal for aluminum wire. This is the point where Kaiser Aluminum and Kaiser Engineers entered the picture.

## The Project

This was the first aluminum project for a client not in the Kaiser family. National was a steel company, and Southwire was a manufacturer of wire products.

Technology used was pre-bake units, and Kaiser Aluminum provided the technology. It began with a three-potline project, but finished with a fourth line and a total capacity of 135,000 tons per year.

Fresh off the success of the Ghana project, the two Kaisers were in a position to offer an up-to-date plant, KA furnishing technology, and KE doing engineering and construction management. (We could not do construction because the owners had insisted the job be done open-shop). Aluminum's new pots, the Ghana design, were used, and emissions were to be controlled by wet Kaiser scrubbing and discharged through a 500-foot chimney.

After some serious negotiations with the ever-frugal owner, contracts were signed and work got underway. The owner's wire plant was in Carrollton, Georgia, a small town about 40 miles west of Atlanta. The aluminum plant was sited on the east bank of the Ohio River near the tiny berg of Hawesville, Kentucky, the nearest city of any magnitude being Owensboro in the same state. For statisticians' reference, Owensboro is one of the largest bourbon producers in the country and has the additional distinction of having grown the largest sassafrass tree in the world.

NSA floated a loan from the local municipal entity which offered certain tax advantages, and they had contemplated a schedule of three years for the program. As we prepared more complete schedules and estimates of cost, it appeared that substantial improvements could be affected in the owner's original program. In fact, a year could be pared off the schedule, and recalculation of the financing arrangement showed that a 4-potline plant could be built within the limits of the original bond issue rather than the three originally contemplated. This simple step earned us the undying gratitude of the very cost-conscious owner, and our task was then to perform as promised. And we did, admittedly in large part because so much had been learned from the Ghana job.

The 4-potline plant has consistently produced about 10 percent more than the rated capacity of 135,000 tons per year and, in spite of rising power costs and difficult years in the aluminum business, has been a consistent profit-maker for the owners. Raw materials come in along the Ohio River and are transported to the points of use by conveyors. Except for some small improvements, the plant is quite similar to Ghana. One major difference is apparent, though, and this appears in the emission control system.

ALCOA had developed a method of bubbling collected pot emission through a fluid bed of alumina, where fluorides were captured by the alumina, and passing the exhaust through bag house dust collectors which then collected the particulates. The arrangement was highly efficient, and ALCOA made the method available to the industry. Not only were all the undesirable effluents prevented from escaping outside the plant, but much of the material was reusable in the process and helped pay for the cost of operating the system.

KA had been doing some testing of the new method and was of the opinion that it could be readied to meet the schedule of our program. Unfortunately, the owner's environmental specialist got cold feet, and we were obliged to install a wet collection system with its attendant settling pond, acid neutralization, and sludge disposal. It was regrettable that we were so close to a major improvement yet unable to convince the client, who, almost certainly, was later unhappy with his decision.

### The People

This project was under the direct supervision of Bill Ball. The owner thought he was a genius because of the way the project saved on capital costs and was able to be built one-third larger for the same budget. The project staff included Dick Stuckgold, Clay Schwalen, Glenn Wilson, Rick Larsen, Debbie Nunn, and Shirley Roll. Jim Miller was construction manager at the site. He was assisted by Rick Larson, Mike Ruzila, Cal Smith, Grif Tiller, Stan Barkalow, Byron Nielson, Stan Rognlien, and Paul Skvarna.

## Noranda Aluminum

*(1969-1971)*

This two-potline, 70,000-ton-per-year plant, was located near New Madrid, Missouri, at the confluence of the Missouri and Mississippi rivers where those streams had changed courses during the 1850 earthquake, the largest in U.S. history. It was so severe that it was said that a cowboy on horseback in the flat terrain outside of St. Louis lost sight of his companion, also on horseback, due to the undulation of the earth's surface.

This project also used KA technology. By this time, it was well honed from the experience on the two previous plants, and it was a fast design job, and construction was quickly begun. This was about the time Southwire was nearing completion as an open shop project in Kentucky, and whether or not that influenced the Noranda job we will never know. In any event, trouble soon reared its ugly head over what was mainly a jurisdictional dispute. Negotiations between management and the union failed to solve the problem, and a strike was called. Who should install ducting in the baking furnace, pipefitters or sheet metal workers? Serious work problems continued to plague this job, costing the owner a budget overrun of about 25 percent and nearly a three-month schedule delay. After some very serious “events,” which marred an otherwise good project, things quieted down, and the job was completed, but not without major effect on schedules and costs.

Five years later in 1976, Kaiser Engineers was given a contract to add a third potline to the original two, bringing plant capacity to 140,000 tons per year. The addition was completed without incident, meeting both schedule and budget commitments.

Ken Polly was project manager. Jim Miller was construction manager. See Jim Miller’s oral history entitled, “New Madrid Notes,” for a discussion of construction problems and a listing of the construction staff.

## Anglesey Aluminium, Ltd.

*(1971-1973)*

A consortium of KA, and others organized to build a 114,000-ton plant near Holyhead on Holy Island off the coast of Anglesey Island, itself off the coast of Wales. A highway bridge connected Anglesey Island with mainland Wales. Bridge load restrictions with respect to width, height, and weight represented a logistics problem for the plant site, requiring that major heavy equipment items be shipped by sea.

KE’s services for the project included overall project management, detail design, preparation of subcontract packages for solicitation of bids from contractors in the United Kingdom, and construction management. The project’s general arrangement drawings were prepared in KE’s Oakland office. Project management, detail design, and procurement activities were headquartered in an office located in Bristol, England, some 300 miles south of the project site. The project manager and a crew of key engineers, procurement specialists, and an estimator were transferred to the project office in Bristol from Oakland. The bulk of the Bristol office staff was recruited from local personnel resources.

The plant utilized Kaiser Aluminum’s reduction process technology. Here again, emissions were carried aloft from a tall chimney to be scattered by the ocean breezes. It was a successful construction program with the project completed ahead of schedule and under budget. However, this accomplishment was, in large part, the result of a decision by project management and the owners’ representative to avoid use of a negotiated site labor agreement covering all union trades, as traditionally used in the U.K. Instead, despite heavy criticism by the British press, it was determined that each subcontractor would be required to negotiate individual labor agreements with each of the labor unions they would utilize.

Ray Ware believes that the decision to require separate labor agreements by each subcontractor was the key factor in keeping the project on schedule and within budget. At the time the Anglesey project was underway in Western Wales, Alcan was performing a similar project in the Midlands of England. For this project, Alcan utilized the traditional approach of a site labor agreement. Considerable labor problems were encountered during the project with the result that the project was completed two years beyond schedule and substantially over-budget.

Key staff members of the project were:

| | |
|---|---|
| Ray Ware, | Project Manager |
| Karl Mathes | Chief Design Engineer |
| C. Jenkins | Site Construction Manager |
| R. Milton | Administrative Manager |

Rocky operations plagued the plant, and for a time things looked bleak for the partnership as problems mounted and production dropped precipitously. Finally, Kaiser Aluminum took prime responsibility and moved some of its own key people into control of operations. By forming teams of local and American operators in a cooperative effort, the program was turned around, and production rose to the hoped-for level and thereafter remained a successful venture. Credit for this turnaround was given to a determined and highly-skilled group of men.

## Bluff

*(1969-1972)*

Bluff was an aluminum smelter built on the southern tip of New Zealand's South Island. Engineering was carried out in our offices in Melbourne, Australia. Begun in 1969, it had an estimated cost of $92 million. It had a capacity of 125,500 tons, using Kaiser Aluminum's technology with emissions vented aloft through a 500-foot chimney. Raw materials were unloaded at a dock and stored in bins and silos at the plant. Completed on schedule and under budget, the plant enjoyed a smooth start up and was soon up to rated capacity.

## Tacoma

*(1980-1982)*

Tacoma, owned by Kaiser Aluminum, was expanded by 20,000 tons in 1966 and again in 1980 by 40,000 tons. Don Montez was project manager.

## Major Marketing Efforts

There were a number of major marketing efforts undertaken in this period. They all appeared to have the proper elements for successful completion. They had assured sources of bauxite or alumina and sources of relatively cheap power. Plus, they had the financial resources needed. But, as will be seen in the projects discussed, politics and international intrigue thwarted our efforts.

Alumax, from 1972 to 1975, turned out to be a flurry of studies and moves from one site to another. For three years we provided preliminary layouts; first in Puerto Rico, then Astoria, Oregon, and finally near Pendelton, Oregon. Ultimately, we lost out to ALCOA technology and, therefore, to Bechtel. Enough engineering had been done to develop both detailed schedules and estimates for each of the three sites. In Puerto Rico, geologic studies finally turned up evidence of a nearby seismic fault, and the owner elected to cancel that location. In Astoria, a local environmental group mounted a crusade against the project, and again the owner elected to move on. Pendelton appeared to be the final step in a game of chess as it was for us. By this time, the owner had concluded ALCOA technology was preferred to that of Kaiser Aluminum. Frustrated and disappointed, we filed away several million dollars of engineering.

In 1973 in Algeria, presentations were made for a plant of 90,000 tons per year, and it was anticipated that engineering would begin in a matter of weeks. Unfortunately, the country was at the beginning of political duress, and we watched our hopes diminish with the slide toward anarchy.

At the same time, much engineering was carried out on a Libya project, and it appeared that the project would actually go ahead in spite of the deteriorating relations between the U.S. and Libya. Ultimately, however, it became increasingly difficult to collect our progress payments, and that project also faded into the mists of politics.

Alcan, in 1981 and 1982, was scheduled to build in Australia a 150,000-tons-per-year plant incorporating the most complete up-to-date technology, including fluid bed emission control of effluents. Basic concepts were established in Montreal, Canada. General layouts, schedules, and estimates were done in Oakland, and we were moving personnel to our Sidney office to carry out detail engineering when the aluminum glut hit the industry. We reluctantly filed away the drawings for a future restart, but that date never came.

In 1975, we assembled a team and flew to Russia for discussions on aluminum and alumina plants. The intent was to provide engineering and technology for both types of plants and for cleaning up the older, very dirty plants located as far away as Siberia. Meeting with Russian engineers and technicians in Moscow and Stalingrad (now Leningrad once again), we formulated a general program for about $2 billion in engineering and construction costs.

Our meetings were extremely friendly, and we were treated to plays, ballets, the famous Russian circus, and a private tour of the Hermitage. A protocol agreement was signed at a final banquet where vodka flowed like water and good fellowship prevailed. We returned home with a feeling of accomplishment and awaited notice to assign our Russian team and get to work. The notice to proceed never came. But we had had a great tour of Russia, if nothing else.

## Alumina Processing Projects

### Introduction

Kaiser Engineers was introduced to alumina production following the acquisition of the reduction plants in the Pacific Northwest. Kaiser Aluminum relied on a contract with ALCOA for its supply of alumina, but soon it felt the need to develop its own sources with the result that it acquired the Baton Rouge plant, which had been operated by ALCOA. After the war, Baton Rouge was declared surplus by the War Assets Administration. Design drawings were missing, lost or destroyed, and Kaiser Engineers' personnel were assigned to prepare as-built drawings. Along with the tedious task of measuring the facilities, it was necessary to redesign the materials handling system to accommodate bauxite from the Kaiser Jamaican mines.

From this rocky beginning, Kaiser Engineers began a learning process often fraught with valve and pipe failures when handling the caustics and in air ducts being eaten away by the extremely erosive alumina. It was not long before this division learned its lessons, and in the end, became one of the world's most proficient in the art of alumina plant design. By the time of the slowdown in aluminum, we could lay claim to plants totaling 7,500,000 tons in annual capacity. (Editors' Note: It takes roughly two tons of bauxite to produce one ton of alumina and two tons of alumina will produce one ton of aluminum.)

In this section we describe eight plants. They were designed and built by a separate KE staff, moving from project to project. The plants are located all over the globe. They are Baton Rouge in the United States, Gramercy in the United States, Hindalco in India, Queensland Alumina in Australia, Alpart in Jamaica, Eurallumina in Italy, Worsley in Western Australia, P.T. Aneka Tambang on Bintan Island, Indonesia.

Beginning with Gramercy, all projects are noteworthy because they represent the successful application of high-temperature digestion technology as developed by Kaiser Aluminum. Pioneering in high-temperature, high-pressure digestion systems and improved slurry handling, Kaiser's engineers and metallurgists designed more efficient plants as well as systems that could deliver coarse, sandy, or floury alumina. As with reduction plants, alumina led us on a world tour in various parts of the world, touching a variety of conditions and cultures.

Each refinery includes a boiler plant to supply steam for process and for power generation. Bauxite receiving and alumina load-out are included and, in some locations, personnel, housing, and medical facilities were constructed.

The write-up covering P.T. Aneka Tambang has been included to show how engineering efforts may be expended wastefully when economic and political factors are not considered or when they overtake one's planning.

## Staffing

Designing and building alumina plants was truly a global undertaking. These important works were accomplished by mobilizing KE's worldwide engineering and construction forces. On the international scene, the KE international divisions cooperated in providing liaison with forces within the area, including assisting in the staffing, providing knowledge about the local environments, and assisting with day-to-day management of the projects.

Overall responsibility for all projects was under Carl Olson, the vice president in charge. Reporting directly to him was Bill Fisher. In later years, Bill Deeths was placed in charge. For projects in Europe, joint responsibility fell on Earl Peacock, vice president for the Europe and Africa area. In later years, Dick Lowell replaced Peacock. In Australia and India, Frank Davis was the vice president, followed by Lee Gillett when Davis was reassigned.

Fisher and Deeths had a number of technical personnel assisting them, including construction personnel. This staff handled the various projects, moving from one to the other. Listed below are the people involved as recalled several decades after the fact:

| | |
|---|---|
| Bill Fisher | Ray Forrest |
| Dick Curry | Bill Deeths |
| Omar Finsand | Charlie Graff |
| Erik Evren | Dick Miller |
| Harry Christensen | Bud Olds |
| Sherrill McDonald | Norine Ferrantes |
| Jorge Brown | Bill Crass |

## Baton Rouge, 1951

Baton Rouge was the first plant expansion KE undertook in the field of alumina. This is the plant designed by ALCOA and purchased from the War Assets Administration as surplus property. Since drawings were not available, KE staff literally measured the facilities to establish an as-built set of drawings.

The two projects undertaken in 1951 had estimated project values of $7 million and then $19 million. These were renovation projects to redesign the materials handling system to accommodate Jamaican ores and to redesign the system of valves and pipes that were eroded by handling the caustics involved. Air ducts were eaten away by the erosive alumina.

Chet Case, a chemical engineer, was project engineer. Key design supervisors, reporting to George Schumann, played important engineering roles in our entry into this new industry. This is where KE engineers started to learn how to handle erosive materials like bauxite and alumina.

## Gramercy, 1955
## Facilities and Process

The Gramercy plant was a new departure in bauxite processing. It was designed to handle Jamaican bauxite which contained a higher percentage of monohydrate (bochmite) than the more widely used Surinam ore which had a very high trihydrate (gibbsite) content. The digest would require higher temperature and pressure to efficiently put the monohydrate ore into solution.

The higher operating conditions would cause the flow stream to cascade down through the system in a stepwise flashing train, allowing the solution to reach atmospheric pressure while preheating spent caustic liquor in shell and tube heat exchangers flowing counter current to the flashing train. All valves in the circuit were specially designed for high-pressure slurry regrinding service in the digestion system. These special valves would become the standard of the industry.

Gramercy was built on the banks of the Mississippi River near Reserve, Louisiana. When the plant was initially built, the facilities included the alumina plant, a power plant and a caustic-chlorine plant. The caustic would be used at Baton Rouge and Gramercy and the chlorine sold on the commercial market. The power plant supplied steam for the alumina process, for pump drives, and electric power for the electrolytic cells in the chlorine plant. The entire plant was built on wooden piles (approximately 10,000). The red mud residue was dumped back into the river, something which would be prohibited today.

## Erosion/Corrosion Problems

Kaiser Aluminum personnel used to refer to the operation of Baton Rouge as going to high school, while learning to operate Gramercy was much more like a college education. Operating problems cropped up during initial operation. Among them, and most critical, were those associated with the erosion / corrosion phenomenon of hot unbuffered caustic liquor which ate through steel like a hot knife through butter. Impellers on liquor pumps were eaten away in a matter of a few weeks. Control valves did not operate properly because the internal parts were damaged due to the erosion / corrosion. Temperature and pressure had to be reduced (and alumina yields sacrificed) while a solution to the problem was found.

During this period, another equally critical situation surfaced. The high-pressure slurry valves did not work. The valve bodies were marginally serviceable, but the valve stems were not heavy enough. Every time a valve was operated under process conditions, the stem flexed with a noise like a cannon going off. The temporary solution was to derate the valves so that 600# valves were used in 300# service and 300# valves in 150# service.

This derating in conjunction with the need to reduce temperatures in the areas where erosion / corrosion was taking place forced the operators to lower throughput until the problems were corrected.

The solution of nickel lining the piping and pump internals was not revealed to KA and KE engineers in a blinding flash of light. It took intense laboratory work and field tests to establish the fact that various stainless alloys would not work to combat erosion, and the nearer the combination came to pure nickel the better it performed. Rather than waste valuable time (and loss of production) attempting to optimize the level of nickel alloy necessary to resist unbuffered caustic solution, a decision was made to use pure nickel either in sheet or plated form depending on configuration and accessibility of the wetted surface.

KE's Purchasing Department immediately called in Lunkenheimer Valve Company and Stockhom Valve Company, who had been high bidders on regrinding valves, and asked them for a price on nickel lining the 600# valves that were offered in their initially unsuccessful bids. KE's chief metallurgist, Tom Stephens, worked closely with both companies to ensure that nickel lining of proper specification and thickness was applied. He also monitored the application of sheet nickel and nickel plating to the piping in this service. These two firms successfully applied the nickel lining in valve bodies and hard surfacing on valve seats. The two companies, one in Cincinnati and one in Birmingham, would split the slurry valve business between them through the next 20 years.

An important lesson was learned from the near debacle. Be careful when buying from the low bidder, especially in critical service.

## Hindalco, (1959)

Hindustan Aluminum Company, located in Uttar Pradesh, India, was a combined alumina plant and reduction plant. The alumina plant was a smaller version of the Gramercy plant with a capacity of 60,000 tons per year. The adjoining smelter had a capacity of 30,000 tons of metal per year. The plant was built in 38 months for about $30 million. Engineering design and major procurement were carried out in Oakland.

## Lost Digestion Vessel

Digestion vessels, 10-feet in diameter by 60-feet, were built at the Kaiser Steel Fabricating Plant in Napa, California, were barged to San Francisco and deck loaded on a ship sailing for Calcutta via Vancouver, B.C. The ship hit a storm in Puget Sound, and one of the heavy vessels broke it's tie-down cables and rolled into the sea. The Coast Guard began an immediate sea and air search for the pressure vessel, which was filled with an inert gas (to keep internals dry), but it was never found.

The vessels had been fabricated with left and right nozzle orientation (mirror images), and it was initially assumed that the bills of lading were correct and that the left-hand vessel had been lost overboard. An engineer went to Vancouver to make positive identification as to which vessel to replace. Kaiser Steel was alerted to immediately commence fabricating a replacement vessel. The trip paid off, a check of the shipping papers revealed that the vessel identification had been reversed, and it was the right-oriented vessel that would have to be replaced. The prompt action saved the overall schedule and severe headaches later.

## Building the Plant

The alumina plant was built in conjunction with the reduction plant that it would supply with feedstock. The onsite crew was a mix of American and English expatriates with locally recruited Indian construction personnel. Life was different in India in the 1950s, and mechanization was not exactly commonplace. For example, we specified and bought coal-fired package boilers with moveable grates for ash removal. The owner's representative vetoed this approach to ash handling as too expensive, since their normal practice was to do the task manually; that is, workers with rakes. They also showed us a new level of purchase order and contract negotiation, which seemed to consist of a combination of persuasion, threats, and even tears.

Concrete was mixed and moved and placed manually. Picture an endless stream of men, women, and children with buckets on heads pouring footings and vessel foundations. It most nearly resembled ants building an anthill. Scaffolding for steel erection was heavy bamboo tied by hand. The workmen were amazingly dexterous and speedy in assembling and disassembling the scaffolds.

While piping was smaller (flow rates throughout the plant were lower), the nickel lining requirement became more complicated. Specifications and procedures for lining pipe 12 inches and larger would not be suitable for 4-inch through 8-inch diameter pipe. The solution was to fabricate nickel sleeves that, when inserted in the pipe, would be expanded in the mating pipe with pressure in excess of the nickel yield point but below the steel pipe yield point. In effect a shrink fit. The piping fabricator brought in some welding experts to supervise the installation of this critical piping. Kaiser Engineers' chief metallurgist, Tom Stephens, oversaw this successful operation.

## Queensland Alumina Limited
*(1964-1968)*

The Queensland Alumina Limited (QAL) facilities are located in Gladstone, Queensland, Australia. The QAL plant was designed and built to process the Weipa bauxite into coarse, sandy alumina. The partners in the Gladstone alumina project were a group of leading world metal companies whose shareholders were as follows:

| | |
|---|---|
| Kaiser Aluminum of the United States | 52% |
| Aluminium Limited of Canada (Alcan) | 20% |
| Pechiney Company of France | 20% |
| Conzinc RioTinto of Australia, Ltd. | 8% |

The companies represented amongst themselves about 40 percent of the Western world's aluminum production capacity. The partners in Queensland Alumina would draw on Comalco's very extensive bauxite resources at Weipa on the Cape York Peninsula for the Gladstone alumina refinery. In broad terms, two tons of bauxite yield one ton of alumina. The same ratio applies generally to the ultimate reduction stage, with two of alumina yielding one ton of primary metal.

Construction was completed in May, 1967, with operation beginning in July, 1967. Capital cost of the original plant was $94 million, expanded by $45 million in 1968. QAL was ultimately expanded to a capacity of over 2,000,000 long tons per year, making it the largest alumina plant in the world.

## The Process

The process for producing alumina from bauxite at QAL was essentially the same as at Gramercy. Initially, instructions from Kaiser Aluminum, who represented the partners, was to design the plant based on the Gramercy design even to the extent of using the Gramercy drawings and simply substituting a new title block. This approach lasted about a month or until the process group made changes in layout (horizontal spent liquor heat exchangers instead of vertical) and a completely reconfigured evaporation and heat interchange unit. The Weipa bauxite had different handling characteristics than Jamaican bauxite and necessitated a completely different material handling and ore preparation system design.

## Building the Plant

The selected plant site was formerly the marshalling yard and slaughterhouse area of a Swift's meat packing plant that had been a fixture and a major source of employment for the village of Gladstone for almost 75 years. The advance group's reception in Gladstone in late 1963 changed from the typical warm Aussie greeting to an icy frigidity when it was revealed that the consortium was taking over the meat works and effectively "throwing" over half the town out of work.

Engineering began in early 1964 in Oakland, with site preparation and foundation construction underway in mid-1964. The KE expatriates had their first exposure to Australian construction workers. In spite of being unionized, they were fairly independent. KE construction managers eventually became used to seeing welders (as well as other workers) dressed in open toe sandals, khaki shorts, and bush hats working on a tank seam with the welding stinger between their almost bare feet. Why there weren't more burn injuries is hard to explain except that most of the Aussies considered themselves indestructible, and they kept proving it day after day.

Design and construction scheduling were so closely tied together that the design office set up a daily conference call between Oakland Engineering and Gladstone Construction to coordinate activities. For example, certain area slabs had heavy pump and compressor foundations. A grid was established for the area, and the field sent in construction priorities for specific areas on the grid. The structural group provided construction details and released Approved for Construction portions by grid coordinates.

It was a difficult site insofar as any given area, especially digestion, requiring both piling and spread footings.

A bachelor camp on the outskirts of Gladstone provided room and board for the workers. However, the Italian contractors carrying out structural steel fabrication, erection, and painting felt their workers would be happier (and better controlled) with dormitory caravans and Italian cooks. They were right about the food being better. Not long after, the catering contractor improved the quality of the food in the main mess hall to almost the level of the Italians.

Engineering for plant expansion began concurrent with startup of the initial plant. The design work was carried out in KE's Sydney office with certain specialties subbed to local architecture-engineering firms. Experience with the Gramercy, Louisiana, plant had taught KE several lessons in the design of the high pressure, high temperature end of the digestion unit, which was incorporated into QAL and all subsequent plants. All wetted portions, such as control valves, slurry valves, and spent liquor piping were lined with nickel or, in the case of a pump impeller, cast in nickel.

KE's chief metallurgist (one of the best in the business) spent several months at the jobsite overseeing the selection and application of weld rod and welding procedures for pipe joints and inspecting nickel lining for proper thickness and adherence to the underlying steel surfaces.

## ALPART
### *(1966-1969)*

Everyone who has seen the James Bond film, "Dr. No," will remember the chase scene on the bauxite wharf at Port Kaiser in Jamaica. Aluminum Partners of Jamaica ( ALPART), a consortium of American aluminum producers, with Kaiser Aluminum as the lead partner, oversaw the engineering and construction of the plant. This 650,000-tons-per-year plant was constructed at Nain**,** St. Elizabeth Parish, Jamaica. This would be the largest initial plant built to date. The location is *25* miles inland from the Kaiser dock built earlier to ship out bauxite destined for Baton Rouge and Gramercy. The original ALPART project started in 1966 was completed at a cost of $151 million. By 1969 the plant was expanded by expenditure of an additional $62 million.

Modifications were made to the dock and port to receive liquids and other plant raw materials and to ship out the final product to the alumina plant some 15 miles inland. Most of the fabrication work was done in the United States and shipped to Jamaica. Getting things through customs often proved difficult because items would get “lost,” and it then required the expenditure of some dollars to “find” them.

## Design

Design engineering was carried out at Kaiser Engineers’ Oakland, California, offices. Construction would be accomplished by lump sum subcontracts scoped in such a way that they could be relatively easy to monitor.

It became evident that local contractors would not be able to handle piping fabrication and erection, structural steel and tank fabrication, or other complex installations. Worldwide bids were requested from pre-qualified international firms for ship loaders, calciners, boilers, heat exchangers, process pumps, instrumentation and control valves, and the like.

## Corrosion Problems

Corrosion is a major problem in alumina plants due to the caustic atmosphere, so on this project extensive use was made of a special steel. The material was Corten, developed by U.S. Steel. The surface soon appears like rust but will stabilize and, thereafter, be highly resistant to the effects of corrosion. The surface is very rough and caused us a problem we had not anticipated; when pulling wire and cable through cable trays, much of the insulation would get scraped down to bare wire, and this had to be corrected by using standard galvanized trays.

## Building the Plant

Time did not mean the same to the Jamaican workmen as it did to us, and we had to deal with the local “mañana” attitude as we tried to expedite work. Our labor relations people did a fine job in avoiding strikes or work stoppages, but often workers failed to show up on the job which slowed the project. In spite of this, the job was completed within a reasonable schedule.

One mishap on the job was the almost loss of a 100-foot long by 12-foot diameter digester vessel, which, fortunately, ended up in a soft dirt bank on a tight turn on the narrow road between Port Kaiser and the plant site. No damage was done, and the heavy vessel was lifted and put back on its trailer to resume the haul to the job.

The construction work was carried out by 5,000 workers. By 1969, a total of 137 contracts were in force.

## Eurallumina

*(1969-1973)*

This 600,000-tons-per-year plant was built at Portoscuso on the southern tip of Sardinia (at Port Sousa) for a partnership of international firms. Studies had indicated savings in tariffs and shipping costs, and the location offered easy access to Mediterranean and European ports.

The partners consisted of the following companies:

- Eurallumina Spa - Italy
- Kaiser Aluminum ( KACC ) - USA
- Comalco - Australia
- Metallgelshaft - Germany

Kaiser Engineers provided project management, engineering, procurement services, and construction management for the $81-million process area. Engineering began in early 1969 with construction completed in 1973.

## Design

Basic engineering began in January, 1969, and was to be continued in KE’s London office at Twickenham. Plant layouts, flow diagrams, and standard specifications were completed and partially shipped. The bid package for site preparation was pretty much rushed to completion to save time during the move of key personnel to England. Request for bids were issued from Oakland with bids received in London. That was the first error. When the civil contractors received our bid request and specification, we almost became laughing stock when it was pointed out that almost all bidders were used to working with English language documents.

We had had everything translated into Italian before issuing them from Oakland. The laughs came because the translation service not only had translated into non-technical Italian but had used a Sicilian dialect. We corrected that “boo-boo” with minimal damage control—luckily—and went on with a series of conflicting orders that saw us scrapping process flow diagrams and general arrangement drawings, which had been produced in Oakland, and we started from “scratch” in Twickenham.

Soon after the restart, we were instructed to prepare all the design drawings in metric units. Since we had started work in English units, we went back and reworked all drawings to include metric dimensions with corresponding English units in parentheses. It was sort of one step forward, two steps back. Luckily, the Italian pipe and valve suppliers came to our rescue when they asked us point blank why we were going to the trouble of designing in metric when almost all their products were manufactured to API and American standards. It seems they supplied equipment and material to oil and refinery industries which used U.S. standards.

In all, we probably lost six to eight weeks in our design schedule but managed to close the gap by adding some extra designers and resetting a few construction priorities.

## Building the Plant

Extensive studies established that local Italian contractors were available and qualified to carry out the construction on a lump sum basis. Equipment was bid and purchased on an international basis. The Italian partners offered “qualified” bidders for the tank and digester work, but we found them unfamiliar with the requirements and had to assign one of our engineers to the fabricating plant to assure the quality of the work.

A major part of the physical plant consisted of tank farms which included precipitation, mud settling and CCD, and seed separation. Usually, we used experienced international tank fabricators, such as CB&I for this demanding, specialized work. This time, our client, Eurallumina, directed us to award the contract to a structural contractor in Turin. Unfortunately, the contractor had no experience in the design, fabrication, and construction of large diameter (100 by 115 feet), scallop bottom, shallow cone mud settlers. Faced with a possible delay, or worse yet, a potential failure in structural integrity if the tanks were not properly designed, we assigned one of our senior structural engineers to take up residence in Turin and literally engineer the complex tank connecting joints and seams. A small-scale mockup of the tank bottom segment joints was set up in the shop so that construction could be checked out and welding procedures verified. The concerted effort paid off with the contractor successfully completing the tank fabrication and erection with only minimal budget and schedule overruns.

The plant site was sloped down toward the sea and was essentially beach sand. Site drainage was installed that would keep the site dry and workable. Franki piles were driven on a grid that blanketed the site. With the addition of the pile caps, a more than adequate foundation system was achieved.

The problem involved with nickel lining and plating, where necessary, had essentially been solved with the four previous plant designs. The only problem that cropped up was the refusal of one of the major suppliers of slurry regrinding valves (Stockham) who simply would not work in Italy under the existing licensing and liability laws. It’s not everyday you see a sales manager weep real tears when turning down a $2,000,000 purchase order. No amount of persuasion would make Herbert Stockham and his management change their minds. The other supplier, Lunkenheimer, was more than ready to accept the full order for all pressure classes of regrinding valves.

One added requirement for this plant was to produce floury alumina for Metallgelschaft. This setup was to be done on a campaign basis.

Despite the many difficulties, the plant was completed with only minor schedule delays and a minor budget overrun.

Production suffered during the early period of operations, but help from suppliers and much work on the part of our engineers and metallurgists enabled us to surmount the difficulties, and plant output was soon up to design capacity.

## Worsley Alumina

*(1979-1985)*

The Darling Range in the Southwestern part of Western Australia contains large reserves of low grade bauxite (30 percent to 35 percent $Al_2O_3$ ). Exploitation of these reserves started in the early ’60s when ALCOA began mining bauxite at Yarrahdale for its refinery at Kwinana. In the late ’60s, ALCOA built a second refinery just north of Pinjarra and began mining bauxite above the escarpment, just east of the refinery site. ALCOA holds the mineral lease of the western side of the Darling Range. The reserves on the eastern side of the range were held by News LTO and BHP, an English group.

Exploration and test work was done to determine the extent and grade of these reserves. In the early ’70s, Reynolds Metals took an interest in the reserves and commenced testing and pilot plant work on the bauxite. Test work and feasibility studies were carried out under the direction of Reynolds Metals, and in the late ’70s a consortium of Reynolds (USA), Shell Minerals (Dutch), BHP (English), and Kobe Steel (Japanese) was formed, and the decision was made to proceed.

The Worsley Alumina complex is the largest alumina refinery project ever undertaken. It incorporates the latest technological developments in its process design and process control system. It is the most environmentally designed alumina refinery undertaken until this time. Since reaching its full capacity in early 1985, it has been the lowest-cost producer in the world. When the project was started by KE in 1980, its estimated cost was $956 million.

## KE’s Responsibilities

During 1978 and 1979, Kaiser Engineers assisted Reynolds Aluminum with conceptual studies and capital cost estimates. In March, 1980, Kaiser Engineers was awarded a contract to design and build an alumina refinery complex in the southwestern part of Western Australia. Kaiser Engineers was responsible for the complete project, including design engineering, process engineering, construction management, cost and schedule control, procurement of construction materials, and preparation of major bid packages. Engineering was carried out in our offices in Perth, Western Australia. A total of 8,500 drawings were required for the total project of which 7,000 were done by KE.

At the peak of construction in early 1983, more than 100 contractors and 3,300 workers were on the site. The overall project is one of the largest ever undertaken and incorporated the latest technology in the process and control. The plant was turned over to the owner in late 1983. It has achieved the lowest operating cost in the industry and was at full capacity by 1985. Environmental regulations were strict. For example, for each tree cut in the construction program, a new one was required to be planted.

## Facilities

The scope of the project consisted of the following major facilities:

## Mining Operation and Mine Plant

The mining and crushing facilities are capable of producing and processing feed to a 2,000,000-tons per-year alumina refinery. The mine facilities included administration building, maintenance shops, tree nursery, washroom, and first-aid. The mine plant was to be located near the town of Boddington.

## Transport System

A system for the transport of the crushed bauxite from the mine site to the refinery site, near Collie, a distance of approximately 52 km was selected to handle bauxite for the 2-million-tons-per year refinery production.

## Alumina Refinery

Complete with bauxite blending, storage and reclaiming, the process plant included bauxite grinding, desilication, digestion, clarification, bauxite residue wash, liquor filtration, heat interchange, precipitation, hydrate filtration, seed preparation, alumina calcination, and evaporation. At this site, facilities were required for process plant maintenance, water supply and water management structures, dams and ground water monitoring, caustic receiving and storage, alumina handling, storage and rail loading, fuel oil receiving and storage and administration, laboratory, and training facilities. The original plant production would be 1 million tons of calcined alumina per year with later expansion to full capacity.

## Steam Power Plant

Its capacity is 82 megawatts of power plus process steam for the process plant. The power plant was connected to the West Australian power grid in such a way that surplus power could be exported, and power could be purchased from the grid in case of emergencies. In addition, three diesel power generating sets were installed to provide emergency power.

## Railroad Spur

The spur is about 11 km long, connecting the refinery site with the West Australian government rail line from Collie to Bunbury.

## Port of Bunbury

Additional facilities were provided at the port for receiving, storing, and shiploading. Caustic receiving, caustic storage, and railcar loading facilities were built.

## Engineering

Engineering commenced in April, 1980, with conceptual studies and preparation of a project work plan. Concurrently, design engineering commenced on site preparations and preliminary tank design to allow an early start of construction and early procurement of plate for tank fabrication. By August, 1980, the conceptual work was essentially completed, and a project work plan submitted. The work plan included a description of the project scope of work, a description of the technologies to be applied in the process plant, design engineering criteria, comprehensive policies and procedures to be used in the project execution, a capital cost estimate, and a detailed project schedule.

KE was responsible for procurement of equipment and construction materials, except for those included in lump-sum contracts. The following lump-sum, turnkey contracts were awarded:

- Steam boilers to Mitsubishi
- Bauxite transport system to Cable Belt
- Evaporator to Babcock Wilcox
- Calciners to Lurgi

These contracts included technologies, design, and construction of the complete facilities (except for site development and foundations).

Local consultants were used to design support facilities such as maintenance, administration, and water management systems. All of the mine plant and process facilities were designed by Kaiser Engineers. Of the 8,500 drawings scheduled for the project, approximately 7,000 were prepared by Kaiser Engineers in the company's Perth, Western Australia, office. At the peak of design and procurement, 550 people were employed in Perth.

## Construction

Construction commenced in September, 1980, with site development of the process plant site and the cable belt route. A site construction office was built to accommodate the construction management personnel. At peak, Kaiser employed 295 people in the site management team.

To accommodate construction labor at the site, three 500-men camps were built. One of the camps also had accommodations for Kaiser Engineers' field personnel. Each camp was complete with kitchen and dining room as well as laundry facilities for the construction workers. At peak of construction, more than 100 contractors were engaged on the site, and the number of construction workers peaked at 3,300 in early 1983.

Strict environmental rules applied to the design and implementation of the project. For each tree cut at the plant site, a new one had to be planted elsewhere in the area. Worsley Alumina had purchased marginal farm land in the plant vicinity, and these lands were used for tree plantations. Plant site ground water control was assured by grout curtains in the bauxite residue dam, in the refinery catchment lake dam and by monitoring bores, and control structures downstream from the plant site. In the site development of the cable belt route, strict control of the movements of soil from cuts to fills were employed due to the Yarrah Dieback problem in the forested areas of the route. At the mine site, mining areas were stripped of the top soil and forest debris and stockpiled for later use. When a mining area had been mined out, the top soil was distributed, and new trees were planted. Worsley Alumina worked closely with the State Forest Department in implementation and reforestation.

Air quality was controlled by electrostatic precipitators at the power plant and by dust collection in the bauxite and alumina handling systems.

The mine plant was completed in March, 1983, and mining and bauxite transport commenced in May, 1983, when the cable belt and the bauxite stockpile systems were completed.

Check-out and testing of the power plant and the alumina refinery process plant commenced in June and in September, 1983. Worsley Alumina's plant operations team commenced hot caustic circulation in process train No.1. Bauxite grinding was started in October, and the first alumina was calcined in December, 1983. Process train No.2 was started up three months later, and the process plant facilities were completed in April, 1984. Completion of the service facilities, plant clean-up, demobilization of the sub-contractors and completion of landscaping was completed in December, 1984.

## Expansion

In 1986, Kaiser Engineers carried out studies for solving bottlenecks and expansion of the refinery, and in 1987 was awarded a contract to expand and modify the process plant to allow maximum utilization of all the process plant units. Modifications and expansions were made in the precipitation, seed filtration, and bauxite residue filtration areas. One additional Lurgi calciner was installed. By these modest expansions to the original plant, and by continuously improved operations and maintenance, the refinery production by the end of 1993 was 1.8 million tons of high-quality alumina, nearing its ultimate design capacity.

## Aneka Tambang, *Not Built*
***(1980-1981)***

Studies were carried out for an 800,000-tons-per-year alumina refinery at three sites and bauxite mining at two sites in Indonesia. Costs and revenue estimates were prepared and a project feasibility study was prepared showing that the project was feasible. Kaiser Engineers was then instructed to proceed with design and solicitation of bids. We had reached the point where vendors' drawings were required before proceeding with detail drawings when the project was cancelled by the Indonesian Ministry of Mining and Energy. It had been decided that with the Japanese completing a reduction plant in Indonesia and having a long-term contract with ALCOA for alumina, there was no reason to proceed with the new project.

The project is described here as a demonstration of another project that was cancelled by political and economic considerations.

The P.T. Aneka Tambang is an office of the Ministry of Mines and Energy for the Government of Indonesia. In 1980, it considered the development of bauxite mining operations at Wacopek on Bintan Island and the construction of an alumina plant near Kijang, also on Bintan.

Kaiser Engineers was engaged to assist in the study and implementation of these projects. The study evaluated the impact of combining the bauxite mining operation and the production of alumina as a single economic entity. The cost and revenues of the mining facilites and the alumina plant combined were used to calculate return on investment and return on equity as well as sensitivity effects.

Prior to this study, KE prepared an economic analysis of the bauxite mining for a 600,000-metric ton per year plant. Three sites were evaluated.

Based on the viability shown in the project report, Aneka Tambang contracted with KE to design and manage construction of the project. Design was advanced to the stage of requiring vendors' drawings for completion of design, but the work was curtailed. The Japanese made the unfavorable recommendation to the Indonesian government to stop the project. The situation arose from the fact that, at the time, the Japanese were completing the construction of an aluminum plant in Medan, Indonesia. It would require 600,000 tonnes of alumina to feed it. It was then that they made the recommendation to contract with Japanese suppliers for the source of alumina rather than to build an alumina plant on Bintan.

It is worthwhile to remember that due to the high cost of producing energy, Japan had to close down various aluminum reduction plants and was saddled with a contract with ALCOA for the supply of the same 600,000 tons of alumina for the remainder of a 30-year contract. This prompted them to build the aluminum reduction plant at Medan in a joint venture with the Indonesian government.

**Table 5.1**
**Aluminum Projects List**

| Job No.[1] | Project Name | Client | Location | Project Value $x million |
|---|---|---|---|---|
| | *Architect/Engineer Construction Projects* | | | |
| 4828 | Aluminum Rod Mill | Kaiser Aluminum | Newark, OH | 2 |
| 5110 | Aluminum Reduction Plant | Kaiser Aluminum | Chalmette, LA | 148 |
| 5120 | Alumina Plant | Kaiser Aluminum | Baton Rouge, LA | 7 |
| 5121 | Bauxite Mining | Kaiser Aluminum | Jamaica | 10 |
| 5186 | Carbon Baking Furnace | Kaiser Aluminum | Mead | 7 |
| 5191 | Alumina Plant Additions | Kaiser Aluminum | Baton Rouge, LA | 19 |
| 5193 | Steam Plant Additions | Kaiser Aluminum | Chalmette, LA | 55 |
| 5430 | Aluminum Rolling Mills | Kaiser Aluminum | Ravenswood, WV | 22 |
| 5505 | Refractory Brick Plant | Kaiser Aluminum | Ohio | 5 |
| 5510 | Aluminum Reduction Plant | Kaiser Aluminum | Ravenswood, WV | 82 |
| 5520 | Boiler Plant Additions | Kaiser Aluminum | Baton Rouge, LA | 5 |
| 5522 | Aluminum Rolling Mills | Kaiser Aluminum | Ravenswood, WV | 91 |
| 5543 | Aluminum Extrusion Plant | Kaiser Aluminum | Maryland | 6 |
| 5592 | Alumina & Chlorine Plants | Kaiser Aluminum | Gramercy | 76 |
| 5605 | Ninth Potline | Kaiser Aluminum | Chalmette, LA | 14 |
| 5818 | Heat Treat Facilities | Kaiser Aluminum | West Virginia | 8 |
| 5922 | Alumina Plant | Kaiser Aluminum | India | 32 |
| 6020 | Aluminum Smelter | Kaiser Aluminum | India | 32 |
| 6351 | Aluminum Smelter | Valco | Ghana | 192 |
| 6427 | Alumina Smelter | Valco | Ghana | 120 |
| 6435 | Queensland Alumina Plant | Qualco | Australia | 94 |
| 6629 | Alumina Plant | Jamaica Alumina Partners | Jamaica | 146 |
| 6641 | 4th Potline | Kaiser Aluminum | Tacoma, WA | 20 |
| 6650 | Alumina Plant | Qualco | Australia | 41 |
| 6692 | Alumina Plant | Alpart | Jamaica | 146 |
| 6714 | Alumina Load Out | Kaiser Aluminum | Baton Rouge, LA | 5 |
| 6721 | Rolling Mill Expansion | Kaiser Aluminum | Ravenswood, WV | 42 |
| 6739 | Aluminum Reduction Plant | National Southwire | Kentucky | 93 |
| 6746 | Caustic Chlorine | Kaiser Aluminum | Baton Rouge, LA | 25 |
| 6748 | Caustic Chlorine | Kaiser Aluminum | Gramercy | 25 |
| 6824 | Aluminum Reduction Plant | Noranda Mines | New Madrid, MO | 81 |
| 6872 | Bluff Aluminum Reduction Plant | New Zealand Aluminum, Ltd. | New Zealand | 89 |
| 6873 | Alumina Plant | Qualco | Australia | 45 |
| 6902 | 4th Potline, Power Plant | National Southwire | Kentucky | 60 |
| 6931 | Alumina Plant | Euraluminum | Italy | 27 |
| 6932 | Strontium Carbonate | Kaiser Aluminum | Nova Scotia | 13 |
| 6942 | Alumina Plant Expansion | Alpart | Jamaica | 62 |
| 6964 | Alumina Plant Expansion | Qualco | Australia | 114 |
| 6965 | Aluminum Plant | Euraluminum | Italy | 81 |
| 7018 | Aluminum Smelter | Valco | Ghana | 22 |
| 7041 | Fluoride Plant | Kaiser Aluminum | Louisiana | 5 |
| 7131 | Aluminum Reduction Plant | Amax | Puerto Rico | 18 |
| 73101 | Aluminum Potline Expansion | Noranda Mines | New Madrid, MO | 62 |
| 78149 | Aluminum Plant | Kaiser Aluminum | Baton Rouge, LA | 66 |
| 79185 | Goldendate Aluminum Smelter | Martin Marietta | Washington | 120 |
| 80103 | Worsley Aluminum | Worsley Aluminum Pty | Australia | 800 |
| | *Construction Management Projects* | | | |
| 6869 | Aluminum Smelter | Angelsley | Wales | 92 |
| 6872 | Aluminum Smelter | New Zealand Constructors | Bluff, NZ | 89 |



cont

**Table 5.1 con't**

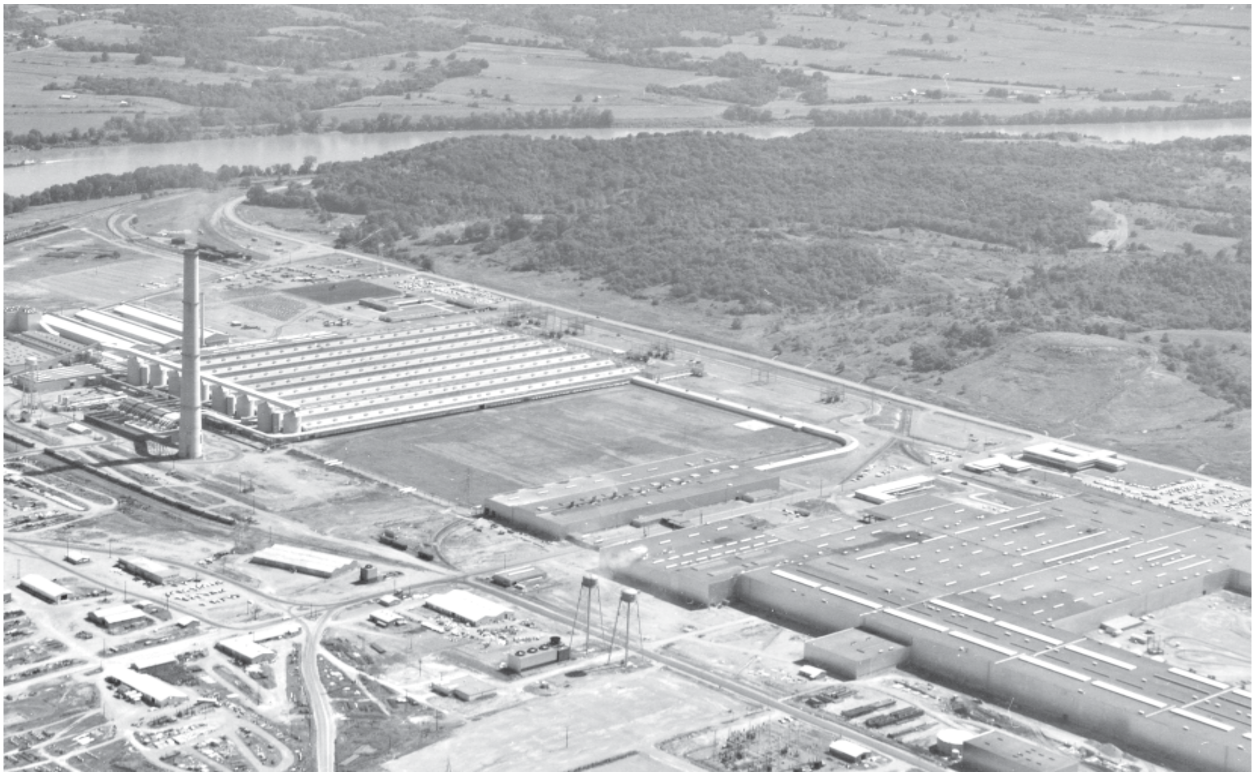
| Job No.[1] | Project Name | Client | Location | Project Value $x million |
|---|---|---|---|---|
| | *Construction Management Projects con't* | | | |
| 79089 | Aluminum Smelter | Aluminum Bahrain | Bahrain | 66 |
| 79185 | Goldenville | Martin Marietta | Washington | 140 |
| 80051 | Kalimantan Bauxite/Alumina | Worsley Alumina | Australia | 956 |
| 80086 | Capricorn Smelter | Alcan | Australia | 430 |
| 81052 | Zwara Aluminum | Libya Aluminum | Libya | 1,000 |
| 81145 | Alumina, Bauxite | Alumina Partners Jamaica | Jamaica | 115 |
| 82024 | Aluminum Rolling Mill | Gulf Aluminum | Bahrain | 102 |
| 85109 | Aluminum Rolling Mill | Gulf Aluminum | Bahrain | 48 |
| | | | | 6,273 |

*Notes:*

[1] Numbering is chronological with the first two digits indicating the year the project was initiated.

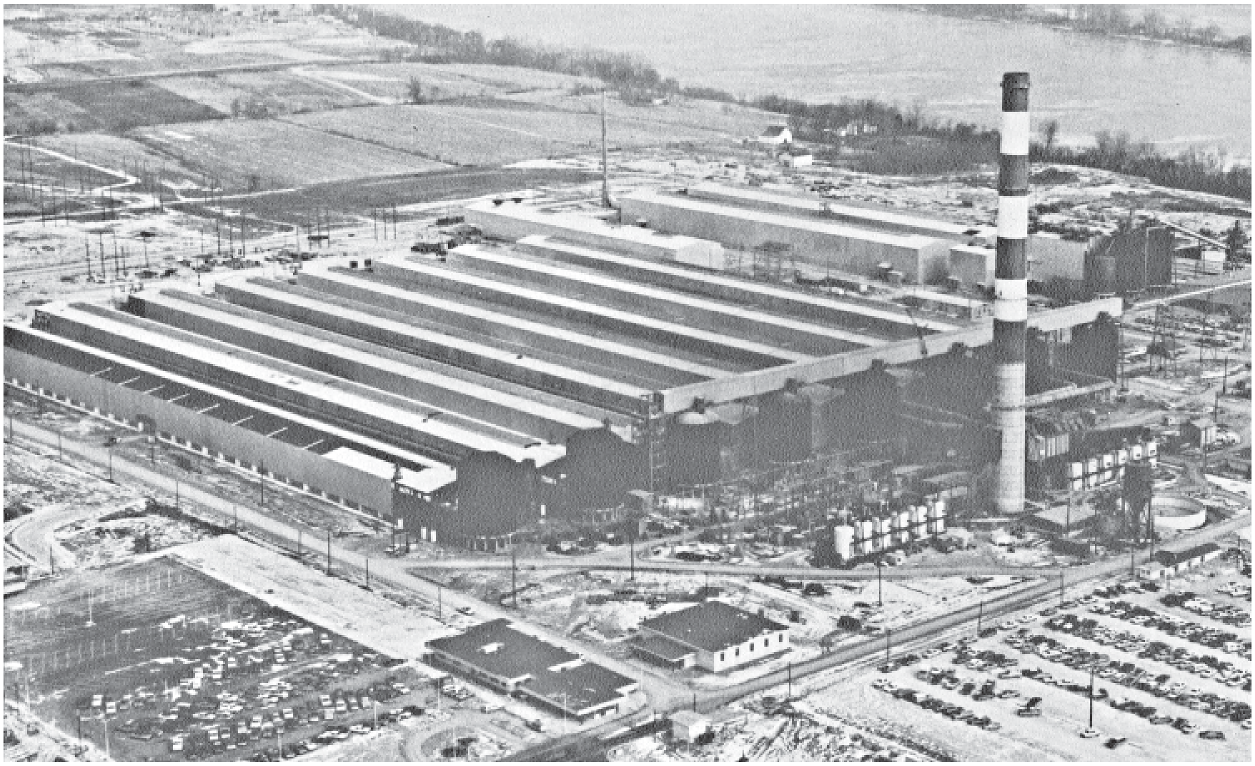
Chalmette, 1951. This was the first of a number of projects designed and built by KE. The plant was ready for initial production in 11 months.
Smoke from the stack was later solved by KE's and KA's environmental engineers, and later plants were smoke free. Built at the river bank of the Mississippi, the soil required all structures to be founded on wood piles.
Built in Louisiana to take advantage of cheap gas, the power plants were gas fired. To take advantage of the aluminum market, KE provided Nordberg gas engines for half the initial power since they could be erected much faster than conventional power generators.

The Nordberg gas generators.



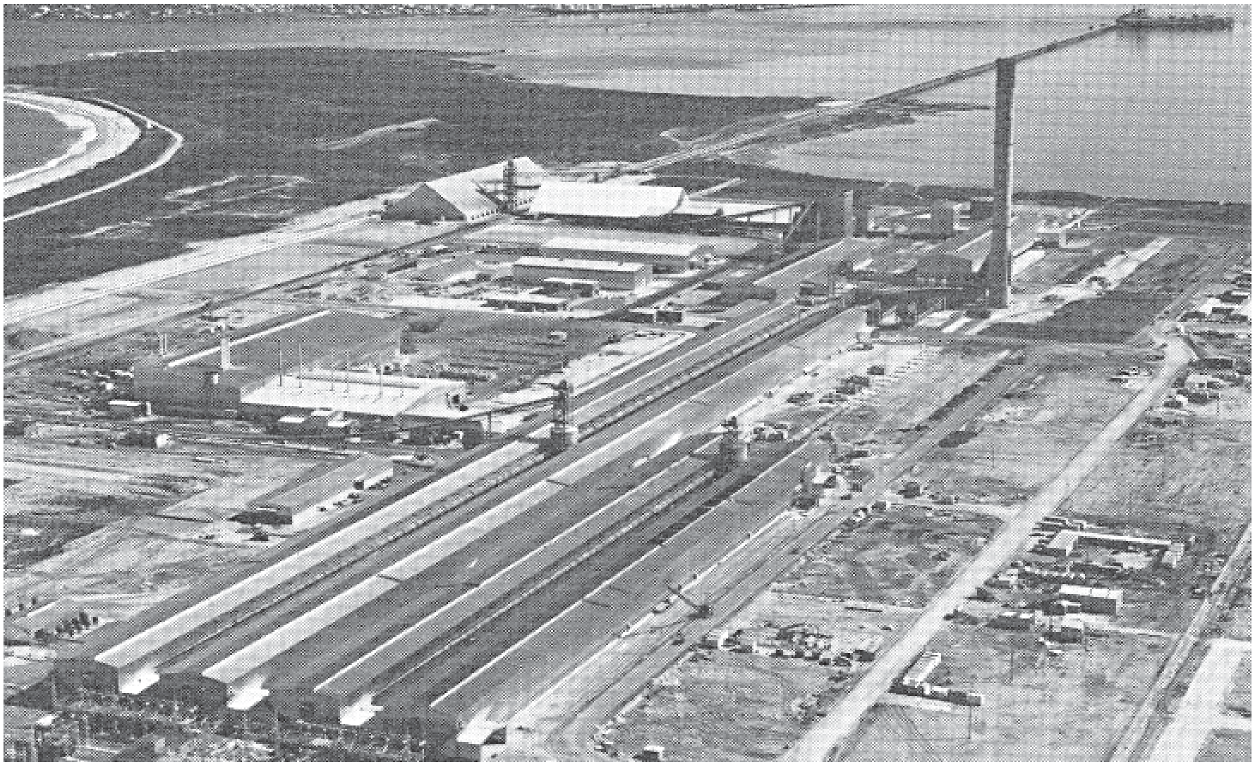
The Ravenswood, West Virginia, aluminum reduction plant, built by the same crew that built Chalmette.

The Volta Aluminum Company (Valco) aluminum reduction plant potlines. Built in 1956 by KE, it utilizes power from the Volta River Dam, also designed and built by KE.
Design of Valco was performed in KE's London office, and KE built Valco with its own forces. It was also engineer for the Government of Ghana in building Akosombo Dam and Powerhouse.

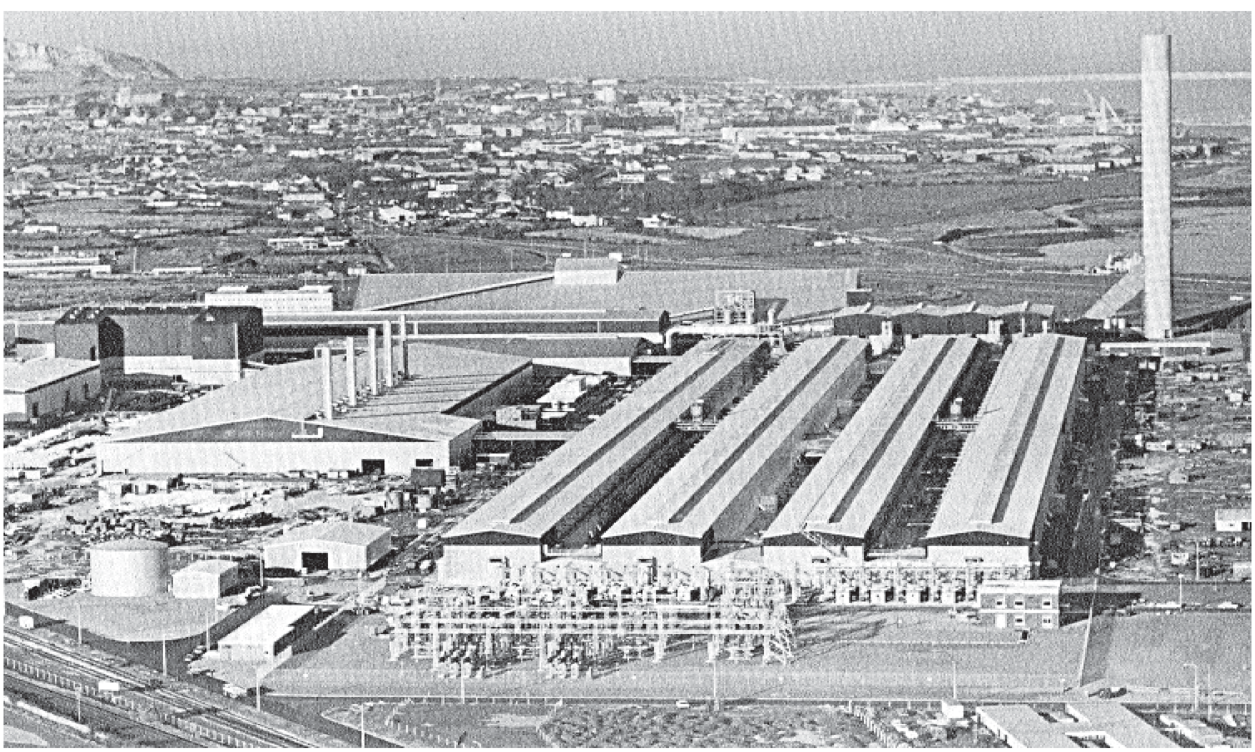


After getting its start designing and building aluminum plants for Kaiser Aluminum, KE's services became available to the aluminum industry in general. Successful aluminum plants were built in the U.S. and around the world totaling 1.3 million tons of capacity. Some of these plants are shown here.
National Southwire Smelter was designed and built in Kentucky in 1968-1970. It is a 180,000-ton-per-year plant.

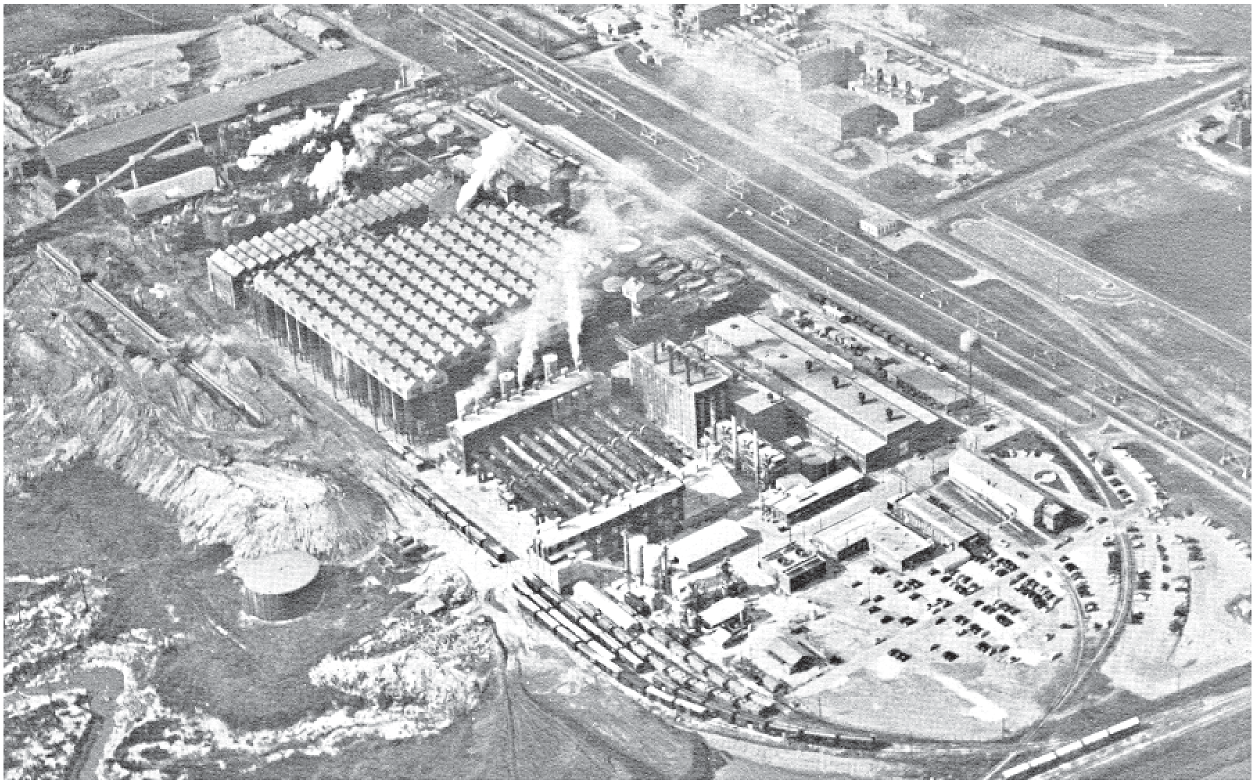
Noranda Aluminum Smelter was designed and built in 1968-1971 in New Madrid, Missouri. View of potline.



Bluff Smelter for New Zealand Aluminum was designed and built by KE in 1969-1972. It is a 125,000-ton-per-year plant.

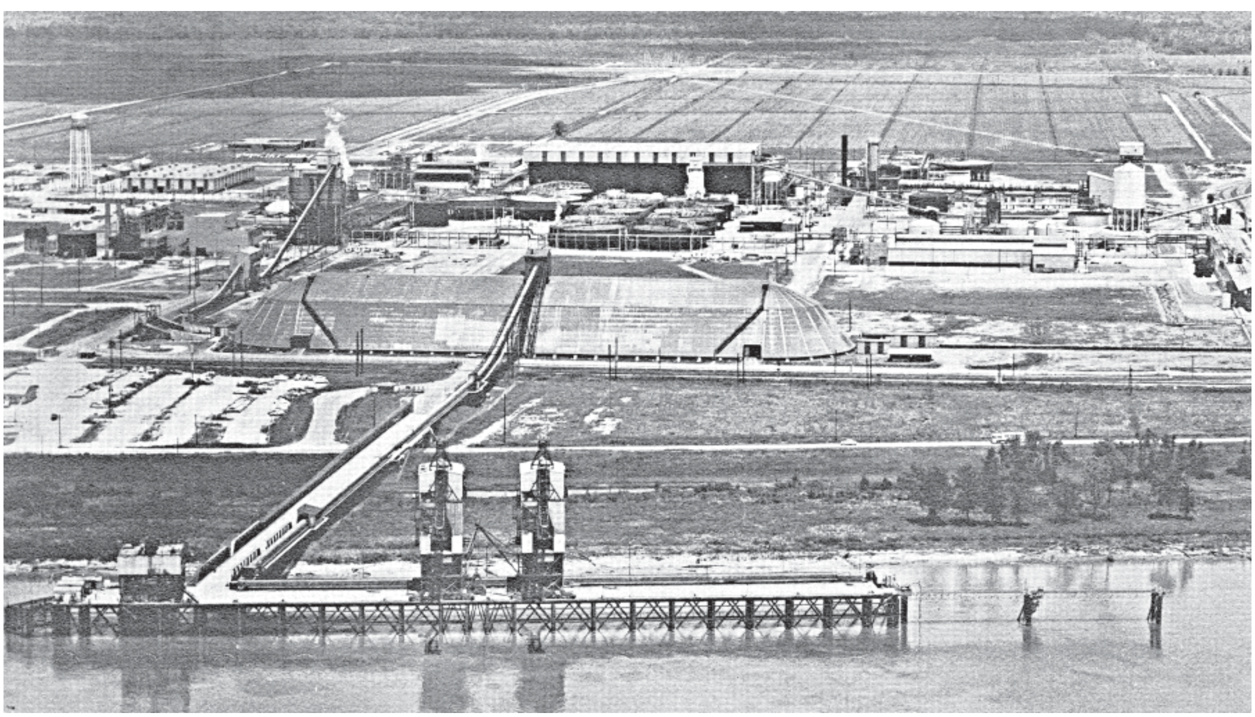


Anglesey Aluminum Smelter built in 1971-1973 is located at Holyhead, North Wales.

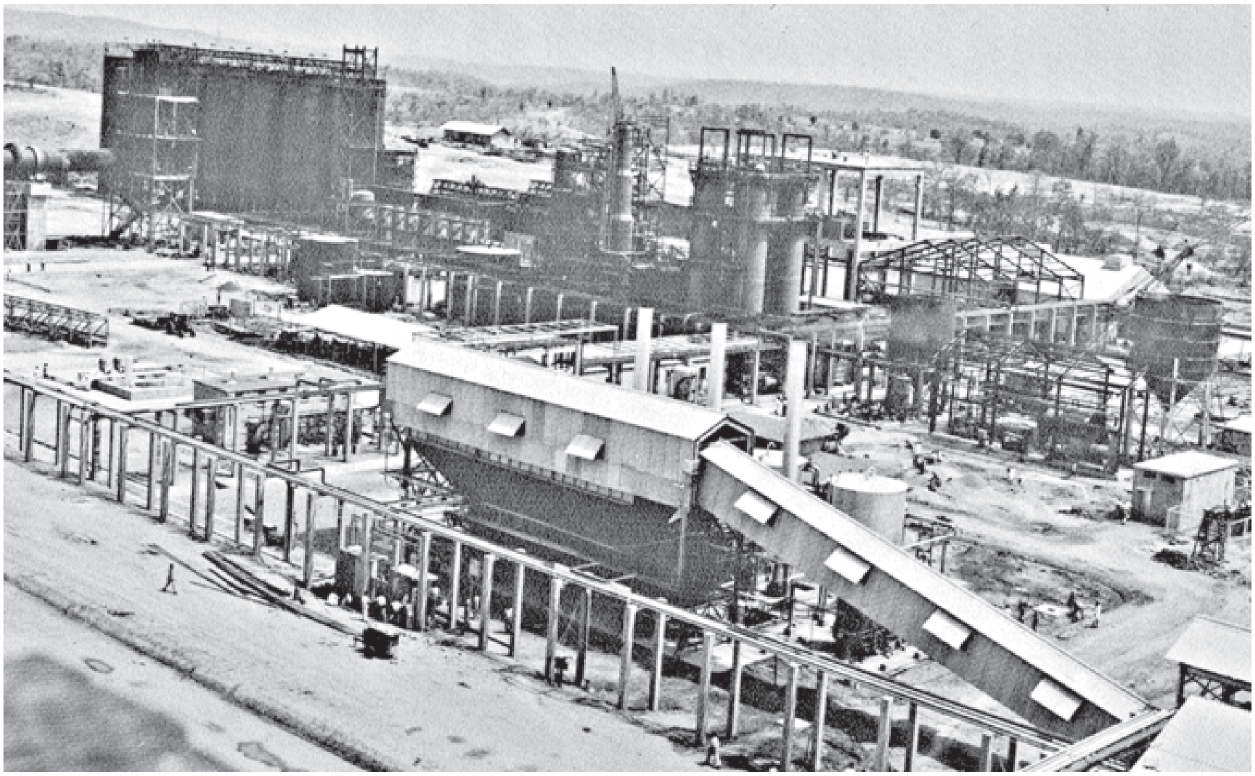


KE maintained a separate group that had expertise in the chemical processing of bauxite to produce alumina, the first step in production of aluminum. KE built a number of such plants, beginning with renovation of Baton Rouge and building Gramercy, Hindalco, Queensland, Worsley, and Alpart in Jamaica.

KE got its start in design of alumina processing plants with the renovation of the Baton Rouge, Louisiana, plant to accommodate Jamaican bauxite as its ore. The plant expansion (above) occurred in 1951.

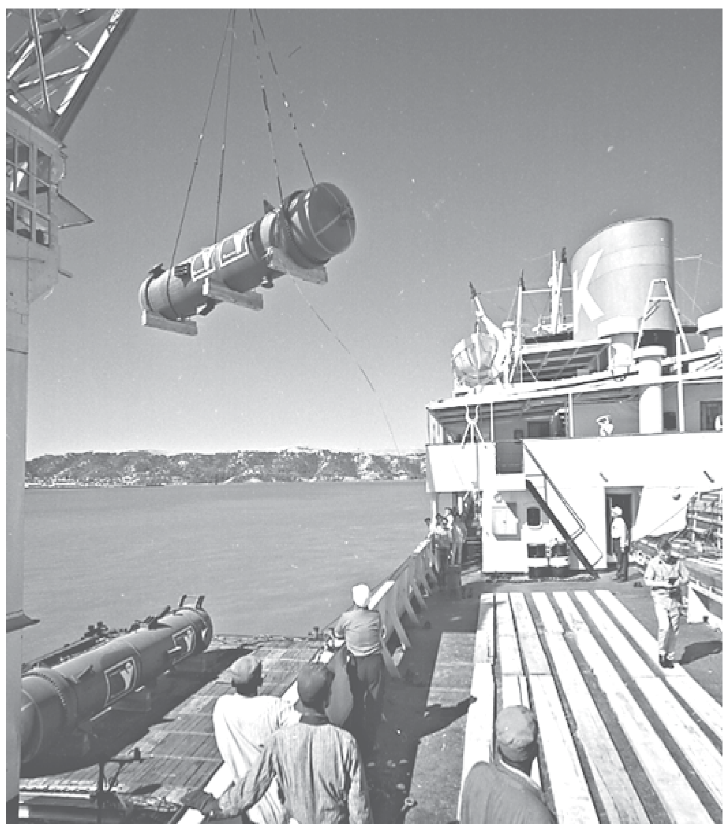


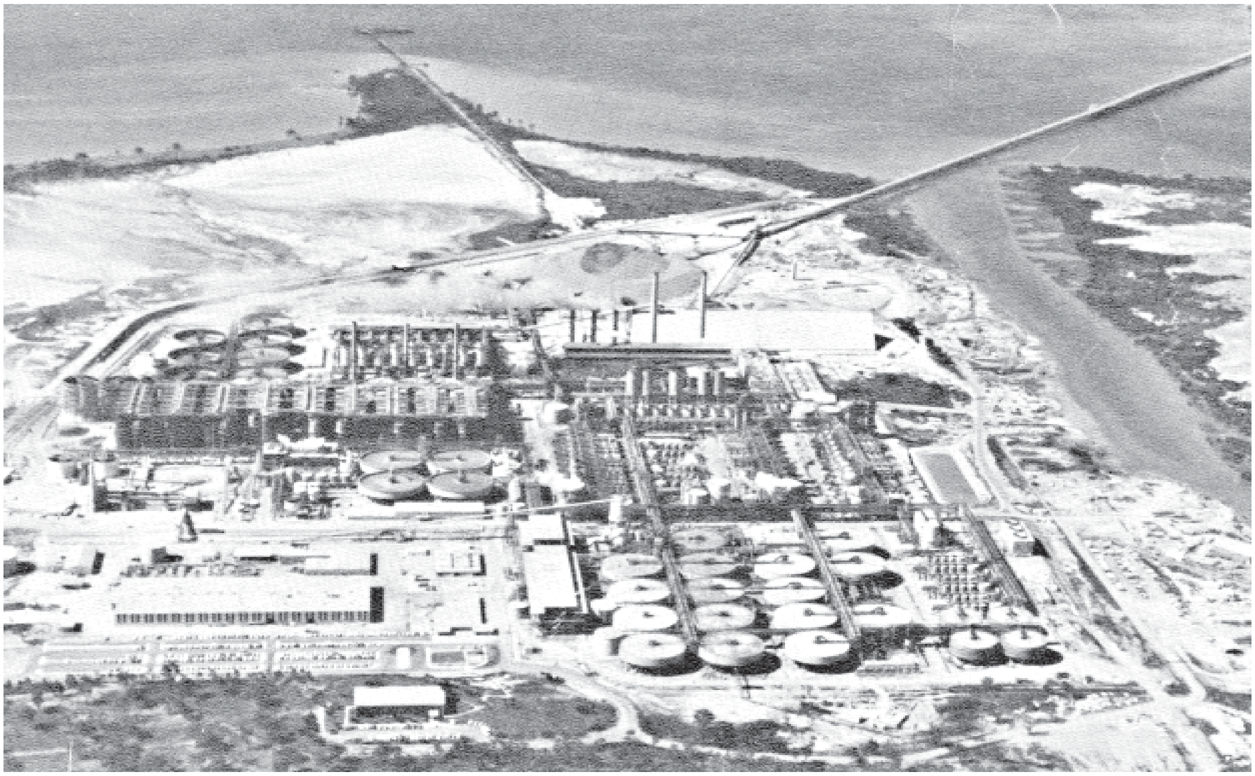
Grammercy, designed and built in 1955, was KE's first completely new and integrated alumina plant.



Hindalco was built in India for the Birla interests. Birla is one of the largest industrialists in the country. This continued the good relations built from the Tata project with KE's know-how in India and its alumina know-how. Hindalco, started in 1959, was built in rapid order to meet market conditions.

This photo (right) shows the replacement for the famous digester lost at sea in a storm being loaded aboard ship at Port of Benicia, California.

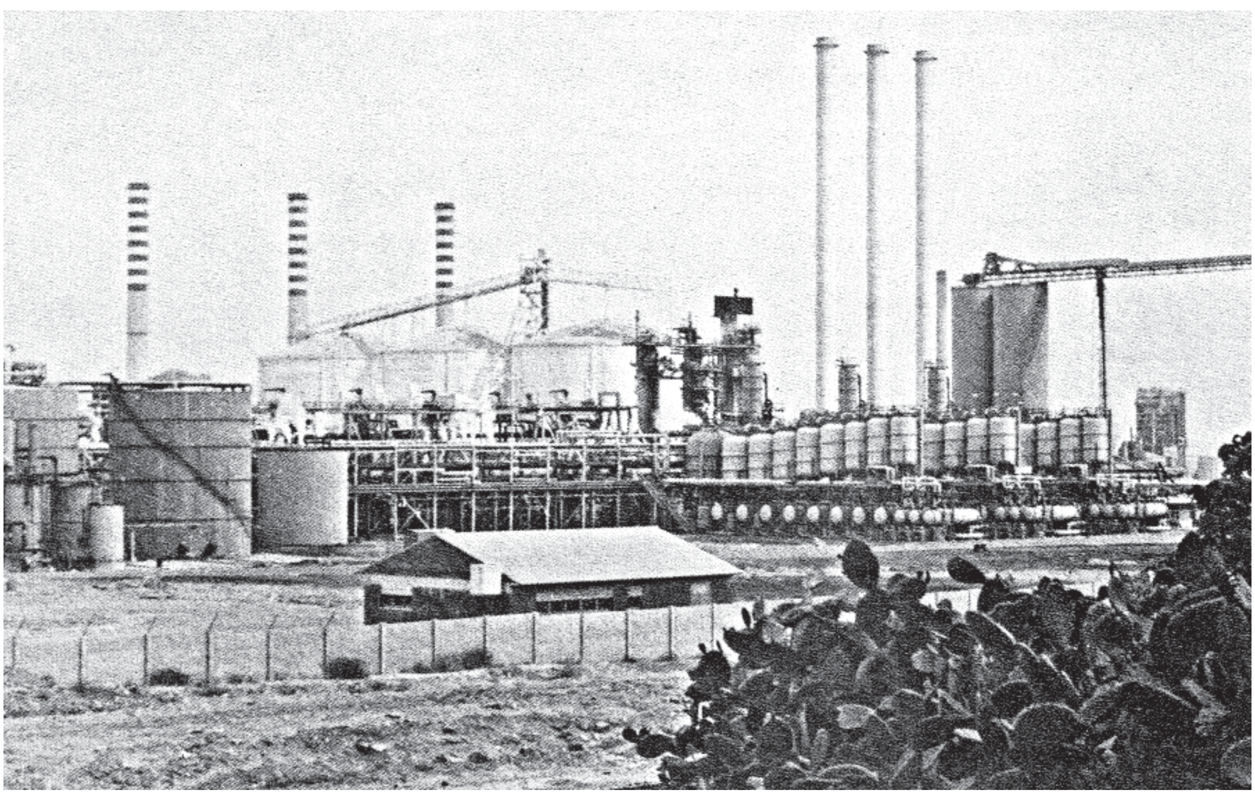




Queensland, Australia, a 600,000-ton-per-year plant was built near Gladstone, Australia, in 1964. Ultimately, the plant was expanded three-fold.

Worsley, located in Western Australia, started in 1979, is the largest alumina plant ever built. By 1990, it was producing 1.8 million tons per year of high-quality alumina. Plant cost was close to $1 billion.

Alumina drying kilns at Queensland Alumina Plant, Gladstone, Queensland, Australia.



Euralumina was designed by KE along with construction management services. The plant had an initial capacity of 600,000 tons with planning to triple production (1969).

Chapter 6

# Cement, Sand, and Aggregate

## Kaiser Engineers Industrial Minerals Division

Arnold Kackman was Vice President and Manager of the Industrial Minerals Division for nearly 20 years. Under his direction, Kaiser Engineers became the dominant engineer-builder of Portland cement manufacturing plants in the Western world. Arnold recalls that when he joined KE in 1966, the company's organization responsible for industrial minerals projects including cement, gypsum, aggregates, lime, diatomaceous earth, and the like was officially known as the Industrial Minerals Department. Portland cement plant projects then accounted for over 95 percent of the department's work and, as a result, it was affectionately known as the "Cement Group." In the late 1970s, the department's name was changed to "the Industrial Minerals Division."

The following pages describe Kaiser Engineers' background of work in the cement, gypsum, and aggregates industries. KE "cut its teeth" in these industries through engineering and construction work for other members of the Kaiser family of companies. Accordingly, for the purpose of establishing historical perspective, these *stories* each include a brief overview history that describe Henry Kaiser's involvement in the cement, gypsum, and aggregates industries which, in fact, became the origins of Kaiser Cement and Gypsum Corporation and Kaiser Sand and Gravel Company.

Table 6.1 is a summary listing of KE's projects in the cement, gypsum, and aggregate industries. The listing is exclusive of more than $60 million representing the construction cost of many individual small projects performed by KE related to these industries.

## Portland Cement Projects

### Overview

In 1914, when the Portland cement industry in the United States was less than 50 years old, Henry Kaiser began a construction business building roads and bridges in the Pacific Northwest. This business continued and expanded until the 1930s when the period of great dam-building ventures began. One of the first of these great dams was Hoover, built by the Six Companies joint venture of which Henry Kaiser was a member. Following this project, the Kaiser Company as joint-venture sponsor also built the Grand Coulee and Bonneville dams on the Columbia River. From the performance of these projects, Mr. Kaiser learned well the major importance of a reliable and economical supply of Portland cement for the construction industry.

He took a giant step into the cement supply industry when he won the contracts to supply the cement and aggregate for construction of Shasta Dam in northern California. The award was made even though he didn't have his own cement manufacturing capability! To meet the cement requirements of the contract, his staff of engineers and construction personnel built a two-kiln cement plant at Permanente, California, beginning production of cement only seven months after groundbreaking. The Permanente Corporation was incorporated in 1939, and the company was known as the Permanente Cement Company. Its name was changed to Kaiser Cement and Gypsum Corporation in 1964. For the sake of brevity, in the pages that follow the company is referred to as "Kaiser Cement Company."

The incorporation of Kaiser Engineers in 1941 as a division of the Henry J. Kaiser Company with personnel including those who had built the original cement plant at Permanente was the beginning of a long corporate history of cement plant design and construction. Kaiser Engineers' leadership and accomplishments in this industry have been both international in scope and at the cutting edge of its technology.

### First Projects

Kaiser Engineers' work in the cement plant industry through 1955 was entirely for Kaiser Cement Company. During this period, the Permanente plant was expanded in stages from a two-kiln facility to a six-kiln facility, distribution facilities were built on the Pacific Coast and in Hawaii, and a new greenfield plant was built at Cushenbury in Southern California near the Kaiser steel mill at Fontana. During the next 30 years, KE performed many additional projects for Kaiser Cement Company (changed to Kaiser Cement and Gypsum Corporation in 1964) and its domestic and international affiliates with total construction costs amounting to $721 million ($2.2 billion in year 2000 dollars).

In 1955, KE obtained its first contract to design and build a cement plant for a non-Kaiser company, a $7.5-million facility at Cape Girardeau, Missouri, for the Marquette Company. This project was followed over the ensuing years with contracts for cement plants for Arkansas Cement Company, Atlantic Cement Company, Mysore Cement Company in India, and a host of others in the United States and other parts of the world. During the 30-year period from 1955, KE performed cement plant projects for non-Kaiser Cement Company clients in 32 countries having a combined construction cost of $1.5 billion ($3.1 billion in 2000 dollars).

## KE and the Portland Cement Industry

The Portland cement manufacturing industry, unlike the steel, aluminum, and gypsum wallboard basic industries, is relatively open and free of proprietary restraints regarding technology and manufacturing methods. Personnel in the industry move frequently from plant to plant and company to company. The industry has two major conventions a year—the IEEE Cement Industry Conference and Rock Products Cement Seminar—attended by industry managers, engineers and plant operators, and by personnel of the equipment manufacturing and supply industries, all mingling freely and conversing openly. Technical papers are presented, problems are discussed and ideas exchanged. Kaiser Engineers personnel participated in these industry conferences, submitting technical papers and making presentations regarding company projects, experience, and problem solving.

## Conflict of Interest an Impediment

As of 1955, because KE's cement plant experience was almost exclusively for Kaiser Cement Company, some industry circles considered Kaiser Engineers to be a captive of the Kaiser family of companies, and therefore, did not have the independence to serve private clients with loyalty and without conflict of interest. Accordingly, until the mid to late 1970s, the Cement Group was limited to work for cement companies other than Kaiser Cement Company that were located east of the Mississippi River. Those companies west of the Mississippi River perceived Kaiser Engineers as a part of their competitor, Kaiser Cement Company. Also, KE was judged to not have process knowledge as good as their competitors.

The conflict-of-interest business impediment was largely dispelled in 1977 by the liquidation of Kaiser Industries Corporation and the sale of KE to Raymond International Corporation. Additionally, this business impediment was further dispelled in 1978 when Kaiser Cement Company awarded the contract to modernize their Permanente plant to LaFarge Engineering Company, a competitor for cement plant engineering work. Shortly after this event, KE captured two projects in California from other cement companies when they realized that KE was not "in Kaiser Cement Company's pocket."

## Cement Plant Design

Conceptual and detail design of the domestic plants was performed by the engineering staff of KE's Oakland office. Construction of these plants was managed by teams comprised of KE's experienced field personnel. For the plants that were built in the Far East (except Hong Kong), conceptual design was performed in KE's Oakland office. Detail design of these plants was accomplished by the suppliers of the major equipment—IHI at Okinawa and Cha Am, Thailand, and by Mitsubishi Heavy Industries in Hiroshima, Japan, for the Indonesian plant. The Japanese design cost was $3 per hour for the Okinawa plant and $3.50 per hour for the Thailand and Indonesian plants. These low rates, combined with IHI's and Mitsubishi's familiarity with locally manufactured equipment, resulted in significant savings in the total cost of these plants. KE put one or more of its engineers in the offices of IHI and Mitsubishi to oversee their work.

## Kaiser Cement's Hawaiian Plant

An interesting event occurred regarding the Hawaiian plant, and its story is worth telling because it is typical of how Henry Kaiser worked. Kaiser Cement Company, without competition, had been supplying the Hawaiian Islands market for many years by bulk carrier from its Permanente, California, production plant. Mr. Kaiser, by 1959, was living in Hawaii. About this time, a new company, American Cement Company, announced that they were going to build a cement plant in Hawaii. When Mr. Kaiser became aware of this, he immediately called a press conference and announced that Kaiser Cement Company had been studying the Hawaiian market and that they would build a plant in Oahu. Immediately after the press conference, he called Kaiser Cement Company's management in Oakland, told them what he had done, and gave the following directive: "I want you to get with KE, develop the cost for the plant, call a special meeting of the Board of Directors for tomorrow morning, and appropriate the money."

Needless to say, KE's Oakland staff worked all day and most of the night until 4:30 a.m. the next morning to develop the estimate of cost to build the plant. The Board of Directors met, and the money for construction of the plant was appropriated as directed. Then in the morning of the next day, all concerned sat down and began to face facts:

- A site for the plant had not been selected
- There was no known source on the island of suitable raw materials—clay and limestone, etc.

These simple facts then started a crash program to find and acquire a suitable site and to locate a source(s) of suitable raw materials for production. Company geologists did find suitable raw materials sources, and a plant site on Oahu was selected. However, acquisition of the plant site hit a snag when negotiations with state and local officials reached an impasse because of disagreements regarding location of the selected site, zoning variances, local ordinances, and related acquisition costs, just to name a few of the stumbling blocks thrown up by the officials in front of Mr. Kaiser. Again, in the solution of this impasse lies another story attesting to the genius and tenacity of Henry Kaiser, and it, too, deserves to be told here.

## Mr. Kaiser Solves a Problem

Mr. Kaiser told the officials he was negotiating with of the now-surplus baby flattop aircraft carriers that had been built in his shipyards during the war. He then said to them, "If you won't let me build my cement plant here on land, then I will have it built on one of these aircraft carriers and will anchor it offshore for production." Then, in the presence of the officials, he instructed an associate to call Oakland with the directive that Kaiser Engineers should immediately commence design of the cement plant on an aircraft carrier. It is not known if Mr. Kaiser really believed that a cement plant on an aircraft carrier was feasible. However, the idea was sufficient to impress the officials that he meant what he said and to realize that the state and local agencies stood to lose considerable tax, sale, and job revenue if, in fact, Mr. Kaiser would go ahead with his plan to put the plant on an aircraft carrier. Accordingly, negotiations for the site were resumed, sticking points were worked out, and Kaiser Cement Company was given approval for site acquisition and development.

The idea of putting a cement plant on an aircraft carrier was immediately recognized by KE personnel to be completely unfeasible and impractical! The single largest piece of equipment in a cement plant is its rotary kiln, 12 to 15 feet in diameter and 400 to 500 feet long, supported by rollers mounted on a number of concrete piers built on a firm foundation to provide precise, non-varying alignment of the kiln itself. An aircraft carrier, or any large vessel, is a live structure, constantly working due to sea state, wave action, and temperature variation. There is no way that an aircraft carrier could provide the stable foundation or platform required to support a rotary kiln!

Upon site approval, design of the plant was initiated, and the final budget estimate for the project was only about $30,000 higher than the "crash estimate" generated in less than 24 hours for the appropriation request.

## 'What's the next problem?'

Another anecdote from the Hawaiian project was related by Ken Olsen after one of his many trips to Hawaii in the early stages of the project. Mr. Kaiser called a meeting to review progress of the work and to discuss any problems that may have developed. Ken told him that the kiln sections would be arriving at the jobsite and that the individual sections weighed nearly 100 tons each. The problem at hand was that they had been unable to locate a crane with the capability to lift the 100-ton kiln sections off the ship. Mr. Kaiser said, "Just a minute," picked up a phone, and called someone (probably H.V. "Lindy" Lindberg) and said, "Do you recall that 200-ton floating crane that Steinberger has? Well, I want you to buy it and get it over here." He then turned to Ken and said, "All right, what's the next problem?"

## **Far Eastern Cement Plants**
### Okinawa

The Far Eastern projects were especially interesting because they presented some unusual problems. The Ryukyu, Okinawa, project was KE's first experience with a pre-heater kiln. The project also required a great amount of long-distance telephone calls between Art Tousley, KE's representative in Tokyo, and Bill Eddy, formerly a KE employee, Kaiser Cement's representative in Okinawa. These calls were made mainly to resolve electrical design questions but, in addition, gave Bill Eddy a shoulder to cry on about the problems of living and working in

Okinawa. On his periodic trips to Okinawa, Art always carried a "care package"—steaks and avocados—two items Bill couldn't get on Okinawa.

## Thailand

The equipment supply contract for the Jalaprathan, Thailand, cement plant project was awarded to IHI following spirited bidding and negotiations with U.S., German, and Japanese firms. Paul O'Connor was KE's representative in Tokyo and responsible for coordination and review of the detail design work being performed by IHI. He was supported by structural, electrical, and mechanical engineers on loan from KE's Oakland office. The most serious occurrence during the project took place at the Jalaphrathan construction site. The first activity by the client had been to build a "Spirit House," a Thai custom, to provide a place for the spirit of the land to reside in during construction of the plant. It was small, like a dollhouse, about 2 feet by 3 feet in size. The client's manager at the site was Mr. Manat, a very capable but autocratic Thai. One day, two big black sedans drove onto the site; two men got out and "bang-bang" shot Mr. Manat. It is suspected that Mr. Manat had not been making the right pay-offs to the right people. The client immediately built a much larger "Spirit House."

## Indonesia

By the time work on the Cibinong, Indonesia, plant commenced, Ian Watson, a KE project manager, had moved to Kaiser Cement Company, becoming chief engineer. Ian had KE prepare very detailed conceptual plans and specifications for the plant, which were then used for competitive bidding for the detail design and equipment supply contract. Mitsubishi Heavy Industries was awarded the contract. The design work was performed in Mitsubishi's Hiroshima offices, and KE assigned Lee Gregory as project manager in Hiroshima to oversee Mitsubishi's work. He was assisted by Fred Hoffinger, mechanical engineer, and Dale Richardson, electrical engineer.

Construction of the Cibinong plant was performed under a unit-price contract awarded to Morrison Knudson Company (MK) by Kaiser Cement Company. MK staffed the construction job with personnel coming from the company's cost-plus-fee projects in Vietnam. These people knew very little about cement plant construction with the result that some significant construction scheduling and quality problems began to occur. These problems were alleviated when KE's Hal Meyer was assigned to the project as construction manager to oversee MK's work and to guide them in steel erection and equipment setting.

Construction of the Cibinong plant ran into another problem which wasn't as easily solved as the quality and scheduling situations. The plant site was underlain by limestone which, in the wet Indonesian climate, had partially dissolved, leaving large underground caverns. By the time these caverns were discovered in exploratory drilling, it was too late to relocate the plant to a better location. Ed Becker, KE's geotechnical engineer, and the project and engineering personnel spent many agonizing hours devising solutions to the foundation problems of the site. The smaller caverns were opened and filled. One of the largest and deepest caverns was found to be under the location of the pre-heater tower—the tallest and heaviest structure in the plant. To provide an adequate foundation for this structure, it was necessary to bridge this cavern with concrete beams up to 4 meters wide, 6 meters deep, and 20 meters long.

## Cement Plant Projects for Other Companies

Kaiser Engineers' first cement plant work for an outside company started in 1955 with a contract with Marquette Cement Company for an addition to their plant at Cape Girardeau, Missouri. Next, in 1957, came a new green-field plant for Arkansas Cement Company at Foreman, Arkansas, followed by plants for Mysore Cement in India in 1958; Atlantic Cement Company, New York, in 1963; plant expansions for Arkansas Cement Company in 1964; and Atlantic Cement Company in 1966.

In the late '60s and throughout the '70s, KE's cement plant work for other companies far outweighed the work performed for Kaiser Cement Company. Much of this work involved the new precalciner technology which made for larger plants distributing product to a wider area. Imports from Mexico, Canada, and the Far East cut into domestic cement production. Consequently, construction of new plants and plant expansions in the U.S. after 1980 became few and far between. United States' environmental restrictions, compared to the lack of same in Mexico and the Far East, further contributed to the non-competitive position of the U.S. cement industry.

Kaiser Engineers tried different business development approaches to obtain additional international cement plant work. Joint-venture arrangements with equipment suppliers such as Fuller Company and Combustion Engineering were tried. However, competitors from Germany, Austria, and other countries were able to offer more attractive incentives to capture new business than KE. As a result, the international work KE was able to obtain after the early '80s consisted mainly of studies, owners-representative assignments, or similar non-substantial work.

A contract to build a new green-field cement plant at Pylos, Greece, started out well but shortly became a disappointment. The wealthy ship owner, Michail Karageorges from the Peleponeses, wanted to put some industry in Greece in the area in which he was born to provide some economic benefits. We became involved with the project as the result of some personal friendships between Earl Peacock and other KE people and some of Karageorges' people. The early work on the project progressed well with geological investigations performed by Mike Morgan and Arthur Twiggs of KE's London office. Site, utilities, and other investigations were performed by Les Franz, also of the London office. General arrangement drawings were well underway when the Greek Department of Archeology stepped in and stopped the work. They had identified two ancient aqueducts spanning two ravines near the quarry site. They were concerned that quarry operations would cause damage to the aqueducts. The project was cancelled.

## Kaiser Engineers Cement Project Personnel

KE's remarkable success and achievements in the Portland cement industry can be attributed in large part to the experience and capability of its personnel, the continuity of their assignments within the company division responsible for cement plant work, and their familiarity with the cement industry and its key personnel. Over the years, KE's "cement people" were a very stable group, going from one cement plant project to another. They knew the companies working in the industry, including their managers and plant operators, on a first-name basis. They knew the equipment suppliers and their personnel, also on a first-name basis. They were thoroughly familiar with the cement-making process and its state-of-the-art technologies.

It is appropriate to name a few of the many KE personnel working in the company's cement project work who, working together job after job, accomplished KE's remarkable 35-year span of outstanding and highly profitable work in the Portland cement industry.

Project management staff personnel included Ed Baldinelli, Al Barzoloski, Earl Berthold, Dick Brown, Charles Bush, Ralph Capriolla, Stan Chao, Fred Charyn, Geoff Dodson, Les Franz, Hoke Garrett, Herb Gaskin, John Gilcrest, Jim Gneckow, Lee Gregory, Arnold Kackman, Ray Krekel, John Loague, Tom McCranie, Alden McElrath, Jack Morgan, Paul O'Connor, Ken Olsen, Dick Pitney, Giff Randall, Tom Smith, Art Tousley, and Ian Watson.

Estimators included Bud Hosch, Ed Lowell, and Faye Vincent.

Engineering Division personnel included Carmen Abate, Dick Brennan, John Carroll, Jim Fontanilla, M. Handa, Al Hazbun, Les Henry, Bill Hopper, Tim Lee, Tony Low, Jim Murray, John On, Bill Pearson, Sundar Rajan, Chris Rayner, Joe Runyon, Wendell VanVleck, and "Wink" Winkler.

Key construction personnel who handled many of the projects included Ewe Clausen, Clyde Gray, Hal Meyer, Bob Miller, Vaughn Scott, Foster Scisson, Don Smith, Bill Stevens, and John Taluc.

## Gypsum Wallboard Projects

### Overview

Henry Kaiser's entry into the gypsum products market was consistant with his interests in the basic building materials industries. The postwar boom in housing construction presented a major demand for gypsum wallboard for construction of interior walls, and Mr. Kaiser saw an opportunity for profitable participation in this market.

The Standard Gypsum Company of California was formed in 1944 by the the Henry J. Kaiser Company and the Standard Gypsum Company, Inc. Its plant assets at that time consisted of a plaster mill at Long Beach, California, and a high-grade gypsum quarry on San Marcos Island in the Gulf of California. The quarry was operated through a subsidiary company, Compania Occidental Mexicana. The Long Beach plant was expanded in 1945 to include facilities to manufacture gypsum wallboard and related wallboard products.

In 1948, the Henry J. Kaiser Company purchased all of the assets of the Standard Gypsum Company of California including those of Standard Gypsum Company, Inc. Operation continued as a division of the Henry J. Kaiser Company. The Redwood City, California, gypsum wallboard plant was purchased in 1949. In 1951, the gypsum division became a wholly-owned subsidiary of the Permanente Corporation which, in 1964, was renamed the Kaiser Cement and Gypsum Corporation. For the sake of brevity, the gypsum part of the corporation is referred to below as "Kaiser Gypsum."

Gypsum Carrier, Inc. was organized in 1950 as a wholly-owned subsidiary to operate bulk gypsum ore carriers from San Marcos Island to the company's wallboard plants. The *S.S. Harry Lundberg* was put in service in 1950 but was lost at sea in a storm off the coast of Lower California in 1954. It was replaced in 1956 by a 10,700-ton bulk carrier which was renamed the *S.S. Harry Lundberg.* It was replaced in 1957 by a new carrier, the *S.S. Kaiser Gypsum.* Subsequently, it was rechristened the *S.S. Harry Lundberg,* and its predecessor renamed the *S.S. Ocean Carrier.*

## KE's Gypsum Plant Projects

Kaiser Engineers' work in the gypsum industry was almost exclusively for Kaiser Gypsum and its predecessor corporate entities. During the period 1953 through 1965, KE nearly always had at least one Kaiser Gypsum wallboard plant project in progress. These projects included a major expansion of the Long Beach plant in 1956, design and construction of new green-field plants in Seattle, Washington (1954); Antioch, California (1956); Rosario, New Mexico, (1959); Jacksonville, Florida (1963); and Delanco, New Jersey, (1965). Also performed was a major expansion in 1956 of the San Marcos Island gypsum quarry and its bulk carrier gypsum loadout facilities.

The Redwood City wallboard plant has an interesting story in its history. It was the principal wallboard manufacturing facility in the San Francisco Bay Area until early 1955 when it was destroyed by fire. At this time, KE was designing and commencing construction of the new Antioch wallboard plant. After the fire, Kaiser Gypsum's initial intentions were to undertake an all-out effort to rebuild the Redwood City plant at Redwood City to expedite getting it back into production. However, this plan changed quickly, and the decision was made to relocate and rebuild the Redwood City plant in Antioch alongside the new Antioch plant, construction of which was then underway. This was accomplished on an accelerated schedule, and the "little" (Redwood City) plant was back in production in a few months. However, this was not the end of the story! When Kaiser Gypsum decided to establish wallboard production in New Mexico, they did so by relocating the original Redwood City plant equipment from Antioch to Rosario, New Mexico.

An interesting part of KE's work for the Long Beach plant involved remedial design and construction to prevent flooding of the plant during abnormally high tides. At such times seawater tide levels could rise to an elevation several inches above the floor level of the main plant. The plant was located on the shoreline of Long Beach Harbor, in an area that was experiencing extensive land subsidence due to extraction of oil from shallow oil bearing sands by oil wells in the Long Beach area.

## KE's Gypsum Plant Work for Other Companies

KE's work for Kaiser Gypsum Company after 1965 was concerned mainly with relatively small modernization and expansion projects. Unlike manufacturers in the Portland cement industry, producers in the gypsum wallboard and related building products industries were highly secretive concerning their operations. Equipment suppliers told KE personnel on numerous occasions that when they were asked to come to a plant because of a problem with their equipment, they would be led directly to their equipment, told to do what they had to do, and then, when finished, would be led directly to the plant gate. Because of the proprietary nature of this industry and KE's extensive working relationship with Kaiser Gypsum Company, it was 1986 before KE was able to obtain a significant gypsum industry project from an "outside" company client.

Kaiser Engineers' one significant *outside* gypsum plant project (1986) involved a lump-sum contract to design a new wallboard plant in Newark, New Jersey. KE's contract for this project was with Flackt, a Swedish equipment supplier without prior experience working in the U.S. Flackt had a lump-sum contract with the owner, Atlantic Gypsum Company, a New Jersey building materials supplier with no prior experience in running a production facility. In the early stages of the project, KE was directed several times by Flackt to curtail, but not stop, work while the owner solved his own problems.

KE decided to perform design of the Newark project in the company's Pittsburgh, Pennsylvania, office, which needed the work and was thought to have lower average salary costs than the company's Oakland office. Additionally, the Pittsburgh office planned to use some "job shoppers" for some of the work, also thought to have lower overall salary costs; unfortunately, this did not happen to any significant degree. As a result, both design labor man hours and direct labor cost far exceeded their budgets, and the project was not a profitable or satisfactory undertaking.

## KE's Gypsum Project Personnel

KE's gypsum project work was accomplished within KE's mineral industries division, also responsible for KE's Portland cement plant work. The design work for these two industries had much in common, and placing responsibility for their work in the same division resulted in both efficiency in personnel utilization and quality of work. Some of those involved in KE's gypsum work over the years included:

**Engineering and Design**
Harry Bernat
Earl Berthold
Dick Brennan
Dave Carlson
Hoke Garrett
Lin Gee
Jim Gneckow
Walt Hanson
Don Montez
Ken Olsen
Ray O'Niell
Art Tousley
Ian Watson
Lynn Wiele

**Geology**
Dan Frost
Alden McElrath

**Construction**
Don Cardarelle
Rufus Chatham
Hal Meyer
Vaughn Scott

# Sand and Gravel Projects

## Aggregate for Shasta Dam

A bit of history concerning Henry Kaiser and sand and gravel is taken from Albert Heiner's book, *Western Colossus:* "Lost in the glamour of Kaiser's conquest for Shasta Dam's cement was the fact that he also made the winning bid in 1939 to supply the concrete aggregate for the dam." It involved 12 million tons of aggregate, and his bid was $4.4 million. His source of supply was a gravel deposit along the Sacramento River that he had located and purchased 20 years earlier when working on a road job in the same area.

The gravel deposit was 1 1/2 miles from a line of the Southern Pacific Railroad. Southern Pacific would not build a spur line to the gravel deposit; instead, they insisted that Mr. Kaiser build a 2-mile belt conveyor to bring the aggregate to the railroad. Then, unable to negotiate an acceptable haulage rate with Southern Pacific, Mr. Kaiser made the decision to build a belt conveyor system from the aggregate deposit all the way to the dam site, a distance of 9.6 miles. It would be the longest belt conveyor system in the world at that time, having 26 transfer points, requiring two crossings of the Sacramento River, 6 crossings over roads, and a crossing over the main line of the Southern Pacific Railroad. The entire system was built in 6 months, including nearly two months' time necessary to repair severe winter storm damage that occurred during its construction.

During the five years of its operation, the conveyor system transported over 12 million tons of aggregate to the dam site at a cost of 18 cents per ton as compared with the railroad's offer of 27 cents. It proved reliable from the time it started until the dam was completed.

Upon completion of Shasta Dam, the conveyor was dismantled, and its belting, idlers, pulleys, and drives put on the market for sale. Within two years, practically all of this equipment and the original 120,000 feet of belting had been sold to other project undertakings in the U.S. and at other locations in the world.

## Original Radum Aggregate Plant

The original Radum aggregate plant was built by Henry Kaiser in 1931. Over the next 35 years, it was in continuous production of aggregate products primarily for the San Francisco Bay Area. During this time, the plant was modified many times to meet changing product and capacity demands with the result that it became a complicated maze of old conveyors, screens, crushers, trommels, classifiers, bins, and other process equipment.

Alden McElrath remembers an interesting tale concerning Kaiser Engineers and this old plant. In the early days of Kaiser Engineers, a young and budding engineer's first assignment was to be sent to the Radum plant to prepare a flow sheet of the facility. The plant had become so complicated due to the myriads of changes that it was almost an impossible task to make a flow sheet. It is not known how much time was allowed the young engineer for this task, but it resulted in many hours of frustration and worry. Alden believes Lou Oppenheim was one of those unlucky lads!

By the 1960s, maintenance and operating expenses of the old plant had become very high. Another area of concern was the plant's load-out capacity. Changes were necessary to provide fast loading and ticketing to avoid the long lines of waiting trucks.

## New Radum Plant

In 1965, Kaiser Sand and Gravel Company retained Kaiser Engineers to design and construct its new aggregate plant at Radum, California. Kaiser

Sand and Gravel, working with KE, developed the conceptual design of the plant, and its final design was accomplished in KE's Oakland office.

The plant was designed to produce a 3,000-ton per hour net load rate from the quarry into the processing plant and a 4,500-ton per hour load-out capacity. The plant was designed also to permit increasing the load-out capacity to 6,000 tons per hour to accommodate future market demand.

The sand and gravel are mined from a pit adjacent to the plant area and conveyed to the plant by belt conveyor. The plant is divided into four basic areas:

- Washing and sizing
- Sand production and sizing
- Storage and surge
- Load-out facilities

The washing and sizing, sand classification, and storage and surge facilities are not unique to the industry except that the washing, screening, and initial surge storage were designed as one vertical structure with the rotating trommels on top, discharging to screens below which, in turn, discharge into lower bins. The confined space design was necessary because it was required that the old plant remain in operation during construction of the new plant facilities.

The most unique facet of the design of the Radum plant is the truck batch load-out system and the first use of computer control in an aggregate plant. The plant has two control points, the plant control panel located on top of the main process plant structure and the dispatch office located in the load-out area. A digital computer is utilized to make and implement the myriad logic decisions required for blending materials, filling load-out bins, and truck load-out operations.

With an annual one-shift production capacity of 4 million tons, and 7.6 million tons with two shifts working, the new Radum plant was the largest and most highly automated plant in the industry. It also represented the first use in the industry of a computer for process control.

Construction started in 1965 and was completed in 1966. The total cost of the new plant was $11,621,000. Some of the Kaiser Engineers personnel involved in the project were Arnold Kackman, Ray Krekel, and Alden McElrath.

## Sunol Lightweight Aggregate Plant

Lightweight aggregate is used in the production of lightweight concrete and blocks. In the late 1950s and early 1960s, the demand for lightweight concrete was intense. Kaiser Sand and Gravel did not produce lightweight aggregate, and it was necessary to purchase it from a firm producing it in a plant near Napa, California. It was economically desirable that they produce their own lightweight aggregate. The aggregate is produced by bloating at high temperature shale material of specific physical and chemical properties. Such a material was located near Sunol, California. After a series of laboratory tests performed by Fuller Company in 1964, it was determined the shale deposit was suitable for the manufacture of lightweight aggregate and sand. All of this preliminary testing was managed by Kaiser Sand and Gravel.

In 1965, Kaiser Sand and Gravel retained Kaiser Engineers to perform preliminary engineering studies. Detail engineering and procurement commenced in May, 1965. Construction commenced in October, 1965, and was completed in October, 1966. The plant was designed to have a capacity of 28 tph of lightweight sand or 21 tph of lightweight pellets on a 24 hr/day production schedule. An unusually compact plant facility was designed with the capability of future expansion.

Manufacture of lightweight aggregate is a straightforward process in which shale of specific properties is crushed and sized to minus 1/2 inch, dried, heated in a rotary kiln to approximately 2100° F, cooled, stockpiled, and shipped. Although it is a relatively simple process, the temperature range at which bloating occurs is very narrow, and the kiln temperature control is critical. If the temperature is too low, the shale will not bloat. If the temperature is too high, the material becomes sticky and forms "logs" which force shutdown of the kiln. This critical operational problem was foremost in the design of the kiln system.

There were several unique features in the plant design. The 11-foot diameter by 170-foot long kiln was equipped with 10 planetary coolers. An 11-foot diameter by 36-foot long rotary dryer was located upstream from the kiln, utilizing waste heat from the kiln. Off-gasses from the kiln and dryer were directed to a glass bag dust collector, the first of its type to be used in the industry. In lieu of kiln feed consisting of crushed shale and in order to utilize kiln dust, all raw material was crushed to minus 1/8 inch and along with the kiln dust, was fed to an extruder producing *pellets* which were fed to the kiln, producing a very uniform bloated product. Controls and instrumentation were more advanced than previous installations. The plant control center was located adjacent to the firing floor and contained automatic recording equipment, closed-circuit television monitoring, kiln control, extruder controls, feed controls, stockpiling controls, and all other instrumentation required for one-man operation of the process. The total cost of the project was $4,105,300.

Some of the Kaiser Engineers' personnel involved in the project included Ken Olsen, Arnold Kackman, Alden McElrath, project manager, Earl Berthold, Bernth Johansson, design, and John Loague, instrumentation. Project manager for the owner was Jack Heck.

## Gifford-Hill Crushed Stone Plant

Gifford-Hill & Company, Inc. was a large building materials company with headquarters located in Dallas, Texas. It produced cement, crushed and natural concrete aggregate, and a host of other construction materials. It was one of the largest aggregate producers in Texas. The planned construction of the huge Dallas-Fort Worth International Airport in the early 1970s offered Gifford-Hill the opportunity to furnish the required cement and aggregate. The existing Gifford-Hill crushed aggregate plant located at Bridgeport, Texas, approximately 50 miles northwest of Dallas, was not large enough to furnish the high daily demand for aggregate at the new airport complex. Reserves of limestone were sufficient, but the crushing, storing, blending, and load-out were not. A new plant was required to meet the demand.

In May, 1970, Gifford-Hill retained Kaiser Engineers to initiate an engineering study covering water supply and treatment, crushing and storage of sized material relative to potential market demands, blending methods, use of existing equipment, load-out requirements, and control systems. This study was completed in November, 1970. In January, 1971, Kaiser Engineers was notified to proceed with the design, procurement, and construction of the new facility. The new plant was designed to have a capacity of 3.2 million tons per year of crushed limestone. No sand was to be produced except that which was washed from the crushed product.

In some respects, the Gifford-Hill plant resembled the Kaiser Sand and Gravel plant at Radum, California, except that the Radum plant processed natural aggregate whereas the Bridgeport plant processed crushed stone.

A major concern of the operation at Bridgeport was the existence of hard clay seams, interbedded with the limestone, which had to be eliminated by scrubbing in order to produce a specification aggregate.

The existing quarry equipment was of sufficient capacity to furnish primarily crushed material to the plant and, therefore, was not changed. Material received from the quarry was passed through two 8-foot diameter by 46-foot long scrubbers to eliminate the clay fraction. After passing through a series of screens, the material was stockpiled by size over a 10-foot diameter by 800-foot long reclaim tunnel. The stockpiles consisted of 210,000 tons of sized aggregate. Aggregate was reclaimed into storage bins from which it was blended and conveyed to the load-out bins and weigh hoppers. The entire plant operation, including load-out, was controlled from a central control room located adjacent to the load-out facility. The truck load-out rate was 3,000 tph or the equivalent of approximately 120 trucks per hour. Closed-circuit television monitors were placed throughout the plant, and plant operation, blending, load-out, and ticketing were controlled by computer.

There were several outstanding features of the plant. The only way the high load-out rate could be accomplished was with the use of weigh-hoppers. Truck operators never needed to leave their vehicles; tickets were sent by pneumatic tube directly to the driver's truck window.

The scrubbers each required 3,000 gallons per minute of water. This large quantity of water plus that used in the wet screens and load-out washing required a high-capacity water source, which was not available in plant wells. A 9-mile pipeline was constructed from Bridgeport Lake to the plant to furnish the water requirements. A large settling pond was constructed in an area of the mined-out quarry to store water, which was recirculated in the plant.

Construction was completed on schedule in March, 1972, in time to begin shipment of crushed aggregate to the new Dallas-Fort Worth Airport project. The total cost of the project was $92 million.

The project was accomplished by a team consisting of Alden McElrath, project manager; Earl Berthold, Jorge Brown, design engineering; Whitey Walker, mechanical design engineer; and Dave LeCount, purchasing.

The field forces were headed by Hal Meyer, resident manager. Gifford-Hill's project manager was W. T. Rush.

**Table 6.1**
**Summary Listing of Cement, Gypsum, and Aggregate Projects**

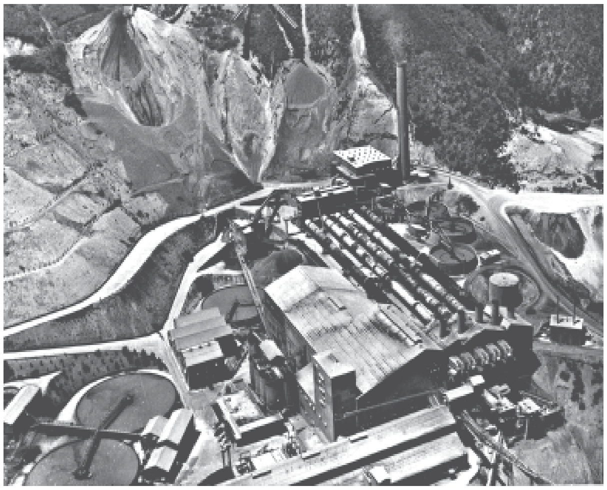
*Architect/Engineer Construction Projects:*

| Job No. | Project Name | Client | Location | Project Value $ x millions |
|---|---|---|---|---|
| 5033 | Fifth Kiln | Kaiser Cement | Permanente | 4 |
| 5340 | Wallboard Expansion Plant | Kaiser Gypsum | Seattle | 3 |
| 5503 | Wallboard Expansion Plant | Kaiser Gypsum | Long Beach | 3 |
| 5505 | Refractory Brick Plant | Kaiser Aluminum | Ohio | 5 |
| 5518 | Wallboard Plant | Kaiser Gypsum | Antioch | 6 |
| 5529 | Sixth Kiln | Kaiser Cement | Permanente | 4 |
| 5530 | Cement Plant | Kaiser Cement | Cushenburry | 13 |
| 5559 | Cement Plant Additions | Marquette Cement | Missouri | 8 |
| 5706 | Foreman Cement Plant | Arkansas Cement | Arkansas | 11 |
| 5919 | Cement Plant | Kaiser Cement | Hawaii | 11 |
| 5920 | Wallboard Plant Relocation | Kaiser Gypsum | New Mexico | 2 |
| 6012 | Wallboard Plant | Kaiser Gypsum | Florida | 6 |
| 6119 | Cement Plant | Kaiser Cement | Montana | 10 |
| 6121 | 3rd Kiln Expansion | Kaiser Cement | Cushenburry | 9 |
| 6416 | Wallboard Plant | Kaiser Gypsum | New Jersey | 7 |
| 6441 | Cement Plant Expansion | Arkansas Cement | Arkansas | 13 |
| 6558 | Radum Aggregates | Kaiser Sand & Gravel | California | 12 |
| 6908 | Cement Plant Expansion | Gifford-Hill | Texas | 6 |
| 7034 | Crushed Aggregates | Gifford-Hill | Texas | 9 |
| 7145 | Calcining Plant | Kaiser Cement | Long Beach | 3 |
| 7366 | Kiln Replacement | Huron Cement | Michigan | 23 |
| 79719 | Mojave Cement Electrical | Calif. Portland Cement | Mojave | 15 |

*Architect/Engineer Construction Management Projects:*

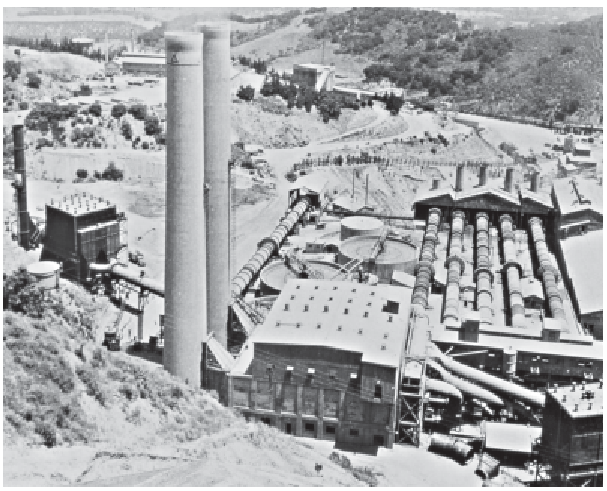
| Job No. | Project Name | Client | Location | Project Value $ x millions |
|---|---|---|---|---|
| 7201 | Cement Plant | P.T. Semen Cibinong | Indonesia | 42 |
| 7228 | Cement Plant Modernization | Medusa Cement Co. | Georgia | 12 |
| 7318 | Cement Plant Expansion | Whitehall Cement | Pennsylvania | 11 |
| 7362 | Long Horn Cement Expansion | Kaiser Cement | Texas | 11 |
| 74244 | Cement Plant | P.T. Semen Cibinong | Indonesia | 71 |
| 75054 | Cement Plant | Messinia Cement | Greece | 94 |
| 76077 | Cement Plant Modernization | Coplay Cement | Pennsylvania | 52 |
| 77127 | Marquette Cement Plant | Marquette Cement Co. | Missouri | 95 |
| 77118 | Medusa Cement Plant | Medusa Cement Co. | Michigan | 57 |
| 77174 | Cement Plant Expansion | OKC Corp. | Oklahoma | 23 |
| 78040 | Mojave Cement Plant | Calif. Portland Cement | California | 110 |
| 78108 | Calaveras Cement Expansion | Genstar Corp. | Redding | 40 |
| 78114 | Finishing Mills | Calif. Portland Cement | California | 6 |
| 78125 | Cement Plant | Martin Marietta | Iowa | 5 |
| 79068 | Rashadiya Cement | Kingdom of Jordan | Jordan | 185 |
| 80014 | Cement Plant Conversion | Lone Star | Florida | 11 |
| 80060 | Cushenburry Cement Plant | Kaiser Cement | California | 131 |
| 80070 | Hong Kong Cement | China Cement | Hong Kong | 350 |
| 81191 | Conversion to Coal | Puerto Rico Cement | Puerto Rico | 14 |

*Note:*
The first four digits of the job number represent year the project was started.

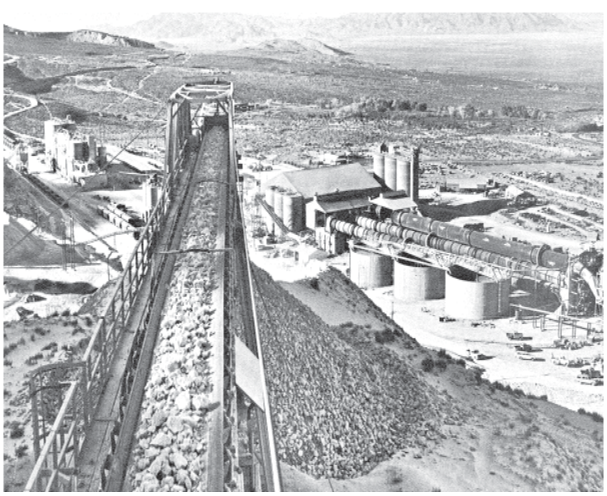


The Permanente Cement Plant. The original plant was built in 1939 by the same forces who eventually operated it. It was a two-kiln plant placed into operation within 6 months. The two-kiln plant, when completed, was the largest cement plant west of the Mississippi. The first two kilns built are those on the left in the photograph.

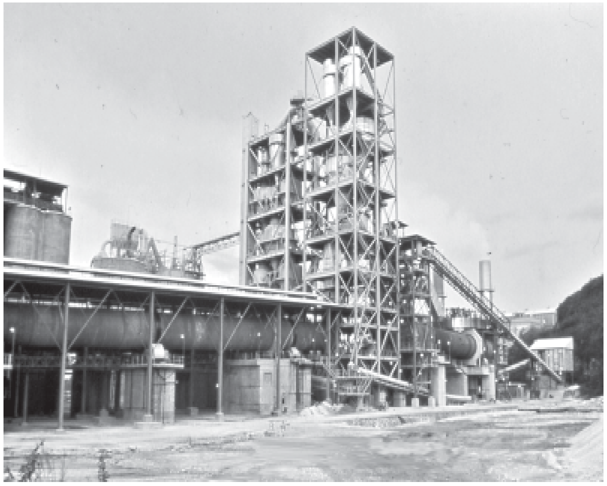
KE became involved in 1950 with addition of the fifth kiln shown in the photo. The fifth kiln is in line with the first four, the last on the right. KE became the engineer of record from that time on, performing engineering, procurement, and construction. Annual capacity was 8.5 million barrels.



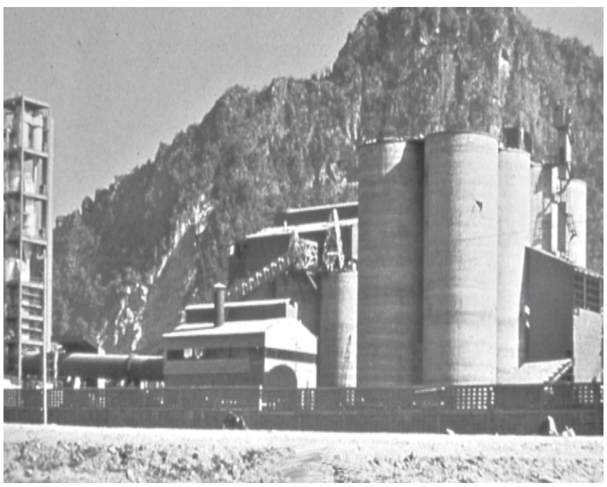
The Permanente Cement Plant after addition of its sixth kiln in 1956. The sixth kiln is the one on the left. Included in the sixth kiln program was an expansion of the existing Cottrell electrostatic precipitator (left side of the photo) and the addition of a second fume exhaust stack. Annual capacity increased to 10.4 million barrels.



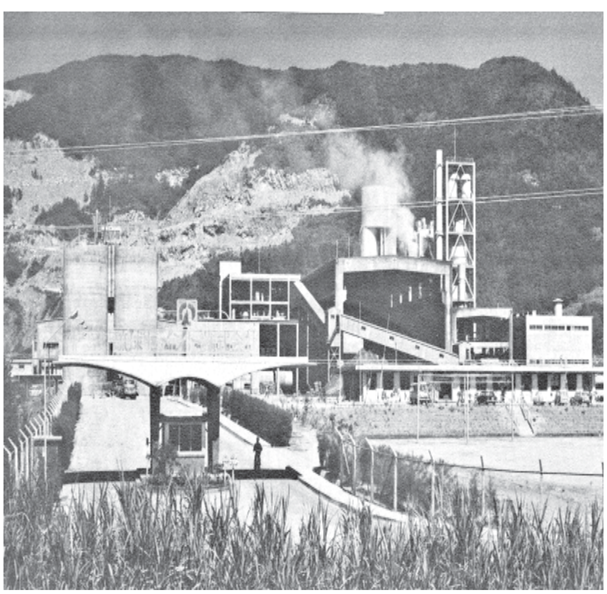
Cushenbury Cement Plant, designed and built by KE for Kaiser Cement in 1955, expanded with a third kiln in 1961 and again in 1980. Plant shown is the three kilns with a capacity of 5.4 million barrels annually of Portland cement. KE developed new process flow and pioneered new process equipment and modernization of kilns.



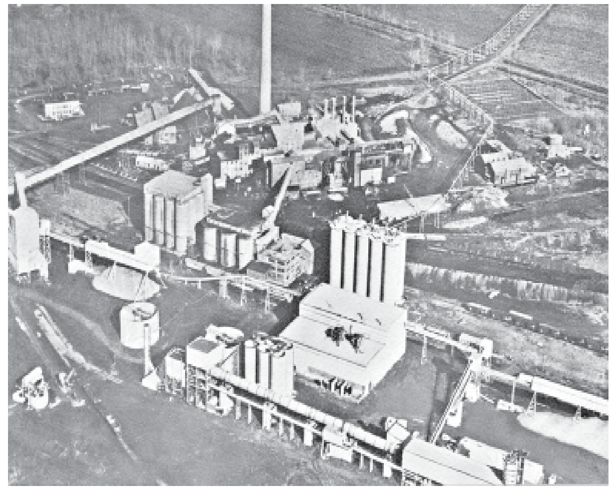
By the 1960s, KE had developed a reputation as one of the premier designers of cement projects. This project was built for Marquette Cement in 1977. Similar facilities were built for a cross-section of the U.S. cement industry, including Coplay, OKC, California Portland Cement, Lone Star, Arkansas, Medusa, and Atlantic Portland to name a few. These projects were designed by KE, including procurement of major equipment. Construction was done as construction managers with independent contractors erecting the equipment.



Ryukyu Cement in Okinawa was built in 1966. It was KE's first experience with a pre-heater cement kiln.



Thailand Cement Project. KE provided technical assistance in 1971.



P. T. Semen Cibinong, built in Indonesia. Design and construction management by KE, 1972-1975.

Coplay Cement kiln under erection (1978) in Nazareth, Pennsylvania. It is a 1-million-ton-per-year plant (by this time, ratings were made in tons rather than barrels. Convert at 6 barrels per ton).

Martin Marietta Cement plant in Davenport, Iowa, 1981.

In the period of 1953 to 1965, KE designed and built a rumber of gypsum wallboard plants for Kaiser Gypsum, an affiliate of Kaiser Cement.

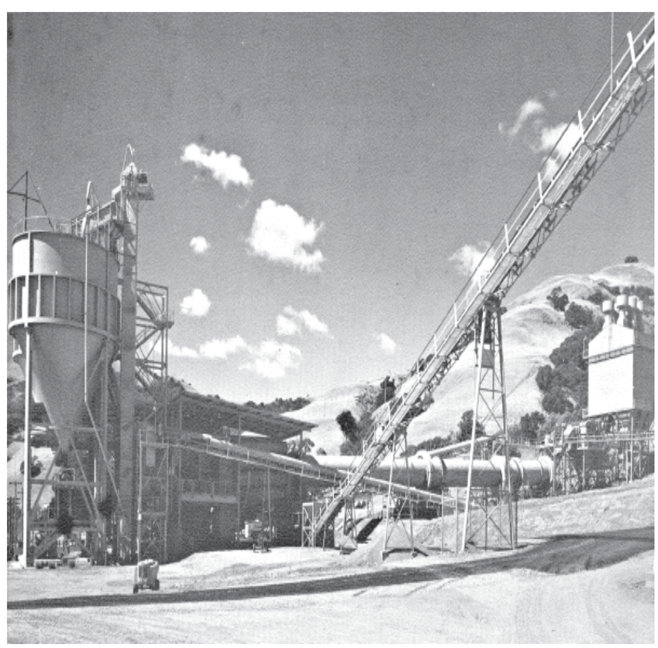
The Seattle Gypsum Wallboard Plant and plaster-making plant, built in 1954. KE participated in a number of technical studies, leading toward Kaiser Gypsum's building and operating the ship in the foreground. It is the *S.S. Harry Lundberg,* which carried gypsum rock from San Marcos Island, Mexico, to plants strategically placed along the Pacific Coast. KE designed the shipboard ore unloading system as wellas the shore-side ore handling systems.

The cement and gypsum engineering group played an important role in designing Kaiser Industries' sand and gravel facilities. Sand and gravel was the company's first industrial supply business.

Plants were designed and expanded at locations in Radum and Sunol in California and at Steilacoom in Washington in the period of 1955 to 1965.

In 1972, KE designed and built a large aggregate plant for Gifford-Hill in Texas.

Shown is the Sunol lightweight aggregates plant built near Niles Canyon, California, in 1965 for Kaiser Sand and Gravel.



Chapter 7

# Mining and Minerals

## Overview

Kaiser Engineers' history and experience with mining and minerals parallels, in many respects, Henry Kaiser's interests and those of the Kaiser industries. To be sure, the earliest Kaiser ventures included excavation and processing of sand and gravel and quarrying of rock for dams and roadways. Some early ventures included quarrying of limestone for cement and processing iron ore for Kaiser's steel mill.

This overview and the introductory section which follows treat the entire experience of the KE organization including those mining and minerals activities, which were handled by other departments other than the mining and minerals department. These include specific production processes like cement, bauxite production, sand and gravel activities; and rock quarrying for heavy construction and, of course, alumina and aluminum. Organizationally, these specific process industries were handled by other departments within KE and are described in other chapters of this book.

For those readers who may not have participated directly in mining and metallurgical projects, the introductory section that follows contains definitions of the minerals industry. This definition section, we believe, is an excellent primer that puts mineral projects in the proper perspective of what they are and how they are used. Jim Thompson wrote the section. (Thompson was the originator of the idea behind the writing of this history of Kaiser Engineers. In his own right, he was a prolific writer of technical articles.) His own criticism of the introduction was to state a fear that it might be interpreted as being too pedantic and might be misinterpreted as being a textbook on metallurgy and, therefore, beyond the scope of this book. The editors of this section of the book feel, however, that it is a concise and interesting introduction and that it will be interesting and useful to most readers.

The early sections of this chapter describe large iron projects followed by a section that describes KE's entry into the non-ferrous minerals field, including copper, zinc, lead, and other minerals. The final section describes KE's activities in coal processing. Of especial note is the large coal gasification project called Great Plains Coal Gasification Project. It is noteworthy for its unique character requiring various KE disciplines, including project management, construction, design, and process know-how. It was a very large project at over $2 billion in costs adjusted to costs prevailing after the year 2000. It was a large contributor to the company's service volume and profits with over $110 million in services revenue.

## Introduction

In the post World War II days, Mr. Kaiser decided to industrialize and to move away from construction-only projects. In Mr. Kaiser's own words, he said that he wanted, "To define projects that knew no completion dates." His emphasis was on basic industries such as steel, aluminum, and cement, along with the associated basic minerals.

Paralleling Mr. Kaiser's interest in basic materials, KE undertook to provide services to the affiliated Kaiser companies by developing a cadre of professional engineers. They could now provide such services as finding and processing of ores. As the experience grew, services were provided to others outside of the affiliated companies. As the staff grew, opportunities arose to branch out into other minerals that were not traditionally mined or processed by Kaiser companies.

The sections which follow address the major projects undertaken by the mining and minerals department, including the following projects:

- **Iron Ore Projects**
  - Eagle Mountain Iron Ore Mine
  - Canadian Iron Ores
    - Quebec Cartier, Canada
    - Wabush Mines, Canada
  - Brazilian Iron Ore Story
  - Hamersley Projects, Australia
  - Reserve Mining
  - Cleveland Cliffs Tilden Project
- **Non-ferrous Minerals**
  - Braden Copper, Chile
  - Kennecott Magma, Utah Copper Smelter
  - Gaspe Copper, Quebec
  - Asarco Copper, Arizona
  - Other Non-ferrous Minerals Projects
- **Coal Mining & Processing**
  - Kaiparowitz, Utah Coal Project
  - Vancouver Coal Mining

Sunnyside, Utah Coal Mining
Coal Cleaning in Pennsylvania
Westar Coal Cleaning,
British Columbia
Coal Terminals in Virginia
**Great Plains Coal Gasification**
**Nuclear Fuels-Mining & Processing of Uranium**
**Major Project Studies**
Klukwan, Alaska Iron Ore
Mt. Bruce, Australia Mining Co.
Alegria, Brazil Iron Ore Project

## Definition of Mining & Minerals Industries

Before entering this new field of endeavor, it was felt necessary to define what it was so that KE's sales effort could be properly focused. J.V. Thompson authored the following definition as an introductory piece for management and staff who would be new to this industry. The industry is defined as follows:

> The mining, concentration, smelting, and refining of metals and non-metallic ore to some well-defined end point such as wire, bars of copper, pigs of lead, uranium oxide (yellow cake), or fertilizers such as triple super phosphate.

Not all the functions are involved in each of the subdivisions of the minerals industry. For example, iron is taken, by definition, only to some form of oxide raw material such as direct shipping ore, sinter or iron concentrates in pellet form. Pre-reduced pellets with high iron metal content would be included in the mineral industry, but smelting of iron-bearing raw materials to produce ingot metal would be part of the steel industry. On the other hand, the copper mineral industry would include mining, concentrating, smelting (to an impure blister cake or anode), and electrolytic refining to a high purity copper in some wholesale bulk shape. Fabrication would not be considered as part of the mineral industry.

The term "concentrator" requires a special definition. In antiquity and through the nineteenth and early twentieth centuries, most metals and mineral products were produced from high-grade ores that were near 100 percent pure mineral species. Lead was produced from almost pure galena, which is lead sulfide roasted to the oxide and reduced to metal in crude blast furnaces with charcoal and later using coke from coal. Often the impurities in galena were silver and gold.

Copper was produced in much the same way from ore containing high copper content in the form of various copper sulfide or oxide minerals. Iron was produced from high grade raw ore fed to blast furnaces, and much metallic iron is still produced from high grade direct shipping ore containing upwards of 65 percent iron. In antiquity, the only concentration was hand sorting or washing to remove clay minerals. The fines, meaning particles finer than about one-quarter inch diameter or less, were often discarded from base metal and iron ores.

As high-grade ores were depleted, it became necessary to concentrate the desired species of minerals in a concentrate which was nearly 100 percent valuable mineral. An ore may contain 1 percent copper amounting to 3 or 4 percent copper sulfide minerals, and the remainder would be gangue or worthless minerals such as quartz or limestone. Economics demanded that the gangue minerals be removed and only a concentrate of the desired minerals be fed to the smelter or the next downstream process. Such concentration almost always resulted in mineral particles that were too small to be treated in the follow-on process, especially if it were a blast furnace or other fixed-bed high-draft reactor. This brought on the development of various agglomerating processes, such as sintering, pelletizing, nodulizing, and briquetting.

Concentrating, in general, means a physical separation of minerals from gangue rather than a chemical attack that dissolves and then precipitates the desired product. There are three broad types of concentrators: gravity, flotation, and electro-magnetic. Gravity concentrators separate minerals by differences in their specific gravity. Valuable minerals usually have a higher specific gravity than gangue minerals. Flotation is a process where minerals are selectively attached to the surface of a bubble in a froth because of reagentizing the ore slurry with various flotation chemicals that do not attack the mineral particles according to their electrical conductivity or lack thereof. Magnetic concentration separates minerals according to their magnetic properties. Today, most base metal concentrators use froth flotation; iron ore concentrators may use gravity or magnetic separation, or a combination of both; electrostatic concentration is in use in at least one large iron ore plant and in almost all beach sand titanium minerals plants.

Hydrometallurgical plants which involve chemical attack on the desired element are, of course, concentrators. Examples are leaching of copper ores, uranium extraction, and gold and silver cyanidation plants.

## KE's Entry into Mining & Minerals Industry

Late in 1956, KE's management convened a top-level meeting in Carmel to discuss future markets and long-range planning. Senior executives discussed strategy and made historic decisions concerning KE's expansion of its minerals industry capabilities. Prior to that time, KE had been mostly committed to heavy construction in the public works sector and industrial work for the other Kaiser affiliated companies in the cement, steel, and aluminum industries. And it was just embarking on industrial projects overseas. It was clear that future work for the affiliated companies was on the decline and that large public works projects such as Hoover Dam were not too plentiful. During this meeting, the decision was made to concentrate KE's marketing efforts in the industrial sector, and that it would pursue design and construction work in a broad spectrum of specific industries, including the mining and minerals industry.

People with in-depth experience were recruited and employed in each of the industry groups, and they became the staff of the Development Department headed by a veteran Kaiser companies executive, Thomas A. (Tim) Bedford. The term development meant business development which really meant sales. The word sales did not seem to fit too well in an organization such as Kaiser Engineers.

The Minerals Group, which is the subject of this chapter, was headed by Ralph Bates who hired J. V. Thompson as his first technical expert in early 1957, followed shortly thereafter by Albert A. Wallach. Thompson and Wallach became the backbone of the organization and were key players in the many successful projects discussed later. They were on the scene for the full tenure of the minerals department until about 1980.

Responsibility for the minerals department fell upon Vic Cole, executive vice president, who had responsibility for a number of other divisions also. He had the vision and drive to promote the successful development of the department, and much of its success is attributable to him.

Bates took early retirement in 1965 for health reasons and was replaced by Jack Havard. Bates laid the groundwork, and a number of successful projects followed under the leadership of Cole, Havard, Thompson, and Wallach.

After the historic decision to offer services to the general industry, a consumer survey made for KE management resulted in the rude awakening that it was almost unknown as a design and construction firm in the minerals industry. Kaiser was a household name known as builders of mighty dams across raging rivers and for building great numbers of ships during World War II. On the West Coast people knew about the air pollution caused by Kaiser Steel in San Bernardino County. They knew about the cement plant near San Jose, and they knew about Kaiser Aluminum's aluminum foil. Only 17 percent of the people surveyed could identify Kaiser Engineers. Among executives of the minerals industries, the name sounded familiar. Didn't they make aluminum cable?

Few within KE knew whom the competition was. They knew Bechtel from past joint ventures, but they were unaware that Bechtel was big in the design and construction of mineral industry facilities such as the Morenci, Arizona, copper plant for Phelps Dodge. Few had ever heard of Stearns-Rogers of Denver, the designers of many major copper, potash, and cement projects worldwide. A major competitor, Western Knapp Engineering of San Francisco, enjoyed a worldwide reputation as designers and constructors of mineral industry projects. To KE, they were machinery vendors.

For those who were to hit the road in a sales effort in the mineral industries, their work was cut out for them. However, within a year KE's recognition factor had doubled to 35 percent. The name Kaiser was well enough known and would open doors, but the identity of Kaiser Engineers was confused by other things related to other Kaiser activities. Some potential clients looked upon us as competitors. To the cement industry, we made cement. To the gypsum industry we made wallboard. To the steel industry we made steel and were soft on union labor. We were even accused of making bad automobiles.

With this initial effort, came the realization that to gain a strong foothold in the minerals industry, KE needed to develop a professional sales staff. Ultimately, KE was successful in getting known and promoting the projects described in this chapter. A fuller discussion of sales efforts can be found in the "Marketing" section of Chapter 2.

## Jim Thompson Recalls Early Studies

Now with a nucleus of a staff in place, the KE marketing posture was to gain a foothold in the industry. There was no better way to demonstrate our capabilities than by conducting preliminary studies, master plans, and feasibility studies for the industry. Jim Thompson, in addition to being an excellent mining/metallurgical engineer, was an excellent report writer and could explain complex processes so that clients could readily understand them. It was he who headed up many of the studies that gave KE a foothold in the industry. He recalls some of the early studies made:

> Conceptual design and feasibility studies were the early steps in major projects, and in many cases the culmination of our work along these lines resulted in Kaiser Engineers being awarded contracts for detail design and or turnkey projects.
>
> Conceptual design and feasibility studies ranged from minor efforts to major work. The first of these efforts was for Kaiser Steel's Eagle Mountain Project and resulted in further work being awarded to Kaiser Engineers. The start of studies for Kennecott's Braden Mine in Chile was in 1956 and continued intermittently until 1965 at which time a major effort was made for the modernization and expansion of the property and resulted in providing sufficient reports to enable Braden to obtain World Bank financing.
>
> Additional efforts by Kaiser Engineers along these lines ranged from major efforts such as Klukwan in Alaska and Mt. Bruce in Australia and minor efforts such as the production of Misch Metal (used for cigarette lighters) in the United States.
>
> A feasibility study was prepared for the expansion of a metallurgical limestone quarry and crushing plant in India. The existing operation employed 5,000 men and women. A modern mining facility and crushing plant was conceptually designed for a facility of three times the capacity of the existing operation. Capital and operating costs were estimated, and to our surprise the conclusion was to hire an additional 10,000 employees. This decision was reached because no known crushing facilities could produce the minimum number of fines, as did the hand operation.
>
> A study was prepared for the production of 10 million tons per year of iron ore products for Samitri, at Alegria, Brazil. The study was followed by the design of a pilot plant to test the ores.
>
> Kaiser Engineers was awarded a contract for the design, procurement, and construction of a pilot plant for Wabush Mines, a consortium of ten steel companies, at Wabush Lake in Labrador, New Foundland, Canada. This was the largest pilot plant, 320 tons per day, ever built. It was unique in that it contained a 10-foot diameter autogenous grinding mill that could be operated either wet or dry and six different concentrating flow sheets. After the pilot plant was run for a year, during which time Kaiser provided engineering assistance, Kaiser Engineers was awarded the design, procurement, and construction contract for the 7,000,000-ton-per-year plant.

## Mining & Minerals Project List

Before describing many of the projects undertaken by this group, a review of KE's perpetual job list reveals the diverse number and types of projects undertaken. The client list is impressive. Projects were located in the mining states of the United States and abroad. Table 7.1 shows a first group of projects where KE acted in the single-responsibility capacity. For the projects in the first group, KE did the architect-engineering and the construction. The second group identifies those projects for which KE was the architect-engineer but acted only as construction manager for the project, supervising other contractors who did the actual construction.

They were mostly large projects. The aggregate cost of the projects listed at the then current costs of construction is $6.5 billion.

## Iron Ore Projects

One of the first large minerals projects undertaken by Kaiser Engineers was the Eagle Mountain Mine started in 1948, several decades before services were made available to general industry. This was the beginning of the know-how KE started to acquire about iron ore. There then followed other projects as described below.

Kaiser Engineers provided practically all design and construction services for Kaiser Steel at its steel works and at its iron ore mine during the steel company's entire life. The steel mill and iron mine were closed for economic reasons in 1980. The steel mill design was started by KE in 1942, and the mill went into production in 1943. From 1943 to 1948, iron ore was obtained from mines near Cedar City, Utah, and the Vulcan mine located in the eastern desert regions of Southern California.

## Eagle Mountain Iron Ore Mine

This mine was a captive mine owned by Kaiser Steel Corporation. It was located in Riverside County in California about halfway between Indio and Blythe on Interstate 10. A major undertaking was the design and construction by Kaiser Engineers of a 60-mile company-owned railroad from the mine to the Southern Pacific railroad at Ferrum Junction. Local wags called it the Pinto Indio and Salton Sea railroad, which went by the acronym of PISS. From Ferrum the distance via Southern Pacific was 112 miles to Fontana.

The townsite at Eagle Mountain was at elevation 1,250 feet, and the climate was hot and dry with about 2 inches of rainfall coming usually as one disastrous cloudburst in late summer or early fall. The year-round warm climate gave Eagle Mountain an advantage over most North American iron ore mines in that with no freezing conditions, more open construction could be used, and stockpiles and blending facilities were easier to operate. The downside was that the extremely hot weather caused a high labor turnover, especially in the early years when there was inadequate family housing.

From 1947 through 1980, some $128 million were invested in capital improvements to the Eagle Mountain Mine, including the railroad, camps, townsite, and machinery for a number of expansion programs.

Eagle Mountain was always in a state of expansion until about 1975. The total production of pellets, lump ore, and sinter fines was about 120 million tons. Of the total, about 20 million tons of pellets were shipped to Japan along with some lump ore. Shipments to Japan were terminated in 1970.

The first Eagle Mountain facility built was the railroad, owned and operated by the company with company locomotives and Southern Pacific ore cars. It was down-grade with the load all the way to Ferrum. The first mining facilities consisted of 2-1/4-cubic-yard shovels and 17-ton trucks. Ore was crushed and screened into lump and sinter feed fractions. There was a sintering plant at the Fontana steel mill. Direct shipping ore assayed 54.63 percent iron and about .09 percent to as high as .40 percent sulfur. Very selective mining could produce ore that was over 60 percent iron.

By 1953, plans were being made to provide beneficiation facilities that would increase the grade and reduce the sulfur. The first beneficiation plant treated only the +3/8-inch fraction by magnetic separation, cobbing and sink-float heavy media separation. The -3/8-inch fines were sintered at the steel plant. The high sulfur content of the fines would soon force beneficiation of the fines, and in 1957 a jig plant was brought on-stream to treat the fines. Extensive stockpiling and blending were provided to insure uniform ore feed to the blast furnaces.

The next major expansion came on-stream in 1966. A separate concentrator was built to treat high sulfur ores, and most of the pellet plant feed came from this new concentrator. The fine grinding required for pellets provided the opportunity for several stages of magnetic cleaning to remove the sulfur minerals of gypsum and pyrite. The pellet plant capacity was 2.3 million tons. The peak year production was 1968 when the combined total product was 6.9 million tons of pellets and direct shipping ores.

It was one of the world’s great iron ore mines, and the management was always ready to try new machines and new systems. It pioneered the use of down-the-hole drills and ammonium nitrate-fuel oil explosives and later metallized slurry explosives. The shovel fleet grew from 2 cubic-yard machines to 17 cubic-yard machines; and if the mine were in production today, it would probably be using 25-yard shovels. The truck fleet was never worn out. The management obtained ever-larger trucks as soon as they became available. A truly novel two-stage heavy media circuit was developed to overcome a problem of intermediate gravity waste material. Eagle Mountain and the steel mill at Fontana were never out of date. They were always state-of-the-art facilities to the end.

Most of the facilities described were designed and built by KE. In addition, KE provided consulting assistance in mining and metallurgy for the full life of the mine.

## Canadian Iron Ores

United States producers became interested in Canadian iron ores as a result of the depletion of the high-grade ores of Michigan and Minnesota and at the development of the Iron Ore Company of

Canada's northern Quebec mine. This occurred during the Korean War.

## Quebec Cartier Iron Ore Concentrator

In the fall of 1957, Quebec Cartier Iron Ore Company, the newly formed U.S. Steel subsidiary, selected Kaiser Engineers to provide conceptual engineering, detail design, and procurement assistance for a major iron ore concentrator at Lac Jeannine. A short time later, Kaiser Engineers was retained to rebuild the existing pilot plant and to assist in its operation. At a later date, Kaiser Engineers was assigned the contract for construction management of the concentrator.

The plant was to produce 25,000 tons per day of high-grade concentrate. It was the first major plant in the world to utilize autogenous grinding and was one of the first to be designed to operate throughout the winter in sub-Arctic conditions. Autogenous grinding utilizes ore lumps to crush and grind itself without the use of steel rods or balls as a grinding medium.

After the operation of the pilot plant at Lac Jeannine during the summer of 1958, the completion of conceptual design of the concentrator, and the start of detail design, the results of some laboratory tests were so intriguing that KE was asked to design and build a new pilot plant in Pennsylvania. The purpose was to investigate the use of wet versus dry autogenous grinding. The plant was designed and built in 42 days, a seemingly impossible task. After it started operation, a decision was made by U.S. Steel and Quebec Cartier officials to change the process from dry to wet autogenous grinding. This change to design and procurement was accomplished without changing the completion date for the plant.

The production plant was designed to process approximately 60,000 tons per day of mined ore from a large open pit mine and delivered to a crushing plant with two of the largest jaw crushers in the world. The crushers were fed by a unique feeding system utilizing the largest wobbler feeders, secondary feeders, and gyratory crushers to provide rock crushed to minus 10 inches. This was conveyed to large ore bins from which it was fed to twelve 18-foot diameter wet autogenous grinding mills. The ground material was pumped to spiral concentrators that produced a high grade concentrate and a tailing or waste product. The tailings were pumped to a waste disposal area and the concentrate was dried and conveyed to storage bins from which it was loaded into rail cars for transport to the port on the St. Lawrence River some 180 miles away.

Kaiser Engineers provided testing and startup assistance and, in fact, provided the plant superintendent and assistant superintendent for the first two months of operation. This plant started on December 7, 1960, and ran successfully until the depletion of the ore reserves after 20 years of operation. It was sold to be used to process ores from another ore deposit.

Project manager was Harry Bernat with a key staff transferred from the Oakland office. They included San Terry, chief design engineer, later to become chief mechanical engineer in Oakland; Don Mauser, structural engineer, later to become vice president of engineering in Oakland; Granny Holman, piping supervisor, later to become president of KE; Bernth Johanson, mechanical supervisor, later to become vice president in Australia; and Al Wallach, process engineer, later to become vice president of the minerals division in Oakland.

## Wabush Lake Concentrator Preliminary Work

At the start of 1959, KE received a contract from Pickands Mather to design and build a pilot plant and camp at Wabush Lake Labrador. This pilot plant was to be capable of testing either dry or wet grinding and a number of different concentrating systems. Project and design personnel were available from the Quebec Cartier project and were utilized in the design and procurement of this pilot plant, which was to be capable of processing 320 tons of ore per day. This is considered quite a large size for a pilot plant.

The plant site in Labrador was accessible by air with a small single engine plane or by boat from a point near milepost 180 on the Quebec Northshore and Labrador Railroad. The boat landing some 15 miles from the railroad allowed access to the first of three lakes, which had to be traversed to reach the plant site where there were a log cabin and two tents.

A crash program for design and procurement was implemented and immediate work was started to enlarge the camp to accommodate the 100 or so men who would be required to construct the permanent camp and the pilot plant, maintenance facility, and utilities. A wartime tank landing craft was obtained, hauled up the railroad to milepost 180, and hauled by tractor for 15 miles to the lakeshore where it was launched on June 15, the day the ice on the lake melted. It was anticipated that the craft could operate until September 15, and plans were made to obtain and haul all required materials, equipment, and supplies by that date. Incidentally, the lake froze-over the night of September 15.

The narrows between the lakes were blasted open so that the landing craft could cross from lake to lake and, in fact, almost all the required haulage was completed on time. A winter road over the muskeg between the railroad and plant site was later utilized. As one can imagine, it must have been quite a sight for any of the Indians in the area to see that high-powered landing craft speeding across the lake. It was not a canoe.

The new camp with accommodations for 120 and the large well-equipped mess hall were completed before winter set in, and the pilot plant was completed by the spring of 1960. Wabush Mines, a new corporation including Pickands Mather and Partners, started the operation that spring and operated the pilot plant until the main plant was almost completed. It was used to develop the flow sheet, provide concentrate for laboratory and later pilot plant testing of sintering and pelletizing operations. Later, it was used for the training of plant supervision and operators of the new commercial plant. KE provided an engineer/metallurgist for approximately one year of the pilot plant operations, visiting the plant each month to ensure that measurements were being obtained that would be useful for the most efficient plant design.

## The Concentrator

In the spring of 1961, KE was selected by Wabush Mines, which by now included 10 partners, to provide conceptual design, detailed design, procurement, and construction services for the concentrating plant to produce 5 million tons per year of high-grade ore concentrate.

The plant consisted of two major gyratory crushers, a large screening plant, sophisticated conveying and bin loading system, and a grinding mill feeding system. All of these, as well as subsequent systems, were designed to provide a blended feed. There were eight 24-foot diameter wet autogenous mills, spiral concentrators, concentrate dryers to produce a hot dry feed to high-tension separators for upgrading the concentrate, and a unique railroad car loading system.

The hot dry concentrate was loaded into five separate bins located above the railroad track and designed for loading the trains on-the-fly. The concentrate cars, which resembled tank cars, had a long slotted opening along the top, and as the locomotive passed under the bins, a device was lowered to open the covers above the slots. As the car passed under each of the bins, a chute lowered and fed a measured amount into each car. This storage and loadout system continued the blending carried throughout the plant.

In addition to the concentrating facilities, major maintenance and repair facilities for the mine and concentrator were provided as were emergency power generating and warehousing installations. When the client encountered problems with the town site contractor, KE was contracted to finish the remaining houses, roads, and other facilities.

In 1967, a disastrous fire took place in the concentrator at Wabush Lake, and KE was assigned the task of getting the plant back in operation. With the concentrator down, all other operations ceased, so that it was necessary for KE to recruit top construction supervisors from projects in the United States and Canada to coordinate the work of Wabush mining and operating personnel for rebuilding operations. This crash program was a classic, resulting in the mine and plant coming back into operation within 61 days, although the complete rebuilding took a number of months longer.

KE personnel who managed the construction continue to be justifiably proud of the accomplishments at the Wabush Mines. In assembling this brief description, several background descriptions were reviewed, including the final project report and a detailed review in the magazines, *Pit and Quarry* and *Engineering & Mining Journal*. There are notations about the unique engineering features designed to withstand unusual requirements in an area where temperatures got as low as minus 62 degrees and where winter lasts from October until April with 12 feet of snowfall annually. Innovations noted were means of facilitating maintenance of equipment where conditions were so hostile.

The plant was designed to produce 5 million tons of concentrate annually. Project costs totaled $68 million in a time period of 1961 to 1963, some $4 million under budget. KE earned a nice fee of $2.3 million on this project.

Project manager for both projects was Al Wallach. His staff included Bruno Boik, assistant manager engineering, later becoming President of Amax Engineering; Les Trew, process engineer; Pat Bedford, assistant project manager construction, later becoming Vice President of Construction in Oakland.

## Brazilian Iron Ore Story

Prior to the Kaiser company's interest in Australian iron ore, reported on later in this chapter, it had a real interest in the rich ores of Brazil. Early in 1957, a high-level management team visited the area and became interested in developing the iron ore export potential. The team was headed by the famous Tom Price who so successfully developed the Hamersley properties in Australia.

A local mining consultant was employed by Kaiser Industries, and KE was requested to study the feasibility of developing the massive iron ore deposits of the Iron Quadrangle of Brazil in the state of Minas Gerais. The study was conducted under the direction of Col. George Gerdes and proposed that the initial deposits be started in the vicinity of Itabira and that a dedicated railroad be built from the mining area to a new port at Vittorio, on the Atlantic Coast. The report was presented to the Brazilian government officials and became a guide for future planning for the development of these resources. In fact, the studies outline was followed fairly closely by a government-owned corporation, which later developed the properties.

KE maintained a surveillance of the area for several decades and was alert to developments in the area. One such was the Alegria Mine for Samitri in 1970. The initial assignment was the preparation of conceptual designs and a feasibility report to increase Samitri's production. This was followed by the award of the design and construction of a pilot plant at Alegria to verify the concepts proposed by KE and to obtain information for the detail design of a plant to produce 10 million tons per year of lump and fine high-grade iron ore products. KE assisted in the startup of the pilot plant and programmed its operation during the first year, providing consulting services for several years more.

Continuing with KE's interest in the area, in 1971 Compania Vale do Rio Doce (CVRD), which was the state-owned iron ore company, authorized a study of the disposal of tailings from the major concentrator being built at the Caue Mine at Itabira. This was a joint undertaking by a local Brazilian engineering firm. Later CVRD employed KE's local firm, Milder-Kaiser, to continue consulting on the project. By 1974, Milder-Kaiser had completed conceptual designs of a tailings system for a new plant at Conceao Mine adjacent to Caue. Later, Milder-Kaiser completed detail design of the system and provided construction assistance. At all times technical assistance and ore mining know-how were provided from the KE Oakland offices.

In 1975, Milder-Kaiser was retained by CVRD to provide preliminary and conceptual engineering for the fabulous Amazonas iron ore deposit, named Carajas. This was a near inexhaustible supply of high-grade iron ore located in the northeast of Brazil. Iron ore was easily mined by open-pit means, but it required a major new railroad to be built to the Atlantic Coast to the north. The Carajas, when finally developed, became one of the world's largest mines and catapulted CVRD into the ranks of the major mining companies in the world.

Milder-Kaiser designed a pilot plant for this remote location in the Amazon Basin. During its construction, gold was discovered in the area, resulting in a delay in construction of the pilot plant. After completion and operation of the plant, Milder-Kaiser was authorized to prepare layouts for a processing plant to produce 100 million tons of shippable product and the plan for a future mirror image of a plant of the same size.

Authorization was received in 1978 for detail design of a plant of approximately 45 million tons annual capacity, and the plant was completed in 1980.

Another client, Compania Siderurgica Nacional, authorized another major study in the Iron Quadrangle of Minas Gerais, at a place called Casa de Pedra. This was an expansion to 10 million tons per year. After completion of the study, KE was awarded a contract for the detail design, procurement, and construction management of their major processing plant. Bernth Johansson was project manager; Dick Pitney and Fred Coope were assistant project managers. Sashi Bubna was mechanical supervisor, later to become project manager of the Carajas Project and later vice president of the minerals division in Oakland.

Soon after its completion, another major iron mining company, Ferteco, employed Milder-Kaiser to provide consulting services, preliminary engineering, and eventually construction assistance for the expansion of the operating mine, its concentrator, and new pellet plant at Fabrica.

In conducting the studies, engineering, and construction of all these projects, maximum use of Brazilian personnel was achieved. This training of Brazilian engineers, construction supervisors, and managers has provided Brazil with the ability to independently develop major minerals projects at home and abroad. The use of local talent also meant that the country could pay for the services in local currency, conserving the rare commodity of foreign exchange.

Over the years enumerated above, many KE experts worked on the studies and projects led by Al Wallach and Jim Thompson. They included Phil Chance, Lars Strom, Bob Robbilard, George Aiken, Dick Pitney, Walter Guggenheim, and Leif Jacobson. Support was provided by Bill Simonson from the Rio office and from Don Robinson from the Sao Paulo or Belo Horizonte offices.

## Hamersley, Australia Iron Ore

After its initial forays into Brazil in the late 1950s, Kaiser Industries was invited to come to Australia to look at the new discoveries of iron ore at Hamersley. Tom Price, who had been interested in the Brazilian deposits, made the initial trip to Australia and was so taken with the possibilities that his entire interest focused on those deposits. He never returned to Brazil.

After discovery of the site, Kaiser Steel Corporation formed a joint venture with Conzinc Rio Tinto Australia to exploit the high-grade hematite ores of Western Australia. Kaiser Steel's original position was as a 40-percent owner. It also contributed its knowledge in large mining operations and in iron ore processing as well as its knowledge of the export of iron ore products to Japan. At the time of this discovery, Japan's steel industry was expanding rapidly, and it provided a large market for export of iron ore from Australia.

The initial decision was to develop the property to be able to ship 3 million tons of ore per year to steel mills in Japan, starting in 1966. The project was so successful that by the 1990s, Hamersley shipped over 50 million tons annually worldwide.

The development of the original project required mining and processing plants; power and water supplies; a town site at Mt. Tom Price; a town site at the port; a 200-mile railroad to a new port; and port facilities capable of loading very large ore carriers and unloading equipment, materials, and supplies required to service a sparsely inhabited area. Tom Price was so helpful in the location of the proper export ores and because of his vision and drive in developing Hamersley, the location of the first major deposit was named Mt. Tom Price.

Throughout these initial investigations and following them, KE provided Kaiser Steel with expertise in iron ore exploration. KE provided conceptual engineering and capital cost estimates during the early phases of Hamersley's development. In 1966, KE provided construction management services for the facilities at Mt. Tom Price, the railroad to Dampier, which was the name given to the port, and for stockpiling and shipping facilities.

## Pellet Plant

Shortly after mine production began in 1966, it became evident that Hamersley would produce a surplus of fine ores at minus 6 mm. In order to fill its commitments to the Western Australian Government, it authorized KE to perform a conceptual study and capital cost estimate for a 2.5 million-ton-per-year pelletizing plant at Dampier. Late in 1966, KE commenced engineering and construction work and selected the Lurgi/Dravo technology after analysis of technical and competitive pricing. The plant was completed in late 1968 and produced high-grade pellets until 1978 when it was shut down because of the high cost of fuel.

## East Intercourse Island Project

Studies made concerning a second source of supply at Mt. Bruce proved that project not to be feasible. Instead, KE conducted conceptual designs for a new mine at Paraburdo and a new port at East Intercourse Island near Dampier. Australians are known for their use of salty language. They also were explicit in naming a place. East Intercourse Island was named so because that's where young people went for intercourse.

Another study KE did at this time was a study to upgrade the existing railroad from Mt. Tom Price. Hamersley decided to go forward with the Paraburdo East Intercourse Project and selected KE to refine shiploading concepts, conceptual engineering, and capital cost estimates for the entire project.

The project included railroad unloading facilities using rotary dumpers and automatic car indexing; blending-type stockpiling systems for 2 million tons of iron ore products; and reclaiming and shiploading at the rate of 8,000 tons per hour. The port was designed to accommodate ships up to 160,000 dead weight tons in size. The entire operation was to be remotely controlled from a central control tower. One of the largest sub-contracts was for the dredging of a loading basin and a shipping channel to accommodate these large vessels at low tide. The project was completed in early 1972, and in March the first ship was loaded at the East Intercourse Island wharf.

The facilities of East Intercourse Island incorporated many first-of-its-kind in unloading, storage, reclaiming, and shiploading. The stockpiling and reclaim systems using boom stackers and bridge-type bucket wheel reclaimers are automated and remotely controlled. The system has an inventory control feature. Lump ore is rescreened for quality control, and the shiploading incorporates automatic sampling in accordance with Japanese standards. The shiploading system can load bulk carriers from 25,000 to 160,000-ton capacity at the rate of 8,000 tons per hour. The facilities were considered the ultimate in stockpiling and shiploading techniques and handles efficiently the export of 30 million tons per year.

## Railroad Expansion

In early 1970, KE was authorized to perform conceptual engineering and capital and operating cost estimates for upgrading the railroad to handle 30 or 40 or 50 million tons of iron ore annually from Mt. Tom Price and Paraburdo to Dampier. After completing the report in December, 1970, KE was authorized to commence work on upgrading the railroad to 30 million tons per year.

The project scope included double tracking at the grade of an escarpment, extension of existing sidings, additions of new sidings, new drainage systems, upgrading of the existing radio repeater stations, and installation of a train control signal system. The scope also included the installation of a railroad maintenance shop, a marshalling yard, administration building, and power and communications transmission line. The transmission line paralleled the railroad a distance of 250 miles. The project was completed in September ,1973. The firm Centec provided railroad consultants during the study, engineering, and construction phases.

## Hi-Met Study

Near the end of 1969, KE was awarded a study contract for the development of a direct reduction plant for production of metallized iron from Hammersley ore. This was at a time during the oil crisis in the Middle East when countries rich in gas reserves were trying to utilize waste gases. For this project, a coal-based process was selected because of the source of coal within Australia. Over the next two years extensive laboratory and pilot plant work were completed at the Lurgi test facilities in Frankfort, Germany, and in the Steel Company of Canada plant in Ontario. Demonstration tests of the product were completed in electric furnaces in Canada and in Japan. Following the definition of the technology, the study continued with the preparation of conceptual engineering and capital and operating cost estimates.

## Key Personnel

Some of the many engineers who worked on these Hamersley projects included the following: San Terry, Ron Maddock, Bernth Johansson, Pete Leitig, John Sulzbach, Les Dittert, John Bodner, Dick Scammel, Fred Coope, Dick Pitney, Les Trew, Bob Rice, John Rosten, Ken Long, Jim Thompson, and Al Wallach. In a word—the entire minerals section. Construction personnel included Art Fisher, Chuck Lindbergh, Rolando Blanco, and many others.

## Reserve Mining Ore Project

At the end of World War II, it became apparent that the tremendous war effort had almost depleted the high-grade Mesabi iron ore deposits in Minnesota. In order to fuel the increasing demand for steel for the peacetime economy, the utilization of the lower-grade, fine-grained, extremely hard Taconite ores would be necessary. The first of this new generation of plants was the Reserve Mining Concentrator built on the shores of Lake Superior. Originally designed to produce 5 million tons per year of high-grade pellets, by the mid-1950s it was increased to 10 million-ton capacity.

This increase in production resulted in the release of 20 million tons per year of finely ground waste, or tailings into Lake Superior. By early 1970s, it became apparent that environmental concerns would require the termination of this discharge and also a reduction in the discharge of dust into the air, which came from the crushing operations which were a part of the pelletizing operations.

Kaiser Engineers was selected to provide assistance in the preparation of engineering studies for satisfying the environmental demands as well as to increase the efficiency of the ore processing operations. The logistics required the receipt of 30 million tons of mined material at the railroad discharge point, the shipping out of 10 million tons of pellets, and the disposal of 20 million tons of waste product.

After completion of the studies, KE was retained to provide engineering and construction of both the environmental aspects of the project as well as a significant upgrading of the ore processing facilities. The project required that the plant be kept in operation while modifications were made. This required intricate scheduling to modify single units of the plant, one at a time, and resulted in a sequential schedule spanning almost four years. Environmental facilities included new and upgraded existing dust collection facilities from the railroad car dump to the ship loadout points; the cobbing of 30 million tons of dry feed, crushed to minus 3/4 inch; and large dry magnetic separators (the largest ever built). All of this was sandwiched between the existing crushing plant and the concentrator.

Ore processing system upgrading included modification of each of 28 concentrating lines within the concentrator, upgrading the magnetic separators, modifications to the classification systems, the addition of flotation machines, cycloning and filtering out of coarse tailings, and the installation of four 425-foot diameter thickeners. This was located on the sand beach, which had been formed by previously discharged tailings. All of this work was done within the existing concentrator while the operations continued, by working one of the 28 lines at a time. In addition while operations continued, new concentrate thickening and filtering facilities were installed, and improvements were made to the pelletizing plant.

Tailings from the dry cobbing system and the cycloning-filtering wastes (50 percent of wastes) were discharged to rail loading operations for haulage and discharge at a new on-land disposal site together with the construction of an earth-filled dam that will, at completion of the reserves, contain over 800 million tons. Underflow tailings from the thickeners (another 50 percent of wastes) are pumped through a major pumping-pipeline system over five miles inland for discharge behind the dam. To satisfy environmental needs, a completely closed system was designed so that all water is reused with no discharge to the environment.

The project was completed on schedule and within the budget of $345 million and with only minor interference with operations and with no appreciable reduction in plant capacity during the construction period. The project team included both environmental staff and mining and minerals staff members, along with KE's construction crews.

The team was led by Al Wallach as project manager; Leif Jacobson, chief engineer; and a team of project engineers, including George Grandy, Jim Anderson, Shelly Braidman, Debra Mohapatra, and John Logue; Pete Florence, chief design engineer; and a group of 150 designers and engineers. Dave LeCount handled project purchasing, and chief expeditor was Sandy Campbell.

Hugh Fulton headed field forces as resident manager and Ken Scheurman as chief field engineer. A large group of supervisory personnel managed a construction force, which peaked at close to 2,000 people.

## Tilden Project

In 1971, Kaiser Engineers was retained by Cleveland Cliffs to provide engineering, procurement, and construction management of the Tilden Iron Ore facilities in Michigan's Upper Peninsula near Ishpeming. Completed in October, 1974, the Tilden mine is a completely new facility for stockpiling, crushing, grinding, concentrating, and pelletizing low-grade hematite ores. The initial capacity is to process 4 million tons per year of pellets with 65 percent Fe content. Planning is for expansion to 12 million tons per year. The plant is designed to handle 35,000 tons per day of crude ore with 35 to 38 percent Fe content. Material is treated through a complex size-reduction and beneficiation process.

At time of completion, the Tilden pelletizing plant utilized the largest grate-kiln installation in the world.

## Project Execution

The owner, Cleveland-Cliffs, was responsible for mine development and for the selection and purchasing of all major process equipment, as well as site clearing and major earthwork such as many impoundment dams.

KE was responsible for detail design and construction management of the concentrator and for total design and construction of the pellet plant. The mine service building was built by contract to Treadwell. General arrangement drawings were prepared by Allis-Chalmers, and they supplied process equipment for the pellet plant.

KE's project group was moved to Ishpeming in July, 1971, in order to complete the preliminary engineering phase and to prepare an estimate of cost. This was completed by November, 1971, after which detail design was started. Concrete work was initiated in the spring of 1972, and structural steel erection started in July, 1972.

Concrete work was late due to poor foundation conditions and partly due to poor performance by one of the contractors. This delayed steel erection, causing excessive winter work and late enclosure of the building. In turn, this restrained other contractors' work. A six-week strike by the boilermakers delayed the project. A critical shortage of skilled craftsmen impacted the project negatively. Because of the boom period, extensive delays occurred in delivery of equipment and materials. Slippages of several months were common due to lack of foundry capacity to manufacture equipment.

The project was completed in 1974 at a cost of $152 million, some 4 percent over budget and three months behind schedule despite the many serious problems that occurred on the job.

### Key Staff

The KE staff was headed by Frank Kast as project director with Les Trew as project manager and Jim Miller as resident manager. John Biasatti served as procurement manager.

Other Tilden personnel included: Mac McDonald, Griff Tiller (who died of a heart attack), John Aiello, Jack Lipner (who died of cancer while on the job), Dan McCormick, Earl Woodward, Tom Vanderheiden, Ray Dorr, Byron Neilsen, Gene Green, Ed Day, Don Walhovd, Doil Yocham, Clyde Baker, Joe Polfer, Bill Beard, Charlie Harman, Ken Thomas, Chuck Graff, Jim Tabor, Gary Thronson, Don Willman, Mack Horowitz, Roy Hamilton, Paul Skvarna, Walt Pentz, Dick Cranston, Dave Palmer, Dick Shaver, Don Phillips, Floyd Eckles, Jim Roberts, Lachlan McBean, Dave LeCount, Jim Taylor, Cal Nara, Ken Lukins, Dick May, and Mike Ruzilla. Charlie Watkins was field design engineer.

### Jim Miller's Notes

Please refer to Chapter 17, "Oral Histories," where Jim Miller records his Ishpheming Tilden project notes. Miller describes an interesting first-person account of his role on the project.

## Non-ferrous Minerals

Having accumulated a minerals and mining staff capable of pursuing the iron ore industry, KE now had technologists who were also experienced in mining and processing non-ferrous minerals. Now KE was in a position to market itself to firms that were not in the same businesses as were the Kaiser affiliated companies. The marketing effort was a direct result of the posture originally promulgated at the famous Carmel management meeting. Now that we had the talent, what was left was the proper marketing effort.

The great number of projects undertaken in this field attests to the wisdom and success of the planning and execution of the management's vision.

### Braden Copper Facilities

One of the first successes in marketing to the non-ferrous industry came as a result of a cooperative effort between the minerals division and the newly formed Latin America division in early 1956. The first assignment awarded was the preparation of a comprehensive plan to modernize and expand the Braden mines in Chile. Jack Hughes was then the vice president in charge of the Latin America division and had prime marketing responsibility.

The story starts when Hughes got wind of Braden's expansion plans and pursued the project vigorously. Having established a good relationship with the top Braden management, he was invited to golf with them at their private club. The story, as related by the top managers, is that Hughes drove off one of the tees and had a very difficult lie. The vice president told his general manager, "If that s.o.b. tries to drive out of there, let's not hire him." As it happens, Hughes played it safe, and KE was hired to do the study.

From this early assignment, KE became the technical arm for the Braden Copper Company lasting for a full 10 years. KE personnel and Braden personnel had a very fine client/engineer relationship. Whenever they needed help, they called on KE, and KE responded with good results. The comment was once made on one of the follow-on assignments, "Is there no end to the talent that you have? On each assignment we got the very best talent."

Besides the technical relationship, good personal relationships were built up. Families became friends. When Sam Ruvkun took over after Hughes became Assistant General Manager, he made numerous trips to Santiago to keep abreast of new opportunities and to discuss politics of the country (in order to assess business opportunities). Many times he was invited by the chief engineer of the company to have cocktails at the bar of the Carrera Hotel. We knew the relations were good, when upon entering the piano player was asked to play, "I Left My Heart in San Francisco."

## Braden Mine

To understand the magnitude of the projects we were undertaking, one has to know just a little about how complex the existing facilities were. The Braden El Teniente Mine is located 9,500 feet high in the Andes located some 50 miles southeast of Santiago, Chile. It is an upside-down mine in that ore is blasted loose from upper levels, falling through ore passes to lower levels. A company town of 15,000 people is located at Sewell at an elevation of 7,000 feet. All supplies, materials, equipment, and personnel are brought in by a narrow-gauge, single-track railroad that runs 35 miles from the closest town at Rancagua. Just below Sewell, the railroad runs along a precipitous gorge. Travel time one-way is a little less than 3 hours.

The concentrator is located at about the 7,500-foot level, and concentrate is hauled by a 4-mile aerial bucket system to a smelter located at a place called Caletones at elevation 5,000 feet.

The original facilities were built in 1910, with the railroad starting in 1911. Constant modifications have been made for the next 50 years. Some of the original equipment was still in operation at the time KE entered the scene. Braden was a wholly owned facility of Kennecott Copper Company.

## 1956 Master Plan

The purpose of the master plan assignment was to assess a number of opportunities for modernizing and for expansion of the mine. Markets were known to be good, but there were difficult political and economic problems to be solved. The master plan was to be used in top level negotiations between the Chilean Copper Authority, Braden, and Kennecott management.

The preliminary engineering assignment was handled by Col. George Gerdes and J. V. Thompson with technical editing by Sam Ruvkun, under the direction of Jack Hughes, vice president for Latin America at the time. The report delineated several possible expansion schemes with a number of alternate capacities of from 180,000 tons to 380,000 tons of copper annually. The report contained preliminary concepts, flow sheets, descriptions and estimates of construction costs, estimates of operating costs, and financial analyses of payout times.

The recommended scheme envisioned a radical new means of mining, concentrating, and smelting. Mining would now drop the ore into a series of deep shafts down to a new railroad tunnel and a 4-mile extension. *(Note:* To a layman this was a tunnel. To Jim Thompson it was an adit and he delighted himself in wittily describing how to a miner a tunnel is not a tunnel if it does not have daylight at both ends). Ore was to be delivered to a concentrator located at a town called Codequa at elevation 2,300 feet. The company town at Sewell would be abandoned.

The report was a reference document used over and over again in top level discussions. It was referred often as "The Codequa Plan."

The report went into quite some detail explaining operating and construction aspects, including numbers of workers, where they would be located, estimated costs, and return on investment.

The recommended plan had a preliminary estimate of cost of $211 million, which in the year 2000 costs would be about $1.2 billion. This was a substantial investment for anyone to contemplate. It was particularly important to Braden and Kennecott management since repatriation of capital investment had to be guaranteed by the Chilean government. And there would have to be tax incentives to make the investment. The specter of a possible government take-over of a private property like this was always present.

Under assumptions of the report, the project was viable. So the Codequa Plan was referred to many times as negotiations, discussions, and possible alternatives were advanced, covering a span of more than 10 years.

## 1961 Expansion

While the major expansion was always a possibility, a number of relatively minor expansions did go forward. One such was in 1961 when the authorities in Chile granted a special tax incentive for copper companies to make expenditures during the calendar year. This gave rise to a crash program, which was entrusted to Kaiser Engineers. The plan was to improve mining and smelting facilities, improve the electrical system, and renovate housing at Sewell at a cost of $6.8 million, all to be completed within the calendar year of 1961.

To accomplish the engineering, procurement, and construction required an expedited program and a knowledgeable crew to meet the tight schedule. The Latin America division nominated KE's chief expediter, Hal Andresen, to be project manager for the project. He was the ideal candidate because he knew how to meet a tight schedule and was also a graduate civil engineer by training.

Andresen's staff included a task force of top KE talent, which took up residence in Chile. They included San Terry on design along with W. Van Vleck, J. Hart, and E. Phillips. On construction there was S. Stewart, O. Ballheim, and P. Skvarna. John Franklin handled local procurement. R. Langford handled cost control and estimating.

The project was completed by the end of 1961 to the great satisfaction of the Braden management, the Copper Authority, and the Kennecott management. Letters of commendation recorded the satisfaction.

One lesson learned from the project was the difficulty of building facilities in the Andes at the height of winter with frozen ground and constant snowstorms. The inefficiency was pronounced because of the heavy cost of snow removal. This experience was helpful in understanding the effect of winter conditions when planning other expansions, which came later.

## Highway Project

One idea to alleviate the congestion on the narrow-gauge railroad was to build a company-owned highway from Rancaqua a part of the way up the hill for a distance of 32 miles. In 1963, KE was engaged to study the possibilities. Several routes were investigated and surveyed, and traffic patterns were analyzed. The ruling grade was to be 6 percent.

The routing terminated at a relatively level area where the existing smelter is located at elevation 5,000 feet at a place called Caletones.

Bob Rice was project engineer in charge under direction of Sam Ruvkun, with a large assist by the civil design engineering section. Alden MacElrath conducted geological surveys. The project was estimated to cost $10 million. It was not authorized, but results of the study were used in the final long-range plan discussed next.

The report considered in a preliminary way the next phase expansion from Caletones to Sewell. This included a reconnaissance survey and review of existing contour maps. The section is a distance of 5 to 6 miles in a very precipitous area. Winter snowstorms and avalanches occur, so that snow sheds would be required along with tunnels and lots of snow removal. Some grades would approach 9 percent. The rough estimate of cost for this section was also $10 million.

## Project 280

By 1965, the political situation in Chile had stabilized, and it appeared very likely that Kennecott could make a deal with the Chilean government to expand Braden. KE was retained to prepare a master plan for increasing copper production from 180,000 tons per year to 280,000 tons per year. The project was named "Project 280." This master planning was a full year's effort as a joint undertaking of key Braden technical and management personnel and KE's technical staff. Strict guidelines were established by the Braden management that this study consider only utilizing the existing flow sheet (the Sewell Plan) as they did not want to consider anything radical like the mining plan developed by KE a decade earlier.

While adhering to these strict guidelines, KE staff came up with a modified mining plan that came up with many of the elements of the prior Codegua Plan, but not as radical. Fortunately, the staff was able to convince the Braden management to adopt this plan, saving untold millions in capital cost and operating cost. The result of the study was an excellent planning document, with detailed studies of individual components of the project, detailed construction planning, detailed estimates of cost, a detailed critical path schedule, and a full four-drawer file of documentation. This scheme was estimated to cost $200 million in 1965 costs or about $1 billion in the year 2000 costs.

All of this work was done under the direction of Sam Ruvkun with mining and metallurgical direction from Al Wallach and Jim Thompson and input from the entire design office and the estimating department.

## Project 280, Built by Others

Ultimately, after an intense marketing campaign, KE was not awarded the project. The reasoning by the Kennecott management was Machiavellian. Kennecott knew that we had an excellent reputation with the Chilean authorities who knew of the excellent work that we had done before. What Kennecott feared was that the stronger KE became, the more incentive there would be for the Chileans to throw them out and perhaps negotiate with us to provide management assistance rather than have any foreigner having an ownership interest. This, it seems to us, was a warped impression of what KE's motivation would be.

The award was made to others despite the fact that: 1) we had 10 years of excellent relationship with Braden, 2) we provided them with an excellent planning document, using our own innovative mining planning, 3) we had associated with a large local construction contractor (at Braden's suggestion), 4) we got to know very well the head of the Chilean Copper Authority that supervised the Braden operations for the government (also at Braden's suggestion), and 5) we presented them with a competitive proposal to do the engineering and construction of the project.

Thus ended our 10-year association.

## Kennecott Copper Smelter

Despite the ultimate failure to be awarded the Braden project in Chile, the domestic minerals division was successful in landing the copper smelter and refinery project located in Magma, Utah, owned by Kennecott Copper Company. This occurred in 1964 at about the same time that the Kennecott subsidiary in Chile was expanding its smelter facilities.

One significant aspect of the Magma property was the requirement to design and build facilities for cleaning and handling sulfur dioxide contained in smelter gases. KE had been building its expertise, not only in minerals, but in air pollution also.

KE performed engineering, procurement, and construction services for this $24-million project. The scope included rebuilding reverberatory furnaces, converter, powerhouse, and gas handling facilities. The converter aisle was completely rebuilt with new or modernized converters and a new control system. Waste heat was utilized for a new 10,000-kw generator, two new 50,000-cfm blowers supplying converter blast air, compressors supplying plant air, and converter tuyere punching air. Auxiliary equipment included boiler feed water treatment and heating facilities, a new circulating water system with cooling towers, and chemical treatment facilities.

Harry Bernat was project manager, and Clint Milliken was project engineer on the job.

## Gaspe Copper Facilities

In the same time period of the mid-1960s, KE provided engineering services for copper reduction work at the Gaspe Copper mines in Quebec. These services were for treating sulfide and oxide ores produced in expanded open pit mines. Facilities included a crushing plant, concentrator, and tailings disposal.

## Asarco Arizona Copper Facilities

For American Smelting and Refining at its San Xavier, Arizona, plant KE designed and constructed a 4,000-ton-per-day oxide leaching plant. Facilities included crushing, sulfuric acid leaching, and drying facilities. Clint Milliken was project manager.

## Asarco Glover Lead Project

KE performed engineering, procurement, and construction for a 100,000-ton per year lead smelter and refinery. Design was completed in 16 months, and construction was completed in 19 months with an overall project time of 24 months. Sami Haddad and Leif Jacobsen headed up this project.

## Bunker Hill Zinc Plant

At the Kellogg, Idaho site KE did engineering, procurement and construction for expansion of Bunker Hill's zinc plant by 350 tons per day, and increased its sulfuric acid plant by a like amount. This project was completed on schedule and 10 percent under budget. KE also provided startup and operating assistance.

## New Jersey Zinc, Clarksville Project

In the mid-1970s, KE provided planning services for a major expansion of the zinc facilities at the Clarksville, Tennessee, site. Ultimately, a 90,000-ton-per-year electrolytic zinc operation was designed by KE. This operation used off-site concentrates for conversion. Rex Guinevere was project manager.

## Strontium for Kaiser Aluminum

The minerals division continued to provide services to a diverse array of non-ferrous minerals. One such was the services for Kaiser Aluminum's strontium plant in Nova Scotia. KE provided engineering, construction, and start-up services for the plant. This was an urgent operation that required a pilot plant and then engineering and construction of a commercial grade strontium facility. Start-up services were initiated 9 months after notice to proceed with the pilot plant. Les Trew was project manager, and Ed Lacynski provided start-up services.

## Troy Silver and Copper Project

In 1978, the minerals group performed engineering and procurement services for Asarco's Troy, Michigan, silver and copper project. The ore body is underground and is reached by adits. It is located at 4,400-foot elevation in rugged mountain terrain.

Crushing was accomplished underground, and processing of crushed ore at the surface included grinding, flotation, filtering, and smelting to recover silver and copper. Tailings disposal was by an 8-inch pipeline, traversing some 6.5 miles to a tailings pond.

The Troy mine is one of the largest silver mines in the United States.

KE's design effort totaled $5.1 million. The project as built by Asarco cost $90 million.

Project personnel included E. M. Lacynski as project manager, Frank Sparks as design manager, Murray Boyles and Keith Sipes as project engineers, and John O'Leary as principle design engineer. Dave Thomas handled procurement.

## Diatomaceous Earth Plants

The minerals section performed several diatomaceous earth plants. This is a naturally occurring substance that is used in filter aids and for insulation. The story is told of one of our public relations officers who was telling a client about our experience in this non-ferrous field. The client wanted to know what diatomaceous earth was. This discussion occurred just when KE's prominence in the nuclear field was being recognized. So, the PR man responded, "I don't know. But since it has the word 'atom' in it, it must have something to do with nuclear energy." Wrong!

The first of the plans was the Dicalite plant for Great Lakes Carbon in Lompoc, California, in early 1960. KE's role was the design and construction to be able to produce 170 tons a day of filter aids, filters and insulation for use in 20 industrial processes. Facilities included cleaning and flash drying incoming raw materials, calcining, classifying, and bagging facilities. The plant featured a central control room and dust control facilities. Chet Case was project manager, Bill Fisher was project engineer, and Pat Bedford was construction manager.

There followed in 1964 a diatomaceous earth plant for Johns-Manville in Iceland. This produced 12,000 tons per year. Raw materials were dredged in the ice-free season and reclaimed year-round from holding ponds. It utilized steam from underground sources in the process. Estimated cost of the project was $3.5 million. Ray Isherwood, working out of the Montreal office, ran this project.

Following that, another diatomaceous earth plant was built for Eagle Pitcher in Lovelock, Nevada. Its capacity was 36,000 tons per year.

## **Coal Mining, Processing, & Gasification**
## Overview

At the Carmel management meeting in 1956 when the decision was made to organize a minerals processing division, it was an implicit guideline that the division would take advantage of marketing opportunities as they arose. Thus, in the late 1960s and early 1970s there was a serious destabilization of the supply of oil from the Middle East, which drove prices up from $3 to $34 per barrel of oil. The use of coal became a more viable source of fuel. KE's strategy was to provide its skills where the market demanded them. So in early 1970, an energy resource division was formed within the minerals group. Engineers were assembled with experience in all aspects of coal projects including geology, mining, coal preparation and conversion, material handling and transportation, coal terminals, and environmental control.

While KE had had prior experience with coal mining and processing, it was primarily for mining and processing high-grade metallurgical grade coals used in the coking process for the steel industry. Now KE would embark on assisting with the devopment of much larger coal mines for feeding steam-generating plants and for gasification.

The division was successful in providing varied services for a number of large coal projects, which are enumerated below. Of special significance is the very large Great Plains Coal Gasification project.

The division was first headed by Ray Ware and upon his transfer to the international division, Joe Matoney took charge. Key coal process engineers were Claude Moreland, Mike Albrecht, and Dave Chedgy. Coal mining engineers were Dave Olsen, Charles Tilson, Nuri Ozgen, and Larry Watters. Material handling engineers were Dennis Keay, Ray Travanti, and Horst Appenroth. Project managers were Don Robinson, Ed Laczysnski, Keith Kern, Sam Nash, Ed Baldinelli, and Russ Monson. Project engineers were John Foley, Dwight Hagemeir, Lou Larsen, and Dusty Boyd. The division staff totaled over 75 people at one time. Engineering design staff, for the most part, was assigned full-time to coal projects led by Frank McHugh and Tim Lee.

## Geology and Mining
## Kaiparowitz, Utah

This was an exploratory program in Southern Utah for a consortium of utility companies. The program included extensive drilling and complete geological investigation of 13 coal seams in a 47,700-acre lease on the Kaiparowitz Plateau. Planning was to develop four mines with a capacity of over 12 million tons per year to fuel a 3,000-mw steam-generator electric power plant. These investigations by KE staff were extensive. The project would have been the largest underground mine complex in the United States, but the project did not go forward.

## Coal Mine, British Columbia

From 1974 through 1978, KE worked closely with Kaiser Resources, Inc. in Sparwood, British Columbia, providing services in studying, engineering, procuring, and constructing coal mining facilities. The facilities were for dewatering of the underground hydraulic mines at its Panels 5 and 6. They handled 600 tons per hour of raw coal and 5,000 gallons per minute of coal slurry to produce 600 tons per hour of dewatered coal at the surface.

## Sunnyside Mine, Utah

After acquisition of the Sunnyside mine by Kaiser Steel, KE provided the design and construction for a large-scale modernization program which increased mine capacity by reopening and supporting underground workings, completely revamping the ventilation system, and providing new equipment. The mine was later expanded several times and produced about 1 million tons per year of metallurgical grade coal.

Facilities included mine hoists, coal handling equipment, storage bins, rotary car dumper, coal breaker, coal washing and dewatering equipment, a ventilating system, service buildings and a 105-unit housing development.

## Coal Preparation
## Greenhills Project, British Columbia

KE provided studies, detail design, procurement, and construction management services for the Westar Mining Ltd.'s various Greenhills sites and for various capacities. This is a surface coal mine and preparation plant in southeastern British Columbia near Elkford.

The project included material handling, coal preparation, coal drying, and loadout facilities to produce 1.8 million tons of clean metallurgical grade coal annually, with allowances for expansion to double its capacity. The plant was built to operate 24 hours per day, 7 days per week. It included utilities for the process facilities and for the maintenance complex area and power to the portable pit substations in the surface mine.

Major elements included a breaker station for receiving raw coal by rear-dump trucks, 2,500-meter long raw coal conveyors, two raw coal silos of 1,800 tons each, a preparation plant having circuits of heavy media cyclones, water-only cyclones and froth flotation, 1,800 meters of overland clean coal conveyor, thermal dryer, two clean coal silos of 13,500 tons each, and a unit train loadout station.

## Coal Cleaning Test Facility, Pennsylvania

For the Electric Power Research Institute (EPRI), KE performed a number of studies, designs, and training programs. The initial study was for state-of-the-art physical coal preparation technology. It included recommendations for a coal preparation pilot plant that would benefit the coal and power generation industry. Then KE designed the facility, monitored its construction, and operated the pilot plant.

The purpose of the research program was to maximize the BTU yield and quality of coal and to minimize the cost of coals burned by the electric utility industry. The coal cleaning test facility provided a means to accomplish these goals. The facility simulates conventional production coal cleaning processes during initial operations and generates the basic data required before research into other methods of coal cleaning can be initiated. The facility can be used to test significant configurations of various coals in various flow sheet configurations to simulate production techniques and to produce large quantities of cleaned coal and refuse for further testing. Five different flow sheets were tested, but the facility can test other processes also. Extensive sampling, instrumentation, and process control systems were installed in the facility to enhance on-line data gathering and to test the system for practical use in the coal cleaning industry.

The facility was also designed to train coal preparation engineers and plant operators.

## Bullmoose Project, British Columbia

At Teck Corporation's Bullmoose coal preparation facilities in British Columbia, KE prepared a preliminary study with capital and operating cost estimates and then performed detail design services for the coal cleaning and loadout facilities.

KE also provided procurement and construction management services for the facility. It included a raw coal truck dump and breaker station, the preparation plant, a thermal dryer, a clean coal storage station, a unit train loadout facility, and a tailings pond. The facility capacity is 600,000 tons per year of clean thermal coal and 1,700,000 tons per year of metallurgical grade coal.

## Fording Coal, British Columbia

Several projects were performed for Fording Coal Ltd. at its coal mining, preparation, and support facilities. For the underground mines near Lethbridge, Alberta, KE provided the initial mining plans and capital and operating costs for the room-and-pillar coal mines with capacities of 1.2 to 1.3 million tons per year.

At Elkford, British Columbia, KE provided detail design, procurement assistance, and construction management for modifications to increase production capacity to 4.3 million tons per year for coal washing and 5 million tons per year for coal handling. Facilities modified included raw coal receiving and crushing, raw coal storage and reclaiming, tromp circuits, heavy media cyclone circuits, fines circuit, thermal dryer, and refuse handling. Subsequently, KE prepared a study to expand the capacity to 6 million tons per year.

## Westar Mining, Ltd., Coal Cleaning

Westar is the surviving company since 1969 of Kaiser Canada and Kaiser Resources. KE provided services for about 60 projects for Westar. It operates one of the largest coal operations in North America near Sparwood, British Columbia. The Elkview plant was one of the larger projects for which KE was retained. KE provided engineering, procurement, and construction management services in connection with the expansion of the Elkview coal processing plant from about 3.5 million tons per year to about 6.5 million tons per year in stages.

Major changes were made in raw coal handling and storage, coal preparation, thermal dryer, clean coal handling and storage, railroad loadout, tailings ponds, and refuse disposal.

## Coal Terminals
## Dominion Terminals, Virginia

KE provided detailed engineering, procurement and construction services for Dominion Terminal Associates in Virginia. The terminal was sized to have an annual throughput of 16 million tons. Coal was sorted in eight different piles with a total ground storage capacity of 1.6 million tons. The terminal pier and loading facilities were sized to handle coal colliers ranging in size from 20,000 to 188,000-dead-weight-ton capacities.

## **Great Plains Coal Gasification Project**
## Overview

This project, located near Beulah in Mercer County, North Dakota, was an unprecedented application of KE's design and project management capabilities and the company's experience in construction management. The project was noteworthy for its grand scale and significance as an energy producer, using lignite, a low rank coal. It was a cooperative effort between KE and the project manager / plant operator, the ANG Coal Gasification Company. The project was budgeted at over $2 billion, of which KE's portion was $1.1 billion. (In today's costs this would be a $3 billion project.) It was completed ahead of schedule and under budget, and it was a great profit and revenue producer for KE.

The project was so well done that the National Society of Professional Engineers awarded Kaiser Engineers its 1985 award as "one of the outstanding engineering achievements in the United States."

## Background

As a result of the destabilization of oil prices in the early 1970s, the Department of Energy encouraged and funded research for an alternate clean burning high BTU fuel. Substitute Natural Gas (SNG) derived from the gasification of low-BTU sub-bituminous coal, or lignite, was the prime candidate. ANG Coal Gasification Company, a division of American Natural Resources, was doing research in this field and had shipped 12,000 tons of North Dakota lignite to Sasolburg, South Africa, for tests in an existing coal gasification plant. The tests were favorable, demonstrating that lignite can be gasified into high BTU SNG. The complete oil embargo of 1973 solidified the plans to build a full-scale commercial coal gasification plant with funds provided by a loan guarantee through the Department of Energy.

The project had been in the planning stages since 1973, and won approval to proceed in 1980. The project was completed in 1984.

## Great Plains Project

The Great Plains Coal Gasification Project was a green-field coal gasification complex located on a 600-acre site in Mercer County, North Dakota. The owner is a consortium of five large gas and oil producers. The project was designed to produce the equivalent of 20,000 barrels of oil daily and 125 million cubic feet of high-heating value substitute natural gas from the North Dakota lignites. In addition to the gas produced, significant amounts of ammonia (93 tons per day), sulfur, and carbon dioxide were produced. Other byproducts produced were tar, oils, phenols, and naphtha.

Approximately 22,000 tons of lignite daily are received from the Beulah-Hazen coal deposits, and 8,000 tons of fines are returned to the adjacent Basin Electric Power Plant. The remaining 14,000 tons are used in 14 gasifiers. The other essential ingredients include 6.6 million gallons of water daily, 3,000 tons of pure oxygen, and 90 mw-hours of electrical power.

Construction of the plant was scheduled for 48 months but was completed in 45 months. This included placement of 155,000 cubic yards of concrete, 65,000 lineal feet of piles, erection of 55,000 tons of structural steel, 29 miles of process piping, and 150 miles of wire and cable.

## Project Responsibilities

The project was undertaken as a joint venture between Lummus Engineering and Kaiser Engineers. KE was responsible for detail design of support facilities outside of the process reactors and complete construction of the project. KE was responsible for detail design and procurement for site development, support buildings, coal preparation and handling, a 3,100-ton-per-day oxygen plant, steam generation plant, electrical supply and distribution, secondary water treatment, ash disposal, sanitary treatment, raw water intake and transmission pipeline, railroad, and construction camp. Lummus was responsible for detail design of the process unit under license from Lurgi of Germany.

Because of the project's size and demanding requirements, many of the cream of KE's construction group were assigned to the job. It was during George Roberts' reign as vice president of industrial construction that an intensive planning effort began to market this project.

Under his direction, a very comprehensive construction management plan was developed and ultimately the project was awarded to KE.

Significant features of areas that were KE design / procurement responsibilities were:

**Site Development**

Site selection was based on analysis of:

- proximity to coal deposits
- not being over coal
- the area required for the plant
- access to existing roads and railroads
- access to permanent water supply

The site selected is a glacio-fluvial trench of clays, sands and silts, requiring an extensive geotechnical exploration program.

Because the site was located in the 'Beulah Trench,' a peripheral drainage system was designed and constructed prior to any final construction. The peripheral drainage ditch is 22,416 feet long, concrete lined, with an invert width of 12 to 20 feet.

**Coal Storage**

The 125,000-ton live coal storage building and equipment are supported by a proprietary system of soil stabilization called ‘Reinforced Earth.’ The system consists of concrete facing panels, tied back with metal strips embedded in the compacted soil.

The live coal storage facility is the largest constructed in the United States using the Reinforced Earth system.

**Off-site Development**

The raw water intake and pump station are located on Lake Sakakawea, about eight miles north of the plant site. The water intake system consists of an offshore submerged inlet, an on-shore pumphouse, and an interconnecting tunnel. The bid documents were prepared in a performance-type specification format, including design criteria, soils information, and two tunneling methods. The contractor was responsible for design of all facilities.

A new railroad spur from the existing Burlington Northern track provides railroad access to the plant site. The new single track is about 7.9 miles long. Significant features include a 160-foot pile-supported open deck bridge and a 300-foot-long Armco superspan.

**Construction Workforce Housing**

KE’s design/procurement responsibilities included providing housing for the workforce. These facilities were combined with an existing workforce housing facility purchase by ANG. The infrastructure and roads were designed so that after removal of the housing units, the site could be used for a conventional housing development. The following housing units were provided:

- 40 barracks-type buildings each with 16 motel-type rooms each
- 100 pads for RVs with utility hook-ups
- shower and laundry building
- additions to an existing dining hall
- all site development and infrastructure

## KE Staff Personnel

Ken Willis was project manager at the site. His key staff consisted of Ken Shuerman, Joe Sullivan, Ray Dorr, Doil Yocham, Dave McMyler, John Berentis, Gary Thronson, Kurt Kehler, Ken Smith, and Dale Wilson. Key staff grew to a peak of about 600.

In Oakland, Bill Deeths was deputy project director, and Milt Palkowitz was engineering manager. Cliff Gambs was principal project engineer responsible for site development and all off-site facilities. Additional principal engineers were:

| | |
|---|---|
| Mike Jennings | Oxygen Plant |
| Rudy Spatenka | Steam Plant |
| Larry Hedrick | Electrical works |
| Ivo Gustetich | Civil works |
| Les Dittert | Structural |
| Ian Morrison and Jack Delaney | Coal Handling |
| Cloyce Buckert | Piping |
| Chuck Mandell | Scheduling |

## Process Description

The plant uses 14 Lurgi pressurized fixed-bed gasifiers, reacting with steam and oxygen in countercurrent flow with coal. The process begins as the coal is fed into the top of the gasifiers, and steam and oxygen are fed into the coal bed at the bottom of the gasifier. The crude gas leaving the gasifier has a low heating value. The raw gas is further treated by catalysts to upgrade its heating value and stripped of by-products. The final product gas has a normal high heat value of 970 BTU per cubic foot. The gas is cooled, dried, and compressed to pipeline pressure of 1,450 pounds per square foot and injected into the Trans-Continental pipeline for distribution.

## Construction Costs

The loan guarantee for the entire project obtained from the Department of Energy was $2.1 billion. Mine development, handled by the client, totaled $900 million. Project construction was budgeted for $1.2 billion but came in under budget at $1.1 billion. This portion of the project, if built in the year 2000, would cost about $2 billion.

KE’s service revenue was $110 million of which project and design revenue was $41 million, indicating the large volume of design effort required.

## Salient Project Features

Because of the remote location and lack of labor forces, it was necessary to construct a 1,000-man construction camp for craft labor. It was full at all times, and it served the best food in Beulah.

Due to the extreme winter temperatures and the fast track schedule, more than $4 million were spent the first full winter of construction on temporary enclosures and propane space heating.

At the height of construction there were 4,300 craft people on site and 610 KE personnel. There were 41 mobile cranes, and a 1,500-ton ringer crane was used for erection of equipment and steel. Total construction manhours were 11,500,000. Total design project manhours were 3,000,000. By 1983 at peak of construction, there were 4,200 construction workers employed on the project.

A major contributor to the success of the project was the North Dakota Labor Stabilization Agreement negotiated by KE with the international construction trade unions. The project had no significant labor disputes; no work stoppages and no lost time except that due to the rugged North Dakota weather.

## **Nuclear Fuels, Mining & Processing** Overview

Complementing KE's nuclear projects department were the efforts of the minerals group in providing engineering and construction services to the uranium extraction industry. The nuclear industry was particularly active in the 1960s and 1970s. KE's nuclear department had projects in governmental and private nuclear power areas, and it did facility management for nuclear laboratory facilities. This section describes the uranium mining and processing projects performed by KE.

### Uranium Extraction Technology

The common method of extracting uranium from its ores is by dissolving the contained uranium salts in sulfuric acid and then extracting the uranium from the solution by ion exchange into a solution of kerosene containing specialized organics. The uranium salts are precipitated and recovered from the kerosene solution.

Uranium is not a rare metal. It comprises some 4 parts per million in the earth's crust compared with 0.1 part per million for silver.

Extraction of uranium from its ores is performed by a sequence of relatively simple technologies. A typical flow sheet for extraction of uranium from acid-amenable ores is as follows:

- crushing and grinding incoming ores
- agitating leach section with sulfuric acid as the solvent
- counter-current-decantation washing section in thickeners
- clarification section for thickener overflow
- a counter-current solvent extraction section where clarified solution is vigorously mixed with kerosene and organic solution and then flows into a settler tank
- a stripping section, similar to the solvent extraction section in which the pH is adjusted, and uranium returns to an acidic solution, and kerosene is recovered
- a precipitation section with agitating tanks for adjusting pH to alkaline, often by ammonia and yellowcake is precipitated out as fine uranium oxide powder. The mixture is thickened and solids dewatered, and the paste is dried and packaged.
- Typically uranium ore contains only a small amount of uranium. Thus, virtually all the mined material reports to tailings ponds. As much of the solution as possible is returned from the pond to the operating plants.

The above uranium work was accomplished by most of the project personnel in the minerals group including Darl Lewis, Debra Mohapatra, Al Turk, Rex Guinevere, and Al Wallach.

### Churchrock, New Mexico Uranium

In 1968, KE was retained by United Nuclear Corporation to prepare a feasibility study on the use of concentrator equipment that had been purchased by United Nuclear in the Ambrosia Lake area for a new plant at Churchrock near Gallup, New Mexico. After completion of the study, United Nuclear decided to construct an entirely new concentrator to process 2,000 tons of uranium ore per day. A conventional acid-leach plant was designed and constructed. At the time of the original project, KE's recommendation for the installation of semi-autogenous grinding was rejected in favor of conventional crushing and grinding. However, subsequent industry experience bore out the recommendation. The final plant was placed in operation in 1975, using a semi-autogenous grinding mill.

### Conquista, Texas Uranium

In 1970, KE was awarded a contract for the design and construction of a conventional yellowcake producing plant by Continental Oil at its site near Falls City, Texas. The plant was designed to handle 1,750 tons per day of the most difficult type of ore to be encountered. Due to variables in the market price for yellowcake, it became necessary, shortly after start of operations, to mine only the best type of ore, and mill capacity of over 3,000 tons per day was reached with only minor modifications.

The Conquista Project was the first of a new generation of uranium mills that were not subsidized by the Atomic Energy Commission and was financed by sales of yellowcake to Texas power companies.

## Panna Maria, Texas Uranium

In 1975, KE was awarded a contract by Chevron for the design and construction of a uranium extraction plant at Panna Maria, a few miles away from Conquista in South Texas. At this plant a semi-autogenous system was used for the grinding of the ore with the rest of the plant the typical type described above. Conquista had been designed with most of the plant equipment outdoors, and at Panna Maria this was carried further with even the grinding mill outdoors. After completion of the plant, it was purchased from Chevron by a consortium of power companies to assure yellowcake supplies for their nuclear plants. Chevron continued on as operator of the plant.

## Red Desert Project, Wyoming Uranium

In 1976, the Union Oil Company selected KE for the design and construction management of its new concentrator in the Red Desert near Rowlings, Wyoming. This plant was delayed for two years because of the need to protect an endangered species called the black-footed ferret, which had never been found in the immediate vicinity.

The construction of this conventional plant proceeded at a satisfactory rate until the night before turnover to the client, at which time an electrician inadvertently started a fire that caused extensive damage to the walls and roof of the entire plant. A delay of several months resulted from the fire, but the plant was subsequently operated successfully.

## Bluewater Yellowcake, New Mexico

In 1980, KE was awarded the design, procurement, and construction management of the Bluewater Yellowcake plant for Anaconda at its uranium extraction facility in New Mexico, just west of Grants. The plant was designed as one of the largest yellowcake plants in the world to precipitate 25,000 pounds per day. The Rifle Pit owned by Anaconda was known to be close to exhaustion of its reserves, and no other ore body had been nominated to supply uranium to the extraction plant. So, the reason for the plant was not apparent.

The plant was completed and started up to prove its performance capabilities, then shut down, and never operated again. The Rifle Pit, which had 6,000-tons-per-day capacity, was also closed and dismantled. A $25-million project was completed and abandoned.

## Studies

The uranium group conducted several interesting but in-depth studies. The Queensland Mines deposit in Arnhem Land is located in the Alligator River area of the northern territory of Australia. This is a heavily mineralized uranium district with other major deposits at Rum Jungle, Ranger, and Jabiluka. The Queensland Mines deposit at Nabarlak was only a few hundred yards long and a couple of hundred feet wide and deep but it contained over 10,000 tons of uranium at an average grade of 2.5 percent. This compares with the average Wyoming, New Mexico, or Texas deposit with 0.1 to 0.5-percent grade.

Studies were made in parallel for Queensland Mines and the other for Westinghouse. For Queensland, the study was a planning document on how to exploit the deposit. The deposit was so radioactive due to its high grade of uranium plus a high radium content that an operator could not stand on the bench for any reasonable time. Conditions were so dangerous that a plan was produced to utilize a contractor to accomplish the mining at a very high rate, with limited time of exposure for operators. This would result in the mining being completed in a short time, and all the mined ore would be covered over for gradual feeding to the plant. After many years of political wrangling, the project proceeded roughly as recommended.

The Westinghouse study was concerned with this deposit and with the high possibility for several other deposits associated with it. Westinghouse was anxious to purchase the deposits to provide yellowcake to power plants they were building worldwide.

In 1974, a study was accomplished for Pan Continental and Getty Oil companies on the Jabiluka deposit. It consisted of 200,000 tons of uranium. The caprock is impregnated with gold in sufficient concentration to be a profitable gold mine. Since the deposit is overlooked by Kakadu National Park, an underground mining system was developed for use if open-pit mining would not be permitted by the government.

Due to anti-nuclear political pressure and governmental economic theories, the project did not proceed. Jabiluka is still there, and a deposit of 440 million pounds of uranium is available as an insurance against a shortage of fuel for the world's nuclear power plants.

The Timagaouine Project was a feasibility study prepared for Sonarem, the Algerian government mining entity. KE was one of five companies chosen to perform a study on the same property at the same time. The ore deposit is 200 miles to the southwest of Tamanrasset which itself is 1,200 miles south of Algiers, deep in the Sahara. The project scope included full support facilities including a water source 200 miles to the south. Ore grade was unremarkable, the reserves limited, and the potential costs extremely high. The estimate at the time was $850 million for a 2,000-ton-per-day plant. The project never went ahead.

## Environmental Problems

One authority states that it is possible that the radioactivity released from burning coal far exceeds any released by the nuclear industry. Nonetheless, because of environmental concerns, after about the mid-1970s, very few nuclear plants were being built and demand for uranium products diminished. Consequently, KE's role in this field came to an abrupt halt.

**Table 7.1**
**Mines and Minerals Project List**

*Projects where KE was Architect/Engineer and Constructor*

| Job No.[1] | Project Name | Client | Location | Project Value $ x million |
|---|---|---|---|---|
| 4750 | Eagle Moutain Mine | Kaiser Steel | Eagle Mountain | 5 |
| 50102 | Diatomacious Earth | Great Lakes Carbon | Lompoc | 3 |
| 5149 | N & S Ore Bodies | Kaiser Steel | Eagle Mountain | 4 |
| 5218 | Sunnyside Coal Mine Adds | Kaiser Steel | Utah | 5 |
| 5549 | Fine Ore Beneficiation | Kaiser Steel | Eagle Mountain | 4 |
| 5560 | Gilsonite Refinery | American Gilsonite | Colorado | 4 |
| 5704 | Diatomacious Earth | Eagle Pitcher | Nevada | 2 |
| 5836 | Iron Ore Concentrator | Quebec Cartier | Canada | 50 |
| 5844 | Secondary Crushing Facility | Kaiser Steel | Eagle Mountain | 11 |
| 6003 | Townsite | Quebec Cartier | Canada | 10 |
| 6115 | Iron Ore Facilities | Wabush Mines, Ltd. | Canada | 68 |
| 5136 | Iron Ore Beneficiation | Kaiser Steel | Eagle Mountain | 6 |
| 6304 | Asbestos Stripping | Lake Asbestos | Quebec | 5 |
| 6401 | Iron Ore Beneficiation | Kaiser Steel | Fontana, CA | 19 |
| 6402 | Town for Remote Construction | Wabush Mines, Ltd. | Canada | 6 |
| 6545 | Iron Ore Pellet Plant | Hamersly Iron Ore | Australia | 46 |
| 6558 | Radum Aggregates | Kaiser Sand & Gravel | California | 12 |
| 6601 | Pellet Plant Pilot | Wabush Mines, Ltd. | Canada | 5 |
| 6603 | Magnesium Plant | Sea Mining Corp. | Canada | 4 |
| 6620 | Lead Smelter | Asarco | Glover, MO | 34 |
| 6746 | Caustic Chlorine | Kaiser Aluminum | Baton Rouge | 25 |
| 6748 | Caustic Chlorine | Kaiser Aluminum | Gramercy | 25 |
| 67002 | Phosphorous Manufacturing | Electric Rod Co. | Canada | 40 |
| 6866 | East Intercourse Iron Ore | Hammersly Iron Ore | Australia | 110 |
| 6932 | Strontium Carbonate | Kaiser Aluminum | Nova Scotia | 13 |
| 6957 | Copper Crushing, Leaching | Asarco | Arizona | 9 |
| 7034 | Crushed Aggregates | Gifford-Hill | Texas | 9 |
| 7041 | Fluoride Plant | Kaiser Aluminum | Louisiana | 5 |
| 7043 | Iron Ore Concentrator | Wabush Mines, Ltd. | Canada | 31 |
| 7044 | Iron Ore Pellet Plant | Wabush Mines, Ltd. | Canada | 42 |
| 7045 | Copper Concentrator | Gaspe Copper | Quebec | 57 |
| 7051 | Railroad Upgrade | Hamersly Iron Ore | Australia | 41 |
| 7054 | Uranium Ore Processing | Continental Oil | Texas | 7 |
| 7127 | Iron Ore Conc., Pellet Plant | Cleveland Cliffs, Tilden | Michigan | 120 |
| 7145 | Calcining Plant | Kaiser Cement | Long Beach | 3 |
| 7218 | Empire Iron Mine | Cleveland Cliffs | Michigan | 27 |
| 7381 | Goal Gasification Plant | Great Plains Coal | North Dakota | 2,200 |
| 74202 | Zinc Refinery | Jersey Miniere | Tennessee | 136 |
| 74131 | Uranium Mill | United Nuclear | New Mexico | 27 |
| 75083 | Iron Ore Plant | Reserve Mining | Minnesota | 345 |
| 75178 | Uranium Mill | United Nuclear | New Mexico | 27 |
| 76160 | Uranium Mill | Union Oil | Wyoming | 35 |
| 76163 | Uranium Mill | Chevron | Texas | 19 |
| 78152 | Troy Silver/Copper Conc. | Asarco | Montana | 51 |
| 85105 | Coal Gasification Plant | Great Plains Coal | North Dakota | 20 |

con't

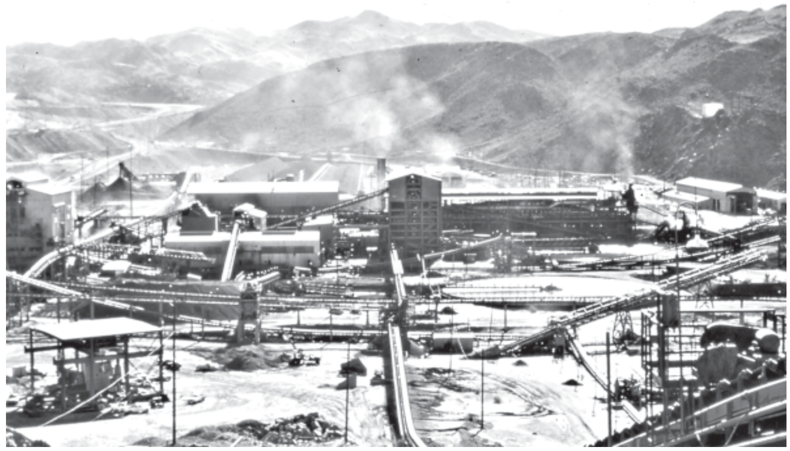
**Table 7.1 con't**

*Projects where KE was Architect/Engineer and Construction Manager*

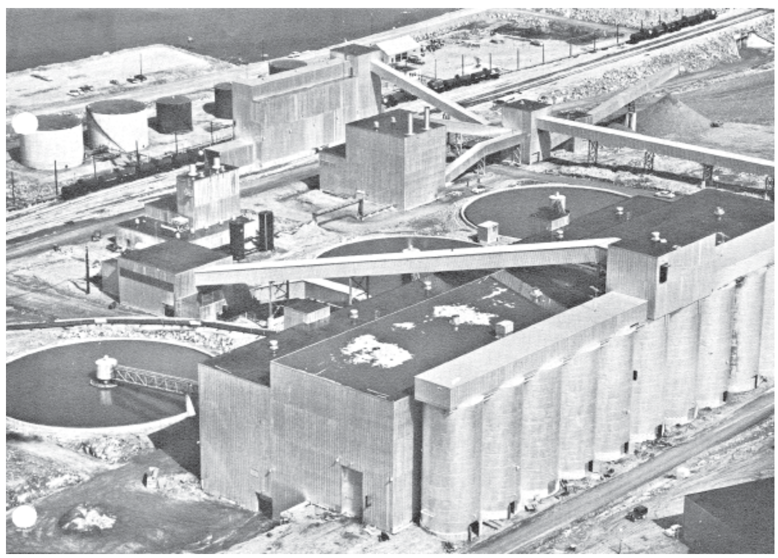
| Job No.[1] | Project Name | Client | Location | Project Value $ x million |
|---|---|---|---|---|
| 6059 | Mt. Isa Railroad | Queensland Government | Australia | 5 |
| 6111 | Copper Production Facilities | Soc. Minera El Teniente | Chile | 7 |
| 6359 | Mt. Isa Railroad #10 | Queensland Government | Australia | 5 |
| 6442 | Smelter Modifications | Kennecott Copper | Utah | 25 |
| 6866 | East Intercourse Island Port | Hamersley | Australia | 110 |
| 7037 | Elkview Coal Prep Plant | Westar Mining | Canada | 11 |
| 7045 | Copper Concentrator | Gaspe Copper | Canada | 57 |
| 74076 | Columbium Flotation | Niobec, Inc. | Canada | 10 |
| 74134 | Coal Prep Plant | Gregg River Resources | Canada | 20 |
| 74202 | Zinc Refinery | Jerseye-Miniere Zinc | Tennessee | 136 |
| 75012 | Lead Sinter Plant | Empresa Minero Centro | Peru | 18 |
| 75149 | Elkview Plant Expansion | Westar Mining | Canada | 4 |
| 75160 | Coal Dewatering Facilities | Westar Mining | Canada | 20 |
| 76138 | Zinc Concentrator | Jersey-Miniere Zinc | Tennessee | 19 |
| 76176 | Copper Mine | Caraiba Metals | Brazil | 325 |
| 78110 | South Trend Mine | Mobil Oil | New Mexico | 30 |
| 79087 | Calcium Carbide | White Martina | Brazil | 80 |
| 79167 | Coal Conveyor | Minas Carbon Escondido | Mexico | 25 |
| 80054 | Centromin Lead Sinter | Empresa Minera Centro | Peru | 41 |
| 80152 | Uranium Rehab | Union Oil | Sweetwater, WY | 40 |
| 81102 | Bullmoose Coal Mine | Tech Corp. | Canada | 99 |
| 81171 | Glendell Coal | Raymond Engineers | Australia | 58 |
| 81192 | Coal Export Terminal | Dominion Terminal | Virginia | 76 |
| 82015 | Copper Concentrator | Empresa Minero Centro | Peru | 300 |
| 82070 | Coal Gasification/Methanol | TVA | Alabama | 1,000 |
| 83196 | Nickel Laterite | California Nickel | California | 6 |
| 84147 | Talc Grinding | Nicor Mineral | Montana | 9 |
| 85116 | Minerals Port | Government of Gabon | Gabon | 150 |
| | | | | 6,413 |

*Notes:*

[1] Numbering is chronological with the first two numbers indicating the year the project was initiated.



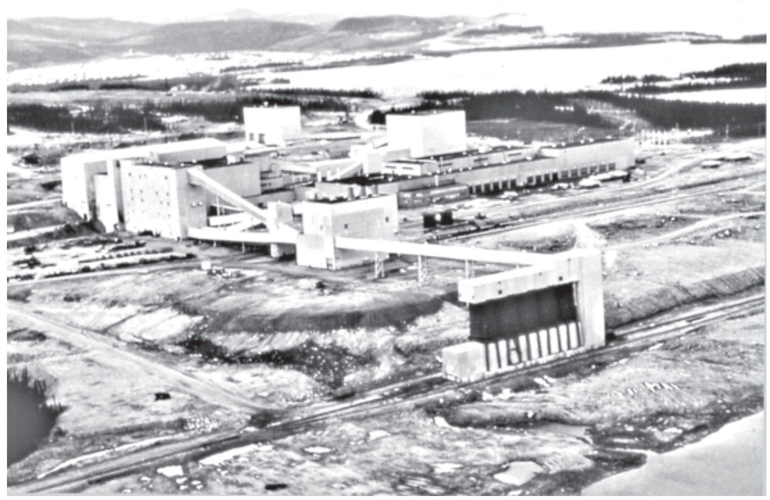
Eagle Mountain Iron Ore Mine where KE got its start in engineering and building iron ore plants. Built in 1947, it was constantly expanded to meet the increasing Fontana Steel Mill needs until cessation of operations in 1980.



In 1957, capitalizing on its background and traditional interest in raw materials mining and processing, KE organized its Mining and Minerals Division. The company recruited key mining engineers and process people to market itself to the ferrous and non-ferrous minerals mining industries.

The Division acquired expertise and became a leader in the design and building of numerous iron ore projects, non-ferrous minerals projects, and coal projects.

Successful marketing resulted in landing large iron ore concentrator projects in Canada. This is a photo of the Quebec Cartier Plant at Lac Jeanine, Candada. Completed in 1960, it operated successfully for 20 years until its ore supply was depleted.

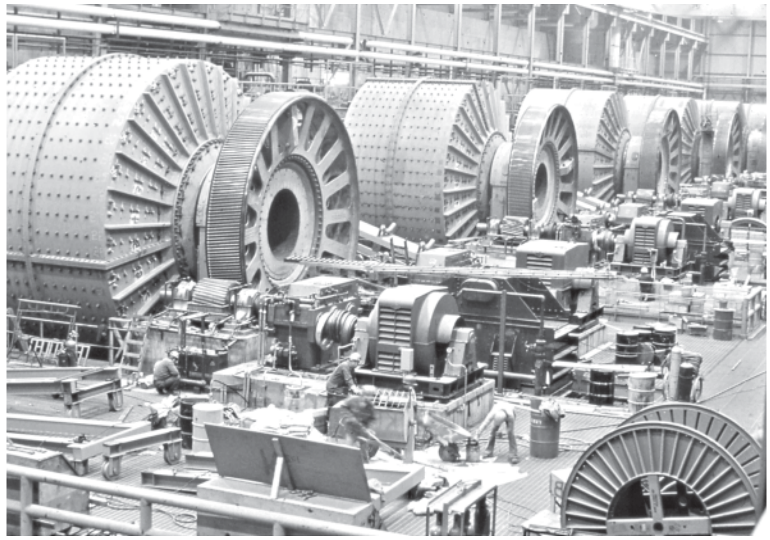


Wabush Lake Concentrator, also located in Northern Canada near Lac Jeanine, was accessible only by small plane and boat. The project was completed in 1963.

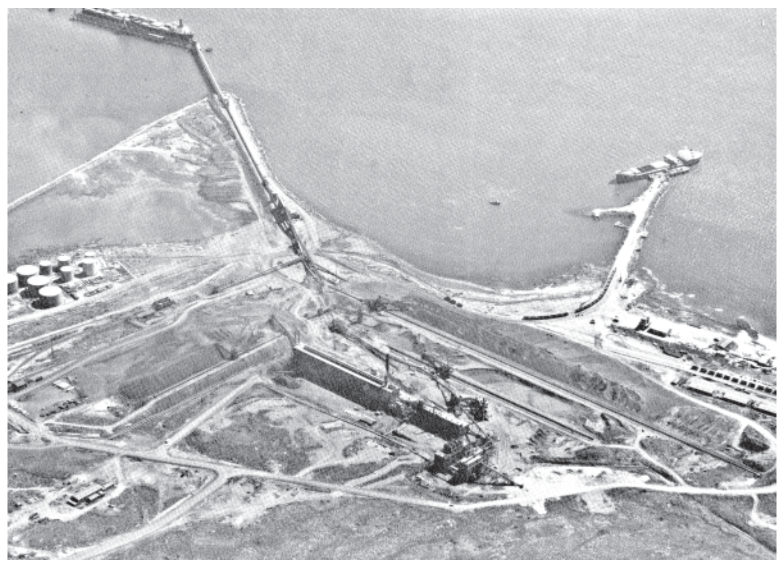
Temperatures got as low as 62 degrees *below* zero. Winter lasts from October to April with 12 feet of snow per year.

KE provided iron ore services for other independent steel companies also. The Tilden Project for Cleveland Cliffs, built in Ishpeming in the northern Michigan peninsula in 1974. At the time it included the largest grate-kiln installation in the world.

Photo (right) shows large autogenous grinding mills being erected. The term ‘autogenous’ means ore grinds against ore without outside media being used.



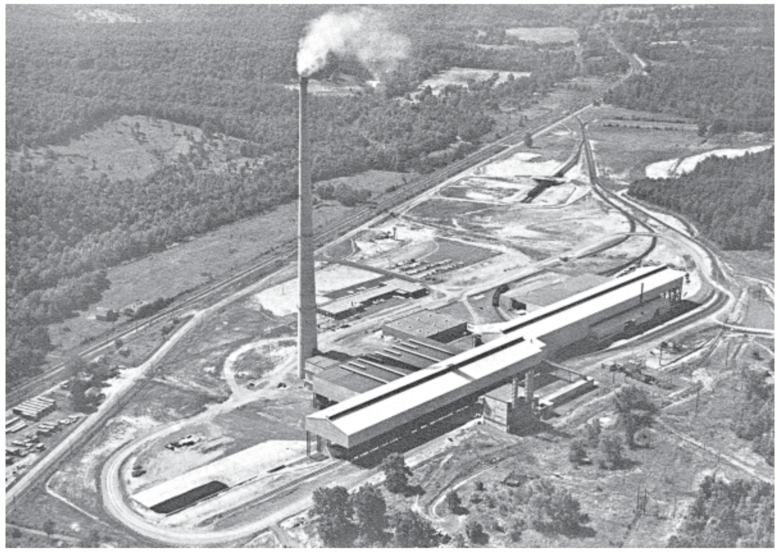
During the early 1950s and 1960s, KE provided Kaiser Industries and Kaiser Steel with engineering assistance as they searched for high-grade iron ore around the world. Initial forages were made to evaluate the high-grade Brazilian iron ores under the sponsorship of Tom Price, who was Mr. Kaiser’s raw materials expert and one of his first employees. When Price made an invited trip to Australia, he ‘discovered’ the Hammersley iron ore range and gave up on Brazil because of its difficult economic and political climate. He went on to encourage what proved to be an extremely successful iron ore venture in Australia.



The initial Hammersley facilities at Dampier (right) included a shipping port which received ore by a 200-mile rail line that we built from the deposits at a location now called Mt. Tom Price (it’s on the map that way). KE provided engineering and construction management services for this 3-million-ton-per year project.

The market grew since the quality and price were so attractive that the facilities were expanded in 1968 and in 1972. By then, a new shipping facility was designed and built by KE at East Intercourse Island near Dampier. By the 1990s, the source was producing at the rate of 50 million tons per year. The port and stockpiles are shown here.

KE's mining and minerals expertise extended to non-ferrous industries also. Projects were undertaken in lead, copper, zinc, diamataceous earth, and coal.



The Glover, Missouri, lead smelter built for ASARCO in 1966.

Great Plains Coal Gasification. Plant located in Beulah, North Dakota.

With the oil crisis in the early 1970s in the Middle East, oil went from $3 a barrel to $34. Coal became a more viable source of energy. KE organized an energy resource group within the mining and minerals division to capitalize on the opportunities. Emphasis was placed on the use of coal as a fuel. A number of coal preparation plants were undertaken. Then in 1980, KE was awarded the massive ANG project for the Great Plains Coal Gasification Plant. KE mobilized a large staff to design the infrastructure and support facilities and to build them. At peak, there were 610 KE personnel at the jobsite. Construction workers reached a peak of 4,300. KE earned a substantial revenue and profit from the job. This project, if currently built, would cost about $3 billion, of which KE's share of the work would be $2 billion. Lummus Engineering did the process design for the reactors, and KE did the erection.

Chapter 8

# Transportation

## Overview

*Editor's Note:* This chapter was abstracted from a book written by Herb Thomas and his staff, entitled, *A Partial History from 1961 to 1986: The Transportation Engineering Division—Kaiser Engineers.* It was published in February, 1996. The book contains 100 pages of text and photographs of projects and the people who did the work. It is an excellent compendium of KE's involvement in all transportation projects beginning from 1961. Space does not permit including it in its entirety. Selected large projects have been abstracted and are featured in this chapter. John Bergerson, who was the last head of the Transportation Division for Kaiser Engineers, edited the chapter for factual accuracy and added information about projects undertaken after the KE history ends (in 1986) through the year 2000.

There was no Transportation Division in Kaiser Engineers prior to 1962. KE had, in connection with its large industrial projects, designed and built roads, bridges, and railroads, but there was not an organization whose purpose was to pursue public transportation engineering. Then through a series of strategies that succeeded, the division took off. We begin the history by relating first the largest, most successful projects undertaken—rapid transit projects.

Rapid transit projects designed by KE for the cities of Los Angeles, Baltimore, Miami, Chicago, and Boston are large by any measure. Each project on its own covered decades of work by KE's staff. For example, in Los Angeles KE was involved from 1966 to 2000, a period of 35 years (even more considering initial studies started in 1961). In Baltimore, we were active for 36 years, 11 years in Miami, 10 years in Boston, and 14 years in Chicago.

These projects were all large. In terms of costs, the Los Angeles Red Line (the first L.A. project undertaken) cost $2.9 billion, and the follow-on Los Angeles lines now called the Blue and the Green Lines cost $1.75 billion. The three sections of the Baltimore system cost $1.3 billion. Miami cost $1 billion; Boston, $750 million; and Chicago, $500 million.

KE also was part of the design team for the Taipei Transit System from 1987 to 1995, which was after the period covered by this KE history.

Following the description of these major rapid transit projects, there is a synopsis of the substantial number of studies, preliminary designs, and research performed for transit vehicle design, transit access to airports, transit within airports, railroad engineering, design of transit and motor bus maintenance facilities, highway bridges, and KE's involvement with the Bay Area Rapid. Transit.

## Background

In the decade prior to 1960, the economics of operating public transit had become so unfavorable that continuation of the service in many urban areas was threatened. This situation first manifested itself on the East Coast between Philadelphia and Boston, particularly with the privately operated commuter railroads. Also, the rail transit systems were losing patrons, raising fares, and eliminating services. Most trolleys operating in city streets were abandoned. The deteriorating economics of public transit were largely caused by the much greater use of the private auto and the resulting great imbalance in the investment in transportation facilities. Highways and related facilities were generously funded while public transit was mostly ignored.

By the early 1960s, the situation had become so serious that governments were taking action first to preserve and later to improve their transit services. As an example, the State of New Jersey in 1958 had established a Division of Railroad Transportation and placed it in its Department of Highways with the mandate to preserve all essential railroad commuter services while long-range improvement plans were developed. Numerous other cities and states in the east were taking similar actions. But the governments soon learned that to accomplish any meaningful improvements, heavy investments would be required.

Responding to this requirement, New Jersey Senator Harrison P. Williams introduced legislation that ultimately resulted in creating the Federal Urban Mass Transportation Agency (UMTA). The first emphasis of this new agency was to fund demonstration projects to test passenger reaction to fare adjustments, to service levels, and to transit vehicle technologies—all for the purpose of developing more knowledge about, and interest in, public transit. Concurrently, capital projects began to be funded by UMTA on a two-third-federal, one-third-local basis. The number of these applications grew rapidly, and UMTA budgets increased, and the federal share was increased to 80 percent.

KE recognized that the engineering of public transit projects had great potential for new business. The man who first recognized this and acted accordingly was Victor E. Cole, then a vice president of KE. At that time, there were only four firms in the U.S. with extensive experience in transit engineering: Parsons Brinckerhoff Quade & Douglas (PBQ&D) based in New York City, DeLeuw Cather & Co. based in Chicago, Louis T. Klauder & Co. based in Philadelphia and Gibbs & Hill based in NYC. In the same period, Daniel Mann Johnson & Mendenhall (DMJM) based in Los Angeles, the Bechtel Corp. based in San Francisco, and numerous other firms, were showing great interest in transit engineering.

Vic Cole's efforts to move KE into transit engineering were first successful in Los Angeles where the Kaiser name was well known and respected. As early as 1961, KE was selected by the Los Angeles Metropolitan Transit Authority (Authority) to develop a "backbone" route as the first increment of a transit system for the Los Angeles area. KE carried out this assignment expeditiously and defined the backbone route as the 23 miles between Century City on the west and El Monte on the east. It did sufficient engineering to estimate that the cost of the 23-mile route would be $218 million. KE offered to complete the design and construct the route on a "turnkey" basis for that amount. Neither the Authority nor the City of Los Angeles could legally, politically, or financially enter into such a contract—and the studies continued.

Concurrently, on the opposite side of the nation, the National Capitol Transit Agency, the predecessor to the Washington Metropolitan Transit Authority, was planning a transit system for the nation's capitol. In 1962 Vic was successful in getting a series of contracts in the planning phase. The first was to develop a 9.5-mile transit route through downtown Washington, D.C. Preliminarygeologic investigations were made and tunneling methods, costs, and schedules were prepared for both line sections and passenger stations. Subsequently, a more detailed planning program by KE evaluated alignments for all planned routes, prepared electrification criteria, and then determined annual cost of power based on the routes and operating plan. When this system went into the design phase, the agency expressed its satisfaction with KE's earlier work by awarding to KE the design of the Connecticut Avenue subway from Dupont Circle just a few blocks from the White House, northwesterly to a location just beyond Rock Creek Park.

## Organization

The group was organized and managed by Vic Cole, who became an executive vice president of KE, until his retirement in 1981. Herb Thomas was employed as the department manager in 1968 and subsequently when the group was given division status, Herb continued to manage the division through 1979 when he was promoted. Frank Matthias was the first vice president of the division until his retirement in 1973. *(Editor's Note:* Matthias was known as a vocal advocate for the merits of Rapid Transit work when it was in its infancy. His remarks at the KE Silverado management meeting in the early 1970s (as recalled by Sam Ruvkun) were eloquent in their clarity. He stated that rapid transit projects were expensive and required subsidies, since only 50 cents out of the dollar came from the fare box. On the other hand, he pointed out how the highway system was equally subsidized by federal grants, gas tax funds, fees, and tax exemptions. In all, at that time, he stated that it cost $1 per mile to operate a car.)

Zoltan Stacho was the manager from 1979 to 1983 when he was also promoted. Then Steve Kauffman managed it until he retired in 1988. Ralph Mason managed the division from 1988 through 1993 when he left the company, and John Bergerson followed Ralph and was managing the Transportation Division when the company was sold to Earth-Tech in 2000.

The major transit projects were usually carried out by joint ventures. The main reason was because a single firm usually did not have the broad range of engineering and architectural experience required to carry out a major transit project. Clients often had favorite and local firms they wanted involved in the work and the joint-venture organization was a means of accomplishing that. The advantage to the designers was that risks were spread—but so were the profits. One obvious advantage for joint venturing was that there would be fewer competitors, but that was not the prime motivation.

The clients on the large projects usually wanted to have essentially all the work done in their cities, thus requiring key personnel to relocate to the site. It also required establishing project offices complete with all the office equipment necessary for efficient engineering and related operations. The KE home office always provided broad policy guidelines and supported the project as the managers requested. But the KE project managers had sufficient authority to manage their work effectively. On all UMTA (Federal Urban Mass Transportation Administration) funded programs, about 15 to 35 percent of the engineering work had to be performed by minority and women-owned firms. Satisfying these requirements resulted in some complex contractual arrangements challenging the skills of the managers. In addition, clients often provided space in their own building for use by its selected engineering firms. The stated purpose was to improve communication and supervision, but likely having closer observation of the engineer's work habits was a factor.

KE's work on the Los Angeles Rapid Transit system started our staffing process as more and more assignments were awarded to us. Recognizing that there could be much more transit work in the years ahead, Vic Cole recruited engineers with transit experience from across the land. He persuaded Farrel Schell to leave his position at Bechtel and hired Herb Thomas from New Jersey. From other divisions of KE came Chris Andersen, Jim Ellis, Ivo Gustetich, Don Mauser, Rey Belardo, Pete Hackley, Gene Stann, and Nev Williams. From colleges on the West Coast, he hired John Bergerson and Bob Murphy. Other early additions to the staff were Ralph Mason, Red Beebe, Ray Snyder, Harv Hunt, Morris Burgess, Bill Custer, Gerry Seelman, Tom Gibson, Zoltan Stacho, Paul Landis, Alan Dale and Nick Brown, all of whom became key people in the growth and success of the transit division. Those named had the longest tenure with the division. Concurrently, many others were added to the Oakland staff and to project offices. The division became a major contributor of revenues and profits to KE.

A decision was made early to concentrate on the engineering of the transit operating systems as opposed to civil and architectural work. There were many firms capable of the latter, but few who were qualified in transit electrification, automatic train control, communications, and vehicle design—the systems that ensure that rail transit will operate safely, dependably, and economically. KE also contributed management personnel to the early joint ventures in both civil and systems engineering.

In Baltimore and Miami, the joint ventures had management committees whose members were one or two principals of each firm. The committees met periodically generally for two days at the project office. The project manager prepared the agenda for the meeting, supplemented by items that the committee members might request. A meeting of the committee with the client was normally arranged during the visits.

Gene Stann was the project manager for the Kaiser Transit Group as the five-firm joint venture in Miami was called. He maintained excellent rapport with all the parties. A feature of the Miami project was the extensive public involvement program carried on throughout the project. At one of the public meetings in the planning phase, a spokesman for one of the groups made a statement to the effect that he and his group had confidence in and believed what Gene Stann told them, but he could not say the same for the Miami officials! After Gene retired Ralph Mason became the project manager.

In Baltimore, DMJM was the sponsor of the joint venture since it was DMJM's marketing effort that captured the job. David Hammond, formerly chief engineer at BART, was the joint venture project manager. Bill Custer was the KE manager in Baltimore during the design phase and until construction of the first section was essentially complete. KE did most of the engineering of the operating systems. Tom Gibson was the principal transit systems engineer. Although Tom remained in Baltimore throughout his tenure with KE, he assisted with systems work on many of KE's projects. Tom succeeded Custer as PM in Baltimore and retained that position until his retirement. Paul Landis succeeded Gibson as PM and completed the project. Paul is still with KE's successor company.

The third large job for KE on the East Coast was as coordinating consultant on Boston's Southwest Corridor. Bill Custer left Baltimore to manage this difficult, technically demanding project. Again, a joint venture was formed for this work with KE as the sponsor. Its partner was the Boston-based firm of Fay Spofford & Thorndike (FST). Zoltan Stacho and Bill Custer did most of the marketing for the job. The client was the Massachusetts Bay Transportation Authority. (Interestingly, Zoltan Stacho had managed a transit contract in Boston for PBQ&D just before joining KE and Herb Thomas had worked for FST for 13 years earlier.) The work was accomplished in a manner similar to Baltimore and Miami—essentially all the work was done in the joint-venture project office. But the Southwest Corridor was much more than transit work—it involved consolidating Amtrak and MBTA in one common corridor, with common stations. This project received 13 awards, more than any other project performed by the Transportation Division.

## Marketing in the Transit Division

Essentially all the transit projects in which KE was a participant were financed by a combination of federal, state, and local funds with two-thirds to 80 percent of the moneys being provided by UMTA. The procedures specified by UMTA for selecting firms required that a client issue a Request for Proposal (RFP) and simultaneously submit it to at least three qualified firms. After review of the proposals, the highest rated proposers would be invited for an interview giving them an opportunity to present their plan for accomplishing the project both orally and graphically. Then the client would make the selection. In reality, these procedural steps were followed, but much more activity was involved.

Communication in the transit industry is good, and firms would know when a government or an operating agency was planning a project. Lobbying of that potential client would begin in several ways, but the most effective way was helping that client in some way by assisting with his planning or by helping him understand UMTA requirements or by furnishing "state-of-the-art" information on transit technology. An example of helping a client with good success follows: a KE man on his return trip from Baltimore arranged to visit the director of a newly organized transit agency in Kansas City. In the course of the meeting, it became clear that the director was worried about a transit speech he was scheduled to give the next day. The KE man offered to draft some interesting material for his speech during the next few hours. The director accepted and provided him with a desk. He was delighted with the material prepared. A few weeks later KE was invited to propose to be the agency's consultant and soon thereafter was selected for the job. (The Kansas City program—later was cancelled, however).

With large experienced clients, often the most effective lobbying was accomplished by visits from KE executives. But in all cases, the lobbying had to be continuous from first news of a new project until the selection was made. This process confirmed the often-heard truism—"If you have not won the job by the time the RFP is issued—you will not."

The Transportation Division always did its own marketing, but not always by a designated marketing person. In the early years contracts were obtained by Vic Cole, Pete Iovin, Farrel Schell, and Herb Thomas. In 1971, Gerry Seelman became the marketing manager but did much more than market. He usually wrote or managed the writing of proposals, managed the interviews, and continued the contacts with the clients during the design and construction phases.

The UMTA-imposed consultant selection process resulted in some interesting actions by clients. KE received a call from the general manager of a transit operating agency on the East Coast saying that UMTA would not approve having the firm that had been doing its work in the past continue on its new project—that he would have to get competitive proposals from three firms and follow the selection process. The caller asked if KE would submit a proposal knowing that it would not get the job because he would select the firm that had been doing his work. KE did—because the caller was a friend, and he was honest with us.

## Footnote on Marketing in Miami

Since the Dade County, Miami, transit project was the first large transit contract that was obtained solely by KE, the threshold work that preceded its selection for this prestige contract against national competition is interesting. It began in 1966 when Simpson & Curtin, a land use and transportation firm based in Philadelphia, obtained an assignment from Dade County to do the initial transportation planning work. Vic Cole persuaded John Curtin to give KE a subcontract to identify appropriate transit routes within broad travel corridors. The amount of the subcontract was $10,000! Farrel Schell and Jim Ellis did a "windshield" and helicopter survey in Miami between Christmas and New Years in 1968. Then small-scale line and grade drawings were prepared of suggested routes and a most-artistic vehicle rendering was prepared. These and a report written were done all for the $10,000 agreed upon.

The original of the vehicle rendering, about 30 by 40 inches was given to the county, and it was hung in a prominent place in the county transportation office. Next, Gerry Seelman made almost continuous contacts with county officials. KE was later invited to compete for the next phase of the work. The presentation that KE made to a state and county selection board was technically comprehensive and professionally delivered—and KE won against national competition. But if Vic Cole had not persuaded John Curtin to give KE the small subcontract, KE might never have been the manager of the project, which produced about $127 million revenues for engineering and management. As is often said in transit marketing, a foot in the client's door is worth a hundred knocks on its door.

## Kaiser Engineers' Standing in the Transit Industry

Prior to 1962, KE was not involved in transit engineering work. After the early contracts in Los Angeles and Washington, DC, and a contract in the Bay Area to design BART's Diablo Test Track in 1965, KE was gradually able to increase its participation in the field. The joint venture with DMJM, consummated in 1966 for the major studies in Los Angeles, was a milestone event. Then came the large and lengthy contracts in Baltimore, Pittsburgh, Miami, and Boston. As a result of our early work with Westinghouse in Pittsburgh on the new automated peoplemovers, KE gained a reputation and obtained a substantial amount of automated system work in the 1970s. KE won the JFK Airport and Newark Airport peoplemover contracts and the Manhattan Passenger Distribution Study in the New York area, the Oakland Airport-BART Connector Studies, the Denver Regional Transit Study, and the Los Angeles Downtown Peoplemover Study. Other projects of significance included the Lafayette, Indiana, Railroad Relocation Study, and with PBQ&D and DeLeuw Cather & Co., the Subway Environmental Research Project for UMTA. This research work produced a handbook and computer program for designing ventilation systems and developing fire emergency ventilation procedures for transit and other underground structures that has been widely used in the industry ever since. An indication of the value of KE's contribution to this effort is that KE has been selected over the past 25 years by many transit properties to apply the findings of the research to their underground facilities in order to improve ventilation and to establish fire emergency operating procedures. The handbook and its related computer program were the resources used.

In addition to the major rapid transit projects mentioned, KE accomplished many smaller transit and transit-related jobs. By 1980, KE was doing as much transit engineering as any other firm in this country—and the excellent quality of its operating system engineering was recognized across the nation.

## Financial Results of the Transit Division

The first year that financial records were compiled for the Transit Division as an entity was in 1966 when a small loss of $67,000 was recorded. The performance of the division improved annually and by 1971 the division had revenues of $3,500,000 and a gross margin of $712,000. Then with large projects proceeding simultaneously in Baltimore, Miami, and Boston, along with many smaller projects, the profits of the division improved dramatically. The division continued to be a major contributor of profits to the company. In 1987, its revenues were a whopping $40 million.

## KE's Rapid Transit Projects in 6 Cities

As cited above in the introductory section, the marketing strategy was very successful and KE's standing in the industry was excellent. The result of good marketing and the strategy of taking small studies and research projects was that KE was accepted as one of the premier designers of rapid transit systems. It was then awarded a series of rapid transit systems covering six major cities in the United States. They are described in this section of the chapter on transportation.

A summary of the projects begins with the following table, entitled, "Major Rapid Transit Systems Designed." Note how time frames involved on rapid transit projects are quite extended as compared to KE's traditional industrial projects. It takes considerable time to obtain environmental approvals and public financing where such financing requires voters' approval. As part of the environmental process, and usually preceding voters' approval, it is necessary to have open public discussions to allay the voters' concerns. All of this takes technical input. These large projects are built in already developed cities, requiring new structures in populated areas, rerouting of major utilities, and significant property acquisition. Being a public enterprise, cities wanted local engineers and contractors involved, requiring multiple contracts and extended bidding periods. And, of course, designs of stations and structures were subject to oversight to meet local architectural standards.

## Major Rapid Transit Systems Designed

Table 8.1

| Project | Recorded Cost ($x millions) | Time Frame of KE's Involvement | Years |
|---|---|---|---|
| Los Angeles | | | |
| Red Line | $2,900 | 1966-2001 | 35 |
| Blue Line | 877 | 1981-1991 | 10 |
| Green Line | 886 | 1988-1994 | 7 |
| Total | 4,663 | | |

| Project | Recorded Cost ($x millions) | Time Frame of KE's Involvement | Years |
|---|---|---|---|
| Baltimore | | | |
| Section A | $795 | 1967-1983 | 16 |
| Section B | 154 | 1978-1987 | 9 |
| Section C | 340 | 1983-1995 | 12 |
| Total | 1,289 | | |
| Miami | 1,018 | 1973-1984 | 11 |
| Pittsburgh [2] | 300 | 1971-1975 | 4 |
| Boston | 753 | 1977-1987 | 10 |
| Chicago | 490 | 1984-1992 | 8 |
| Taipei[3] | | 1987-1995 | 8 |

[1] The Green Line was undertaken after the period of KE's history (after 1986).

[2] The design was essentially complete and construction was in process when the project was stopped.

[3] Taipei, while outside of the US, is shown because KE provided personnel for the design team for the project after KE's history ends. It was reported to be an $18 billion project.

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## Transit Developments in Los Angeles

*(1966-2000)*

### Summary

The year 1966 became a milestone year for KE in transit engineering. A joint-venture agreement was consummated with Daniel Mann Johnson & Mendenhall (DMJM), based in Los Angeles, with KE acting as the sponsor. The relationship between KE and DMJM that started in LA has endured for the past 35 years in Los Angeles, Baltimore, and nationally in other projects.

In the late 1960s, federal funding support from UMTA increased substantially, giving encouragement to Los Angeles to pursue more vigorously transit development. The KE-DMJM joint venture was retained by the Southern California Rapid Transit District (SCRTD) to continue the studies previously carried out by the joint venture. The original 23-mile backbone route grew to 75 miles as transit corridors were added, and then to 89 miles when a route to Los Angeles International Airport (LAX) was included. The electorate rejected an increase in the property tax to provide local share funding. The studies continued. The proposed system again expanded as a result of the deterioration of air quality in the Los Angeles Basin, which prompted environmental agencies to threaten the curtailment of automobile use in parts of the Basin. Next to be proposed was a rail network of 116 miles and 24 miles of bus roadways. The public was still unimpressed.

As a result of public expression, the rail system was expanded to 243 miles plus an extensive bus network to feed the rail stations. A second property tax increase vote failed, and the era of the major studies by the joint venture ended. The joint venture did, however, continue to carry out smaller engineering assignments for SCRTD over the next few years.

KE's share of this early work in Los Angeles had required a technical staff of about 15 engineers. Peter Iovin was the project manager throughout the period. Chris Andersen and Jim Ellis had been transferred from the design division in Oakland, and they spent the remainder of their careers in transit work. Other members of the team included Nev Williams, Morris Burgess, Bob Snyder, and John Bergerson.

### The Red Line

*(1961-2001)*

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In 1980, the electorate in Los Angeles did approve a 1-cent increase in the sales tax. SCRTD then brought in John Dyer, who was the former transit administrator for Metropolitan Dade County, Florida (Miami) and KE's client, to be its general manager. SCRTD then began the process to engineer and construct an 18.6-mile subway line, eventually called the Red Line, from Union Station to North Hollywood. This implementation process took 20 years and almost $3 billion to complete.

Preliminary engineering of the operating systems for this route was awarded to KE in 1981. The civil work went to a joint venture of DMJM and PBQ&D, and the architectural work went to Harry Weese & Associates. In 1983, UMTA agreed to fund design and construction of an initial segment (4.4 miles) of the Red Line from Union Station to Alvarado Street. SCRTD asked the three teams to form a joint venture, which was named the Metro Rail Transit Consultants (MRTC) to become the general engineering consultant responsible for designing and managing the design of the Red Line. This segment of the route was part of the backbone line defined by KE in 1962. It went into operation in 1993—31 years later. The remainder of the 18.6 miles was completed in segments over the period 1991 to

2001, and KE engineers were involved continuously throughout that period.

## System Design

The MRTC joint venture, in conjunction with SCRTD, developed design criteria and operating philosophies for the Red Line systems, including automatic train control (ATC), for communications, electrification, fare collection, and passenger vehicles.

The ATC system has three subsystems, namely automatic train protection (ATP), automatic train operation (ATO) and automatic train supervision (ATS). It was agreed by the joint venture and SCRTD that only proven, state-of-the-art components would be specified for the ATO installations. The ATP design incorporated fail-safe hardware to automatically keep trains separated by safe distances and to prevent vehicle doors from opening unless trains were accurately berthed at station platforms.

The ATO design enables trains to operate at speeds optimized by the ATS system but within safety constraints imposed by the ATP system. The operating plan adopted requires an operator to be in the lead car of all trains to open and close doors and signal the train to proceed.

The ATS subsystem designed by KE features a computer program, a display console, and an alarm, so that not only all the train operations can be continuously monitored, but the functioning of the mechanical and electrical subsystems as well. The ATS program modifies performance levels of individual trains to restore even spacing of trains after a disrupting event. The ATS subsystem enables centrally located supervisors to observe, log, analyze, and respond appropriately to emergency alarms and electrical and mechanical abnormalities.

## Construction Phase

The 4.4 miles of initial rail transit construction in Los Angeles, known as the Red Line, Segment 1, had its share of problems, mostly in connection with tunneling and in accommodating early activation of the light rail line constructed between Los Angeles City Center and Long Beach, named the Blue Line. KE and other members of the MRTC joint venture were also part of the joint venture that designed and managed the construction of the Blue Line, which helped to minimize the integration problems at the Seventh and Flower interchange station. Construction of the initial 4.4 miles did not, however, have the serious problem of gas intrusion into the tunnels as subsequent construction did. The Red and Blue Lines had a common underground station at 7th and Flower in downtown Los Angeles, resulting in schedule coordination problems.

As in the design phase, KE's responsibilities within the Metro Rail Transit joint venture were with the procurement, installation, testing, and activation of the operating systems. In addition to the systems engineered during design, there were added during the construction phase seismic event detection devices; and, in the below-grade structures, gas intrusion monitoring equipment. The systems contracts were let on the basis that the contractor would complete the design based on his technology and after approval, proceed with the fabrication, installation, and testing.

## Schedule, Budget and Patronage

At the time, the full-funding grant was approved by UMTA; the estimated cost of the 4.4 miles was $1.25 billion. At completion the cost was $1.45 billion.

Revenue service for the system commenced in January, 1993, five months earlier than scheduled. With only 4.4 miles in operation, the line in 1995 was carrying about 19,000 passenger trips per day. The remainder of the 18.8-mile Red Line was opened in segments, with the final piece going into operation in the summer of 2000 when the line opened to North Hollywood. Patronage increased dramatically once the line reached the San Fernando Valley, and in 2001 was approaching 200,000 passengers per day. The ultimate cost of the 18.8 miles was $2.9 billion. KE personnel remained on the project until the complete line opened.

## The People

The KE systems team provided both design as well as design services during the procurement, installation, testing, and start-up phases for all segments of the Red Line. Over the period 1981-2000, over 50 KE personnel worked on this project. The following lists some of these individuals:

Alan Dale - Manager, Systems Design
Morris Burgess - Manager, Electrical Equipment
Scott Rhodda - Manager, Mechanical Systems
Charles Fisher - Supervising Engineer, Communications
Kirk Rummel - Manager, Systems Integration
Norm Jester - Manager, Operations Planning

Debra Mohapatra - Design Controls Manager
Nick Brown - Systems assurance, system safety and integration
Ray Snyder - System safety
Tom Eng - System safety
Paul Karlin - Industrial design
Greg Wasz, Mechanical engineering - vehicle and wayside maintenance equipment
Tom McCranie, Mechanical engineering - supervised installation of mechanical equipment and was successful in getting acceptance of the Los Angeles Fire Department and others, of the gas monitoring and seismic detection equipment.
Andy Edelson - Communications and gas monitoring systems
Dan Baicuiano - Traction power
Arvind Patel - Traction power
Steve Sims - Traction power
Dilip Shah - Mechanical engineering
Lope Mayola - Traction power
Bart Blakesley - Communications
Ed Pollan - Fare collection
Chester Yu - Facilities electrical
Phillip Yu - Facilities electrical
Ron Harvey - Fire/Life safety
Bob Boerwinkel - Train control
Hamid Qaasim - Quality assurance

## The Blue Line, formerly Long Beach-Los Angeles Light Rail Transit
*(1981-1991)*

The Los Angeles to Long Beach system is a Light Rail Transit Line (LRT), started by KE in 1981 as a joint venture with Parsons Brinckerhoff Quade and Douglas. It is included here because it was started during the regime of the authors of this chapter, although it was completed several years later by the successor company to KE. Later, it was renamed the Blue Line.

## Preliminary Studies

In 1981, the Los Angeles County Transportation Commission (LACTC) retained the joint venture of KE and PBQ&D to perform a short study to evaluate various potential transit technologies in the corridor between downtown Los Angeles and downtown Long Beach. This corridor was one of the five corridors that KE and DMJM had studied extensively in the late 1960s. Chris Andersen, John Bergerson, and Ray Snyder were the KE personnel on this work. Based on this study, the LACTC on March 24,1982, designated the Los Angeles to Long Beach line to be the first locally financed transit project in LA County—and it would be an LRT system. Interestingly, from 1902 until 1961, a trolley line operated over much of the route planned for the LRT by Pacific Electric, a subsidiary of the Southern Pacific Transportation Company (SPTC).

In January,1983, the same joint venture was again retained by the commission to perform the preliminary engineering of the project on a 14-month schedule. During this phase, alternative alignments were analyzed, station locations refined, patronage by station and line segments determined, and operating criteria were written. After preparation and approval of the Environmental Impact Report (managed by the joint venture) and after establishing a budget, the LACTC on March 27, 1985, authorized the project to proceed. The project budget on this date was $772 million for 21 miles of LRT. The schedule anticipated revenue operation by December, 1990.

The PBQ&D-KE Joint Venture was then expanded to include KE's old partner, DMJM, and was then given the name the Southern California Rail Consultants (SCRC).

## Design and Construction

Design of the LRT line progressed smoothly by the SCRC team until early in 1986, at which time the SCRC discovered that part of the 29 acres acquired in North Long Beach for the maintenance facility had contaminated soil. The yard was redesigned, and the storage tracks and buildings confined to 17 acres. Later that year, the City of Long Beach requested that the transit line be extended by constructing a single track, a one-way loop in their downtown area. After various alternatives were analyzed, the loop was approved by the commission in June, 1987. It followed several city streets and resulted in adding one station and 4,225 feet to the length of the route. Two additional LRVs were required. The city contributed $8.4 million to its cost.

After the loop was added, the route had a length of 21.3 miles, 15.2 miles of which would be located on the SPTC right-of-way. A total of approximately 6 miles was built on city streets at both the Long Beach and Los Angeles ends of the route. This included .6 of a mile which was constructed under Flower Street as it approached the Flower Street Station on the Metro Red Line in downtown Los Angeles.

There are 22 passenger stations, five of which have additional parking spaces provided. Relocation of 12 miles of the SPTC tracks was required. The alignment and route configuration adopted required cut-and-cover construction at 8th and Flower in Los Angeles.

The Long Beach-Los Angeles line was designed and constructed largely as it was defined by the preliminary engineering effort. In order to construct the route on the shortest schedule, final design of the critical path elements had to proceed concurrently with the preliminary work. Also, the Commission authorized the relocation of the SPTC branch line to proceed by the railroad on a force-account basis. As the construction activities were initiated, the Commission retained a joint venture of PBQ&D, DMJM, and the North Pacific Construction Management firm to manage the construction, with KE as a major subcontractor. Then on October 1, 1987, the two joint ventures were combined to complete the engineering and manage the construction to its completion. KE's responsibilities for this project were significantly different than for the Red Line. KE was responsible for the final design of the entire 15-mile stretch of joint-use alignment with the Southern Pacific Railroad, for the design of the new transit structure crossing over the Los Angeles River and for managing the overall facilities design process. KE personnel also were responsible for the integration activities on the project as well as the system safety and assurance functions. During construction, KE was responsible for all site safety monitoring, for managing all the owner furnished equipment and materials procurement and distribution, and provided personnel to fill a number of field inspection and resident engineering positions.

## Ridership

The Southern California Association of Governments prepared estimates of patronage for the year 2000 assuming that several major transit projects would be operating by then. On this basis, SCAG forecast that the system would carry 35,000 passenger trips per day initially, increasing to 54,700 by the year 2000. After the first five years of operation, the average weekday passenger trips were 40,000. The line, called the Blue Line now, has far exceeded its original ridership projections, and the stations were extended in 2001 to allow three-car train operation due to the increased demand.

## Schedule and Budget

The LRT project was constructed very close to schedule. In 1985, the main operating segment was planned to be opened to revenue operations in July, 1990—and it was. The added loop in Long Beach was opened in September, 1990, and the below-grade section under Flower Street was completed in February 1991—less than two months later than scheduled in 1985.

The cost growth of this project indicates that the people involved in the early phases had a very different idea of the trolley project than what was actually designed and built. At the time, PB/KE did its first work on the line in 1981, an amount of $150 million was "talked about" as its cost. The planners on the Commission's staff produced a figure of $194 million in 1982. The first detailed estimate made by the Southern California Rail Consultants in March, 1985, estimated the cost to be $772 million. At the time, the design was actually completed, this amount grew to $852 million. The final figure was $877 million.

The cost growth from $772 to $877 million resulted from a gradual but continual technical upgrading of the system to improve its safety and reliability. The functions of Central Control were added, increasing its costs. The subway station under Flower Street was changed from having a single-center platform to two side platforms, and the added Long Beach loop was costly. Requirements of the Los Angeles fire department, other public agencies, and the railroad accounted for some of the increase, $80 million of which occurred during the design phase and $25 million during construction. The Blue Line was the fifth LRT facility to be opened in California.

*Historical Note:* A time capsule was buried near the shop building at the time the facility was dedicated in April, 1989. The capsule contains various contributed items and will not be opened until the entire 150-mile rail transit system for Los Angeles is completed.

## The People

The project was carried out under the direction of John Bergerson, who at that time was the Western Regional Manager for the Transportation Division. The on-site manager was Ray Snyder. Chris Andersen handled the civil work; Ron Rypinski operations and maintenance; Gabor Farkasfalvy was chief estimator; Steve Lee was project engineer for traction power; and Foster Needles and Diane Kravif were responsible for systems integration. Gulzar Ahmed was the systems assurance engineer;

and Bill Volkmer was project engineer for maintenance equipment and for fare collection equipment. Barbara Wilson was the project engineer for the Long Beach section of the project. Bill Houppermans managed the design of the railroad corridor section, supported by Ivo Gustetich, Mike Phillips, and John Maher. Roger Troxell managed the design of the transit bridge over the Los Angeles River employing the latest earthquake design codes. Cliff Gambs was field engineering manager during the construction phase. The construction crew included Mack Horowitz, Sherrill McDonald, and numerous others.

### The Green Line

*(1988-1994)*

The Los Angeles Green Line was undertaken in the years after the KE history ends in 1986. It is included here as a historical note of follow-on work performed by a later generation of KE people. It was an $886-million undertaking.

## Rapid Transit in Baltimore

*(1967-1995)*

### Summary

The experience gained in Los Angeles in the 1960s resulted in KE and its joint-venture partners being selected to engineer and manage large transit projects in Baltimore, Miami, and Boston. Initial transit lines in these cities were completed and put into operation considerably before the first Los Angeles line. As a matter of fact, Los Angeles received the benefit of the experience gained on the East Coast, witness the vehicle specifications written principally by KE for the Miami and Baltimore projects, which were largely used for the Los Angeles vehicles.

Baltimore consisted of three distinct projects, called Section A, Section B, and Section C. Their combined construction cost, as recorded, was $ 1.289 billion for 15 miles built. Like Los Angeles, this was a long-term series of projects lasting for 28 years.

It all started in 1967 when our same joint venture, DMJM-KE, became the engineering consultant for Baltimore. DMJM was in the lead as sponsor this time because it was DMJM's marketing effort that captured the job. One month after the last section went into service, the line was carrying 48,000 passenger trips per average workday.

The Baltimore project was the recipient of several awards during its life, including the Construction Specifications Institute National Award for Excellence in Specifications for a major public works project. It also received in 1995 from the Construction Management Association of America its Construction Management Achievement Award.

### Baltimore Section A

*(1967-1983)*

### Subway Everyone Loves

"Baltimore's got the subway everyone loves." "Baltimore's 13.5-mile subway system is the apple of the transit community's eye." "Keys to success seem to be cooperation among owner, consultants, and contractors and a willingness to try new approaches to old problems."

These quotes originated in the January, 1981, issue of the American Society of Civil Engineers magazine, *Civil Engineering.* This was unusual copy in a period when transit projects were far more often a subject for criticism by editorial writers than praise. An example of the cooperation referred to was the no-strike agreement negotiated with the principal construction unions prior to construction; an example of innovation was the use of precast concrete tunnel liners for the permanent tunnel lining in a 1,500-foot test section.

A difficult 7.5-mile segment of Baltimore transit between Charles Center in Baltimore's central business district (CBD) and northwest to Reistertown Plaza Station, 4.25 miles of which were below-grade and had construction costs of about $795 million, was opened to revenue service in 1983, reasonably close to both the schedule and budget established years earlier. The joint venture attributed this success to "good planning, good engineering, and good luck."

### Good Planning

All transit projects of this magnitude have a long period of development, and Baltimore's project was no exception. It all began, insofar as KE was concerned, in 1967 when the joint venture of DMJM-KE was retained by the Baltimore Regional Planning Council to continue studies of the metropolitan area that had been carried out earlier by others. The objective was to define the facilities needed to accommodate the CBD-bound traffic, particularly in the peak commuter hours. The firm of Alan M. Voorhees and Associates was retained by the joint venture to study the travel patterns, conduct surveys, and make projections of travel for the year 1985, based on the actual home-based CBD trips in the year 1962, which had been determined earlier. The projections made by the Voorhees firm indicated that the number of CBD trips would increase by nearly 50 percent by 1985; and, that nearly one-half of the trips would be made on public transit in the defined corridors if a modern, fixed-guideway system were provided. The study also found that about 10 percent of the trips would be made by motorbus.

The planning work defined six corridors appropriate for fixed-guideway transit, all converging on the CBD. The length of the six routes totaled 71 miles. The patronage projections, however, were surprisingly low for a fixed-guideway system in a city the size of Baltimore. This led to a review of all available and emerging vehicle technologies to determine if some system other than conventional steel-wheel / steel-rail vehicles might be more appropriate for the patronage projected. The results of this review were that rubber-tired, electrically-propelled, medium sized vehicles would have a cost advantages for Baltimore. Such a technology was adopted as the "yardstick" system and was used for continuing the planning and cost estimating for the proposed 71 miles in six corridors.

## Good Engineering

With the corridor priority established, with the vehicle technology set, with the route defined, and the station locations determined—all with local participation in the process—the next requirement was to do more engineering. In 1970, the DMJM-KE joint venture was retained for the preliminary engineering phase. Working under the terms of a subcontract to the joint venture, the geotechnical firm of Balter and Balter performed the soils investigation along the northwest route. Numerous cased borings were driven, soil and rock samples lifted and tested. The results were plotted, giving a reasonably good profile of the subsurface conditions along the route. Ground and aerial surveys produced accurate topographic maps for preparing preliminary line, structure, and station area drawings. Architectural concepts for each station were prepared as well as standards for the common features to be used in all the stations. It was in this phase that first consideration was given to the use of precast concrete liners.

Concurrently, the operating subsystems were defined. Since it had been mandated by the Maryland Legislature that Baltimore Transit should be technically compatible with Washington's, some basic decisions had been made. The track gauge would be standard and not the wide gauge adopted by BART. The technology would be steel-wheel on steel rails. Traction energy would be 700-volt DC delivered by a third rail and picked up by sliding shoes. Also as a matter of policy concurred in by the client, DMJM-KE would specify standard, tested, "off-the-shelf" hardware for the operating systems with emphasis on safety and reliability. The operating plan adopted called for semi-automatic operation of the trains to the extent that acceleration, running speed, train separation, deceleration, and station stopping would be by mechanical, electrical, and electronic components. There would be, however, a motorman on board to open and close the doors at the station stops and signal the train to proceed.

Volumes of criteria were prepared for use in the design stage, and outline specifications for the project were written. Some 120 drawings of standard features to be used throughout the system were drawn and 160 preliminary line, grade, and structure drawings were completed.

The Northwest line as defined by this engineering effort was the 13.5 miles between the Charles Center Station in the CBD and a terminus at Owings Mills Station. Of this, 4.25 miles of this route were planned to be in tunnel, 2.25 miles would be elevated on structure, and 7 miles would be at-grade construction. Twelve passenger stations were planned: six subway, three aerial, and three at grade. The extent of this preliminary engineering permitted reasonably accurate cost estimates to be made. The schedule at that time was for the route to start carrying passengers in late 1982. The estimated engineering and construction costs, escalated to the completion date, totaled $911 million.

The preliminary engineering phase provided a solid foundation for preparing the construction plans and specifications. Because the project was being financed with public funds, the documents had to be prepared for open public bidding of all facilities including line structures, passenger stations, operating systems, and vehicles. The design phase began in 1973, at which time UMTA and the State of Maryland entered into a full-funding agreement to build Section A of the Northwest Line

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## Section A of the Northwest Line

This section was defined as running between Charles Center and the proposed passenger station at Reistertown Shopping Plaza. The budget for Section A was set at $721 million, and completion was scheduled for November, 1983.

By 1973, both governmental officials and the citizens were becoming impatient to see some action since studies had been underway since 1965, and the joint venture had been working since 1967. To accomplish the design work in the earliest time, the MTA and the joint venture agreed that the Northwest Line would be subdivided, and several engineering firms would be retained by the Joint venture to prepare the contract documents for discrete sections of the line, for passenger stations, for station architectural finishes, and for specialty work.

The design of the operating systems was handled differently. The joint venture designed all of the operating systems with the exception of the train control, which was based on a semi-automatic train operation as defined by the joint venture and the MTA. This work was subcontracted to DeLeuw Cather & Co. by the joint venture. Also, specialty subcontracts were let for fare collection, lighting, and for maintenance equipment.

## Construction Phase

The first construction contracts were let in November, 1978. Construction of Section A in the years from 1976 to 1983 was managed partly by the joint venture and partly by the firm of Ralph M. Parsons. The joint venture managed the installation of all the operating systems, and Parsons managed the construction of line structures and stations. Since the preliminary engineering phase, the Joint Venture had been promoting the use of precast concrete tunnel liners for a section of the route. The MTA was successful in getting additional funds from UMTA to use the concrete liners in a 1,500-foot section of single track driven tunnel. The parallel tunnel for the other track used steel liners, enabling a good comparison of steel versus concrete in essentially identical geologic soils. The concrete liners were found to be structurally competent, sufficiently watertight, and economically competitive with the steel. Precast liners had been extensively used in other countries; their first use in this country for transit was in Baltimore.

The 7.5-mile Section A, with its difficult tunneling and underground stations in the narrow streets of downtown Baltimore, was completed in November, 1983, at a total cost of $795 million.

## Baltimore Section B
*(1978-1987)*

The joint venture was authorized to proceed with the design of Section B in 1978. Section B is a 6-mile long extension of Section A from the Reistertown station to Owings Mills. It has three stations. Most of the route is in the median of Interstate 795. The design was carried out in the same manner utilizing engineering firms to do the detailed design based on standards furnished by the joint venture. The operating systems were an extension of those installed in Section A. With the exception of train control, which again was designed by DeLeuw Cather, the design and preparation of the contract documents for the operating systems were prepared by the joint venture.

Construction contracts were managed by the MTA itself rather than employing Parsons as it did for Section A. The joint venture managed the construction and installation of the operating systems. This arrangement worked well. The close relationship between the MTA and the joint venture resulted in having an excellent team approach to resolving the few problems that did develop. The original budget for Section B was $189 million. The 6-mile extension was completed for $154 million. The primary reasons for the under-run were that inflation during the construction period was much lower than had been forecast, there was a favorable bidding climate at the time, and the cost of right-of-way was also lower than had been estimated. Section B was opened to revenue operation in July, 1987, two months ahead of schedule.

## Baltimore Section C
*(1983-1995)*

The largest single employer in Baltimore is the Johns-Hopkins Hospital complex located 1.5 miles northeast of the Charles Center Station, the downtown termination of the Northwest Line. The hospital employs 12,000 people and has thousands of visitors daily. It seemed obvious to the planners that by extending the transit line to this complex, the citizens of Baltimore would be better served.

Extending the line would require 1.5 miles of subway and two underground passenger stations. This extension, Section C, was built, and revenue operation began in May, 1995.

## $226-million-per-mile System

The total cost of the 1.5 miles was about $340 million or at the rate of $226 million per mile! With the central maintenance and storage facility and the operations central control complex constructed in Section A, with no additional transit vehicles required and with the operating systems the same as in Sections A and B, requiring only extensions of similar equipment, how could 1.5 miles of underground transit cost $340 million? There were good reasons for it.

Contributing substantially to the high cost of the extension were man-made installations—a 99-inch sanitary sewer and the Jones Falls stream, which was contained within a three-cell masonry conduit with outside dimensions of 20 feet high and 60 feet wide. Also contributing to the high cost was the low profile of the line, all of which was considerably below sea level, requiring sections of the tunneling to be done under compressed air. The two passenger stations were costly to build with complicated entrance and exit structures.

After analyzing alternatives, it was found necessary to relocate the 99-inch sewer with 400 feet of it relocated parallel to the transit tunnels. Then it crossed over the tunnels at a flat skew, making the total length of the relocation 650 feet. The connections at each end of the relocation had to be made without interrupting the sewage flow.

The Jones Falls conduit crossed the proposed location of the transit line about in the middle of the planned Shot Tower passenger station. There was no alternative location for the station, so it became necessary to reconstruct the below-grade masonry conduit one cell at a time with reinforced concrete for a distance of 90 feet at the location where it would overpass the station.

Construction of the three-level Shot Tower passenger station was difficult. It was done by the cut-and-cover method, but because the entire station had to be constructed considerably below the water table, the conventional soldier pile and lagging method could not be used. Instead, the slurry wall technique, similar to that employed in constructing the Charles Center Station in Section A, was used. In this case, however, the walls were much deeper, thicker, and longer. The work was painfully slow, but the results were good.

The wet environment of this station required that an inner “cocoon” be constructed inside the structural walls. A light stainless steel “drip roof” was erected under the structural roof to provide an umbrella against seepage, particularly from the Jones Falls conduit, but also from the large storm drains passing over the station. At the mezzanine level of the station the inside architectural walls were polished granite. There was sufficient space between the granite and structural walls to permit inspection and maintenance. At the platform level the architectural walls are sheet glass. Sections are removable for periodic cleaning and maintenance. All seepage through the outer walls is conducted to the trackway drains and eventually pumped out.

The Johns-Hopkins station, also constructed by cut-and-cover methods, is 850 long, 450 feet for the platforms, and 400 feet to accommodate double crossover tracks just south of the station. The 99-inch sewer crosses the rail tracks just north of the station and forces the station to be about 65 feet below the street at the track level.

During the construction of Section C, there were unexpected delays and extra costs. One of the tunnel contractors, Kiewit-Shea, had a large cave-in at the intersection of two busy streets. Next, and far more serious, while tunneling under compressed air, there was gasoline contamination into the work areas. Contractors worked around the clock for seven days lifting and testing samples. Although tunneling was only stopped for three days, at a cost of $50,000 per day to the MTA, the work thereafter proceeded at a slower pace.

## Design Team

Planning for the extension started in 1983. An Alternatives Analysis and Environmental Impact Statement was completed in 1984. Preliminary engineering was carried out in the period from 1984 to 1986. In 1988, the firm of Parsons Brinkerhoff Quade and Douglas was added to the DMJM-KE joint venture and from then on it was called the DKP joint venture. The design was accomplished in the years 1988 and 1989 by this joint venture. The operating systems were also done by the joint venture with the exceptions of supervisory control, designed by the Macro Corp., and some of the communications work, designed by LS Transit Systems. The construction management for Section C was awarded to the DKP Joint Venture. The construction department of the MTA worked closely with DKP in an oversight role.

## Patronage

The weekday daily trips on Sections A and B averaged 39,000 trips before Section C was opened. With only one month of operation of all three sections, the daily weekday trips had increased to 48,000.

## Schedule and Budget

Section A cost $795 million and was opened to revenue service in November, 1983, about one year later than the earlier published dates. Section B cost $154 million versus a budget of $189 million and was completed two months ahead of schedule. Section C cost about $340 million versus a budget of $321 million and was 11 months late in providing revenue service. The total cost of the 15.05 miles of Baltimore transit sections completed is $1.289 million.

## Our Good Luck

The good luck the project experienced was a product of its good planning and good engineering. But the project also had a good client—a client who let its engineers do the engineering and let its architects be creative. Another factor contributing to its success was the remarkable continuity of the joint-venture staff. As an example, Jim Francomacaro of DMJM who was engineering manager for the Joint Venture was in Baltimore from its inception in 1967 until 1995. The last three years he was project manager.

## The People

During the 28-year period, many DMJM and KE people were engaged on the project. Those KE people who had the longest tenure and contributed the most to its success included Bill Custer, Tom Gibson, Paul Landis, Al Routhier, Morris Burgess, Colin Lewis, Gerry Schaefer, Phil Kaiser, Tom Yurman, Arun Patel, Harv Hunt, Yoav Arkin, Louis Sanders, Howard Gregson, George Morschauser, Scott Rhodda, and Bob Snyder.

The DMJM key people were Dave Hammond, project manager, Earl Tillman, Jim Francomacaro, Dru Desai, WaIly Dela Barre, Basil Acey, Mike DeBernard, and others.

The DMJM-KE Joint Venture reported to Walter Addison, administrator of the MTA during most of the design and construction phases. He was assisted by, and later succeeded by, Kim Kimball.

## **Miami Transit**

*(1973-1984)*

Miami is where KE was the sponsor of a five-firm joint venture. Initial studies started in 1973, with project work beginning in 1976, to build a 21-mile-long elevated conventional, rail transit facility. It went into operation in May, 1984, with a total cost of the system being $ 1.018 billion. By the mid-’90s, the system was carrying 51,000 passenger trips per workday.

## Preliminary Engineering Phase

The preliminary engineering phase was accomplished in the period from 1973 to 1975. These early planning studies considered a number of alternatives for transit to serve the entire county connecting all five of the major cities. It concluded that a rail system of about 48 miles would be required to meet the needs. Later, studies by KE in carrying out the preliminary engineering and by the Kaiser Transit Group (KTG) in the design phase, identified the initial stage to be 21 miles of fixed-guideway transit with 20 stations. The preparation of the construction drawings began in 1976 and was essentially completed in late 1979.

Work began in December, 1973, with development of a detailed work plan containing 90 tasks and subtasks. Data were collected and analyzed, and alternative concepts were developed and compared by means of a complex rating matrix which assigned numerical values to alternatives in terms of projected ridership, social, economic, and environmental impacts. The results were documented in a series of eight Milestone Reports (numbering is as numbered in the reports) covering all aspects of the system, namely:

7. General System Concept and Criteria - the basic transit corridors were identified and criteria for subsequent system design and development were defined.
8. Vehicle Technology - the current vehicle technologies available within Dade County’s time frame were identified and analyzed.
9. Land Use Policy - specific policies to determine and control land use around

proposed passenger stations were defined.

10. Right-of-Way and Relocation Policy and Procedure - Federal, State and Dade County property acquisition requirements were compiled and summarized.
11. Route Alignment and Station Location - specific routes and station locations were established.
12. Safety and Security - criteria related to safety and security of the users of the proposed facilities were written.
13. Architectural and Urban Design - concepts and criteria were defined for use in the planning of station locations and in the design of station facilities.
14. Final System plan - a consolidation and refinement of all previous work.
15. A detailed description of the system, construction staging and cost estimates.

The first seven Milestone Reports (not listed) were characterized as drafts and were never issued in final form, but they were used in the public involvement program as a basis for discussion with citizen panels. Final results of this process were incorporated in the final report.

An Environmental Impact Analysis was conducted in accordance with federal standards to analyze and examine the effects the system and its various alternatives would have on the environment and the means by which any adverse effects could be eliminated or mitigated.

Concurrently, the Public Involvement Program was organized to educate the public on transit matters, inform it of progress in the various stages of planning and design, and to obtain the public's response as to its concerns and preferences. This program was, and perhaps still is, the most comprehensive such program ever undertaken on a major project. The program was continued throughout the preliminary engineering phase and then continued over the longer period of design, particularly as input to the Station Area Design and Development Program.

## Design Phase

In March, 1976, the Federal UMTA announced a grant of $ 15.2 million to begin final design of the first stage of the system. Kaiser Engineers organized a joint venture of five firms with Kaiser Engineers acting as sponsor and manager. The other firms were Harry Weese and Associates of Chicago; Post Buckley Schuh & Jernigan of Miami; Carr Smith & Associates of Coral Gables; and Schimpeler-Corradino based in Louisville, Kentucky.

This joint venture, known as the Kaiser Transit Group (KTG), submitted a proposal to the county for the work in competition with other nationally known firms and joint ventures. Our proposal was accepted, and the design started in August, 1976. The contract was comprehensive. It not only included design of the guideway, passenger stations, and the central maintenance area but also the operating subsystems which included electrification, train control communications, fare collection, vehicle design, and system safety and security. In addition, it required that the public involvement program, which had been so successful in the earlier work, be continued through the design phase. It also included an option to add construction and procurement management. KTG's title was General Architectural and Engineering Consultant (GAEC). The county then gave the system a name, and from then on it was the Metrorail.

But even before "pencil was put to paper" on the design, UMTA requested that a study be made of low cost alternatives to fixed-guideway transit. Accordingly, 21 alternatives were identified then screened and evaluated against technical, community, and environmental considerations. This process was used to reduce the alternatives to two: the base system developed during the preliminary engineering phase and a bus system with some exclusive bus roadways. The County Commissioners adopted the fixed-guideway with some adjustments in the extremities of the route and made its recommendation to UMTA.

So was the system finally defined? Far from it. In January, 1977, UMTA approved the county recommendation but said it would only fund 16.5 miles, eliminating from its funding the last four miles to Hialeah. The problem with this decision was that it also eliminated access to the location proposed for the central maintenance area!

The essential ingredient, political and professional stamina, was not lacking, and in December, 1977, UMTA, on the basis of a premium funding proposal and the identification of an acceptable new yard and shop site west of Hialeah (the Palmetto site, since renamed the William F. Lehman maintenance facility) raised the funding commitment to cover a 20.5-mile fixed-guideway facility extending to West 8th Avenue in Hialeah. Thus, a fast-moving (and often hair-raising) sequence of studies, events, and reactions in the period from August, 1976, through December, 1977, were ultimately resolved with the definition of a system which in very large measure is that in place today.

The guideway route is elevated except for two short sections where the absence of cross streets made it feasible and economical to bring the guideway down to grade. Below-grade construction was considered during the early studies and during preliminary engineering both by cut-and-cover and by tunneling methods of construction. But because of the nature of the subsoil together with the high water table throughout the area, below-grade construction would have been far more costly.

Because of the extent of the elevated double-track structure, KTG was presented with a challenge to develop a design that was both economical and that could be constructed rapidly. Innovation was required and innovation resulted. The KTG structural engineers developed a double-T shaped concrete girder that would not only carry the required load, but would provide a flat surface on which the transit running tracks could be laid. The girders were designed to be precast, prestressed, pretensioned heavily reinforced concrete. About 3,000 of them were required, most having a standard length of 80 feet. Some were as short as 40 feet.

## Station Design

A passenger station was located about every mile—20 stations in all. It was planned originally that all stations would be designed by KTG, principally by Harry Weese & Associates. However, the Miami area architects complained and lobbied effectively for each station to be designed by a different architect. The grounds were that this would produce a variety of designs, would make use of local architects who had the experience with the ambiance of Dade County, and would provide work for many local people. The decision was made that KTG would prepare detailed criteria and specifications for guidance of the many local architects and that HWA would design one station completely to serve as a model for the others.

Because of the warm climate of Dade County, the stations were designed to be open, taking advantage of the sun and wind for heating and cooling. Like most elevated transit systems, the stations have two levels. Passengers access the station through the lower level where fares are collected at machines by coins or by magnetically encoded monthly passes. The lower levels also have a small office and sanitary facilities. The upper level has the platforms for train access and generally have open sides with a roof for sun and rain protection. Along the edges of the platforms, a strip of exposed aggregate concrete was used to provide passengers with a tactile warning when they step too close to the edge—especially those with impaired vision. All the stations are equipped with escalators, stairs, and an elevator for disabled passengers.

Prior to beginning station design, a Station Area Design and Development Program was conducted as an extension of the Public Involvement Program that began during the prior preliminary engineering phase. About 150 meetings of the public were held in which citizens were afforded the opportunity to make recommendations as to the appropriate character of the stations in the diverse neighborhoods, and to suggest desirable station finishes, landscaping, and the type of development to be permitted around each station. When this process was completed, the people had confidence that they would get an attractive and traffic functional station that they could accept in their communities.

## Systems Design

The design of the operating systems—vehicles, electrification, automatic train control, communications and fare collection—was similar to that described in some detail under the Los Angeles project even though the Miami work preceded that in Los Angeles. Ralph Mason managed the design process. The quality of his work was recognized as excellent by the client and the suppliers and contractors who furnished and installed the systems. Because of this, the authorities in Los Angeles assigned all the systems work to KE.

## Schedule and Budget

The estimated cost of the project at the time the preliminary engineering phase was completed in 1976 was about $700 million. At that time, the completion of the project was scheduled for December, 1982. In 1978 the budget established by KTG and including only the work for which KTG had contro,l totaled $611 million. In late 1981 this budget proved to be about 7 percent low. In May, 1984, the system began regular passenger carrying service, and soon thereafter the total costs were determined to be $1.018 billion. The files are voluminous in tracking, recording, and justifying the cost growth and schedule slippage.

The record is quite clear, however, that the cost increases are attributable to three principal causes: (1.) Escalation - the estimates included escalation at 7 percent per year as mandated by the client and by UMTA, whereas a KTG study showed that escalation in Metropolitan Dade County was at the rate of 10 to 12 percent in the 1979-1982 period. (2) Changes - there were many changes during the design and construction period, some of which resulted in a higher quality system. (3) Schedule - the schedule slippage was caused by (a) the added studies required by UMTA and the county (yards and shops location etc.); (b) delays in right-of-way acquisition and utility relocations; (c) design review and coordination resulting mostly from having over 20 engineering and architectural firms designing stations and sections of the guideway; (d) administrative details resulting from project funding from county, state, and federal sources; and (e) change in the client leadership at the height of the construction activity.

In the period when budgets were being increased, the Dade County Commissioners referred to KTG's "poor estimates." In one communication defending the KTG estimates, Ralph Mason, the then KTG project manager, wrote to the effect that KTG understood that the objective of the County was to get a high-quality, dependable transit system at the lowest cost and at the earliest practical date. Ralph then wrote that he wanted to assure the County Commissioners that the objectives of KTG were exactly the same—and since both objectives were identical, the two parties should be working together to accomplish those ends.

### People Who Did It

At the outset of the project, a management committee was formed made up of a representative from each of the firms in the joint venture. This committee met monthly or as required. For five such diverse firms, both technically and geographically, they worked together efficiently. One reason for this may have been because the chairmanship of the committee was rotated among the firms even though KE was the sponsor of the venture.

### Key Project Staff

Gene Stann KE, Project Manager, KE 1973-1976, KTG 1976-1980
Don Mauser KE, Deputy Project Manager, Facilities 1976-1979
Ralph Mason KE, Deputy Project Manager, Systems 1973-1980, Project Manager, KTG 1980-1982
Jim Ellis KE, Chief Civil Engineer 1973-1980
Doug Tilden HWA, Chief Architect, KTG 1976-1982
Alan Dale KE, Manager, Systems Engineering, KE and KTG 1976-1983
Hank Adams KE, Manager, Administration, KTG, 1976-1980
Rueben 'Red' Beebe, Facilities Design Manager, 1976-1982
Ray Snyder – Systems Safety & Assurance Manager, 1976-1980
Dick Line, Vehicles, 1976-1984
Gopal Venugopalan, Chief electrical, 1976-1982
Rey Belardo, Traction power, 1976-1982
Constande Yacoub, Structures,1976-1982
Joe Abbas,Traction power,1976-1984
Yoav Arkin,System Safety,1984-1987
Roberto Conrique,Trackwork,1977-1982

## Boston Southwest Corridor

*(1977-1987)*

Work on the Southwest Corridor transit system began in late 1977. The old, antiquated SW Corridor elevated transit line was relocated along with the 3-track elevated AMTRAK railroad into a common below-grade, retained-cut corridor. The 4.4-mile transit, railroad, and area rehabilitation project was completed in 1987 at a cost of $ 753 million. Before the relocation, the old line was carrying 45,000 trips per workday. Within one year, the trips increased to 50,000 on the rebuilt line.

### Setting

In the late 1960s, the design of Interstate Route 95 from the southwest into Boston was progressing rapidly. In acquiring right-of-way to accommodate this multi-lane freeway, hundreds of structures were demolished. The citizens of the area were displeased that so much of their community was removed for the highway and they let their displeasure be known to the public officials. The Governor, Francis Sargent, listened, and in 1970 he ordered a halt to the construction of I-95 in the southwest corridor. He then initiated a re-evaluation of transportation plans in the Boston metropolitan area to be done under the auspices of the Transportation Planning Review Group. As a result of this work, Governor Sargent announced in 1972 plans to improve transit, railroad service, and arterial streets rather than continuing with I-95 - and the Southwest Corridor Project was born.

The goals of the corridor project were threefold: to improve transportation facilities by all modes in the Corridor, to strengthen and revitalize the residential communities, and to encourage residential and commercial development along the corridor.

## Project Description

The Corridor Project was far more than an upgrading of an existing transit route. The plan included:

1. Removing the three-track Amtrak route on elevated embankment which divided the communities through which it operated (the elevated tracks were also used by Authority-operated commuter railroads) and reconstructing it below grade in retained cut.
2. Constructing two new transit tracks in the same cut replacing the antiquated, noisy, eighty-year old elevated structure over which the Authority's Orange Line operated.
3. Reconstructing the adjacent arterial streets including constructing 22 new bridges over the retained cut.
4. Constructing a 53-acre linear park with basketball and tennis courts, walking and bicycle paths, community gardens and play grounds—2,900 feet of the retained cut to be decked over to increase the area of the park and to provide community continuity on both sides of the transportation corridor.
5. Construction of eight passenger stations, three of which would also be served by the commuter railroads, and two of these would also have service by Amtrak trains operating between Boston and New York.
6. Rehabilitation of the signal and communications systems in the existing Orange Line tunnels in downtown Boston.
7. Expanding the signal system to the northern terminus of the existing Orange Line.
8. Installing cab signals in the transit cars built by Hawker-Sidley that would operate on the Orange Line.

All of this was accomplished in the ensuing eight years. Eliminating I-95 after most of its right-of-way had been acquired resulted in there being available nearly 20 acres of land for housing and commercial development even after the 53 acres were dedicated to the park. The transit improvements, removing the elevated embankment, and providing the park all helped to revitalize the corridor and meet the project's goals.

## Engineering

In early 1977, Kaiser Engineers formed a joint venture with the Boston based firm of Fay, Spofford and Thorndike. This joint venture competed against other nationally recognized firms for the assignment of Coordinating Consultant for the Southwest Corridor Project. The KE-FST joint venture was selected by the Authority, and as such it was responsible for developing design criteria, preparing directive and standard drawings, and was responsible for the design of all the operating systems for the relocated transit line, including electrification, communications and signal systems, escalators, elevators, and fare collection for the project.

In addition, the joint venture prepared criteria for the design of Amtrak and MBTA's commuter rail operation, as follows: prepared dynamic envelopes of clearances for all existing and planned rolling stock configurations; wrote criteria and interface details for future catenary electrification; designed the trackwork; identified the interfaces for signal and communication design to receive Amtrak trains; and, designed the tunnel ventilation system to purge the diesel exhausts safely. The Joint Venture was also responsible for design coordination, scheduling, estimating, and cost control.

After the work was well defined throughout the corridor and was ready for final design, the corridor was divided into three distinct sections. Section 1 at the downtown end of the corridor, 1.1 miles in length, was awarded to the KE-FST joint venture for design. This section was the most difficult to engineer. It had extensive commercial development confining the space available for the below-grade transit and railroad tracks. It had a high water table, the land having been reclaimed from the Charles River in the nineteenth century. There were extensive utility interferences. And the area had restricted access.

Section 2, 1.4 miles in length, was awarded to the firm of Fredrick R. Harris based in New York, and Section 3, 2.2 miles in length, went to Howard Needles Tammen & Bergendoff whose headquarters were in Kansas City.

Preceding the detailed design of all three sections, the communities along the route were involved in the planning and design process by a program carried out by the Authority and the KE-FST Joint Venture. Throughout the program, there were more than 1,000 community meetings during the planning, design, and construction phases. The extent of this citizen participation helped shape the character of the project.

## Section 1, Joint Venture Design

The problems of designing Section 1 were enormous. Reconstructing the three Amtrak tracks and putting these tracks and two transit tracks below grade was a challenge to the KE-FST staff. It was located in a severely confined space with restricted access for contractors' trucks and equipment. During construction, rail, transit, and street traffic had to be maintained in the extremely congested area along with protecting and then relocating the utility services. In addition, there were old multi-story buildings supported on wood piles, new 40-story hotel towers adjacent to the proposed project walls, a multi-story building that had to have one track and a platform placed through its foundations, a high water table, and a mixture of natural and man-placed soils.

As a first step in the design process, an extensive boring and soil analysis was carried out. It was found that the filled land was mostly granular over the tidal mud, which had a high organic content. The mud was underlain by a Boston blue clay stratum up to 160 feet in depth to bedrock. The upper layers of the clay formed a dense crust of variable thickness, which supported the wood pile foundations. This situation required that the water table be maintained to prevent rot of the piles.

In planning the construction program, it became essential to let a number of contracts in advance of the major construction in order to control schedule and budget. These early contracts were as follows:

1. Demolition of Back Bay Station and construction of a temporary station.
2. Reconstruction of a Boston school building to eliminate an interference.
3. Structural protection of an 8-foot diameter, 100-year-old brick interceptor sanitary sewer.
4. Modifications to a parking garage and to an eight-story building to permit rail facilities to be built beneath them.
5. Several utility relocation contracts.
6. Railroad force-account work.

After the numerous early contracts were completed, the main construction contracts were let. The results of the extensive geotechnical engineering dictated that different designs would be required for every few hundred feet of the depressed concrete structure. Foundation systems included caissons, steel H piles, pipe and prestressed concrete piles, sheet piling, soldier-piles and lagging, bin walls and slurry walls. Elaborate soils monitoring equipment was installed to measure and control ground water levels, soil movements, and construction related vibrations. To build one track and a platform under the historic Heath Building required the removal of the foundation piles under part of the building. To keep the building erect, an ingenious design was developed by KE-FST. Large structural "C" frames were built, and the load on the piles was transferred to the frames. The opening through the C"s was designed sufficiently large to accommodate one track and a passenger platform. No damage to the building resulted.

Section 1 was constructed under the terms of two major line contracts, one temporary station contract, two permanent station contracts plus the several early contracts previously identified.

The joint venture prepared design criteria, directive drawings and concept plans for the eight passenger stations in the corridor. The architectural work for each station was done by a different architect. The firm of Stull & Lee prepared the architectural guidelines to be used in the design of all stations. The three principal stations—Back Bay, Ruggles Street and Forrest Hills—are architectural masterpieces having received several awards for their outstanding design.

## Schedule and Budget

At the time, the federal grant was approved in 1978, the budget for the corridor was about $700 million, and completion was scheduled for 1985. When design of all three sections was in process, the budget was increased to $793 million. The reconstructed Orange Line started carrying passengers on May 4, 1987, about 18 months later than the schedule set eight years earlier. The final cost of the Southwest Corridor Project was $753 million, or $40 million under the budget set 5 years earlier. The cost per mile of transit has no relevance in this case because the project was far more than typical transit construction.

## Other Awards

The most significant award that the Southwest Corridor Project received was from the American Society of Civil Engineers. It was the recipient of the Outstanding Civil Achievement Award for 1988. As a result of the project receiving this national award, the Japanese Society of Civil Engineers invited key members of KE-FST and the two other firms who engineered Sections 2 and 3 to present the project to the Japanese Society of Civil Engineers in Japan. Bill Custer of KE and Bob Loney of FST led the delegation. Not only did they present the project, but also the Japanese government officials escorted the delegation on a brief tour of Japan.

The project won a national award for design excellence from the U.S. Department of Transportation and another from the National Endowment for the Arts for the extensive community participation program, which was directed by the Authority and carried out by KE-FST. In addition, there were the following awards:

New York Association of Consulting Engineers, First Prize, 1988 for Engineering Excellence
The Boston Society of Architects, Wilhelm Moltke Award for Excellence in Urban Design
Boston Society of Civil Engineers, Outstanding Civil Achievement of 1988
Commonwealth of Massachusetts, Governors Design Award for 1986
Boston Preservation Alliance, Parkland Design Award
National Endowment for the Arts, 1988 Federal Design Achievement Award
Massachusetts Society of Professional Engineers, Massachusetts, Outstanding Engineering Achievement Award
Bruner Foundation, Inc., Finalist in Rudy Bruner Award for Excellence in Improving the Urban Environment
Progressive Architecture, 26th Annual Award for Urban Design

## The People

William J. Custer was the first project manager for KE-FST, serving in that capacity from 1977 through 1981. He was followed by John Reilly who held the position until 1985, and then Albert Comeau managed the work to its completion in 1988.

The operating systems engineering was handled by Morris Burgess, Thomas Grier, and Robert Fraze. Schedule, budget, and project controls work was the responsibility of Russell Chamberlain, David Pleau, and Jack Pavia. William Bunker was construction manager.

The project mechanical engineer was William Connell; the electrical engineer was Marius Ziaugra; trackwork engineers were William Hearne and E. Michael Cook. Wayside and transit car signal design and installation were handled by Frederick Jeffries and William Boerwinkle. Ward Kingma was responsible for station finishes; James Britt was the safety assurance engineer; and the drafting supervisor was Edward Venti.

The Fay, Spofford & Thorndike key people were Herbert Spooner who was project manager for a year in 1983. Herb later joined KE and was the PM for the Chicago Southwest Corridor project. Robert Loney was the deputy project manager throughout the entire program; Neil Daykin and Kenneth Morgan were structural and civil engineers, respectively; Jeff Sheldon was FST's electrical engineer on the project; Edward Cronin was a project engineer, and Neil MacKay was the contract administrator.

## Pittsburgh Skybus Transit

*(1971-1975)*

The Pittsburgh Skybus transit system is included here because it was one of the important early design engineering projects for the Division. Engineering was completed, but *the project was not built.* It was an interesting experience in witnessing politics versus technology. Herb Thomas so aptly says that a lengthy book could be written on the developments of transit in Pittsburgh in the years from 1964 to 1987.

There were a number of developments by the Port Authority of Allegheny County to improve rail commuter services using existing railroad lines. Then there were developments of new initiatives for using rubber-tired vehicles.

Then the Port Authority had consultants study rubber tires versus steel-wheel vehicles. This was followed by the Port Authority becoming involved with a system designed by Westinghouse called “the Skybus.” This became a system called the Transit Expressway Revenue Line (TERL). The TERL was based on the Westinghouse Skybus design. In 1971 KE formed a joint venture to design that specific system. The venture included Richardson Gordon and Associates, a structural firm based in Pittsburgh; Celli-Flynn, an architectural firm from Pittsburgh; and Eliot and Noyes, an environmental design firm from Pittsburgh.

The work was assigned to KE’s Pittsburgh office to design. The planned completion was set for the year 1978. The estimated cost of the project in the then current cost levels was $ 300 million. In terms of cost as of the year 2000, this would be a $700-million project.

## Opposition to the Program

Pittsburgh is a steel town—the center of the steel industry in the United States—and also a railroad center. The city had difficulty accepting that its new transit line would be rubber on concrete rather than steel on steel. Westinghouse Air Brake Company (WABCO) at that time, and historically, had been the principal supplier of railroad signal systems and of train control equipment for rail transit systems until Westinghouse Electric competed for, and underbid WABCO, for the train control system for the prestigious Bay Area Rapid Transit System—a very large contract. Westinghouse then developed a train control technology for operation of its Skybus system.

Opposition to the project escalated, culminating in a suit to stop the Early Action Program filed by the mayor of Pittsburgh and other municipalities. The suit asked the court to stop all work, claiming that the Authority had not complied with all actions required of it by the 1959 Act creating the Authority. The brief filed with the Court by the Authority contained a list of 11 endorsements of the Skybus technology by an impressive list of government agencies, technical institutions, engineering firms, and research organizations. Endorsement number 7 was a statement by Kaiser Engineers that, “The Transit Expressway (Skybus) is technically feasible and is ready for final design, engineering, and implementation.” The Court was not concerned with the technology but ordered all work stopped and required the Authority to develop a plan of integrated operation of transit within the County. It was appealed by the Authority and then Kaiser Engineers was ordered to proceed with its work.

## Project Stopped

Opposition to the Early Action Program continued to be voiced, and the Authority was criticized for whatever it tried to do. It could not get legal authority to proceed with its program, and in early 1975 KE was instructed to discontinue within 30 days all its activities on the program. At that time, the design of the 13-mile route between the Golden Triangle in downtown Pittsburgh and the South Hills villages was essentially complete including the line structures, the passenger stations, the operating systems, and the central repair and maintenance facility for a fleet of 300 vehicles. The design of the rubber tired, automatically operated transit car was 99 percent complete. A total of $13 million dollars had then been expended by the design team (1975 dollars). Not only was the design complete but several construction contracts had been let, the largest one being the rehabilitation of the Wabash Railroad tunnel to make it safe as a people-carrying tunnel and for operation of the rubber-tired cars.

## Staff

Gene Stann managed the project with Zoltan Stacho, his deputy, until Gene was transferred to Miami to manage the work there. Zoltan then became the manager. Although the Authority had great respect for both men, and the engineering work was being carried out most professionally, it was the combination of politics, the use of new technology, and industrial firm competition in Pittsburgh that caused the work to stop.

## Follow-on Work

Ending the Skybus TERL project was just the end of a chapter in the book of transit development in Pittsburgh by the Authority. In the mid-seventies, the popular transit technology was Light Rail Transit (LRT). The Authority retained PBQ&D to engineer an LRT line to serve the South Hills area. This time, PBQ&D included the firm of Gibbs & Hill, also based in New York City, in its team. As a result of this effort the Authority made the decision to put the downtown section below grade rather than rehabilitate an existing surface line. This decision increased the cost dramatically, and since UMTA would not increase its grant, only about one-half of the line could be built. At the conclusion of this part of the project, the Authority sued PBQ&D for alleged design errors, and again all work with this firm was ended, with the matter being settled in 1993.

In 1986, KE was brought back into the transit work in a "general engineering consultant" role. Numerous projects, including design and construction management, were carried out until 1994.

This work was essentially all done by the Pittsburgh staff. The key people were Rich Debski, Joe Stancampiano, Jim Hunter, Ralph Stofko, Norm Hamilton, Frank Mingrone, Paul Smith, Ray Luncher, Metin Hur, Bill Eminger, and George Gore.

## Chicago Southwest Corridor

*(1984-1992)*

The Chicago Southwest Corridor project was also started during the regime of the authors of this chapter, but was completed by the successor company to KE. It is a large project also.

The City of Chicago is served by several transit and railroad commuter lines all converging on the downtown Loop Area. One corridor not having such service in the 1980s was the Southwest Corridor running between the Loop and Midway Airport, a distance of 9.3 miles. In 1981, the City of Chicago Department of Public Works retained a joint venture of KE and DeLeuw Cather to study a wide range of alternatives and to prepare a draft environmental impact statement for a proposed transit line in this corridor. The work, completed in 1982, proposed a conventional rail transit line to serve the corridor—5.3 miles would be elevated on embankment, and 4 miles would be an aerial structure. Eight passenger stations were proposed. Costs were estimated and construction schedules prepared.

The city was successful in transferring from federal highway accounts allocated to the Chicago area a total of $496 million to construct the Southwest Corridor.

### KE Joint Venture Responsibilities

In 1984, KE in joint venture with Envirodine Engineers, Inc. based in Chicago, was retained by the Department of Public Works to carry out preliminary engineering for the corridor, to prepare the Final Environmental Impact Statement and refine schedules and budgets. The joint venture was to be the "supervising consultant" for the project. In this capacity, the joint venture defined the operating systems and prepared standard drawings supplementing those in the Department of Public Works. It participated with the client in selecting firms to do the detail design on seventeen separate sections of the line. It prepared contracts for sixteen system-wide procurement and installation contracts for trackwork, the operating systems, and for essentially all components that were common to all or to several of the seventeen sections. The joint venture also supervised the work of the many firms doing the final design.

To assure continuity at the passenger stations, the Joint Venture prepared a set of design standards, which included station structures, and finishes and standards for elevators, escalators and station graphics. Guidance was provided for installing all conduits for the operating systems plus fire alarm and master dock circuits. The terminal station adjacent to Midway Airport, the busiest on the line, included convenient transfer facilities for bus patrons and a concourse for airline passengers. Additional offices and special equipment for reporting traffic and operations were also provided at this station. Other stations provided accommodations for kiss-and-ride, park-and-ride, and bicycle-arriving passengers. The Chicago Transit Authority reports that there has been less graffiti damage at the Southwest Corridor stations than at others because of the "anti-graffiti" finishes used.

At the Midway Airport end of the line, the work also included a storage, light repair, and maintenance facility for the vehicles. The joint venture developed the concepts, did the preliminary engineering, and then supervised the design of this facility with capacity to serve a fleet of 176 vehicles. The repair and maintenance shop has a floor area of 55,000 square feet.

The joint venture also had right-of-way acquisition responsibilities. It identified the parcels of land required, communicated with the owners, did the land surveying, prepared the acquisition drawings, acquired the land for utility relocations as needed, identified the railroad property to be used for the transit line, and assisted with the acquisition negotiations with the railroads and utility companies.

## Completed Below Budget

The nature of the transfer of $496 million in Federal highway funds was such that no increase in this amount could be obtained. Any overrun in the budget would have to be made up by the City - and the Department of Public Works made it clear to the Joint Venture that the project had to be completed within the budget. Consequently, the Joint Venture was vigilant in its pursuit of cost savings and in expediting construction. As an example, the original plan included a below grade section at Midway Airport. The Joint Venture changed this to open retained cut; and, short sections of aerial structure were eliminated and retained embankment used at less cost. The effort had good results. In the planning phase the schedule called for project completion in October 1993. It was actually opened to revenue service in October 1992 a year ahead of schedule. The final costs were $6 million below the budget of $496 million.

## The People

Bill Custer was the project director, and Herb Spooner was the project manager. Dick Herbeck handled the track work; Bill Sly, the estimating; Dave Allen, the structural work; Ron Rypinski, operations and maintenance; Dave Pleau, the scheduling; S. Lee, the operating systems; M. Gilliam, the civil work; and M. Stepian, project controls.

## People Who Did the Subway Ventilation Engineering Using the Handbook Developed in the Research Project

| | |
|---|---|
| Baltimore | John Bodner, Robert Murphy, Al Routhier and Jess Pascal |
| Montreal | Robert Murphy, James Murray, and David Shrimpton |
| Toronto | Robert Murphy, Cheri Sheets, Paul Miclea, and Dan McKinney |
| BART | Robert Murphy, Diane Kravif, and Cheri Sheets |
| Washington, DC | Al Routhier, Harvison Hunt, William Connell, David Shrimpton, Robert Murphy, Cheri Sheets |
| Boston | William Connell and Robert Murphy |
| New York | Robert Murphy, Paul Miclea, Mark Deng and Dan Brunner |
| San Francisco | Muni, Robert Murphy, Bill Houppermans, and Cheri Sheets |
| LA People Mover | Robert Murphy |
| Detroit | Al Routhier and David Shrimpton |
| Jet Prop. Lab. | Robert Murphy and Bill Houppermans |
| Seoul | Al Routhier, and David Shrimpton |
| Istanbul | Robert Murphy |
| London | Robert Murphy, Paul Miclea, and Dan McKinney |
| Hong Kong | Robert Murphy, Dan Brunner, and Paul Miclea |

## Oakland Technical Support

A special note is in order to acknowledge the technical support received from the Oakland staff. The people who carried out the several major projects described are identified with each project. But in addition, many engineers and support people from the Oakland office continually assisted the project staffs on design, engineering, and construction matters, contributing to their success. In particular, Farrel Schell was most frequently consulted on transit vehicle design and on policy for engineering the operating subsystems. Farrel also managed vehicle design contracts and transit facility engineering within airports for the Port Authority of New York and New Jersey, at JFK and at Newark Airports. Farrel also managed the major transit development study and preliminary engineering for the Houston, Texas, Metropolitan Area.

## KE's Studies, Preliminary Engineering, Research & Other Transportation Projects

Marketing was a most important aspect of the success of the Transportation Division. Part of the marketing strategy when the division was formed, was to obtain small consulting studies to obtain a "foot-in-the-door." This strategy was successful as is shown in this section of the transportation division chapter. By taking small studies, KE became familiar with the players in the transit industry, gained knowledge, and expertise and accumulated a staff of transit experts. Marketing was looked on as a cost of doing business. On the other hand, the strategy of taking consulting assignments, studies, and preliminary engineering was self-sustaining. The revenue permitted the recruitment of an expert staff ready for future large transit assignments.

This section describes some of the early studies undertaken, preliminary engineering assignments, research projects, and other transportation projects.

## Transit Vehicle Design

KE's initial contract in Los Angeles included the preparation of performance specifications for a *new* *generation* transit vehicle. The resulting specification was well received by the transit industry and led to a series of vehicle design contracts over the next 20 years. It was principally KE who prepared the drawings and specifications for conventional rail transit vehicles for Miami and Baltimore, a joint procurement, and for the BART "C" cars. It did the same for a smaller rubber-tired car based on the Westinghouse Skybus technology. It represented the owners' interests in the fabrication of light rail transit vehicles on a project in which essentially all the prominent transit engineering firms in the country were involved.

A major study to develop cross-town "people movers" in Midtown Manhattan and circulation in Lower Manhattan required the study of innovative small vehicle systems such as "continuous capacity" vehicles, "capsuled conveyors," and variable speed moving sidewalks. None of these concepts was developed because of the financial crisis in New York City at that time.

Other clients who engaged KE for vehicle design include the Disneyland owners for design assistance on new cars and for rehabilitation of older ones; the Port Authority of New York and New Jersey (three separate contracts between 1961 and 1984); and the City of Seattle for rehabilitation of its monorail vehicles.

## Transit Access to Airports

In the early 1960s, KE developed a largely elevated transit line to operate between the Union Station in downtown Los Angeles and the Los Angeles International Airport. This "Skyrail" project, as it was then known, examined four different vehicle technologies that might be appropriate for the proposed 65-mph service between the city and the airport. Funding did not develop, and the project did not move beyond the study phase.

Later, KE carried out a series of studies of high-speed rail service to operate between LAX and the proposed new airport at Palmdale, about 65 miles north of LAX. This proposed system was to be constructed first to a station in the San Fernando Valley, a distance of 16.5 miles. Alignments were developed that would permit speeds of up to 125 mph in the valley and alternate routes permitting speeds of 125 and 250 mph from the valley to Palmdale.

The total cost of the large 125-mph route was estimated to be $2.2 billion in 1989 dollars. There was no source of funds for such a costly project—but LAX is still planning on a new airport in the vicinity of Palmdale with completion by 2015.

## Transit Within Airports

Over the years subsequent to 1968, KE has participated in studies, planning, and engineering for fixed-guideway transit at airports to carry people between parking facilities and the airline terminals and among the terminals. Such work was done at Newark International Airport (New Jersey), at JFK International, at Boston-Logan Airport, at Oakland International, at Detroit Metropolitan, and at Chicago O'Hare Airports. The Newark facility is being constructed but without KE being involved. At O'Hare, KE was a subcontractor to the French firm Matra, had won a turnkey contract to construct the first 2.7 miles of an intra-airport line and to operate it for five years. The facility started carrying passengers in 1993 and is operating successfully. John Bergerson and Farrel Schell managed most of the airport transit work.

## Railroad Engineering

For the city of Lafayette, Indiana, KE has been involved with the Riverfront Railroad Relocation project from initial studies in 1970 until completion in 1997. It was a difficult relocation project involving three rail lines passing through the city at street level, involving 50 grade crossings. Ken Kenevel managed the project. KE managers were Ralph Mason, assisted by Jim Ellis; then Pete Hackley and Dub Warren worked on other phases. Design in Oakland was handled by Bill Houppermans and Dick Rasmussen. The highway bridges were designed under the direction of Paul Landis in the KE Baltimore office.

In addition, KE has accomplished many other significant railroad jobs. The DMJM-KE Joint Venture engineered the rehabilitation of the Amtrak Baltimore Station, one element of the $2.2 billion Northeast Corridor rail improvement program. Also on the Corridor the KE-FST Joint Venture working as a subcontractor to Electrak, Inc., designed the foundations for the catenary structure supports for electrifying the route between New Haven and Boston. In Mexico, KE was retained to coordinate the engineering of signaling and communications on the electrification of the Mexico City-Queretaro Railroad with railroad components originating in Pittsburgh (WABCO), in Italy, in Japan, and with

GE in Connecticut. KE also engineered the electrification of the 15-mile unit train operation between Utah International's coal mine and the Four Corners Power Plant in New Mexico. Werner Siemens and Ash Siddiq engineered the railroad electrification projects.

In Chicago, KE working as a sub-consultant to Envirodyne, Inc., performed the industrial engineering to modernize two large railroad yards to accommodate substantially increased commuter operations and to make the yard operations and vehicle maintenance more efficient. On the East Coast the same two firms engineered the replacement of an old swing bridge on the Long Island Railroad (operated by the MTA). KE found an abandoned Bascule bridge in Florida and arranged for shipping it to the site by ocean-going barge—at considerable cost saving. But the most difficult project carried out by Envirodyne and KE was the rehabilitation of the Park Avenue railroad tunnels in New York City, also for the MTA. Construction of these tunnels dates back to the 1870s. Their maintenance had become so costly that continuing the Amtrak and the many commuter trains through them was threatened. Developing methods of rehabilitating the deteriorating cut-and-cover tunnels while maintaining both the Park Avenue street traffic and the dense railroad movements while the extensive work was accomplished, including lowering the three tracks up to 18 inches, challenged the abilities of the two firms. The work was performed successfully at a cost of $125 million. George Morschauser was the lead engineer on this project. Ron Rypinski and Dick Herbeck were the managers of the Chicago yard improvement projects.

Next, KE carried out a series of railroad improvement projects for clients in Maryland (with DMJM), in Connecticut, and in New Jersey. The varied and successful experience that KE had in vehicle design resulted in it being selected by NJ Transit to provide technical support for its project to overhaul 230 electrically propelled railroad cars. These cars operated on the high speed Amtrak line between New York and Trenton, NJ. Included in the overhaul was the replacement of the DC propulsion system with AC motors, the first such application for commuter cars in the U.S., and to convert the friction braking to a combination dynamic and friction system. As part of the project, KE established a computer-based documentation control system, which was later expanded into a configuration control management program for tracking reliability and performing failure analysis. Clive Thomes and Hal Nelson were the principal engineers on this project.

## People Who Did Railroad Engineering

A summary of the KE people who were involved in the many railroad engineering projects mentioned follows:

Lafayette Jim Ellis, Chris Anderson, Pete Hackley, Ralph Mason, Dub Warren, Don Sooby, Paul Landis, Dick Rasmussen, and Bill Houppermans

Early Railroad Studies, Chris Anderson and Jim Ellis

Baltimore Railroad Station, Tom Gibson, Al Routhier, and J. Shaffer

R F & P Electrification, Werner Siemens and Ash Siddiq

Northeast Corridor Pole Foundations, John Reilly

Mexico Electrification, Werner Siemens, Vic Kieman, and Jun Adela

Navajo, Four Corners Electrification, Werner Siemens, Ash Siddiq, Bill Heme and Bill Houppermans

Chicago, Ron Rypinski, Dick Herbeck, M. Gillam, and Barbara Wilson

Long Island Railroad -George Morschauser, and Robert Fraze

Maryland Dept. of Trans., Al Zubor, Clive Thomes, Gene Grawe, and Gerry McCann

Park Ave. Tunnels, George Morschauser, Joseph Merzinger, Agnes Spielman, Ed Becker, Roberto Conrique, Les Dittert, Ben Cavin, and Gerry Haskin

Connecticut Dept of Trans., Bill Rutherford, D. Fordham, Michael Cook and Dick Herbeck

New Jersey West Shore RR, Bill Rutherford, Howard Sakel, Hugh Radbill and Greg Hoer

New Jersey Car Rehabilitation, Clive Thomes, Hal Nelson, Al Zubor, Frank Banko, Ed Heisey, Gene Grawe, Harv Hunt , and Yoav Arkin

## Design of Transit and Motorbus Maintenance Facilities

Because of the large number of industrial plants that KE had designed for the aluminum, steel, and cement industries, KE was well qualified to design the central maintenance and repair shops for transit and bus systems. In marketing, this fact was emphasized with potential clients. As a result, KE did a great amount of shop design. Once again, it all began in Los Angeles. In the 1970-1975 period, the KE-DMJM Joint Venture in Los Angeles and the Department of Highways (now CalTrans) engineered for the Southern California Rapid Transit District an exclusive bus roadway running between the Civic Center in Los Angeles and El Monte, 11 miles to the east. Most of this busway was located in the median of the San Bernadino Freeway, and this work was done by CalTrans. DMJM did the architectural work for two intermediate stations and for the terminal station at El Monte. KE designed the maintenance facilities and provided services during construction for the bus maintenance and repair shop, for office facilities, and a bus storage yard for a 100-vehicle fleet.

Following this, KE designed the central maintenance and repair shops for the Atlanta rail transit system, a complex of five buildings having floor space of 250,000 sq. ft. Pete Hackley was the project manager on this demanding but very successful project. It was completed close to budget and schedule.

In addition to the yard and shop work that KE did on the major rail transit projects in Miami, Baltimore, and Pittsburgh, KE engineered a shop and yard improvement program for the Southeastern Pennsylvania Transportation Authority for 262 transit cars, 29 Light Rail Vehicles (LRV), 26 trolleys, and 16 rail work cars. For the New York City Transit Authority, KE provided design services for the rehabilitation and modernization of its East 180th Street facility. For the Port of New York Authority, KE did an analysis of the current and future maintenance requirements of the Port Authority Trans Hudson fleet. This analysis compared the benefits of rehabilitating a 73-year old yard and shop versus constructing a new facility on one of nine potential sites. Many variables had to be analyzed before recommendations were made.

For Pierce Transit in Tacoma, Washington, KE did the value engineering and construction management for a new operations and maintenance base building having 78,000 sq. ft. and an administration building having 35,000 sq. ft. Hal McClain was the construction manager, supported by John Thomson. For Staten Island Rapid Transit, a unit of the New York Transit Authority, KE did the design for modernizing its maintenance complex and for a new transit car washing facility.

In all these yards, the design of the buildings was generally not difficult. Designing the yard layouts, selecting the equipment to do the maintenance and repair work, and developing the industrial layout of the shops for maximum efficiency was the challenge. These tasks we always accomplished working with the client. The fact that KE was selected to do so much of this type of work is very good evidence that the clients were satisfied with KE's industrial engineering abilities.

## KE Transit Work in the Bay Area

Although most of the references to the transit projects in this summary have been to major programs located on the East Coast or in Los Angeles, KE did considerable work in the Bay Area.

When BART was initially conceived, KE was in a unique position because of our location and reputation to be named engineer for the entire project. At the same time, Edgar Kaiser had volunteered to be chairman of the Bay Area citizen's group that was advising the authorities about long-range planning, which included BART. When he became aware of KE's interest in the project, he voluntarily excused us from participating in the project on the basis that he thought it would be a conflict of interest for a Kaiser entity to profit from a project on which he was volunteering his services.

This was a unique instance where being a Kaiser affiliate mitigated against us. Normally, we obtained his support in promoting projects, witness the massive Ghana hydro and aluminum projects.

Later, after the initial system had been built and Edgar Kaiser's services were no longer being rendered, KE was successful in performing services for BART. KE prepared performance specifications for the procurement of 90 additional transit vehicles. These specs put particular emphasis on quality control in the fabrication of the components, the assemblies and the operating systems; and to making the vehicles as fire resistant as possible. KE did the engineering for the expansion of three of BART's vehicle storage yards. It participated as a subcontractor to PBQ&D in the design and construction of the $150-million track extension and turnback track just south of the Daly City Station. It carried out several contracts on ventilation and fire emergency procedures for BART's underground stations, for its tunnels, and for MUNI. Probably most significant, was a general engineering services contract awarded to KE in 1981 by BART. Under the terms of this agreement KE carried out a variety of technical assignments until 1987. Bob Murphy was the project manager for most of this work for BART supported by members of the Oakland staff. More such work was awarded to ICF-KE subsequently. And KE has continued to provide on-call services to BART for both design and construction management throughout the 1990s.

For the San Francisco Municipal Utility District, KE also carried out a series of technical contracts on its trackwork, on electrification of one of its bus routes, and on improving the catenary lines for LRV operation. The largest contract with MUNI was the rehabilitation of the Geneva car-barn to store, test and repair its new LRT vehicles. KE did this work in joint venture with DMJM. Ash Siddiq was the project manager

For Alameda-Contra Costa Transit, KE did the planning, design, and construction management for a new central maintenance, repair, and storage facility for a fleet of 850 buses. Its cost was $25 million. The AC Transit system was divided into operating divisions. New physical facilities within four of these divisions were engineered, or existing facilities improved by KE, as were some of the system-wide facilities. The total cost of the work was $110 million and was accomplished between 1980 and 1991. Hal Nahler was the project manager and John Thomson was the engineering manager.

## Rail Transit in Washington, D.C.

### Background

In 1952, Congress authorized land use and transportation studies to be carried out in the nation's capital. As these studies progressed, 25 miles of rail transit, were identified and planned to form the core of a regional transportation network. Congress approved this plan and authorized $150 million of Federal and District of Columbia funds to initiate more detailed planning and engineering. In the early 1960s, Kaiser Engineers participated in the early stages of the transit engineering by carrying out discrete studies.

### Design

In 1967, KE was selected to design a section of the Connecticut Avenue route from Dupont Circle, near the White House, northwesterly to Rock Creek Park. This section of the route was designed to be all below grade in rock to be constructed by tunneling and mining methods. For the lining of the double track tunnel KE prepared alternative design - one for cast in place concrete lining and the other a rock bolt and shotcrete lining. The contractors were permitted to bid on one type or both. The successful bidder chose the rock bolt and shotcrete alternative, which was somewhat less costly.

The work also included the design of the Dupont Circle Station. This deep underground station was designed to be constructed by tunneling and mining methods. The domed vault that was excavated in rock to accommodate the station was about 800 feet long, 70 feet wide, and had a maximum height of about 50 feet—with no interior columns. The structural lining of the vault was accomplished with rock bolts up to 20 feet in length and several layers of shotcrete reinforced with steel mesh. Precast concrete coffered panels were installed for the finish lining of the vault. This treatment gave the interior not only an attractive but a durable and low-maintenance surface. Dupont Circle was one of the most difficult stations to design in the entire system. Its construction was accomplished with no unusual problems. KE also designed several hundred feet of double track cut-and-cover tunnel south of Dupont Circle Station and a surface traction power substation.

The transit tunnel crossed the Lydecker water tunnel with only 6 feet of rock separating the two facilities. Since the water tunnel was constructed between 1882 and 1902 and carried about half the water supply for Washington, D.C., it was determined that the tunnel, a brick-lined horseshoe shape with inside dimensions of 9 feet by 9.8 feet, should be de-watered and lined. KE prepared the design for a steel lining and pressure grouting. Also, KE was asked to submit a proposal to supervise the work of installing the lining. It did, but included a condition that its liability would be limited to the amount of the contract. This limitation of liability was not acceptable to the Authority, so that work was done by others.

The authority had planned to have the construction of its system managed by the firms that designed each section. But the limitation of liability matter caused the Authority to change its plans and retain one firm to manage all the construction. At the time the construction manager was to be selected by the Authority, the Bechtel firm was completing a similar assignment for BART and lobbied effectively for the job. It was successful.

The amount of the original design contract was $891,000. The final amount was $985,000, including numerous changes and the design cost for the lining of the Lydecker water tunnel. The total amount of the original bids for the construction was $22 million (1967 dollars). All work was accomplished with no unusual problems.

### The People

All design of the Connecticut Avenue tunnel and Dupont Circle Station was accomplished in KE's Chicago office as the workload at that time was low. Roger Troxell managed the project in Chicago. His staff included Bob Olander, civil engineering; Bill Custer, structural engineering; Joe Wychocki, electrical engineering; Barbara Stengal, mechanical engineering; and Rich Morris and Bill Friend. Cliff Gambs was the resident engineer stationed in Washington, D.C.

## Highway Bridges

Over the years, the City of Oakland has built many structures, three of which were outstanding accomplishments, combining engineering ingenuity, architectural elegance, and at the same time achieving good economy. The city's instructions to its designers and architects was in, one case, "blend aesthetics and function" and, in another location, "to build a beautiful bridge capable of stimulating redevelopment of the surrounding area." In each case, Kaiser Engineers headed a team of engineers, architects, and specialists to accomplish the city's goals. The three projects completed were as follows:

23rd Avenue Overpass – 1962
Hegenberger Expressway Overpass – 1965
Adeline Street Overpass – 1976

The 23rd Avenue Overpass was done in association with John Carl Warnecke, architects, and T. Y. Lin and Associates, pre-stress consultants. Don Mauser managed the project. Roger Troxell, Henry Wolf, and Bob Taboloff were the structural engineers.

The same team did the Hegenberger Overpass. Roger Troxell was project director. Bill Bertwell was the chief structural engineer, and Henry Wolf was structural design engineer.

The Adeline Street Overpass was done by KE alone with Roger Troxell acting as project manager. Bob Taboloff was chief structural engineer. Tim Lee was structural supervisor and L. H. Chang and M. I. Kuo were structural design engineers. Ma Chi Chen performed dynamic analysis work. KE

The Transportation Division began in the 1960s with the organization of the division and the recruitment of key transit personnel. Initial assignments started with small study projects, blossoming into full-blown engineering projects.

KE (sponsor) in joint venture with DMJM was awarded in 1966 the first of a series of contracts to design the Los Angeles Metropolitan Rapid Transit System. KE and its people participated in all of the system's growth and expansions over the next 27 years.

The Transportation Division went on to design six major rapid transit systems for the cities of Los Angeles, Baltimore, Miami, Pittsburgh, Boston, and Chicago. All designs were in joint venture with major rapid transit consulting firms.

Some KE personnel devoted their entire careers to these projects, each lasting several decades as they solved technical and construction problems involved with congested downtown sites along with the practical and political problems associated with getting approval of funds. In all, these projects had a constructed value of some \$8.5 billion, equivalent to about \$11 billion now.


A view of a Los Angeles Red Line System train in station. Note sign above the train, 'To Union Station.'

The expertise gained in Los Angeles led to projects to engineer and manage construction of large transit systems located in five other U.S. cities. In later years, KE participated also in an \$18-billion transit system in Taipei.

The Baltimore Rapid Transit System was built in three phases over the period 1967 to 1995. The 13.5-mile system project cost was \$1.3 billion. It was reported as 'the subway that everyone loves.'

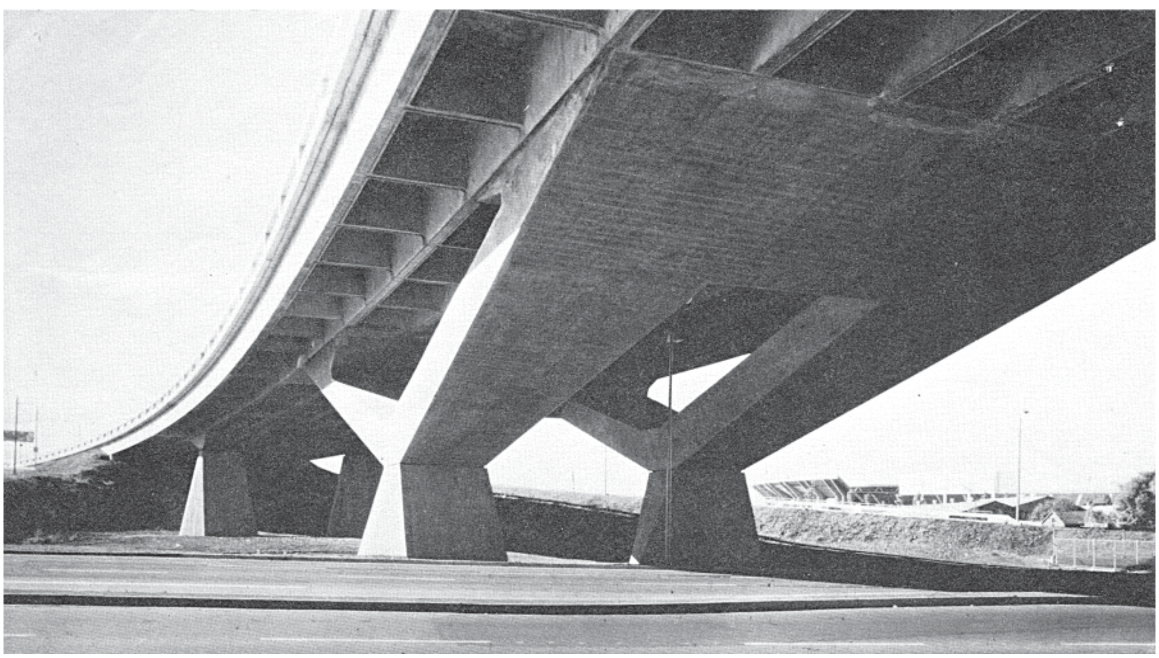
The Cold Spring Lane Station (right).

One section of 1.5 miles was built in a very difficult and congested area over large, deteriorating sanitary sewer systems and with underground passenger terminals built below existing water table. The result was a whopping cost of \$226 million per mile!

KE was the joint-venture sponsor for design of the Dade County (Miami) Rapid Transit System. It was a 21-mile long, elevated, conventional rail transit facility. The project began in 1976 and was completed in 1982 with a total cost of $1.018 billion. KE developed and designed the 85-foot long, double ‘T’ precast, pretensioned box girder sections for the elevated railway, shown being erected (above). Approximately 3,000 tons of these sections were made and erected.

The photo below shows a train approaching the Dadelands North Station (below). By the mid-’90s the system was carrying 51,000 passenger trips per workday.

In addition to the six major rapid transit systemprojects undertaken, the division was also responsible for the design of a section of the Washington, D.C. Metro System route between Connecticut Avenue and Rock Creek Park. Included was the design of the DuPont Circle Station shown above. Design was done in KE's Chicago office in 1967.



In our own backyard, the Transportation Division was responsible for the design of three highway bridges in Oakland, California. These structures, crossings of the Nimitz Freeway were 23rd Avenue Overpass, 1962; Hegenberger Overpass, 1965; and Adeline Street Overpass, 1976. Shown above is the attractive Hegenberger Overpass located near the Oakland Coliseum. Built in 1965 in association with a local architect.

Chapter 9

# Marine Terminals

## Overview

Kaiser Engineer's initial involvement in marine terminals and related port and waterfront facilities had its origins in the design and construction of Henry Kaiser's World War II shipyards in Richmond, California, and in Oregon and Washington states. Additionally during 1944-1946, the company designed and constructed marine terminal ship loading-unloading facilities for both sacked and dry bulk Portland cement in the ports of Redwood City, California; Seattle, Washington; Anchorage, Alaska; and Honolulu, Hawaii. Many of the personnel who managed and staffed these early projects were those who went on to lead and participate in Kaiser Engineers' subsequent projects to design and build marine port and terminal facilities throughout the world.

Table 9.1 is a summary listing of selected marine port and terminal projects performed by Kaiser Engineers during the years 1950-1985. Not included in the listing are the marine terminal facilities that individually were only a part of many of the major projects designed and constructed by the company. Kaiser Engineers' range of services for its work in the marine terminals industry included all phases of project planning and design and construction / construction management.

The first part of this chapter describes Kaiser Engineers' Marine Terminals Department and its projects during the years 1966-1977. Included in the second part of the chapter are descriptions of other selected port and bulk ship loading-unloading facilities designed and built by the company during the years before and after the period of operations of the Marine Terminals Department.

## Marine Terminals Department

### Origin of the Department

Kaiser Engineers' Ports, Terminals, and Cargo Systems Department (later renamed the Marine Terminals Department) was created in 1966. It was the natural outgrowth of the numerous dry-bulk ship loading-unloading terminals that Kaiser Engineers had designed for its affiliated company projects, including Kaiser Steel Corp., Kaiser Aluminum and Chemical Corp., and Kaiser Cement Company worldwide. It was KE's decision to capitalize on this experience and market it to the public and private clients as the workload from its affiliated Kaiser companies was declining.

Another reason for creating the new department was to get the jump on development of expertise in the newly emerging cargo handling technology known as "containerization." This shipping technology involved packaging cargo in uniform-sized metal containers, generally 8 feet high by 8 feet wide and 20 feet long or longer instead of on small pallets known as "break-bulk cargo." This revolutionary concept would require the construction of entire new fleets of cargo ships as well as new marine terminals with specially designed cranes and cargo handling systems. The timing for KE to get into the beginning of this new market was perfect!

### Key Personnel

Hal Anderson was appointed as the first department head of this new industry department, reporting to Sam Ruvkun, vice president. Department heads following Hal were Bob Young, Fred Wholfsen, and Fred Nielsen. Other key members of the original department staff included Doug Pinkham, administrative engineer; Dick Brennan, Russ Monsen, Ed Burk, Vello Kiisk (project engineers / managers); and Ralph Kreuger and Jeff Ford, management trainees. Fred Nielsen was a member of the original staff as well as the last person to "turn-off the lights," when the department was deactivated many years later. Other members of the department came and went as the workload changed.

### First Marine Project

The first project undertaken by the newly formed Marine Terminals Department was a contract to design a new bulk cargo terminal, part of an expansion program by the Port of Los Angeles, California. This terminal served as the export terminal for iron ore pellets shipped from Kaiser Steel's Fontana, California, steel mill some 50 miles east of Los Angeles. Bob Young was the project manager. A unique feature of this terminal was the crawler-tractor mounted bucket-wheel reclaimer, the only one of its kind at that time. Unfortunately, it remained the only one of its kind because it proved to be a very high maintenance piece of equipment.

Otherwise, the terminal was considered a success and remains in operation to date.

## Container Terminal Projects

Over the next five years the Marine Terminals Department grew to more than 20 personnel in the project group, about half of which were new hires with specialized expertise in the emerging cargo containerization and computer technologies. The department became involved in major terminal projects at the U.S. ports of Oakland, New Orleans, Charleston, New York, Los Angeles, and San Francisco. Most of the container terminal projects began with the development of master plans, including cargo forecasts and financial analyses, followed by engineering design and construction services. Some of the relevant features of these terminals are described below.

## 7th Street Marine Terminal
## Port of Oakland

Shortly after the commencement of the Los Angeles bulk terminal project, the Port of Oakland hired KE to plan and design the 7th Street Marine Terminal for the Port of Oakland. This facility would be the first full-fledged container terminal on the U.S. West Coast. At that time, there was a very small combination container break-bulk terminal in existence at Alameda, California, known as the Encinal Terminal. The planned new terminal was the brain child of the resourceful and opportunistic Oakland Port Director, Ben Nutter. Ben decided to get the jump on the other West Coast ports and capture the lion's share of the West Coast container trade as it developed.

KE's services for the project included preparation of a comprehensive economic evaluation, a containerized-cargo projection analysis, and a master plan of the new 9-berth containership facility. The master plan evaluated both the acceleration in the use of containership design and the related requirement that the terminal have capability to handle conventional general cargo ships, present generation container ships, and the large specialized container ships of the future, with minimum modification of facilities.

The 140-acre terminal site was constructed on bay fill that created a new peninsula on the Oakland waterfront. Fill material consisted of excavated soils obtained from the Bay Area Rapid Transit District (BART) Berkeley Hills tunnel excavation project. BART also paid for the construction of the filled-area perimeter dike. During the course of filling the site to an average depth of 30 feet, an accumulation of fines in suspension developed in the water ponded between the growing fill and the perimeter dike. This material, which amounted to approximately 40,000 cubic yards in volume, was unsuitable for use as fill material because of the extremely long period of time required for consolidation. Accordingly, alternative plans for disposal of this material were developed, including ponding and evaporative drying or removal of the material by suction dredge and dump barging for disposal at sea. The latter alternative was selected and was carried out under Kaiser Engineers' supervision. This filling and dredging aspect of the terminal site presented many unusual and challenging engineering problems, the solutions to which were applicable to other demanding harbor development and maintenance programs.

Kaiser Engineers' services included also design of the wharf structures, transit sheds, utilities, access roads and all support facilities, and resident engineering services during construction. Fred Nielsen was Kaiser Engineers' project manager, and Jeff Ford was the resident engineer during construction, reporting to Fred. The terminal went into operation in 1968 and, for many years to follow, Oakland was the leading container shipping port on the West Coast. The 7th Street Marine Terminal became a model for development of future U.S. container terminals, and Kaiser Engineers became known as the leading expert in this new technology.

## France Road Terminal
## Port of New Orleans

The France Road Terminal in the Port of New Orleans consists of a 280-acre site at the intersection of the Inner Harbor Navigation Canal and the Mississippi River-Gulf Outlet. Served by railroad, highway, and on-grade access roads, this terminal has adequate space for the increasing use of large-scale containerized cargo facilities.

The Marine Terminals Department developed both the original and an updated master plan for the France Road Terminal. In the studies made for the master plan, Kaiser Engineers interviewed representatives of steamship companies and agencies, stevedoring companies, railroads, local government agencies, and other organizations and persons directly and indirectly concerned with the development of the France Road Terminal. The information contained in other completed studies for the Port of New Orleans, the Maritime Administration, and the Department of Transportation was also evaluated for its applicability to the master plan.

In updating the master plan, KE projected the general cargo facilities necessary to meet the requirements of the shipping industry, identified recent and projected technology changes in cargo handling and transportation systems, prepared capital cost estimates and phased construction plans, and determined the economic feasibility of the entire project.

Kaiser Engineers' services for the France Road Terminal included design of all its waterfront facilities, transit sheds, utilities, and support facilities. Since all of the existing general cargo facilities of this port were designed for the handling of break-bulk cargoes, the planning of this 9-berth terminal was based on a gradual phase-over from break-bulk operations to a fully containerized system. The transit sheds, required initially to be positioned close to the wharf's edge to support break-bulk cargo operations, were designed so that later they could easily be relocated some 800 feet behind the wharf to serve as container stuffing sheds in a fully containerized operating mode.

A unique feature of the wharf's design was the use of precast concrete deck panels supported directly on precast concrete piles, without pile caps. This feature minimized the necessity for and related expense of extensive over-the-water concrete form construction, as required with conventional wharf design.

This huge 9-berth terminal is now fully developed, very much in conformance with Kaiser Engineers' original master plan prepared more than 30 years ago. Vello Kiisk was the project engineer responsible for development of the terminal's master plan. Russ Monsen followed as project engineer responsible for the design phase of the terminal's initial development.

## U.S. Lines Terminal
## Port of New York

U.S. Lines handled its marine cargo from an existing finger pier on the West Side of Manhattan Island. The company wanted to convert its existing "break-bulk" handling facility to handle containerized cargo. However, the terminal did not have adequate backland area available for the storage of containers. Accordingly to circumvent this problem, Bob Young and one of the department's younger engineers, with a master's degree from Stanford and very computer literate, devised the concept of a vertical container storage structure, 10 stories high with a computerized operating system. This system later became known as the Kaiser "Speedtainer System." U.S. Lines never installed the system as the company soon came to the realization that the present location of the terminal presented increasingly severe terminal traffic access problems. Accordingly, they relocated their operations to Brooklyn where access was better and adequate terminal land area was available. Bob Young was the project manager for this project. The patent is in his name.

Kaiser Engineers' rights for the marketing and further refinement of the Speedtainer System were eventually sold to Pacific Coast Engineering Company, then headquartered in Alameda, California.

## Manchester Lines Terminal
## Port of Montreal

This terminal was the first fully containerized terminal to be built in Canada. The Furness-Withy Company for Manchester Lines of Great Britain operates the terminal. A unique feature of this terminal is the cover over the pre-stowed container storage area, required because of Montreal's severe winter weather with frequent periods of freezing rain. This weather condition would cause a build-up of ice in the corner castings of the containers. The ice would prevent the container handling equipment from moving the containers, resulting in extensive vessel loading delays and demurrage costs.

The master planning and conceptual design of this terminal was performed by the Marine Terminals Department in KE's Oakland office under the direction of Vello Kiisk, project manager. Design of the terminal was conducted in KE's Montreal office under the direction of Les Trew.

## LASH Terminal, Pier 96
## Port of San Francisco

This unique terminal, utilizing the LASH (Lighter Aboard Ship) concept, developed by the United States Maritime Administration, was planned by Kaiser Engineers for joint use by American President Lines and Pacific Far East Lines. The terminal utilized floating barges carried on huge mother ships serving remote locations in primarily Third World countries without adequate port facilities. The San Francisco terminal was to be highly automated. Even though the concept made some sense in certain applications and a number of mother ships were constructed, the concept never really caught on. Besides, Pacific Far East Lines (now defunct) got into financial difficulties, and what is left of the terminal, finally designed by the Port staff, now "lies in ruins" at pier 96 of the Port of San Francisco. Ralph Kreuger was KE's project manager for this project.

## Roll-on/Roll-off Terminal<br>Dalhousie, New Brunswick, Canada

This terminal was constructed at a major production facility of International Paper Company to serve the largest roll-on / roll-off vessels in Canadian ports. The facility was constructed on a rock island with the wharf piers drilled into the underwater rock. Construction continued throughout the harsh winter with concrete placement performed within heated enclosures. Dredging of the approach channels in the Bay of Chaleur required hauling the muck 19 miles to sea to avoid contaminating the environmentally sensitive lobster beds.

Fred Nielsen was project manager working out of KE's Montreal office. Jeff Ford was resident engineer during construction.

## Bulk Terminal Projects by the<br>Marine Terminals Department

The Marine Terminal Department, while continuing to keep busy in the planning and designing of container terminals, continued to market actively for additional bulk cargo terminal projects. Prime contracts the department was successful in securing included:

- Alumina Unloading Terminal, Port of Tacoma, Washington
- Petroleum Coke Loading Terminal, Benicia, California
- Solar Salt Loading Terminal, Great Inagua Island, Bahamas
- Solar Salt Loading Terminal, Bonaire Island, Netherlands Antilles
- Iron Ore Transshipment Terminal, Panama

Brief descriptions of the interesting features of several of these projects are included below.

## Alumina Unloading Terminal<br>Port of Tacoma

This facility at the Port of Tacoma was designed to unload alumina bulk carriers to supply the alumina feed-stock for the Kaiser Aluminum and Chemical Corp. aluminum smelter at Tacoma. The terminal featured a rail-mounted, traveling clamshell bucket ship unloader and a wooden dome storage structure with airslide reclaim system. Alumina material handling system dust control was a major problem at this facility, and more than 25 years later it still is. Alumina is a very fine powder that is difficult to contain completely in a clamshell bucket without some spillage. Modern alumina unloading systems and equipment now utilize vacuum unloaders, which lend themselves to more efficient dust control.

Dick Brennan and Russ Monsen were responsible for the several phases of this project, including its planning, design, and services during construction.

## Salt Loading Terminal<br>Bahamas and Netherlands Antilles

These terminals were very similar in design, except that the Bahamas terminal was in the Atlantic hurricane belt, and the Netherlands Antilles terminal was not. The owners of these two terminals were Morton Salt Company and International Salt Company, respectively. Both terminals featured stationary shiploaders, with slewing and luffing booms capable of loading ships up to 40,000 DWT in size. The Bahamas terminal suffered some damage when a hurricane passed through the area during construction, including the loss of a barge load of pre-stressed concrete piles from Florida when the barge was beached during the storm. This resulted in a delay in construction completion and additional cost to the project. Construction of the Antilles terminal taught us a lot about driving piles in coral sand, a subject that warrants a book by itself. We also learned the need for increased concrete cover over reinforcing steel and pretensioning strands in tropical, humid environments, especially when exposed to frequent salt spillage from conveyor belts. We also learned that in hurricane-prone areas the design of structures and equipment should be such as to resist the effects of hurricane forces during all stages of construction.

Ed Burk was responsible for direction of all phases of the Bahamas terminal development project. Vello Kiisk directed the planning of the Netherlands Antilles Terminal. Aage Holm was responsible for its design, and Jim Zilli was the resident engineer during construction.

## Marine-related Studies, Planning

The Marine Terminals Department provided a complete range of services to their clients, including cargo projections, feasibility studies, economic analysis, systems planning, estimating, financial planning, and environmental protection planning, as well as design and construction management. This in-house capability to perform a complete project set the department apart from competitors that lacked such overall capability. Studies performed included the following:

- Statewide Port Master Plan
  South Carolina

For the South Carolina State Ports Authority, KE developed a statewide plan for port expansion, including projections of cargo growth, modes of cargo handling, port facilities, and cost estimates thereof as necessary to accommodate the projected cargo volume. The planned development has been implemented, and its usage has been near its projections. Russ Monsen was project manager.

- Superport for Deep Draft Vessels
  State of Louisiana

Kaiser Engineers provided staff functions for the State of Louisiana's Deep Draft Harbor and Terminal Authority. Services included assistance in drafting enabling legislation for offshore oil terminals, development of an environmental protection plan, and studies to define the economic benefits resulting from the planned petroleum superport. Dick Brennan was project manager.

- Port Master Plan
  Cleveland, Ohio

Kaiser Engineers, under a contract with the U.S. Army Corps of Engineers, completed a harbor master plan, including economic, environmental, social, and engineering considerations of port expansion for transshipping 57 million tons per year of bulk cargo through the port. Nine alternative marine and land systems were selected and analyzed. Fred Nielsen was project manager.

## Water Transit Facilities

The Marine Terminals Department developed passenger projections and systems planning for the Golden Gate Bridge Highway and Transit District's $50-million ferry system on San Francisco Bay. This work led to a contract for design and resident engineering services for the $14-million Larkspur Ferry Terminal in Marin County. Included were maintenance facilities for the 750-passenger, gas turbine-water jet propelled ferryboats. The terminal's one acre, triangular space frame is supported at three points. The frame was fabricated in sections in Fresno, California, and assembled at the project site. The frame and roof structure are supported on deep friction piles made of heavy steel H sections produced in Belgium. A mile-long water channel was created to separate recreational sailboat traffic from the high-speed ferries. As a mitigating measure, a marsh was created to replace the wetlands used for the terminal site. Fred Nielsen and Les Dittert were the project managers. Jeff Ford was resident engineer during construction.

## Airport Projects Considered by the Department

The Marine Terminals Department explored the new business opportunity of diversifying its services into the airport development and expansion field. Its reasoning was based on the fact that many of its prime clients, the U.S. Port Authorities, also owned and operated major international airports. At that time, the Dallas-Fort Worth Airport was being completed at a cost of over $2 billion. Additionally, the Federal Aviation Administration was projecting the need for an additional seven similar new airports in the United States during the next 10 years. KE's management felt that the Marine Terminals Department, in conjunction with the construction division, could successfully market construction management capabilities in this field. Such opportunities were subsequently pursued, unsuccessfully, at the San Francisco, Phoenix, and New York (Kennedy) airports. Airport expansion concepts for the Oakland, San Francisco, and Honolulu airports were also produced. However, it soon became apparent that the FAA's projections were overly optimistic and, accordingly, KE's management decided to discontinue efforts to expand into this market. It turned out to be the right decision.

## Demise of the Marine Terminals Department

By 1976, KE had become a recognized expert in the marine terminals planning and design field. Many of the Marine Terminals Department's key project engineers and managers had become almost internationally known as "containerization" experts through technical articles they had published and through contacts with organizations such as the American Association of Port Authorities and the International Association of Ports and Harbors. At about this time, the level of domestic and international minerals business and related port development were declining rapidly worldwide. Additionally, at the same time, port authorities and steamship companies were developing their own in-house expertise in containerization in order to minimize their needs for outside consultants. Their recruiting efforts included unsolicited job offers to key members of the department including salaries up to half-again over what they were currently making with KE. What then happened to the Marine Terminals Department was quite common in our capitalistic system. Many of the department's personnel accepted other jobs, especially the young, upwardly mobile, computer literate people who were not shackled with the loss of retirement and medical benefits.

## Final Blow

The final blow to the department came when Raymond International acquired Kaiser Engineers and announced that all port projects would henceforth be handled from its headquarters office in Houston, Texas. Faced with the prospect of having to move to Houston, most of the remaining department staff opted to be absorbed by other KE departments in order to remain in the Bay Area. And, after about 10 years of existence, that marked the end of a once very successful Marine Terminals Department.

Many of the former members of the Marine Terminals Department went on to successful careers after their *internship* with Kaiser Engineers. Ed Burk became an executive with a large Chicago- based international engineering consulting firm. Ralph Kreuger became a senior vice president with a large U.S. steamship company in New Orleans. Vello Kiisk became and retired as the Executive Director of the Port of San Francisco, and Aage Holm and Alden Lofquist went on to successful careers with the Bechtel Corporation.

## Other Port and Terminal Projects by Kaiser Engineers

Many of Kaiser Engineers' major mineral industries projects included extensive port and terminal facilities for the berthing of ocean-going cargo vessels and loading-offloading systems and related equipment. Several major projects are described below.

## Bulk Alumina Ship Loading Terminal
## Aluminum Partners of America
## Nain, Jamaica.

Included as part of a bauxite mining project in Jamaica for Alumina Partners of America (ALPART) was design and construction of the Port Kaiser marine terminal. Port facilities included a 450-foot-long dock located at the end of a 275-foot-long rock-filled approach embankment, rotary rail car dumper, boom stacker, and bauxite shiploading equipment. Several years later, KE converted the existing ship loaders to handle alumina instead of bauxite and made provisions for receiving caustic soda and petroleum products.

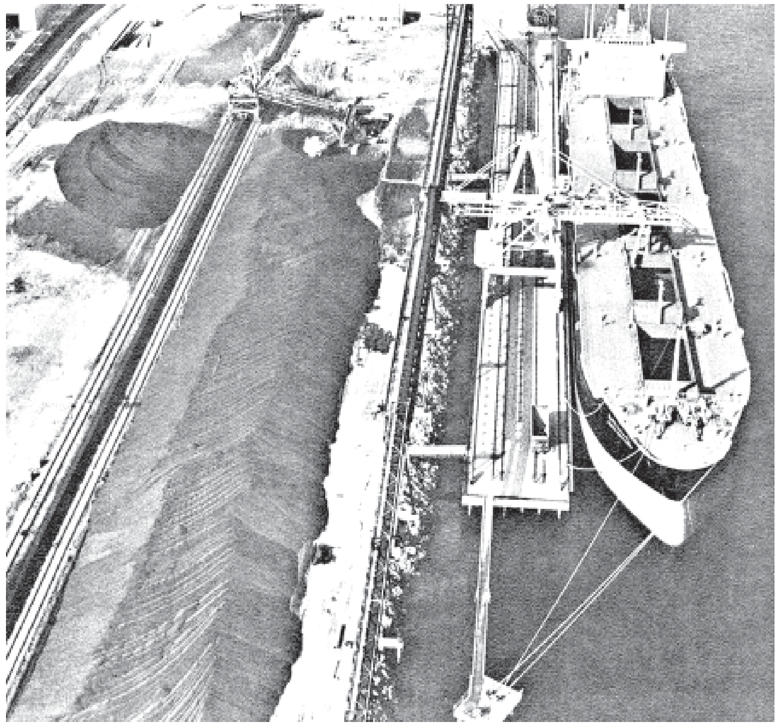
## Port and Materials Handling Facilities
## Queensland Alumina, Ltd.
## Gladstone, Australia

Kaiser Engineers provided engineering, design, procurement, and construction management services for both the initial construction and for subsequent expansions of the world's largest alumina plant, Queensland Alumina's 2-million ton-per-year complex at Gladstone, Australia. A major portion of this project was the building of the marine terminal and the material handling system for the offloading of bauxite from ships and the loading of alumina onto ships. The material handling systems were designed for the simultaneous loading of alumina and the offloading of bauxite with the bauxite conveyed by a traveling gantry-type unloader that discharges onto a wharf conveyor. The alumina is transported to the shiploader by a separate fully enclosed 780-foot-long conveyor with 1,200 ton-per-hour capacity that discharges onto a traveling shiploading spout.

**Table 9.1**
**Selected Marine Terminal Projects**

| Job No.*** | Project Names | Client | Location | Project Value $1000s |
|---|---|---|---|---|
| 5121 | Port Kaiser Bauxite Shiploader | KAAC | Jamaica | 2,000 |
| 5604 | Dock Modification | KAAC | Baton Rouge, LA | 2,030 |
| 6129 | Dock & Bulk Loading Facility | Metro Stevedore Co. | Long Beach, CA | 110* |
| 6419 | Bulk Shiploader Facility | Nat'l Metal & Steel Co. | California | 6,500 |
| 6539 | Bulk Alumina Unloading Terminal | KAAC | Tacoma, WA | 226* |
| 6543 | Salt Loading Facility | Morton Salt Co. | Bahamas | 20* |
| 6600 | Wharf Structure | Canada Public Works | Newfoundland | 3,000 |
| 6624 | Cargo Handling Facility | Univ. Terminal Corp | Brooklyn, NY | 60* |
| 6638 | Port Development Plan | Port of Cyprus | Cyprus | 55* |
| 6717 | 7th St. Marine Terminal | Port of Oakland | Oakland, CA | 33,000** |
| 6725 | Manchester Lines Cont Term | Port of Montreal | Montreal | 21* |
| 6820 | Salt Loading Facility | Antilles International | Netherlands, Antil. | 1,212 |
| 6833 | Military Ocean Term Facilities | U.S. Government | U.S.A. | 98* |
| 6861 | Container Terminal | Port of New Orleans | Louisiana | 107* |
| 6866 | East Intercourse Iron Ore Port | Hamersly Iron Pty | Australia | 110,500** |
| 7025 | France Road Terminal | Port of New Orleans | Louisiana | 382* |
| 7026 | Shiploader Modification | Wabush Mines | Quebec | 116 |
| 7232 | Hay Point Expansion Program | Utah Development Corp | Australia | 1,786* |
| 7301 | Wharf and Warehouse | Nat's Dock & Harbor Bd. | New Brunswick | 4,800 |
| 7305 | Superport Study | State of Louisiana | Louisiana | 100* |
| 7316 | Rail Barge Dock | YGK Line | Kentucky | 1,491 |
| 7344 | Port Master Plan | Port Heuneme | California | 71* |
| 74147 | Cleveland Harbor Navigation | U.S. Corps of Engineers | Ohio | 149* |
| 74181 | Dry Bulk Terminal | Mississippi Ports Authority | Mississippi | 46* |
| 77067 | Port of Suez | Egypt | Egypt | 883* |
| 78034 | Berth J Extension | Port of Oakland | California | 300 |
| 78111 | 9th Ave. Terminal Rehab | Port of Oakland | California | 400 |
| 80148 | Long Beach Coal Terminal | Upland Industries Corp | California | 248* |
| 80204 | Bulk Cement Terminal | Port of Long Beach | California | 300 |
| 80135 | Port Expansion | Red Sea Ports Authority | Egypt | 238* |
| 81145 | Bulk Alumina Ship Loading Term | ALPART | Jamaica | 115,000 |
| 83112 | Oil Berth Modification | Caribbean Gulf Refining | Puerto Rico | 116* |
| 83155 | Refinery Marine Facilities | Petrola International | Saudi Arabia | 20,302 |
| 85116 | Minerals Port | Government of Gabon | Gabon | 150,000** |
| 84009 | LNG Import Terminal | China Eng. Consultants | Hsin-Ta, Taiwan | 199* |
| 85194 | Minerals Port | Government of Gabon | Owendo, Gabon | 4,500 |
| 1964-80 | Port & Minerals Handling Fac. | Queensland Alumina Ltd | Australia | 39,000 |

* Engineering Services Fee Only
** Total Value of Overall Project
*** Year of Beginning of Project is the First Two Numbers of the Job Number



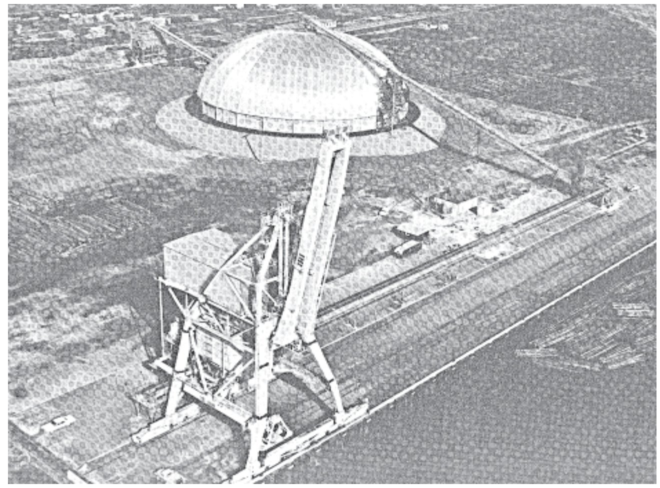
Iron ore bulk-loading facility at Port of Los Angeles (1964). This was KE's Marine Terminals Department's first project after being formed. The terminal served as the export terminal for iron ore pellets shipped from Kaiser Steel's Fontana, California, steel plant. The crawler-tractor mounted bucket-wheel reclaimer was the first of its kind at the time.

Seventh Street Container Terminal, Port of Oakland, California. KE did the feasibility study, the master plan, and design of the new 9-berth containership terminal. When completed in 1968, it was the first full-fledged container terminal on the United States West Coast.

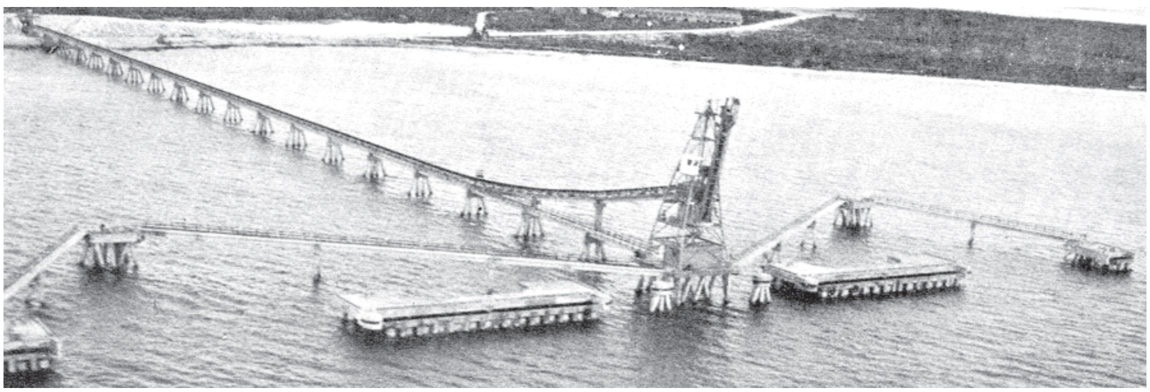
Facilities planned and designed by KE included the 140-acre filled site constructed on the Oakland Waterfront, all of the container handling and storage facilities, the wharf structures, and the site infrastructure.

The Seventh Street Marine Terminal became a model for development of future U.S. container terminals, and KE became known as the leading expert in this new technology.

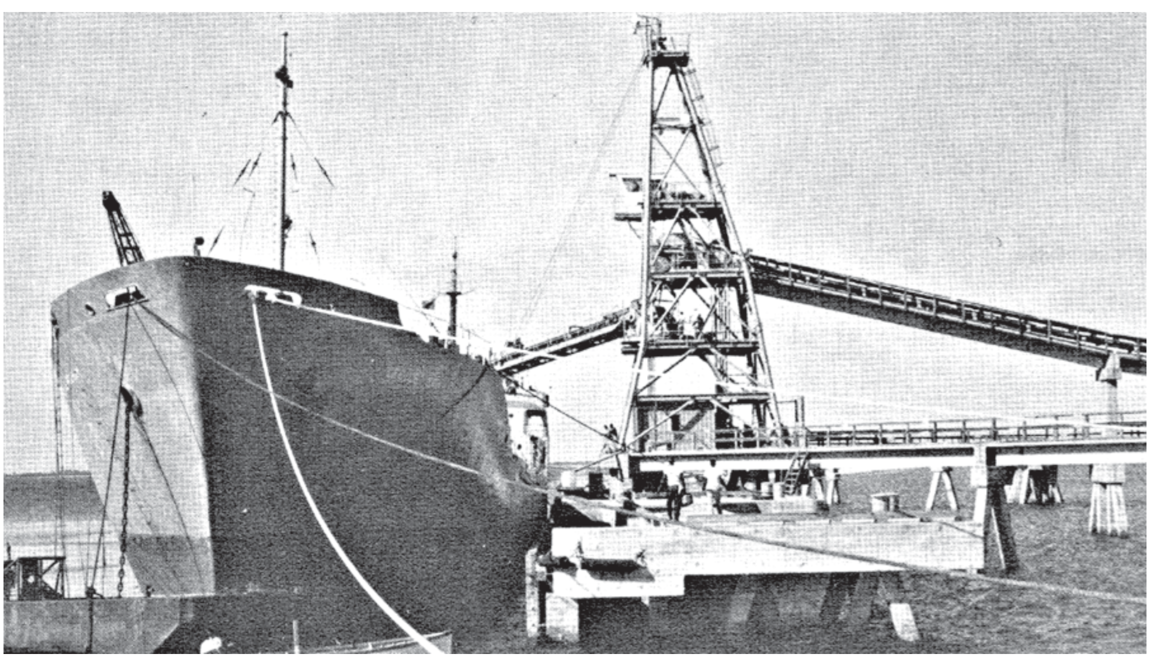
Overall view of the Terminal built at the Oakland Waterfront.



Alumina Ship Unloading Facility, Port of Tacoma, Washington. Design and supervision of construction by KE, 1973-1974. The unloading system incudes a 750-ton-per-hour traveling gantry crane with bucket unloader and a covered conveyor system to transport the alumina to the 50,000-ton storage dome.



Design and supervision of construction in 1965 of an offshore bulk loading facility on Great Inagua Island, Bahamas, for Morton Salt Company to handle cargo vessels ranging in size from 5,000 to 40,000 deadweight tons. The docking facility shown above comprises nine functional structures, including loading tower and mooring platforms and protective breasting and anchor dolphins. Ship loading underway, shown below.



Chapter 10

# Hydroelectricity Design

## Overview

It was a natural transition that brought Kaiser Engineers into the design of complex hydroelectric facilities, given its vast experience and antecedents in building such projects. In the mid-1950s KE had targeted the design of these facilities as potential for new markets for our engineering capabilities by starting to recruit civil engineers that specialized in this field. Early awards included preparation of feasibility studies and economic evaluations of hydro projects. Then in 1958 the opportunity came to serve the Government of Ghana on its large Akosombo project on the Volta River.

How we got it and other great works in Brazil is a story in itself, described below. But once having won the Akosombo project, KE could now assemble a larger staff of experts who not only designed and supervised the construction of that project but went on to build nine major projects over the next 25 years.

Heavy construction activities sponsored by KE continued on a parallel path staffed by KE's construction staff. These activities are described in "Chapter 3, Construction." But included in this current chapter is a review of the technical features of those projects as they relate to our engineering and consulting efforts.

## How We Got Started

Kaiser Industries maintained representation in Washington, D.C. looking for business opportunities. Chad Calhoun, our representative, was one of Henry Kaiser's inner circle of civil engineers who helped with the bidding and award of Boulder Dam in 1933. From there he went on to become one of Mr. Kaiser's most trusted envoys in the nation's capital. It was in 1958 that he became aware of the interest of the U.S. Government in the political situation of the Government of Ghana. This interest extended to U.S. Presidents Kennedy and Johnson. Calhoun recalled the events in an unpublished diary in 1970. This excerpt tells how the project started.

"In 1958, we became interested in the Volta Hydroelectric Project in Ghana and the possibility of building an aluminum plant there. Edgar Kaiser and I had established close and warm relationships with Premier Kwame Nkrumah, later President. The United States was closely involved in the political and economic aspects of Nkrumah and Ghana. As time passed and Nkrumah looked more and more to the East, our government became quite concerned. Because of our friendly but non-political relationship with Nkrumah, Edgar and I, separately or together, could and did have some beneficial, though temporary, influence on Nkrumah. We always reported our visits in Ghana to the State Department and, later by request, when Nkrumah began to indicate or foster anti-Americanism, directly to the White House beginning with President Kennedy.

Edgar and I had just returned that day from Ghana where we had had serious talks with Nkrumah about his actions and unfriendly attitude towards the United States. In Edgar's plane we had flown on arrival at Kennedy Airport, from Ghana via Rome, to Washington, and gone directly to the White House meeting with President Johnson to report on our conversations and observations. Present, besides the President, Edgar and me, were Dean Rusk, Secretary of State, Ambassador Averell Harriman, George Ball, Under Secretary of State, John McCone, CIA Director, and Ambassador William Mahoney, Ambassador to Ghana, then in Washington.

After hearing our report and asking many questions, the President sincerely thanked Edgar and me and expressed gratification and praise for Kaiser enterprise, attitudes, and accomplishments."

Note how involved Presidents Kennedy and Johnson were in attempting to get Ghana to be friendly to the West. It became a matter of national interest, given the escalation of the Cold War at the time.

As a follow up to this, KE succeeded in getting the job and made a reassessment of prior studies of the Akosombo project. This project was originally under the direction of KE's vice president for Europe and Africa, Jim Boyce. When he transferred to Kaiser Cement, Earl Peacock took over as vice president in charge. Peacock brought his knowledge of hydroelectric developments, having just completed several tours of duty as Colonel in charge of the Los Angeles District of the Army Corps of

Engineers, where he was in charge of a number of hydroelectric operations.

The project was completed in 1965, by which time KE had a number of trained hydroelectric project experts available for reassignment.

In the meantime in Brazil, KE had established a good reputation for its successful completion of a large automobile plant and was well regarded for its work on a large steel complex. Its development efforts targeted the burgeoning demand for hydro developments in Brazil. Numerous contacts were maintained with the governmental power agency Eletrobras. But to this time, KE could only identify numerous targets of opportunity without being awarded an assignment.

The following is a first-person account of how KE got its foot in the door and eventually went on to design five major projects. The observation is by Sam Ruvkun who was KE's Vice President for Latin American Activities.

"KE maintained a small development office in Brazil, headed by Bill Simonsen. In my many visits to Brazil, Bill and I met a number of times with officials of Eletrobras to determine which hydro projects were coming up and to pass on our qualifications. Brazil was on a large power expansion program throughout the country. But we could not break into the market, competing with a number of established hydroelectric design firms.

Then in 1964, Bill was approached by Isaac Milder and Walter Rocha who had a small engineering firm in Sao Paulo called Serete. They wanted to expand their operations and proposed a joint venture with KE. They were from the Northeast of Brazil and knew well the people in charge of a development of new hydro facilities in the State of Ceara, called Boa Esperanza. The project at hand was a powerhouse. But the problem, as I saw it, was that the earthfill dam for the project was already under construction.

Bill sent this information to me in Oakland, and I rejected it on the basis that the project was already underway and that if there were to be a failure on the dam, our presence on the powerhouse could mean that we could be held responsible. But Bill did not give up. He sent rebuttals a second and a third time. Each time the answer was the same. No.

Finally, in frustration, Bill called me by phone. I knew that this was a call of importance because in those days no one made a long distance telephone call except in an emergency. Bill's plea was for me to come down and take a look.

I agreed to discuss it with our experts and would come after that. At this time, several of our experts from the Volta project had returned to Oakland and were awaiting reassignment. So I asked Warren Schumann to review the data we had. He reported that the layout was such that a powerhouse could be sited far enough away from the dam that they would, in effect, be two separate projects.

Arrangements were made for me to fly to the Northeast from Sao Paulo with Isaac Milder and Walter Rocha. As an aside, the trip was memorable for two happenings. Along the way Isaac and Walter's luggage was lost. We three spent the next three days using my shirts and underwear, even though they were a size or two bigger than they were. Then we spent an overnight at the job site. It was memorable because at exactly 2 a.m. we were all awakened by a heavy windstorm. The natives explained that this was a daily occurrence when the warm land air masses and the cooler sea air collided. It's a phenomenon of the area.

Our meeting with the president of the power company went very well. Cesar Cals was president of Cohebe, the acronym for the Boa Esperanza power company. I left the meetings feeling that we were the ones being wooed rather than the other way around. He really wanted our association to succeed.

The next problem I faced was to determine what kind of an association to make with Serete. They were so eager to work with us that it became clear that they would do anything we proposed. Now, having gone through several years working in Brazil, I knew firsthand that problems of rapid inflation and erratic exchange rate fluctuations were serious for our financial well being. We already were finding out from our heavy construction projects that a joint venture was only as good as the word of the participants, not dependent on any iron-clad contract. Adding to the mix, we knew that financing agencies in Washington would only finance the cost of U.S. goods and services.

So I came up with a radical plan for working with Serete. We would enter into a contract with the client for services of our U.S. based staff and would be paid in dollars only. Serete would enter a separate contract with the client for all Brazilian-based services and would be paid in local currency. There would be no need to try to convert currencies and face unknown exchange rates. Then Serete and KE would be tied together with a firm memorandum of understanding. This was worded strongly so that KE's staff had full control of all concepts and decisions, and Serete would, in effect, be a sub-contractor to us.

This was so new that I sought legal and top management opinion. No one objected to the logic behind the arrangement, and all agreed to give it a try. It worked so well that for the next 15 years the same formula was used in other projects in Brazil. For compensation, we used a multiplier on our salaries with the multipliers including full overhead and a profit, even though the men assigned overseas did not cause added costs to our home office overhead. In other words, we just pocketed the inputed overhead. It turned out to be an attractive pricing method. I think this was the first time that we did work overseas in this manner."

So KE now had two engineering crews at work on hydro projects. One was located in our London office where our experts in hydro design led local support personnel. They were active in this activity for the next three decades.

In Brazil, a separate organization of KE hydro experts supervised Serete and its follow-on company, Milder-Kaiser, for more than two decades."

## Range of Services

Now KE could demonstrate to clients its knowledge of hydroelectric developments, including power generation, flood control, irrigation, and water supply. KE began to shift its focus from construction to consulting, engineering design, and resident engineering of hydro projects. During the ensuing 30 years, KE services included all types of engineering services:

**Planning**
project planning
feasibility studies
conceptual designs
geotechnical studies
environmental impact studies
mitigation studies
license applications

**Detail Design**
contract drawings
bidding documents
evaluating construction bids
specifying major hydro equipment
procurement of equipment

**Construction Assistance**
resident engineering
inspection
evaluate progress payments
testing
start-up manuals
start-up assistance

KE's services involved all types and elements of projects as follows:

- Reservoir Storage Projects
- Run-of-the-River Projects
- Dams up to 180 meters high
    - concrete gravity dams, including rolled compacted concrete
    - arch dams
    - rock fill with central clay core or concrete face
    - earth fill and gravel fill
- Powerhouses
    - conventional indoor or semi-outdoor
    - underground
- Hydraulic turbines up to 585,000 hp
    - Pelton wheel high head
    - Francis-type medium head
    - Kaplan Bulb or pit low head
- Tunnels up to 13 meters diameter
    - Conventional drill-and-blast method
    - Tunnel boring machine technology
- Spillways up to 30,000 cubic meter/second discharge
- Canals
- Pumping Plants
- Pipelines
- Substations up to 525 kv
- Transmission Lines up to 500 kv

The KE client base is impressive because it includes many repeat clients. Over half of the assignments came from repeat business from satisfied clients. The list and their acronyms follow. Future discussions refer to clients by their acronyms:

U. S. Bureau of Reclamation (USBR)
U. S. Army Corps of Engineers (USCE)
Snowy Mountain Hydroelectric Authority
East Bay Municipal Utility District (EBMUD)
Pacific Gas and Electric Company (PG&E)
Volta River Authority (VRA)
Energie Electrique de la Cote d' Ivoire (EECI)
Companhia Paranaense de Energia Eletrica (COPEL)
Companhia Hidro Eletrica da Boa Esperanza (COHEBE)
Centrais Eletricas do Sul do Brasil (ELECTROSUL)
Eletricas do Brasil (ELETROBRAS)
Bonneville Power Administration (BPA)
City of Idaho Falls
Empresa Nacional de Electricidad (ENDESA)
Oroville – Wyandotte Irrigation District (OWID)

Included in the pages at the end of this chapter are Table 10.1 entitled, "Hydroelectric Design Project List," and Table 10.2 entitled, "Hydroelectric Capabilities." These data were abstracted from KE's permanent records.

## Major Hydroelectric Engineering Projects

During the ensuing three decades, KE undertook nine major river developments. These were major in the sense that KE provided all services required to complete them, including establishing basic concepts, detail design, contract drawings, equipment specification, assisting with procurement, and providing resident engineering and start-up services. They were major projects that covered periods of time from 5 to 6 years each, during which time KE had personnel assigned to the projects.

From a historical perspective, it is interesting to note how the periods of time for the various projects overlapped, creating continuity of service for our people. The following table demonstrates the time frames involved. In the next sub-chapters each project is described in some detail.

## Major Hydroelectric Engineering Projects (con't)

| | **Year Started** | **Year Completed** |
|---|---|---|
| *Africa* | | |
| Akosombo Ghana | 1959 | 1965 |
| Akosombo Exp. Ghana | 1969 | 1972 |
| Kossou Ivory Coast | 1967 | 1973 |
| Taabo Ivory Coast | 1974 | 1979 |
| *Brazil* | | |
| Boa Esperanza | 1965 | 1971 |
| Salto Osorio | 1969 | 1976 |
| Salto Santiago | 1972 | 1980 |
| Foz de Areia | 1973 | 1981 |
| Salto Segredo* | 1981 | 1983 |

* design completed, construction deferred

## Staffing of These Projects

Design of the four projects in Ghana and the Ivory Coast was performed in our London office with Warren Schumann as Chief Design Engineer. He was succeeded by Al Chan in 1964 when Warren was moved to Sao Paulo to manage KE's hydro work in Brazil. His staff of U.S.-based hydroelectric project experts supervised a local support staff recruited in London. All of our hydro design work in Brazil was performed in our Sao Paulo or Rio de Janeiro offices with Warren Schumann as Project Manager. Warren and his U.S.-based engineers with hydroelectric expertise, supervised a local staff of engineers. Brazilian staff was recruited by Serete originally, and later that company was taken over by Milder-Kaiser, with KE maintaining a partnership interest in Milder-Kaiser.

Timing of the major projects permitted the full-time assignment of two teams of KE's experts. Design of the four projects in Africa covered a period of 20 years. Design of the five projects in Brazil covered a period of 18 years.

But the period of time of activities on both continents did not end with completion of these nine major projects. In the decade of the '80s, a number of projects was assigned where KE's assignment was more limited. This included conceptual designs, consulting advisory services, and resident engineering services that lasted for another decade. These additional services are described below in the subchapter on Conceptual Design and Consulting Assistance.

## Volta River Project Akosombo

This was the first major hydroelectric engineering project awarded to us. The development of the Volta River Project, also called the Akosombo Hydroelectric Project, was closely linked to the independence in 1957 of the former British Gold Coast Colony. This led to an independent Government of Ghana under the leadership of Dr. Kwame Nkrumah. The following year President Nkrumah paid his first official visit to the U.S., and in his meetings with President Eisenhower, he made the Volta Project the principal objective of his agenda for economic development and formally requested U.S. technical and financial assistance.

The U.S. representatives produced a list of American engineering firms that might be considered for the work. Included in the list of possible firms was the name of the Henry J. Kaiser Company. The company's work on the Snowy Mountains Project in Australia was well known and highly regarded. Dr. Nkrumah was known as a doer and was ready to accept the U.S. recommendation.

Arrangements were made for Dr. Nkrumah to meet with Edgar Kaiser, the President of the company as reported in Chad Calhoun's diary previously reproduced. Two days later an accord was established in New York.

Kaiser Engineers was given the assignment to assess prior engineering work on the project and it immediately assembled a project team in Oakland under the leadership of Colonel George Gerdes. Gerdes was retired from the U. S. Corps of Engineers where he had experience in the conceptual design of hydroelectric facilities, and he was already on KE's staff. They lost no time in making a reassessment and delivering a report in early 1959 concerning the engineering aspects and economic feasibility of the proposed hydroelectric project and aluminum smelter.

## Reassessment Report

That report recommended five outstanding improvements with respect to an earlier scheme that had been put forward by the British consulting firm, Sir William Halcrow & Partners: (1) The original damsite on the Volta River at Ajena was abandoned, and a new site for the dam selected at Akosombo, even though it was recognized that a dam at Akosombo would be more difficult to construct, but it was estimated that it could be built in four years instead of seven for Ajena; (2) an aluminum smelter would be built at Tema instead of at Kpong, thus saving the cost of developing a new township; (3) for an initial period, alumina would be imported instead of processing local bauxite. This postponed the development of new mines, the construction of new railways, and the building of an alumina plant; (4) Kaiser Engineers proposed that an electrical transmission grid be created to supply electricity to more industrial and potential domestic users; and (5) the Reassessment Report concluded that the installed capacity of the power plant could be increased and the cost of power reduced significantly.

## Kaiser's Agreement with Nkrumah

In late 1959, Dr. Nkrumah and Mr. Kaiser signed the "Principles of Agreement" which set forth the basic financing arrangements for the project that were put into place. These involved (1) the creation of the Volta River Authority (VRA) by the Government of Ghana patterned after the Tennessee Valley Authority to own and operate the hydroelectric project; (2) the creation of Volta Aluminum Company (VALCO), a joint venture of Kaiser Aluminum and Chemical Corporation (90%) and Reynolds Metals Company (10%) for the purpose of owning and operating a 145,000 ton per year smelter; (3) a long-term power purchase contract between the VRA and VALCO; and (4) various loans from the World Bank, EXIM Bank, and AID of the U.S. Government and Export Credits from the U.K. Government. It should be noted that the Government of Ghana undertook to raise half the money itself. One of the key figures responsible for the successful negotiation of these matters was Chad Calhoun, vice president in Kaiser's Washington, D.C. office.

## KE's Initial Assignment

The hydroelectric project did not appear to be economically attractive until Kaiser Engineers re-evaluated all of its aspects. On the basis of the favorable findings of our reassessment report, the VRA authorized Kaiser Engineers to construct an access road from the port of Tema to Akosombo damsite and to build housing at the damsite. KE then was authorized to perform detailed geological investigations and prepare outline design drawings, specifications, load growth studies, and power rate studies. We also assisted the government in its financing discussions with the International Bank for Reconstruction and Development (World Bank), the Agency for International Development (AID), the Export-Import Bank, and other financial institutions.

## New KE London Office

Following these initial assignments, KE established a new office in London. Personnel of the British engineering firm Balfour Beatty, Ltd., plus key personnel from KE's Oakland office were organized for the purpose of performing the detailed design of the project. As part of the detail design services, KE prepared contract drawings and bidding documentation and then assisted with solicitation of worldwide competitive construction bids and the award of contracts for construction and supply of permanent equipment. Competition for the construction of the project and supply of the permanent equipment was intense. The low bid for the main civil works was submitted by the Italian firm lmpresit-Girola-Lodigiani (lmpregilo). Their price was substantially below the Engineer's Estimate.

Tenders for equipment were received from 98 firms in 12 countries. A public opening of these bids was held in Accra. Ray Ware recalls that it was a monumental task to tabulate all of the bids, evaluate them for conformance with the specifications, and then rank them for review by the Volta River Authority. While the staff was trying to sort out all these bids, Edgar Kaiser showed up unexpectedly, as he often did. He surprised the members of the consulting team in one of the bedrooms of the Hotel Ambassador. They had stripped to their waists to keep cool because of the intense heat and lack of air conditioning. Edgar continued to be intimately involved in monitoring progress of the project.

Much credit for the successful construction of the project was given to Dr. Guissepe Lodigiani, chairman, and Mario Baldassarrini, manager of lmpregilo, who had previously earned a fine reputation for the successful completion of comparable large projects in Africa such as Kariba in Rhodesia and Roseires in the Sudan.

## Volta Project

The Volta River project is outstanding in many respects. The 141-meter high Akosombo central-clay core rock-fill dam is one of the highest of its kind. It measures 640 meters long, and contains 7.9 million cubic meters of material. A nearby saddle dam is 36 meters high and 535 meters long.

Considerable study had to be devoted to various alternative river diversion schemes, the design of the cofferdams, and the necessity of removing the layer of sand covering the river bottom. For maximum stability of this large and important dam under critical conditions, it was decided to clean the entire dam foundation to bedrock. Nearly 1.2 million cubic meters of sand were removed with specially designed suction dredges and airlifts operating to an unprecedented dredging depth of 66 meters.

The planned construction program for the dam included a unique method for river diversion, at that time, believed to be without precedent in the construction of a rock-fill dam.

In development of the construction program it was determined to build a diversion tunnel only large enough to handle the low-water seasonal river flow. This was considered necessary because river flow rates during the three-month flood season were so huge that it was impractical to build a diversion tunnel(s) large enough to handle the entire river flow. It was decided that during one flood season, part of the partially completed rock-fill dam would be used as a flood channel to handle the main river flow. During the flood season, construction continued on the three-fourths of the dam structure that was not part of the temporary flood channel. This diversion method, although a gamble, resulted in considerable savings in construction time and money.

Two rock-fill cofferdams, which were incorporated into the main dam, are among the highest ever built underwater. The downstream cofferdam is 69 meters high, the upstream one 39 meters high. A large flood in 1962 completely submerged both cofferdams without significant erosion. After the flood the cofferdams were sealed on the outside with impervious blanket material. The foundation dewatering operation that followed was one of the most difficult ever attempted. An even larger flood occurred during construction of the dam and had to be diverted over a portion of the partially completed rockfill and clay core section.

Akosombo Dam, which was topped out in January, 1965, backs up the Volta River to form an 8,400-square-kilometer reservoir containing 148 billion cubic meters of water. Lake Volta is the fourth largest artificial lake in the world. Some 80,000 people were resettled or compensated as a result of the inundation of 600 towns and villages.

Two reinforced concrete spillways each have a capacity of 10,340 cubic meters per second, designed to handle a maximum reservoir inflow flood of 34,000 cubic meters per second. The power plant initially included a powerhouse with four 128-mw units with provision for two additional units. The layout and design of the power plant is believed to be one of the most compact and economical ever achieved. The 800-km long transmission system includes both 161-kv and 69-kv substations and transmission lines to serve the southern half of Ghana and the Valco aluminum reduction plant at Tema. The major electrical equipment was designed and manufactured in many different countries, requiring considerable effort on system engineering, quality control, and construction coordination.

## KE's Construction Management Services

The project site was located in a tropical rain forest. Because of the site's remote location, it was necessary to build a self-contained new living community to support KE's construction management staff and their families, Ghanaian personnel, and the project workers. Initial site construction involved clearing and construction of site infrastructure including power generation and distribution system, a water treatment plant and distribution system, and waste disposal facilities. Housing, schools, medical facilities, and a police station were built.

We supplied construction management services, including all inspection, resident engineering, and supervised testing of all permanent equipment through installation and start-up of the first four generating units. Through our cooperation with our sister company, Kaiser Foundation International, we provided medical advisors to the hospital that was built by Impregilo to serve all project personnel.

The first generating unit of the Akosombo power plant was turned over to the Volta River Authority for commercial operation in September, 1965. The turnover of the first unit at Akosombo took place in accordance with a schedule established in early 1960, despite problems that occurred because of record floods during construction. Moreover, the initial 512-mw (four-unit) project was completed at a total cost of about $162 million, over 5 percent below the estimate upon which the financing was based.

An interesting and very important aspect of the project was the necessary medical care of personnel for the prevention of malaria and river blindness. All expatriate personnel, including families, were required to take preventative medication for malaria. The best medication came from South Africa. However, the logistics for importation of this medication into Ghana was a major problem to overcome because of strained political relations between the two countries. The medical care program was very successful in that only one case of malaria occurred. In this case, it was discovered that the individual involved had not followed the preventative medication protocol. For those project personnel who were working regularly down on the river, it was necessary that they take an additional medication to prevent river blindness. This disease is a parasite infection of the eyes, resulting in blindness, caused by the bites of certain insects that frequent the river area.

In the later stages of the construction program it was necessary to plan for a possible emergency evacuation of personnel to Togo because of the possibility of civil war erupting in Ghana. Together with the major contractor for the dam, a plan was developed whereby bulldozers and other heavy construction equipment would be used to build an emergency evacuation route from Akosombo (the damsite) to neighboring Togo. Fortunately, it was not necessary to implement this plan.

The construction and operation of the power project and smelter provided training and employment for several thousand Ghanaians. The inauguration of the project was celebrated by elaborate ceremonies conducted by the tribal chiefs. The project was a major attraction for state visitors to Ghana. Some of these visitors were Queen Elizabeth and Prince Phillip of the United Kingdom, Emperor Haile Selassie of Ethiopia, the first woman cosmonaut to visit space, the Prime Minister of Singapore, and others.

Many talented and dedicated KE people contributed to this outstanding project, including:

Earl Peacock, Vice President Europe and Africa Area, Overall Project Direction
Ray Ware, Project Director
Warren Schumann, Chief Design Engineer, London Office
Al Chan, Assistant Chief Design Engineer, London
Shalom Blaj, Civil Design Engineer
Winston Saimons, Structural Design Engineer
Ed Sorensen, Mechanical Design Engineer
Glen Wilson, Electrical Design Engineer
Don Hooper, Chief Soils Engineer
Bob Koch, Chief Specifications/Contracts Engineer

Doug Pinkham, Office/Contracts Engineer
Giff Randall, Project Engineer/Irrigation and Lake Transport
Burt Janes, Construction Manager
Dick White, Field Engineer
Dr. Jim Hughes, Medical Director/Advisor

## Volta River Project
## Akosombo Expansion

In 1969, the Volta River Authority retained Kaiser Engineers to provide engineering, procurement, and construction management services for the installation of two additional 162-mw generating units at Akosombo, raising installed capacity to 912 mw. This work was completed in 1972.

Other services furnished by Kaiser Engineers over a period of 22 years for this multi-purpose project involved power generation, water supply, irrigation, recreation and inland navigation. Extensive studies were made of lake transportation in 1963. Two feasibility studies by Giff Randall of irrigated agricultural development of the Accra Plains were made in 1963 and 1980. And a power study in 1970 identified and analyzed various potential alternative power sources to meet load growth, such as importing power from Nigeria or building a 188-mw hydroelectric project at Kpong Rapids.

## Kossou Hydroelectric
## Ivory Coast

Favorably impressed with the performance of Kaiser Engineers in neighboring Ghana the newly independent Republic of Ivory Coast in 1963 engaged Kaiser Engineers in joint venture with Electricité de France to prepare an economic evaluation and outline design report of the proposed multi-purpose Kossou Hydroelectric Project on the Bandama River. The original purpose of the project was to provide attractively priced power to satisfy the rapidly increasing domestic demand. The power produced by the project nearly doubled the country's total generating capacity. Later the scope was increased to make this a multi-purpose project.

Then in 1966, the Government of the Ivory Coast created the Bandama Valley Development Authority to finance, operate, and administer the project. At the request of Ivory Coast's President Houphouet-Boigny and with the support of U.S. President John Kennedy, the Export-Import Bank of the United States authorized a major loan to the Ivory Coast for the purchase of U.S. services and equipment for the project. Additional funding was obtained from various other sources.

### Initial KE Studies

Kaiser Engineers conducted the site investigation surveys, power studies, hydro project layout studies, agricultural studies, cost estimates, and economic studies. Electricité de France conducted the hydrological and load growth studies, outlined the transmission system studies, and cooperated on the power plant layout studies and agricultural studies.

The Outline Design Report commissioned in the previous year was completed in 1964 by Kaiser Engineers and Electricité de France. It recommended that the Kossou Dam be built and that a 150-mw power plant be installed.

In 1965, Kaiser Engineers submitted another report on its studies of the feasibility of irrigation development. The foregoing studies and further site investigations and hydraulic model testing of spillway designs resulted in an update of the outline design report, which now established the dam elevation at 55 meters and the installed power capacity at 175 mw. This report was submitted to financing agencies and later updated during 1967 with still further site investigations as requested by these agencies. These studies served as the basis for the project to proceed.

### KE Services

Kaiser Engineers then prepared engineering, detail design, and contract documents, followed by procurement, resident engineering, and construction management services. Services also included evaluation of construction bids and assistance to the Government of the Ivory Coast in negotiation of the contract with Impregilo for construction of the project. At the ground-breaking ceremony in 1969, Ivory Coast President Houphouet-Boigny turned the first symbolic shovel of earth and pushed a button setting off a large charge of dynamite. Dignitaries present included Edgar Kaiser, Chairman of the Board of Kaiser

Industries, Dr. Guisseppe Lodigiani, President of lmpregilo, and others.

## Kossou Project

The Kossou damsite is located about 300 km from Abidjan, the nation's capital. The Kossou Dam is of sloping-core earth and rockfill construction. It measures 55 m high and 1,500 m long, and contains 5,260,000 cubic meters of material. The power plant includes an intake structure, three power tunnels, and a semi-outdoor powerhouse. The powerhouse contains three 58.5-mw units, driven by Francis-type turbines, giving a total generating capacity of 175.5 mw. The Kossou spillway is designed for a peak reservoir outflow of 2,160 cubic meters per second. A high-voltage transmission system carries the power output 279 km to Abidjan via a 225-kv line, and 145 km to Bouaké via a 90-kv line with associated substations.

Construction of this $88-million project was completed on schedule and under the original budget estimate early in 1973. Edgar Kaiser was one of the principal speakers at the dedication ceremony held at the damsite and conveyed congratulatory greetings from President Richard Nixon to President Houphouet-Boigny.

The 160-km-long reservoir impounded by the Kossou Dam has created a fishing industry, and the regulation of the river provides water for irrigated agriculture, domestic consumption, and transportation via an inland waterway.

Through our cooperation with our sister company, Kaiser Foundation International, we provided medical advisors to the hospital that was built by Impregilo to serve all project personnel.

## KE Staffing

By the time this project started, some of the key staff who began the Akosombo project had been reassigned, some of whom became key staff for projects in Brazil. Still, the nucleus for the Ivory Coast projects came from the first Ghana assignment, creating continuity of service as a team. The key people responsible for planning and executing this project included the following:

Earl Peacock, Vice President Europe and Africa Area, Overall Project Direction
Al Chan, Project Manager and Chief Engineer
Bob Koch, Project Manager/Outline Design Report
Dick Lowell, Resident Manager/Abidjan
Shalom Blaj, Chief Design Engineer
Perry Holzgraph, Resident Engineer/Abidjan
Leigh French, Contracts Manager/Kossou
Winston Saimons, Structural Design Engineer
Ted Kiernan, Civil Design Engineer
Geoff Penney, Electrical Design Engineer
Harry Heath, Electrical Design Engineer
Glen Wilson, Electrical Design Engineer
Ed Sorensen, Mechanical Design Engineer
Richard Mieleniewski, Mechanical Design Engineer
Linc Grayson, Contracts Engineer
Mike Morgans, Geologist
Rocky Kabotsky, Geotechnical Engineer
Bob Florent, Administrator of Abidjan Office
Dr. Jim Hughes, Medical Director/Advisor
Barry Cooke, Member of Board of Consultants

## Taabo Hydroelectric Project Ivory Coast

Soon after the Kossou project was completed, KE was awarded the follow-on project of the Bandama River. Fortunately, some of the key staff were still available for this project also.

The purpose of the project was to operate in conjunction with and enhance the output of the Kossou Hydroelectric Project. Taabo Dam is notable for its length rather than its height.

## KE Services

The Bandama Valley Development Authority first engaged Kaiser Engineers to undertake a feasibility study of the proposed project in 1971, while construction of the Kossou project was in progress. Kaiser Engineers later helped the Bandama Valley Authority negotiate the main civil works contract with a consortium of Italian and French contractors headed up by lmpregilo. Financing for the project came from several international sources in the form of loans for construction of the hydro project and transmission lines and supplier credits for supply of the permanent equipment.

Preliminary site investigations, including geologic and soils exploration, and technical and economic studies were completed in July, 1972. The study report recommended the implementation of a 210- mw hydroelectric project.

Kaiser Engineers commenced detail design in 1974, prepared contract documents and specifications, issued bid invitations, evaluated bids, and recommended awards of contracts for construction and the supply and installation of permanent equipment. Finally, Kaiser Engineers provided construction management and resident engineering services when work at the site started in 1975. KE assisted with the testing and commissioning of the three-turbine power plant which was completed in 1979, slightly ahead of schedule.

## Taabo Project
## Ivory Coast

The Taabo damsite is located on the Bandama River about 117 km downstream of Kossou and approximately 200 km by road from Abidjan. The dam at Taabo has a crest length of 7,500 m and a maximum height of 34 m. To achieve the most economic use of materials available at the site, the 8,400,000-cubic-meter dam is comprised of three design sections: earthfill, earth-rock, and rockfill with earth core.

The spillway is equipped with five tainter gates with a maximum discharge capacity of 4,460 cubic meters per second. Three temporary low-level sluiceways were provided in the ogee section to pass river flows during construction of the central closure section of the dam. The sluiceways were subsequently closed with steel bulkheads and plugged with concrete.

The indoor-type power plant houses three 70-mw Francis turbines. The project includes a switchyard at Taabo, additions to an existing substation in the Abidjan area, and 200 km of transmission lines. All work on this $223-million project was completed in 1979.

Kaiser Foundation International equipped, staffed, and managed the site hospital. Expressions of appreciation for our services were received from top client representatives such as Mr. Lambert Konan, general manager of the Ivory Coast Electricity Company (EECI).

## Key KE Staff

The key Kaiser personnel responsible for planning and executing this project included the following:

Earl Peacock, Vice President of Europe and Africa Area, Overall Project Direction
Shalom Blaj, Manager/Chief Engineer of London Office
Chuck Lindberg, Resident Manager (site)
Lane Milde, Chief Design Engineer
John Whiteley, Chief Electrical Engineer
Richard Mieleniewski, Chief Mechanical Engineer
Eric Cole, Chief Civil Engineer
Carlos Sanchez, Chief Structural Engineer
Cliff Misener, Contracts Engineer
Ernie Pearson, Office Engineer
Ian Snedden, Civil Engineer
Angelo Lopez, Soils Engineer
Steele Tanner, Electrical Field Engineer
Eric Scott, Mechanical Field Engineer
John Davidhazy, Administrator/London Office
Bob Florent, Adminisrator/Abidjan Office

## Boa Esperanza Project, Brazil

When the design of the Akosombo project in Ghana was nearing completion in 1964 and activities of that project moved toward construction and start-up services, some key staff were no longer needed there. Several were repatriated to Oakland to await new assignments. At the same time, the Latin America division of the company was following closely the many new hydroelectric developments on the drawing boards by Brazil. Recognizing the availability of our hydroelectric design expertise within KE and the marketing opportunities in Brazil, an intense effort was mounted to get some of that work.

As previously described, the first opportunity came for complete responsibility for the powerhouse design on the Boa Esperanza project. The Boa Esperanza Hydroelectric Project was undertaken by Companhia Hidro Eletrica da Boa Esperanza (COHEBE), with financing provided jointly by the Government of Brazil and the U.S. Agency for International Development (AID). The project provides electric power, water conservation for irrigated agriculture as well as flood control for the economically depressed northeast region of Brazil (States of Piaui, Maranhao and Ceara). Our role was limited, however, to design of the powerhouse.

Boa Esperanza was the first Brazilian hydroelectric design project undertaken by Kaiser Engineers. After Kaiser Engineers successfully completed work on the Willys Overland do Brasil Project and was well underway with the Cosipa Project, we established a development office in Sao Paulo and chased a number of potential projects, finally landing this one.

The project was undertaken in association with Serete, with Isaac Milder as president. Our memorandum of understanding spelled out our prime role in directing the concepts and leading the design. Serete was to provide personnel to perform engineering activities under our direction. As a matter of fact, Milder and his people met all their obligations and performed as our people directed. The client was perfectly happy with the results. An independent review of the quality of the work showed excellence and particular care of the many details involved in a complex structure. The formula and this team approach were the beginning of the Kaiser Engineers' history of hydroelectric developments in Brazil.

## Boa Esperanza Project

The project is located on the Parnaiba River near Teresina in northeastern Brazil. It consists of a semi-outdoor powerhouse with a 120-ton gantry crane and four 54-megawatt Francis turbine-generator units for a total installed capacity of 216 mw in two stages each.

The dam, designed and built by others, is a 5-km long central clay core rockfill dam with maximum height of 55 m and a volume of 3.5 million cubic meters, a spillway, an intake structure with 100-ton gantry crane, four 6.6-m diameter steel-lined power tunnels, and a 230-kilovolt switchyard and transmission line.

## KE Services

The engineering services for the powerhouse project were begun in Sao Paulo in 1965 by Kaiser Engineers in association with the Brazilian firm, Serete S/A Engenharia. This association was selected by COHEBE to provide conceptual studies, contract drawings and specifications, detail design, procurement assistance, resident engineering, preparation of operating manuals, training, start-up and testing.

The president of COHEBE was very pleased with the outcome of the project and his praise of our work was instrumental in our being selected by COPEL in 1969 to design the Salto Osorio Hydroelectric Project on the lguaçu River. The successful completion of Stage I (first 2 units) of the Boa Esperanza Project in 1971 at a cost of $72 million contributed significantly to the strong presence which Kaiser Engineers developed and maintained in Brazil over the 25-year period lasting until 1981. This included several repeat assignments from satisfied clients on other major hydro projects in Brazil.

## KE Staff

Key personnel of Kaiser Engineers included project manager Warren Schumann; assistant project manager Don Hooper; mechanical engineers Ed Sorensen and Paul Grove; electrical engineer Steele Tanner; and resident engineer Cliff Misener.

## Salto Osorio Project
## Brazil

Because of the excellence of the work performed on the Boa Esperanza project, KE was highly recommended to COPEL and to Electrosul for the beginning of a large river development along the Iguaçu River in Southern Brazil. The award of this project was again in association with Serete, based on the successful formula used in the Northeast. But this time our assignment was the full project development, including the dam, powerhouse, and all appurtenant structures. This was to be the beginning of our design of a series of four projects along the Iguaçu. It was now known as "our river."

The Salto Osorio Hydroelectric Project was financed by the World Bank and developed initially by COPEL (Companhia Paranaense de Energia ElÈtrica) and then turned over to Centrais Eletricas do Sul do Brasil (Eletrosul). Its purpose was to satisfy the rapidly increasing demand for electric power in the entire southern region of Brazil including the states of Parana·, Santa Catarina, and Rio Grande do Sul.

## Salto Osorio Project

The project is located on the lguaçu River about 385 km west of Curitiba and about 250 km upstream of the famous lguaçu Falls, which rival Niagara Falls in beauty. It consists of the following facilities:

- A semi-outdoor powerhouse with a 500-ton gantry crane and six 175-mw Francis-type turbine generator units for a total installed capacity of 1,050 mw (initially 4 units followed by 2 additional units).
- A 55-meter high, 750-meter long central clay core rockfill dam with a volume of 4 million cubic meters, which creates a reservoir with a normal maximum capacity of 1.25 billion cubic meters and surface area of 61 square kilometers.
- Two overflow crest and chute with flip bucket-type spillways designed to jointly handle a 10,000-year flood, one having a capacity to discharge 15,000 cubic meters per second, the other capable of passing 12,000 cubic meters per second (the first spillway structure included 10 low-level diversion sluices.
- An intake structure with 250-ton gantry crane
- Six 7.4-m diameter steel penstocks
- Nine 230-kv substations.

## KE Services

COPEL selected KE in association with Serete in 1969 to perform economic feasibility studies, including geotechnical site investigations, hydrological and power studies, conceptual design and cost estimates to optimize layout, contract drawings and specifications, detail design, procurement assistance, resident engineering, preparation of operating manuals, and assistance with start-up and testing.

The feasibility report was prepared in Sáo Paulo by Warren Schumann, Bob Koch, and Kent Miller of Kaiser Engineers. Key personnel of Kaiser Engineers for all other phases consisted of project manager Warren Schumann; assistant project managers Burt Janes and Don Hooper; chief project engineer Shalom Blaj; civil-structural engineers Harry Libner and Leon Guzman; mechanical engineers Ed Sorenson and Percy Dawson; electrical engineers Bill Moon and Steele Tanner; and resident engineer Jeff Elliott. Oscar Nieponice was chief electrical project engineer, and Geoff Penney was electrical engineer for the substations. The Board of Consultants consisted of Barry Cooke, Tom Leps, Jim Libby, and Victor de Mello.

## Construction

The first phase river diversion contract was awarded to Consorcio-CBPO-Paranapanema. The main civil works contract was executed by Consorcio Metropolitano-Consag Ltda. The entire project was completed on schedule in 1976 at a cost of $184 million, which corresponds to a very low unit cost of $175 per kilowatt.

The excellent performance of Kaiser Engineers on the Salto Osorio Project lead our Brazilian clients to award four additional major lguaçu River projects: Salto Santiago, Foz do Areia, Segred, and Capanema to Kaiser Engineers and our associates. That’s why the river became known as “The Kaiser River.”

## Salto Santiago
## Brazil

The next project along the Iguaçu assigned to our team in 1972 was Salto Santiago, located some 55 km upstream from Salto Osorio. But it was already known that we would be handling two other dams upstream. The timing was such that the team completing Salto Osorio (1969 to 1976) would leap frog this next one and handle projects that would begin in 1973 and 1981. So a new team was assembled for Salto Santiago.

The Salto Santiago Hydroelectric Project was financed jointly by the Inter-American Development Bank (IADB); the Brazilian governmental entities Eletrobras, Finame, BNH, and Finep; Buyer’s credits and the Eximbank. The project was developed by Centrais Eletricas do Sul do Brasil (ELETROSUL) for the purpose of meeting the industrial load growth for electric power in the southern and southeastern regions of Brazil (states of Parana, Santa Catarina, Rio Grande do Sul, Sao Paulo, Rio de Janeiro, and Minas Gerais).

## Salto Santiago Project

The project is located on the Iguaçu River about 340 km west of Curitiba, about 355 km upstream of the lguaçu Falls and 55 km upstream of the Salto Osorio Project. It consists of the following facilities:

- An indoor-type powerhouse with two 200-ton bridge cranes and 6 333-mw Francis-type turbine generator units for a total installed capacity of 2,000 mw (initially 4 units, followed by 2 additional units).
- An 80-meter high 1,400-meter long rockfill dam with an inclined clay core and volume of 10 million cubic meters.
- A 60-meter high earthfill-type saddle dam having a volume of 2 million cubic meters which, together with the main dam, creates a reservoir having a normal maximum capacity of 6.75 billion cubic meters and a surface area of over 200 square kilometers.
- Four 13.5-meter diameter diversion tunnels.
- Chute-type spillway designed to pass 24,000 cubic meters per second corresponding to a 10,000-year flood, controlled by eight 20-meter high by 15-meter wide tainter gates and equipped with a flip bucket.
- A 58-meter high intake structure with 75-ton gantry crane.
- Six steel penstocks, each having a diameter of 7.60 meters.
- A 525-kV switchyard.

## KE Assignment

Eletrosul assigned the project to KE in 1972 in association with Serete S / A Engenharia to perform economic feasibility studies, including geotechnical site investigations, hydrological, and power studies; conceptual design and cost estimates to optimize the layout. In 1974, Eletrosul engaged the services of Kaiser Engineers in joint venture with its Brazilian affiliate, Milder-Kaiser Engenharia (the successor company to Serete), to prepare contract drawings and specifications, detail design, and provide procurement assistance, resident engineering, environmental impact report, operating manuals, and assistance with start-up and testing. Work was performed in Rio de Janeiro as an integrated project team to maximize the opportunities for transfer of technology to the Brazilian engineers.

## KE Key Staff

Because there would be several projects performed by KE and Milder-Kaiser at the same time, a second team of hydro specialists was assigned to the Salto Santiago project. The initial assignment was preparation of a feasibility report. This was prepared by project manager Bob Koch, chief project engineer Shalom Blaj and civil project engineer Winston Saimons of Kaiser Engineers. The key personnel of Kaiser Engineers responsible for the detail design phase included project manager Bob Koch; chief project engineer Emil Shabatura; civil engineers Bob Cape and Julian Flint; electrical engineer Russ Harris; mechanical engineers Brian Brett and Stan Holman; and resident engineer Bill Grunert. The Board of Consultants consisted of Barry Cooke, Tom Leps, Jim Libby, and Victor de MeIlo. Bob Koch served on the Board of Directors of the Escola Americana, which provided excellent schooling for our children.

The KE staff achieved true harmony between resource development and environmental preservation in its conceptual layout. The final design located the main dam and spillway upstream from the Salto Santiago falls without flooding out the magnificent falls.

Milder-Kaiser personnel included co-project manager Jaime Piuma; electrical engineers Ubirajara Pereira, Joao Paulo Machado, and Alfredo Toledo; civil engineers Kamal Kamel, Rodolpho Barros, and Mohy Kamel, and mechanical engineer Floriano Lube. Eletrosul president, Douglas Luz, and his senior staff presented us with a letter of recommendation at the completion of the project. The senior staff included Milton Rucker, Henrique Dijkstra, Carlos Massucci, Nivaldo Almeida, Alberto Jabur, Marco Schwab, and Fernando Domelles.

## Construction

The civil works were built by Construcoes e Comercio Camargo Corréa S.A., and the project was completed on schedule in 1981 at a cost of about $600 million, which corresponds to a very attractive unit cost of $300 per kilowatt.

A major animal rescue operation involving 1,500 animals was carried out by a team of 60 people for two months during reservoir filling.

## Foz de Areia
## Brazil

Back in Sáo Paulo, as Warren Schumann's team neared completion of Salto Osorio, KE was assigned another project along the Iguaçu. The Foz do Areia Hydroelectric Project was financed jointly by Brazilian governmental entities and the Inter-American Development Bank (IADB). The project was developed by Companhia Paranaense de Energia Eletrica (COPEL) for the purpose of meeting the industrial and domestic load growth for electric power in the southern and southeastern regions of Brazil, including the states of Parana Sao Paulo, Rio de Janeiro, and Minas Gerais.

## Foz do Areia Project

The project is located on the lguaçu River about 220 km west of Curitiba, about 530 km upstream of the lguaçu Falls and about 175 km upstream of the Salto Santiago Project. Its facilities include the following:

- A semi-outdoor type powerhouse with an 800-ton gantry crane and six 418-MW Francis type turbine-generator units for a total installed capacity of 2,510 MW (initially 4 units followed by 2 additional units).
- A 159-meter high 800-meter long concrete-face rockfill dam with volume of 13.5 million cubic meters, which creates a reservoir having a normal maximum capacity of 6 billion cubic meters and surface area of 150 square kilometers.
- Two 12-meter diameter diversion tunnels.
- A chute-type spillway designed to discharge nearly 11,000 cubic meters per second corresponding to a 10,000-year flood, controlled by four 18.5 meter high by 13.5 meter wide tainter gates and equipped with three aeration chimneys and a flip bucket.
- A 70-meter high intake structure with a 135-ton gantry crane.
- Six power tunnels, each having a diameter of 7.40 meters.
- A 500-kv SF-6 type substation.

## KE Assignment

As the engineering on Salto Osorio neared completion, the team in Sao Paulo now had the capacity to handle another assignment. In 1973, COPEL assigned Kaiser Engineers in association with its Brazilian affiliate, Milder-Kaiser Engenharia S.A., to conduct an economic feasibility study, including geotechnical site investigations, hydrological and power studies; conceptual design and cost estimates to optimize the layout; contract drawings and specifications, detail design; and to provide procurement assistance, environmental impact report, operating manuals, and assistance with start-up and testing.

## Key Staff

Key personnel of Kaiser Engineers assigned to work in Sáo Paulo, included project manager Warren Schumann; deputy project manager Don Hooper; civil-structural engineers Burt Janes and Harry Libner; civil-hydraulic engineer Howard Eriksen; civil engineer Bob Cape; mechanical engineer Lane Milde; and electrical engineers Geoff Penney and George Wallace. The Board of Consultants was made up of Barry Cooke, Don Deere, Victor de Mello, and Nelson Pinto.

## Construction

The first-phase river diversion contract was awarded to Construtora Andrade Gutierrez, S.A. The main civil works contract was executed by Companhia Brasileira de Projetos e Obras-CBPO. The entire project was completed on schedule in 1981 at a cost of about $500 million, which corresponds to a very low unit cost of $199 per kilowatt.

The Foz do Areia Project incorporates several outstanding features and innovations. It was the first concrete-face rockfill dam built in Brazil and at the time of its completion was the highest dam (159 meters) of this type in the world. The 418-mw generating units were the largest installed in Brazil. The 11,000-cubic-meters-per-second spillway was the largest having a fully aerated chute. And the 500 kv, SF6 gas-insulated substation was the first of its type installed in Brazil.

Arturo Andreoli, the president of COPEL, continued to be pleased with our efforts and was very complimentary regarding the performance of Kaiser Engineers and its affiliate, Milder-Kaiser. So he continued to give the team additional assignments.

## Salto Segredo
## Brazil

Even before Foz de Areia was completed, the team was given the assignment to plan and design the next project along the river.

The Salto Segredo Hydroelectric Project was developed by Companhia Paranaense de Energia Elétrica (COPEL) for the purpose of meeting the industrial and domestic load growth for electric power in the southern and southeastern regions of Brazil including the states of Parana, Sao Paulo, Rio de Janeiro, and Minas Gerais.

### Segredo Project

The project is located on the lguaçu River about 290 km west of Curitiba, about 435 km upstream of the Iguaçu Falls, about 80 km upstream of the Salto Santiago Project and about 95 km downstream of the Foz do Areia Project. It consists of the following facilities:

- A semi-outdoor type powerhouse with six 418 mw Francis-type turbine-generator units for a total installed capacity of 2,510 mw (initially 4 units to be followed by 2 additional units).
- A 110-meter high 700-meter long concrete-face rockfill dam with volume of about 10 million cubic meters.
- Two 13-meter diameter diversion tunnels.
- A spillway designed to discharge about 20,000 cubic meters per second, controlled by six 20-meter high by 14-meter wide tainter gates.

### KE's Assignment

Even before Foz de Areia was completed, in 1980 COPEL assigned Kaiser Engineers in association with Milder-Kaiser Engenharia, S.A. to conduct an economic feasibility study, conceptual design, and prepare contract drawings and specifications for the construction and equipment supply contracts. Warren Schumann was the project manager for Kaiser Engineers.

Design and contract drawings were well along, but at that time the country's power load changed, and the political situation changed. While in prior years there seemed to be an insatiable appetite for more power, now the market seemed to change. There were some who wanted to privatize the power generating industry. Faced with these uncertain times, the project was placed on hold.

Completion of this work was delayed. The detail design and execution of this $700-million project was deferred for about 10 years until financing could be arranged.

## Other Conceptual Designs, Consulting Assignments

The crews that designed the major projects along the Volta River, the Bandama River, and the Iguaçu gave KE a fine reputation as designer of complex hydroelectric schemes. When these projects were over, KE still had available a number of hydroelectric specialists who were assigned to additional projects as they came up. From about 1980 on, most of the assignments were for parts of the overall project. Owners now preferred to either do their own design, or to parcel them out to others. But banking institutions required independent review, and some of the clients on their own asked for KE to provide consultation.

The type of services included independent review of conceptual designs, consulting assignments, and later on in Chile resident engineering services. Services for our traditional clients in both Africa and Brazil continued with these consulting assignments. Then, because of the fine reputation established in Brazil, the next door neighbor in Chile hired us for consulting and resident engineering services.

Services continued throughout the '80s and well into the '90s. Table 10.3 entitled, "Other Conceptual Designs and Consulting Assignments" lists those projects through the period covered by this book, which is 1986.

The services included in this category are as follows:

- Proper siting of the facilities, including economic assessment of alternate sites.
- Assessment of river diversion schemes. Because of KE's extensive construction experience on such hydro facilities, our hydro technical staff could assess different alternate diversions, estimating the time and estimated cost of each.

- Evaluation of ultimate capacity, after the first phase capacity is determined by evaluation of the market for the power output. But the powerhouse may have an ultimate capacity far greater than current needs. With projects having a life span of 50 to 100 years, it is prudent to plan for future growth and allow for such orderly growth without interfering with power operations.
- Determination of type of dam, concrete or rock or earthfill. Economic and technical evaluations establish which is best for the particular site.
- Outline design of the current building plan including dams, tunnels, spillways, powerhouse and switchyard.
- Preliminary estimate of cost. Because of KE's extensive experience in building such projects, estimating costs took advantage of such experience.

## 1980s and 1990s

In the 1950s, 1960s, and 1970s, KE's services were provided to underdeveloped countries of Africa and Brazil mostly. By the 1980s and 1990s, Brazil and then Chile found themselves with some engineering capabilities built up over the prior three decades when local engineers worked under direction of KE's experts or firms like ours. Now they had hydro specialists of their own.

In addition, as financing for such projects was limited, countries such as Brazil and Chile had to limit their expenditure of foreign exchange. Still, some parts of the projects like specification and procurement of powerhouse equipment would be purchased from abroad, and financing would come from international financial institutions. These institutions required that the countries hire independent consultants to review the concepts, and in some cases, overview the project. This led to a new kind of market for KE.

This market now provided an avenue for our consulting by assigning a limited number of our key staff, where compensation would be measured as a multiplier on the salaries of our people, similar to the way we started Boa Esperanza in 1956. Such fees were attractive enough for KE so that it sought out such projects and landed a number of them.

## Consulting Assignments in the Ivory Coast

In the period of 1980 to 1990, a major conceptual design effort was made, studying the feasibility of the Soubre Hydroelectric Project for the Bandama Valley Authority, at a site located on the Sassandra River. In 1980, the staff studied the feasibility of increasing the capacity proposed by prior consultants. Subsequently, KE was retained to provide overall advisory services. Then in 1987, KE performed a feasibility study of doubling the transmission line system, which proved to be a feasible project.

In 1989, KE was retained to update prior studies, preparing flow records, new power studies, collecting cost data for updating prior estimates, and evaluating the economic and financial feasibility of two alternatives for the Soubre Project. In all, KE's records show that four jobs were opened for this project in the years of 1979, 1983, 1987, and 1988.

KE staff who participated in these studies included Shalom Blaj, chief engineer and manager of the London office, Eric Cole, Richard Mieleniewski, John Whiteley, and Ernie Pearson.

Later in 1980, KE was also retained to study the feasibility of further development of the Bandama River along eight different sites, including Daboitie. These followed KE's completion of Kossou in 1973 and Taabo in 1978. The Daboitie Study was a year-long study made by the same personnel who worked on the Soubre Project.

In 1988, KE performed a series of studies of the expansion of the Ivory Coast Hydro / Thermal Power System. This was also a year-long study sponsored by the World Bank. It included hydrologic studies, studies of load growth, cost estimating, power system studies, economic evaluations and sensitivity analyses. KE personnel who participated in this study were Graham Morrey, project director, Shalom Blaj, Winston Saimons, Jerry Miller, Bill Morrison, Ernie Pearson and Brad Porter.

## Consulting Assignments in Chile

As a result of the fine reputation for performing hydroelectric projects built up in Brazil, KE was retained by Chilean authorities in the decade of the

1980s to advise and assist them and to provide resident engineering services.

In 1980, Endesa retained KE to provide consulting and technical advisory services for the management of the construction and equipment supply contracts for the Colbun / Machicura Project, located on the Maule River in Chile. Services were provided by Don Hooper as resident adviser, with home office support by Bob Koch. Hooper served in Chile after successive leadership roles in a series of dam projects in Brazil spanning 15 years of continuous duty.

In 1985, similar services were provided by the same team for the Canutillar Project in Southern Chile. The project was completed in 1991.

In 1986, as an extension of the Canutillar Project, KE was awarded similar services of resident engineering and consulting and technical advisory services for the Pehuenche Project upstream of the Colbun / Machicura Project. This project was completed in 1991.

As another extension of the Canutillar Project, KE provided similar services for the Pangue Project on the Bio Bio River. Services were provided until 1992.

By that time, Don Hooper had completed services for Akosombo in Ghana starting in 1959, through Boa Esperanza, Salto Osorio, Foz do Areia, and then these projects in Chile. His tenure lasted from 1959 until 1992, a period of 33 years on hydro projects alone.

## Consulting Assignments in Brazil

When Al Chan had completed his duties in Africa, he was available to perform conceptual designs for the Rosana Project (1976) for CESP in Sao Paulo, Brazil. He acted as project manager and Winston Saimons as chief project engineer as they supervised a Milder-Kaiser staff in performing a feasibility study, geotechnical evaluation, hydrological and power studies, conceptual designs, and estimates of cost. Upon completion of these studies, M-K alone prepared contract drawings and detail design. After two decades of working under KE’s supervision, M-K had adequate trained staff to perform these services on their own.

In 1980, Winston Saimons, as chief project engineer, handled conceptual design of the Capanema Hydroelectric Project. This project is located along the Iguaçu 150 km downstream from Salto Osorio. It was an Eletrosul project for the states of Parana, Santa Catarina, and Rio Grande do Sul. Studies included hydrologic, geologic, and power studies along with conceptual designs and estimates of cost. The project also utilized the services of Milder-Kaiser.

## Consulting Services in Ghana

Then after two decades of working on major projects in Ghana and the Ivory Coast ending in 1979, KE returned in 1985 to prepare consulting services and inspection services at Akosombo in Ghana.

## Consulting Services in China

In 1985, KE was selected to provide consulting services to plan and prepare preliminary design of a computer-based supervisory control and data acquisition system along with protection relays of the power plant for the Three Gorges Project located along the Yangtze River in China. These services were followed by preparation of critical path schedules, project controls, and construction management services for the project. Services at the job site were performed by Chuck Mandell and Kevin Yu.

## Consulting Services in the US

In 1984, KE was called back to the Columbia River in the Northwest of the U.S. to update two projects upon which it had performed joint venture construction decades before. At Wanapum Dam and Priest Rapids Dam in Oregon, KE performed preliminary engineering, economic feasibility and conceptual designs for automating the electrical and mechanical systems.

Services were performed under the direction of Bob Koch by Bill Morrison, senior economist, and project engineers George Wallace, Winston Saimons, and Howard Erikson.

In 1985, KE was retained to provide civil hydrologic / hydraulic and mechanical consulting services for the Calaveras Hydroelectric facilities consisting of a series of dams, tunnels, and power plants on the North Fork of the Stanislaus River. Services were provided by Winston Saimons and Howard Erikson.

For the decade of 1980 to 1990, KE provided consulting, design, and cost estimating services to several departments of PG&E hydroelectric developments. About 15 separate projects were studied by a staff under the direction of Bob Koch as project manager. They included Winston Saimons, Howard Erikson, Wink Winkler, Horatio Casati, Richard Stark, Milton Lay, with Barry Cooke as special consultant.

## Technical Aspects of Heavy Construction

This chapter on hydroelectric design would not be complete without referring to the antecedents to our entry into the design of such projects. Dating back to even before the formation of Kaiser Engineers as an independent entity, the Kaiser organization was known as world-class builders of hydroelectric projects. Even after the founding of the company in 1942 and through three more decades, it continued to act as either a sponsor or a participant in joint venture or heavy construction work. These are all described in Chapter 3 entitled, "Construction."

In the early years, there was a highly technical aspect to construction bidding and execution handled by Mr. Kaiser's inner circle of highly trained civil engineers. They designed river diversion schemes, for example, because the traditional design engineers of the Corps of Engineers and the Bureau of Reclamation left it to the contractor to decide whether to build diversion tunnels or cofferdams.

We include here for reference purposes the technical aspects to projects sponsored by KE during the three decades that it was active in constructing hydroelectric facilities. Following is Table 10.4 entitled, "Technical Aspects of Hydro Projects Sponsored & Built by KE." For historical reasons, Hoover Dam is also included. For most people, it is considered the grand daddy of them all.

The technical aspects are useful as a frame of reference to see the wide range of sizes and characteristics of projects undertaken as a prelude to entering the practice of designing them. KE staff who went on to design hydroelectric projects had full resources of this background to use when researching alternatives to their own designs.

**Table 10.1**
**Hydroelectric Design Project List**

| Year | Project | Client | Location | Project Value $ x millions |
|---|---|---|---|---|
| 1959 | Akosombo Dam[1] | Volta River Authority | Ghana | 160 |
| 1965 | Boa Esperanza Powerhouse[1] | Cohebe | Terazina, Brazil | 65 |
| 1968 | Kossou Hydroelectric[1] | Bandama Valley Auth. | Ivory Coast | 88 |
| 1969 | Salto Osorio Hydro[1] | Copel | Iguaçu R., Brazil | 184 |
| 1971 | Taabo Hydroelectric[1] | Bandama Valley Auth. | Ivory Coast | 223 |
| 1972 | Greenwood Dam/Reservoir[1] Tilden Project[1] | Cleveland Cliffs Iron Ore | Escanaba, MI | 4 |
| 1972 | Salto Osorio Hydro[1] | Electrosul | Iguaçu R., Brazil | 600 |
| 1973 | Foz do Areia[1] | Copel | Iguaçu R., Brazil | 500 |
| 1976 | Water Control/Recycle Fac.[2] | Department of Energy | Colorado | 3 |
| 1980 | Salto Segredo Hydro[3] | Copel | Iguaçu R., Brazil | 700 |
| 1983 | Rock Creek #2 Hydro[2] | Oroville-Wyandotte Irrigation District | Feather R., California | 56 |

[1] Detail Design and Resident Engineering
[2] Detail Design Only
[3] Contract Drawings

**Table 10.2**
**Hydroelectric Capabilities**
*Includes projects planned or designed by KE*
*Listed by Key Elements of the Project*

**Tunnels**

| Project | Country | Diameter (meters) | Length (meters) | Type |
|---|---|---|---|---|
| Alumysa | Chile | 6.3 | 11,580 | Power Tunnel |
| Alumysa | Chile | 7.0 | 4,500 | Tailrace Tunnel |
| Pehuenche | Chile | 7.7 | 6,700 | Power Tunnel |
| Pehuenche | Chile | 9.5 | 6,900 | Power Tunnel |
| Boston Harbor | USA | 13.0 | 340 | Diversion Tunnel |
| Boston Harbor | USA | 4.0 | 7,700 | Wastewater Tunnel |
| French Creek | USA | 7.6 | 14,900 | Outfall Tunnel |
| Canutillar | Chile | 8.0 | 1,100 | Power Tunnel |
| Calaveras | USA | 5.2 | 12,000 | Power Tunnel |
| Rock Creek #2 | USA | 3.0 | 3,000 | Power Tunnel |
| Colbun | Chile | 8.0 | 2,650 | Power Tunnel |
| Segrado | Brazil | 13.0 | 1,500 | Diversion Tunnel |
| Foz do Areia | Brazil | 8.6 | 1,300 | Power Tunnel |
| Foz do Areia | Brazil | 12.0 | 1,200 | Diversion Tunnel |
| Salto Santiago | Brazil | 13.5 | 880 | Diversion Tunnel |
| Taabo | Ivory Coast | 6.6 | 420 | Power Tunnel |
| Kossou | Ivory Coast | 7.0 | 350 | Power Tunnel |
| Akosombo | Ghana | 7.6 | 330 | Diversion Tunnel |
| Lafayette | USA | 2.9 | 5,000 | Water Tunnel |
| Grindstone | USA | 5.2 | 33,600 | Water Tunnel |
| Boa Esperanza | Brazil | 6.6 | 580 | Power Tunnel |

**Spillways**

| Project | Country | Capacity (cubic m/sec) | No. Gates | Height (meters) | Width (meters) |
|---|---|---|---|---|---|
| Pehuenche | Chile | 3,260 | 3 | 15.3 | 10.2 |
| Colbun | Chile | 7,600 | 4 | 16.0 | 14.4 |
| Salto Segredo | Brazil | 20,000 | 6 | 20.0 | 14.0 |
| Doboitie | Ivory Coast | 6,000 | 9 | 10.0 | 12.0 |
| Soubre | Ivory Coast | 6,500 | 9 | 9.2 | 12.5 |
| Salto Santiago | Brazil | 24,000 | 8 | 21.6 | 15.3 |
| Foz do Areia | Brazil | 11,000 | 4 | 18.5 | 13.5 |
| Taabo | Ivory Coast | 4,500 | 5 | 11.8 | 11.0 |
| Salto Osorio | Brazil | 27,000 | 9 | 20.8 | 15.3 |
| Kossou | Ivory Coast | 3,000 | 3 | 10.3 | 10.0 |
| Akosombo | Ghana | 21,000 | 12 | 12.2 | 11.7 |
| Capanema | Brazil | 30,000 | 11 | 20.0 | 15.3 |

(con’t)

**Table 10.2 (con't)**

**Power Plants**

| Project | Country | Capacity (mw) | Type of Powerhouse |
|---|---|---|---|
| Alumysa | Chile | 496 | Underground |
| Pangue | Chile | 400 | Underground |
| Pehuenche | Chile | 500 | Underground |
| Rock Creek #2 | USA | 30 | Semi-outdoor |
| French Creek | USA | 10 | Semi-outdoor |
| Shelley | USA | 10 | Semi-outdoor |
| Canutillar | Chile | 144 | Indoor |
| Wanapum | USA | 831 | Indoor |
| Priest Rapids | USA | 789 | Indoor |
| Wells | USA | 820 | Semi-outdoor |
| Calaveras | USA | 205 | Indoor |
| Colbun | Chile | 400 | Underground |
| Machicura | Chile | 90 | Indoor |
| Capanema | Brazil | 2,500 | Semi-outdoor |
| Salto Segredo | Brazil | 2,500 | Semi-outdoor |
| Daboitie | Ivory Coast | 90 | Indoor |
| Rosana | Brazil | 320 | Semi-outdoor |
| Soubre | Ivory Coast | 320 | Indoor |
| Foz do Areia | Brazil | 2,510 | Semi-outdoor |
| Daboitie | Ivory Coast | 150 | Indoor |
| Salto Santiago | Brazil | 2,000 | Indoor |
| Taabo | Ivory Coast | 210 | Indoor |
| Salto Osario | Brazil | 1,050 | Semi-outdoor |
| Boa Esperanza | Brazil | 108 | Semi-outdoor |
| Akosombo | Ghana | 912 | Semi-outdoor |
| Kossou | Ivory Coast | 175 | Semi-outdoor |
| Susitana | Alaska | 700 | Indoor |
| Kpong | Ghana | 188 | Semi-outdoor |
| Yuba | California | 350 | Indoor |

**Concrete Dams**

| Project | Country | Height (meters) | Crest length (meters) | Type of Dam |
|---|---|---|---|---|
| Pardee, raising | USA | 127 | 1,157 | Gravity, Rolled Compacted Concrete |
| Pangue | Chile | 115 | 400 | Rolled Compacted Concrete |
| Rock Creek #2 | USA | 24 | 58 | Gravity |
| Salto Santiago | Brazil | 58 | 260 | Gravity, Power Intake |
| Salto Osorio | Brazil | 55 | 83 | Gravity, Power Intake |
| Kpong | Ghana | 9 | 1,372 | Gravity |
| Akosombo | Ghana | 34 | 68 | Gravity, Power Intake |
| Foz do Areia | Brazil | 70 | 96 | Gravity, Power Intake |
| Kossou | Ivory Coast | 34 | 100 | Gravity, Power Intake |
| Taabo | Ivory Coast | 35 | 55 | Gravity, Power Intake |

(con't)

**Table 10.2 (con't)**
**Earth & Rockfill Dams**

| Project | Country | Height | Crest Length | Type | Volume million cubic meters |
|---|---|---|---|---|---|
| Alumysa | Chile | 50 | 220 | Rockfill, concrete face | 0.3 |
| Buckhorn | USA | 119 | 540 | Earthfill | 8.5 |
| Pehuenche | Chile | 90 | | Gravelfill | 3.7 |
| Calaveras | USA | 76 | 900 | Rockfill, concrete face | 2.1 |
| Capanema | Brazil | 60 | 900 | Rockfill | 2.6 |
| Salto Segredo | Brazil | 110 | 700 | Rockfill, concrete face | 10.0 |
| Colbun | Chile | 116 | 550 | Earthfill | 13.4 |
| Colbun/ Machicurra | Chile | 32 | 540 | Earth/Rockfill | 1.3 |
| Daboitie | Ivory Coast | 24 | 2,000 | Earth/Rockfill | 1.4 |
| Rosana | Brazil | 32 | 2,800 | Earth/Rockfill | 5.5 |
| Soubre | ivory Coast | 29 | 8,000 | Earth/Rockfill | 5.5 |
| Foz do Areia | Brazil | 159 | 800 | Rockfill, concrete face | 13.5 |
| Salto Santiago | Brazil | 80 | 1,400 | Earthfill Main Dam | 10.0 |
| Salto Santiago | Brazil | 65 | 600 | Rockfill Saddle Dam | 2.2 |
| Salto Osorio | Brazil | 55 | 1,500 | Rockfill | 4.0 |
| Taabo | Ivory Coast | 34 | 7,500 | Earth/Rockfill | 8.4 |
| Kossou | Ivory Coast | 55 | 1,500 | Rockfill | 5.3 |
| Akosombo | Ghana | 141 | 640 | Earthfill Main Dam | 7.9 |
| Akosombo | Ghana | 36 | 535 | Earthfill Saddle Dam | 2.0 |
| Greenwood | USA | 15 | 1,000 | Earthfill | 0.7 |
| Jackson Valley | USA | 55 | 340 | Earthfill | 1.3 |
| Briones | USA | 84 | 84 | Earthfill | 11.0 |

**Table 10.3**
**Other Conceptual Designs & Consulting Assignments**

| Year | Project | Client | Location | Services |
|---|---|---|---|---|
| 1974 | Susquehana River Basin | PA Environmental Services | Pennsylvania | Study Master Plan/ Regional Plan & Water Quality |
| 1976 | Rosana Project | CESP, Sáo Paulo | Lower Para-napenana R., Brazil | Feasibility Study & Site Selection |
| 1979 | Soubre Hydro | EECI | Sassandra R. | Feasibility Study & Review Prior |
| 1980 | Deboitie Hydro | EECI | Bandama R. Ivory Coast | Feasibility Study |
| 1980 | Ghana Plains Irrigation Study | Volta River Authority | Volta R., Ghana | Economic/Feasibility Study |
| 1980 | Capanema Hydro | Eletrosul | Iguazu R., Brazil | Feasibility Study |
| 1980 | Colbun/Machicura Hydro | Endesa | Maule R., Chile | Advisory Resident Engineering/Consulting Services (completed 1987) |
| 1981 | 6 Small/Medium Size Hydro Projects in Sultan & Germ State | Bonneville Power Authority | Oregon/Idaho/ Washington | Review Feasibility, Fed License Application |
| 1981 | Machadinho Project | Eletrosul | Uruguay R. Brazil | Consulting Services |
| 1981 | Ilho Grande Project | Eletrosul | Parana R. Brazil | Consulting Services |
| 1983 | French Creek Hydro | Oroville-Wyandotte Irrigation District | Feather R., CA | Feasibility Studies, FERC License |
| 1984 | Wanapum & Priest Rapids Dams | Grant Co. Util Dist #2 | Columbia R., WA | Feasibility & Conceptual Details for Automation Systems |
| 1984 | Northwest Hydro Plants | Bonneville Power Authority | Columbia R., WA | Improve Efficiency. Prelim Engineering & Economic Studies |
| 1985 | Three Gorges Hydro | USBR | Yangstze, China | Consulting on Power Plant Controls, Automation, Consulting Services, Construction Management Consulting |
| 1985 | Shelby Hydro | City of Idaho Falls | Snake R., ID | Consulting, Permitting Services |
| 1985 | Akosombo | Volta River Authority | Volta R., Ghana | Consulting, Inspection |
| 1985 | Chief Joseph Dam | Bonneville River Authority | Columbia R. WA | Study, Conceptual Design for Fish Hatchery |
| 1985 | Canutillar Project | Endesa | Lake Chapo, Chile | Consulting, Advisory Assistance, Resident Engineering (completed, 1991) |
| 1985 | Calaveras Hydro | Calpine | Stanislaus R., CA | Consulting, Design Services |

*Note:*

After 1985 additional consulting services were provided by the firm that succeeded KE.

**Table 10.4**
**Technical Aspects of Hydro Projects**
**Sponsored and Built by Kaiser Engineers**

**Tunnels Built by KE**

| Project | Country | Diameter (meters) | Length (meters) | Type |
|---|---|---|---|---|
| American River | USA | 4.1 | 38,000 | Power Tunnel |
| Kremasta | Greece | 12.6 | 80 | Diversion Tunnel |
| Eucumbene-Tumut | Australia | 6.4 | 22,000 | Power Tunnel |
| Howard Hanson | USA | 5.9 | 270 | Diversion Tunnel |
| Mammoth Pool | USA | 8.5 | 640 | Diversion Tunnel |
| Tumut No. 1 | Australia | 7.3 | 240 | Diversion Tunnel |
| Tumut No. 2 | Australia | 4.3 to 10.0 | 11,200 | Power Tunnel |
| Detroit Dam | USA | 8.2 | 450 | Power Tunnel |
| Hoover Dam (participant 1933) | USA | 15.2 | 300 | Diversion Tunnel |

**Power Plants Built by KE**

| Project | Country | Capacity (mw) | Type of Powerhouse |
|---|---|---|---|
| Middle Fork | USA | 113 | Indoor |
| Oxbow | USA | 6 | Indoor |
| French Meadows | USA | 16 | Indoor |
| Tumut No. 2 | Australia | 280 | Underground |
| Guri | Venezuela | 527 | Indoor |
| Wells | USA | 769 | Combined with Spillway |
| Kremasta | Greece | 437 | Semi-outdoor |
| Garrison | USA | 240 | Indoor |
| Detroit | USA | 100 | Indoor |
| Grand Coulee | USA | 1,974 | Indoor |
| Bonneville | USA | 514 | Indoor |
| Big Cliff | USA | 18 | Indoor |
| Hoover Dam (participant 1933) | USA | 1,368 | Indoor |

Concrete Dams Built by KE

| Project | Country | Height (meters) | Crest Length (meters) | Type of Dam |
|---|---|---|---|---|
| Tumut Pond | Australia | 88 | 218 | Arch Dam |
| Ralston Afterbay | USA | 18 | 250 | Gravity |
| Ralston Interbay | USA | 21 | 50 | Arch Dam |
| Tumut No. 2 | Australia | 46 | 119 | Gravity |
| Parker | USA | 98 | 261 | Arch Dam |

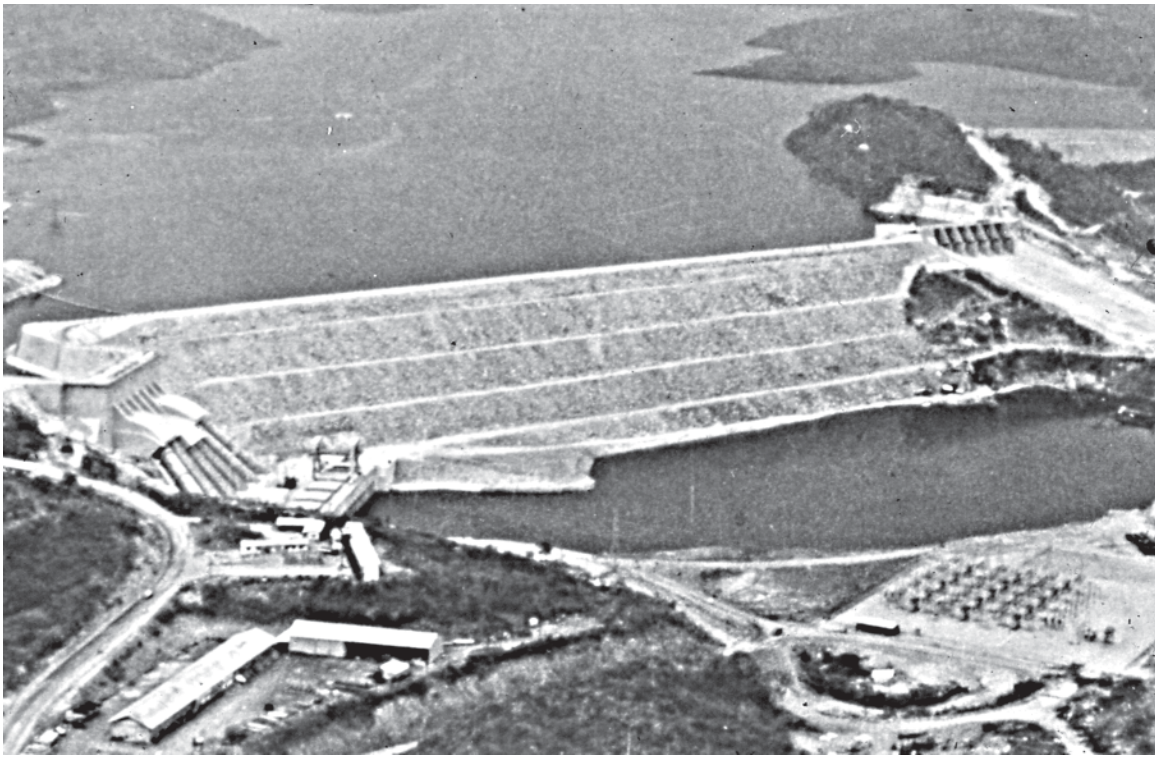
(con't)

**Table 10.4 (con't)**

| Project | Country | Height (meters) | Crest Length (meters) | Type of Dam |
|---|---|---|---|---|
| Bonneville Dam | USA | 60 | 820 | Gravity |
| Guri | Venezuela | 106 | 658 | Gravity |
| Detroit | USA | 138 | 466 | Gravity |
| Parker | USA | 98 | 261 | Arch |
| Big Cliff | USA | 58 | 88 | Gravity |
| Grand Coulee | USA | 168 | 1,272 | Gravity |
| Hoover Dam (participant 1933) | USA | 221 | 379 | Gravity Arch |

Earth & Rockfill Dams

| Project | Country | Height | Crest Length | Type | Volume (million cubic meters) |
|---|---|---|---|---|---|
| American River French Meadows | USA | 71 | 843 | Earthfill | 3.9 |
| American River Hell Hole | USA | 126 | 473 | Rockfill | 8.8 |
| Khancoban | Australia | 18 | 1,035 | Earthfill | 2.0 |
| Kremasta | Greece | 165 | 460 | Earth/Rockfill | 8.2 |
| Howard Hanson | USA | 69 | 222 | Earth/Rockfill | 2.0 |
| Eucumbene | Australia | 118 | 518 | Earth/Rockfill | 9.0 |
| Guri | Venezuela | 106 | 180 | Rockfill | 2.3 |



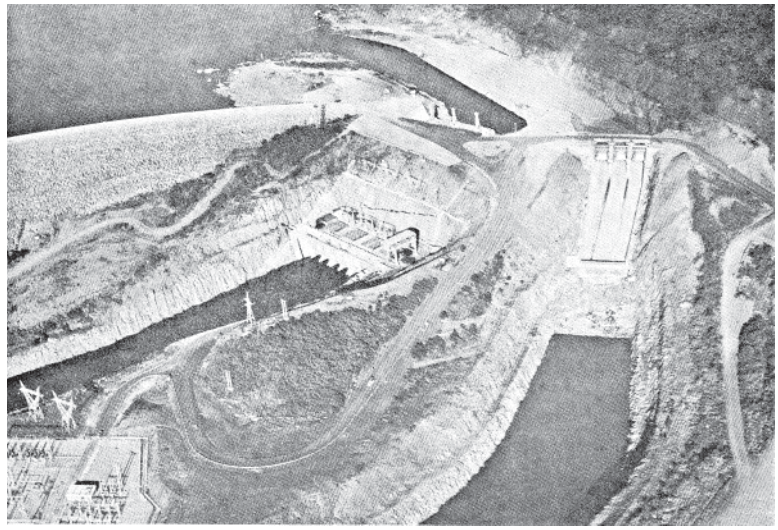
Akosombo Dam in Ghana was the first large hydro design undertaken by KE. Started in 1959, the design was completed in KE's London office. Resident engineering services were provided to assure adherence to the design. Photo of the completed dam built for the Volta River Authority.

Edgar Kaiser was the prime marketer, having developed the project after Chad Calhoun discovered it from his Washington contacts. Edgar became a confidant of the then prime minister of Ghana, Kwame Nkrumah.

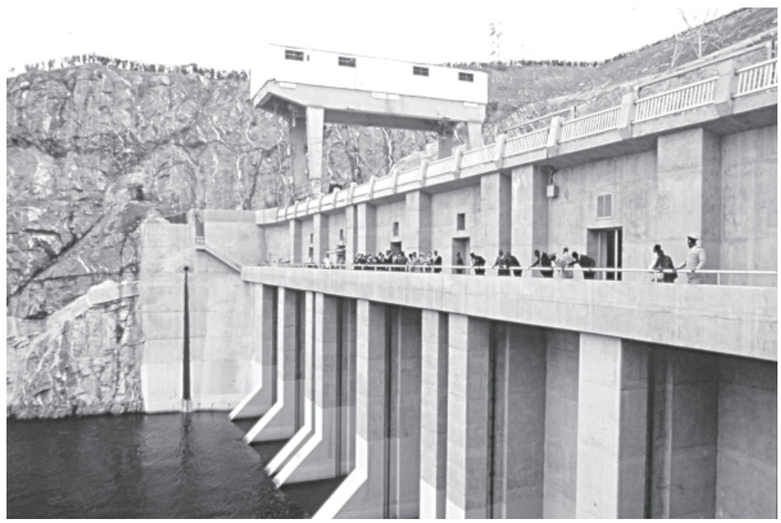
Photo shows Akosombo Dam penstocks during construction. The penstocks are aproximately 18 feet in diameter.

Favorably impressed with the work on Akosombo, the newly independent Republic of the Ivory Coast retained KE to develop its hydro potential at the Bandama River.

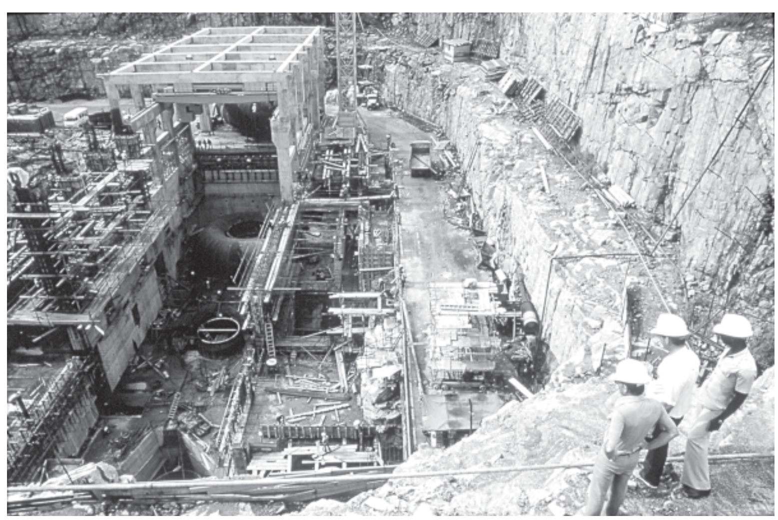
Koussou Dam in the Ivory Coast on the Bandama River, begun in 1968, also was designed by the same crew in London that did the Ghana project. Completed in 1973.

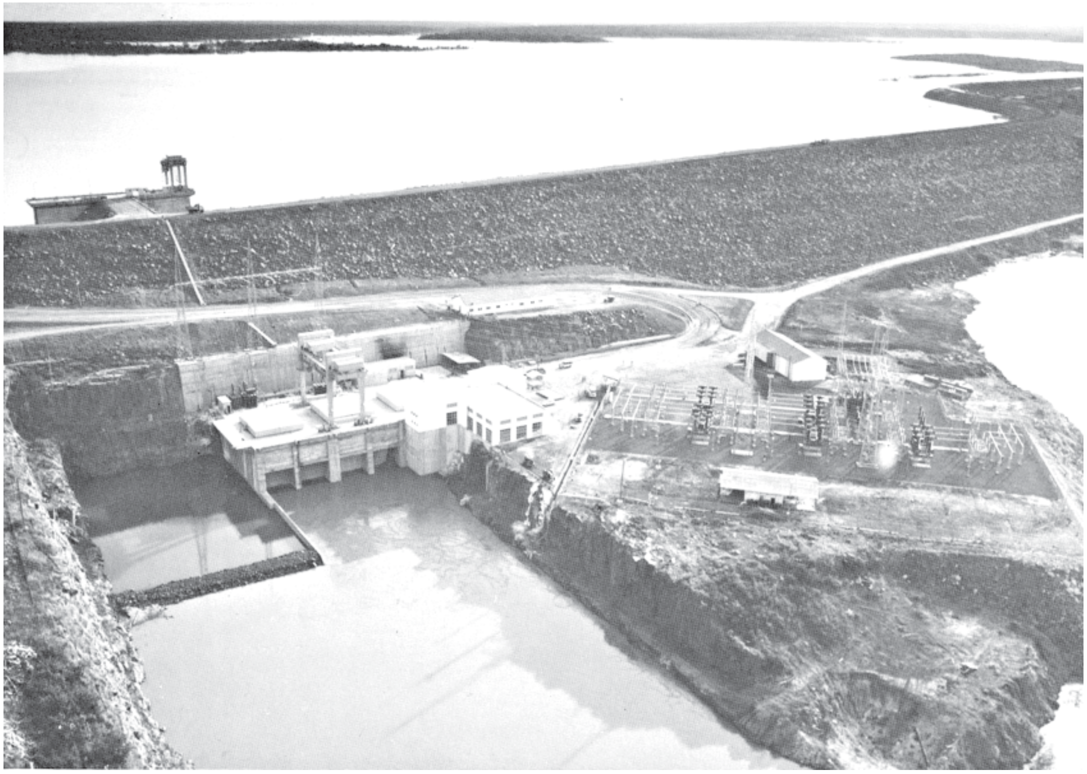


Inaugural day at Koussou. Edgar Kaiser ws the featured speaker that day.

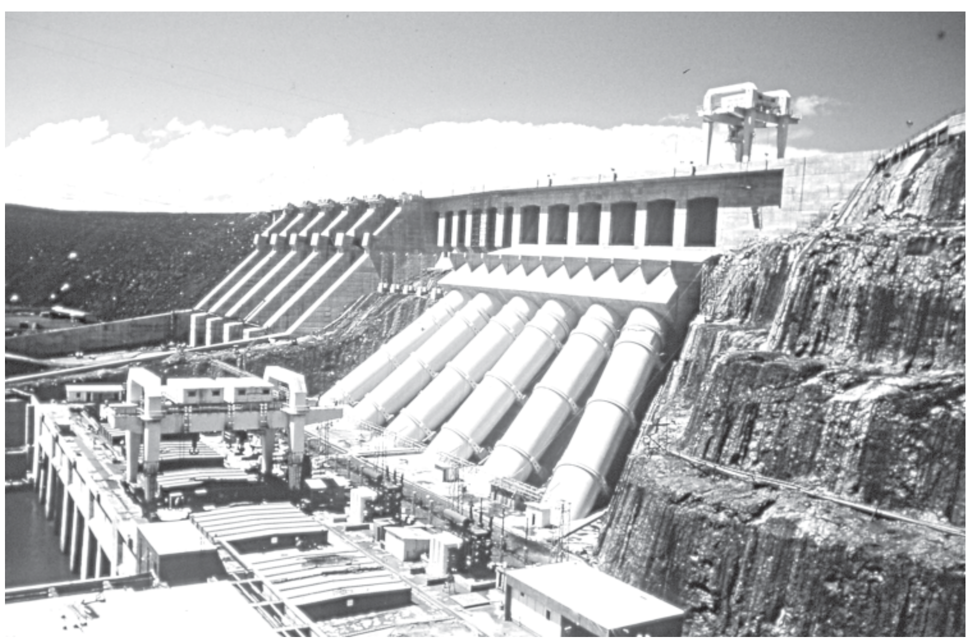


Follow-on work saw completion in 1979 of nearby Taabo Dam shown under construction.





Boa Esperanza Powerhouse in the Northeast of Brazil designed by KE in 1965. This was our first major hydro effort in Brazil, working in association with local engineers and contractors. The project was so successful that other major projects were awarded.



Salto Osorio Dam followed in 1969 in the southern part of Brazil along ‘our river,’ the Iguaçu. Several other major projects were awarded along the river as this one was completed, culminating in several decades of work of our crews.

Dramatic view of Salto Santiago Dam on the Igauçu River. Designed by KE in 1981.

View of the falls in the foreground with the dam in the background.

Other hydroelectric projects completed on the Igauçu River were Foz de Areia and Salto Segredo. These were also major undertakings in their own rights.

Photo depicts the Salto Santiago Powerhouse under construction.

Chapter 11

# Nuclear Energy Technology

## Overview

In the late 1940s, the U.S. Atomic Energy Commission (AEC) had begun a program with the objective to develop nuclear engineering and design capabilities in U.S. industrial organizations. This occurred primarily because Admiral Hyman Rickover recognized the need for a greatly advanced nuclear technology in U.S. industry to support the development and construction of the U.S. nuclear navy. Since nuclear technology was highly classified as “Secret” or “Restricted Data” at that time, dissemination of this technology could not be accomplished through public institutions such as colleges and universities. To accomplish its objective, the AEC undertook a program involving the following elements:

- Establishing the Oak Ridge School of Reactor Technology (ORSORT) where secret/classified technology could be taught in a one-year course to ‘security-cleared’ private industry employees and recent college graduates.
- Allowing private industry organizations interested in entering the nuclear energy technology field to assign properly qualified and security-cleared employees to various nuclear facilities, such as Argonne National Laboratory and Knolls Atomic Power Laboratory, as consultants. Thus, a company could develop a group of nuclear-qualified personnel at little or no cost.
- Issuing ‘Access Permits’ to private industry which allowed security-cleared companies to have access to certain non-defense-related classified information and development work at the AEC’s national laboratories.

The rationale of KE’s management to develop engineering capability in nuclear energy technology was two-fold. First, it was realized that nuclear engineering was a new, highly technical field offering significant new business opportunities for qualified engineering firms. It was realized also that access to its technology could only be obtained through working with the AEC. Second, KE had for many years been trying to break into the engineering and construction market for fossil fuel power plants. However, the company had not been successful in this endeavor, primarily because the utility companies had already established working relationships with other engineering and construction firms that did have the requisite power plant experience, whereas KE had essentially no comparable experience. However, KE’s management, aware of the fact that these competing firms did not have related nuclear power plant experience and capability, reasoned that KE could position itself to be competitive in the emerging market for nuclear power plant work by gaining experience and capability in the nuclear energy technologies.

## Organization and Staffing

In early 1953, KE initiated a planned program to develop engineering and design proficiency in nuclear energy technology. J. H. Hayner was hired as manager of KE’s newly formed Atomic Energy Division. Hayner had previously been a senior executive in the AEC’s Chemical Engineering Division. Philip Bush, one of KE’s project engineers, was assigned as assistant division manager. Hayner and Bush immediately began the task of recruiting engineers experienced in the science and technologies of nuclear energy. Among those joining KE were Wallace Dodson, Joseph Finke, George Humphreys, Alex Lindsay, William Malott, Patrick Selak, and Thomas Stephens. These engineers had worked in the programs of various AEC installations, such as the Savannah River Plutonium, Tritium, and Heavy Water Production Plant facilities, Oak Ridge Chemical and Isotopic Separations Development, Oak Ridge School of Reactor Technology, Knolls Atomic Power Laboratory, Lawrence Berkeley and Livermore National Laboratories, and Atomic International Company. Working together, these personnel comprised the key cadre of management and technical skills that guided more than three decades of KE’ s work in the nuclear energy field.

KE’s Atomic Energy Division, with the foregoing personnel as a nucleus, began developing the capability to handle projects involving the design aspects of nuclear reactor technology and related facilities, during which time, Bush became division manager. In 1953-54, the division completed several study projects, which enabled it to acquire the security clearances necessary to become eligible to compete for key nuclear projects. Then in 1955, KE won its first major nuclear energy engineering project in a national competition conducted by the AEC. KE, with General Electric Company as subcontractor, was awarded a contract to design the 175-mw Engineering Test Reactor (ETR) at the AEC's National Reactor Testing Station near Idaho Falls, Idaho. This reactor was to be the largest in-core test reactor in the world at that time. Shortly after commencement of design, the AEC awarded KE a contract to also construct the facility, making it one of the few turnkey projects the AEC ever assigned to an engineering and construction firm.

## Atomic Energy Division Projects

The ETR project marked the beginning of a long line of successful and profitable projects for the AEC and its successor entities, the Energy Research and Development Administration (ERDA) and the Department of Energy (DOE), other federal agencies, public utility companies, and engineering and manufacturing firms active in the nuclear field. Additional highly qualified personnel were obtained to round out the division's core of nuclear technology specialists. These included Joseph Busch, Lew Carpenter, Frank Harris, Harry Isakari, John Jackman, Joe Kimball, Stan Kulp, Jack Munro, Charles Murphy, and Jack Ritchie. The division thus developed capability and work in a "cradle-to-grave" range of services and projects in the nuclear field, including the following:

- Design of nuclear experimental and test facilities.
- Architect-engineer services contracts at government nuclear installations.
- Design of radioactive waste management facilities.
- Specialized services for the utility industry.

In 1960, Kaiser Engineers established its Advanced Technology Division, headed by Bob Wolf, vice president. KE's former Atomic Energy Division was folded into the new division as a separate department, headed by Phil Bush as its manager. Bush became vice president of the division in 1962 when KE won the Armco 600 Project, and Bob Wolf was assigned as corporate officer in charge.

## Nuclear Experimental & Test Facilities Design Engineering Test Reactor

In 1955, KE was awarded prime contracts by the AEC's Idaho Operations Office to design and build the engineering test reactor (ETR) at the National Reactor Testing Station (NRTS) near Idaho Falls, Idaho. General Electric was subcontractor to KE for design of the reactor core, controls, and radiation shielding. The ETR was to be KE's entry into the engineering of large nuclear experimental and test facilities.

Design and construction of the ETR was a high-priority national project. It was required to support the development program for the reactor power plants of Admiral Hyman Rickover's nuclear navy and also for the Aircraft Nuclear Propulsion (ANP) Program studying the feasibility of nuclear propulsion to facilitate long-duration (days, weeks) airplane flight. These programs required a high neutron flux test environment for the development of long-life power plant fuel assemblies and also for the assessment of radiation damage to power plant components. The ETR would provide such a test environment by having large experiment spaces at high-neutron fluxes right in the reactor core. These spaces varied in cross-section from 9 inches by 9 inches down to 3 inches by 3 inches, extending the full 36-inch length of the core. Its power rating of 175 thermal megawatts would be the highest of any research reactor in the world at that time.

The reactor pressure vessel was of carbon steel clad on the inside with type 304L stainless steel. The vessel was approximately 35 feet long, 12 feet diameter in the upper shell and 8 feet diameter in the lower shell. Its design pressure was 250 psig at 200° F.

The ETR's primary coolant system was based on a reactor cooling water flow rate of 44,000 gpm pressurized to 200 psia to prevent water boiling in the core. Means were included to eliminate the possibility of gas bubble formation in the core and to prevent any boiling in the core resulting from any credible incidents. Demineralized water in the primary coolant loop passed through the reactor and the tube side of the shell and tube heat exchanger; the secondary loop rejected the heat to the atmosphere through a cooling tower.

Design of the ETR began in May, 1955, and was completed in 17 months. Peak manpower was 150 engineers and supporting personnel six months after start of design. Phil Bush was project manager, and Ernie Dukleth was engineering manager.

Construction began five months after the start of design and was completed in 17 months, a month ahead of schedule. Tom Hill was resident manager; other office personnel included Harvey Hautala, John Aiello, Ray Hamrick, John Gilcrest, Dean Canham, and Jack Murray. M. L. "Red" Fulton was construction manager. Red brought with him from the just completed Hanford KE / KW reactor project much of that project's construction supervision personnel, including Clyde Gray, Vic Shaver, and Paul Pond. Pat Donaldson and T. R. Gray, also from the Hanford projects, headed the field construction inspection activity, reporting to Project Manager Phil Bush.

The total cost of engineering and construction of the ETR was $17.2 million. The original budget was $18.5 million. Construction was completed one month ahead of the overall project schedule. In terms of year 2000 dollars, the ETR would be a $200-million project today.

## Experimental Gas Cooled Reactor (EGCR)

In August, 1957, Congress authorized the AEC to proceed with studies for a natural uranium, graphite-moderated, gas-cooled power reactor prototype. Congress initiated these studies because England had successfully constructed and operated $CO_2$ gas-cooled power reactors. In 1957, AEC's Idaho Operations Office selected KE to perform studies of four different types of gas-cooled power reactors, including a 44-mw prototype partially-enriched, gas-cooled, graphite-moderated reactor to be located at the Idaho test site. ACF Industries (later to become Allis Chalmers Company) was KE's subcontractor for nuclear design and hazards analysis. Upon completion of these studies in 1959, the AEC authorized KE to proceed with preliminary design of the experimental gas-cooled reactor (EGCR) to be located in the AEC's Oak Ridge, Tennessee, site. KE's contract with the AEC's Idaho Operations Office was transferred to the Oak Ridge Operations Office (ORO).

The EGCR was an experimental nuclear power plant designed to provide 21.9 mw (net) of electric power. The plant was designed so that it could operate solely as a power-generating facility or as a combined power-generating and experimental facility since it included provisions for three future experimental through-reactor loops. Because the EGCR was to be the first-of-its-kind gas-cooled reactor in the U.S., an extensive research and development program was required to support its design. The purpose of the R&D program was to develop technology for design of a helium-cooled nuclear reactor utilizing a clad-fueled system. This program was conducted concurrently with design and construction, including component and fuel element development, fuel and graphite irradiation experiments, and other materials and engineering concerns.

KE was prime contractor to ORO for all of the EGCR's engineering services under a cost-plus-fixed-fee contract. These services included facility design, preparation of test procedures and operation manuals, and construction inspection. Construction of the plant was begun in October, 1959, by the H. K. Ferguson Company under an existing CPFF work-order construction contract held by the company with ORO.

The key members of the KE design team under Phil Bush, project manager, were Jack Ritchie, assistant project manager; Alex Lindsay and Stan KuIp, project engineers; Wally Dodson, physicist; and George Humphreys, hazards analyst. The design supervision staff included Jim Ball, Ernie Dukleth, John Farrell, Don Hansen, Joe Kimball, Lars Malm, Paul Martin, Harry Thayer, and Harold Young. In mid-1963 upon completion of design and the final *Hazards Analysis Report*, management of the project was centralized in Oak Ridge at the project site under Alex Lindsay as project manager, and Harvey Hautala as manager of Title III Inspection Services, headquartered in the field office.

The EGCR project was terminated by the AEC on January 7, 1966, prior to fuel loading, but with the systems and general plant completed to the point where major system tests would have been started within one or two months. The EGCR project was an effort to advance nuclear power reactor technology at a time when many reactor concepts were being examined and prototypes being constructed. The EGCR project advanced technology and the manufacturing capability of industry in many areas.

The project experienced the difficult consequences of performing research and development concurrent with design and construction. However, adequate technology did not exist in this country on which to base an evaluation of the unknowns in design, hazards analysis, and fabrication of unique components. Difficulties were anticipated early in the project, but their extent was under-estimated due to the lack of experience with this first-of-its-kind gas-cooled reactor in the U.S.

## Loss of Fluid Test Facility

KE was awarded a contract by the AEC in 1963 for engineering design and services during construction of the Loss of Fluid Test Facility (LOFT). The LOFT facility was constructed at the government's National Reactor Testing Station northwest of Idaho Falls, Idaho. The purpose of the LOFT facility was to conduct loss-of-fluid accident tests on a 50-mw light-water-cooled nuclear power reactor. The tests simulated maximum credible incidents in order to establish the characteristics of such incidents and to determine the effectiveness of current engineered safeguards, including auxiliary nuclear-core cooling systems, safety coolant injection systems, and physical containment. The results of these tests were to be used to design emergency core-cooling systems for large commercial nuclear power plants. KE's services continued through construction of the LOFT, completed in 1971.

The original test program of the LOFT facility envisioned a deliberate partial or full meltdown of the core and reactor internals. The resulting distribution of radioactive gases and particulate matter would be measured and inventoried in order to determine the quantity of gases and fission products discharged from the containment vessel following a reactor core meltdown or a leaking containment vessel. For safety purposes to avoid a "China Syndrome" incident resulting from core meltdown, the test program objectives of the LOFT facility were changed to test a variety of engineered systems to prevent meltdown of the reactor core and internals as the result of various loss of coolant accidents.

Over the eight-year duration of the LOFT contract and its range of services, three KE personnel served as project manager, beginning with Jack Ritchie, then Stan KuIp, followed by Wally Dodson. Ernie Dukleth was engineering manager.

## Rocket Engine/Stage Test Stands 2-3 Complex (ES/TS 2-3)

The ES/TS test stand facility was to be part of NASA's NERVA program to develop a large nuclear rocket engine for space applications. The purpose of the test stand complex was to ground test the NERVA engine while simulating the environment of outer space. KE's services included conceptual, preliminary, and final design and construction planning. The project was terminated during its final design phase upon cancellation of the NERVA program by NASA.

## Space Power Test Facility (SPF) National Aeronautics & Space Administration

The purpose of the SPF built at NASA's Plumbrook Station in Ohio was to test full-size spacecraft engines, including nuclear-powered ones, in a simulated outer space environment. Its test chamber is essentially a "bottle full of cold empty space" at a pressure of $10^{-8}$ mm Hg and a temperature of -320° F. The test chamber is of stainless steel-clad aluminum 100 feet in diameter and 120 feet high with a hemispherical head. The stainless steel cladding was necessary to prevent corrosion of the aluminum walls of the test chamber by the exhaust products of certain space engines resulting from test firing. This cladding concept was made feasible by Kaiser Aluminum's research laboratory which, at KE's request, developed a process to metalurgically bond stainless steel to aluminum.

The test cell was built inside a 130-foot diameter, hemispherical head, reinforced concrete cylinder with walls 5 to 7 feet thick. There is a 5-foot annular space between the test chamber wall and the inner surface of the concrete cylinder. The concrete cylinder is designed to withstand an entire atmosphere of pressure and also to provide radiation shielding.

Vacuum pumps and 32 diffusion pumps in the floor of the test chamber are employed to evacuate the test chamber. The chamber's test temperature is achieved by circulation of liquid nitrogen through approximately 15 miles of tubing attached to the inner surface of the aluminum test chamber.

The facility includes attached test-article assembly and disassembly areas connected to opposite sides of the concrete cylinder structure. Three parallel sets of standard gauge railroad track connect these areas, passing through 50-foot square doorways in the concrete and test chamber cylinder structures. The doorways are closed-off for test operations by moving massive wheel and rail-mounted doors into position and sealing them in place.

An illustration of this space-age test facility is on page 287. It is the largest facility of its kind ever built.

KE's services included conceptual and final design and engineering services during construction. Project personnel included Don Daly, project manager, and Wally Dodson, Fred Nielsen, Frank Sparks, John Gilcrest, Doug Pearse, and Harry Kelley.

## Architect Engineer Services at Government Installations

Consistent with the procedures of most federal agencies the AEC's National Laboratories selected the architect-engineer (A-E) individually for each project, utilizing a time-consuming and costly, competitive "request for proposal" (RFP) and review process. This procedure was used for almost all of their architect-engineer selections, regardless of project size or complexity. In the early 1970s, the AEC and its national laboratories determined to simplify this process by selecting a qualified A-E for a general engineering services contract, using the traditional competitive RFP and review process and then assigning numerous projects to that A-E over the life of the contract, usually several years.

These architect-engineer services contracts led to some very interesting and challenging projects, both large and small. The contracts required the A-E to be very flexible and able to build-up project staffs with a wide variety of experience and capability. Additionally, their projects required the A-E to develop working relationships with consultants and subcontractors when specialized experience was needed.

The first successful application of this concept was in 1977 when KE was selected for an engineering services contract for the Idaho National Engineering Laboratory. During the years that followed, KE performed similar engineering services contracts for the Lawrence Livermore and Los Alamos National Laboratories and a major A-E management contract at DOE'S Hanford, Washington, site.

## A-E Services Contract with the Idaho National Engineering Laboratory (INEL)

From the time KE was awarded the ETR contract in 1955 to the time that the DOE Idaho Operations Office requested proposals for engineering support services in 1977, KE had been working on various DOE projects continuously. The INEL contract for engineering support services was the first such contract that KE competed for and subsequently won.

The U.S. Navy built prototype nuclear power plants for their submarines and surface warships at INEL. (It is true that the U.S. nuclear navy's sailors are trained in the Idaho desert.) Spent nuclear fuel from the navy's ships is also chemically processed at the INEL Chemical Plant. KE personnel became intimately familiar with this facility and the handling of the radioactive waste produced in the plant. The waste was calcined, cast in dry pellets, and stored in large bins. KE designed some of the calcining equipment, a pelletization pilot plant, pellet transfer stations, and underground-shielded storage bins.

Other projects performed under this contract included an analytical chemistry laboratory, a plant decontamination system, and the Scientific and Engineering Development Laboratory. The engineering services volume of this contract was $4.3 million. Stan Kulp was project manager. Other engineering personnel participating included Tom Stephens, metallurgist; Dick Miller, mechanical engineer; and Charles Murphy, instrumentation engineer.

## A-E Services Contract with the Lawrence Livermore National Laboratory (LLNL)

In 1977, the Lawrence Livermore National Laboratory, located in the Livermore Valley near San Francisco, was planning and staffing for the design of the Shiva Nova High-energy Laser Facility. Shiva Nova would be the world's largest laser facility built to explore inertial confinement of a nuclear fusion reaction. LLNL recognized that their in-house technical manpower resources were insufficient to meet the design requirements of the project and, accordingly, decided to obtain the necessary technical manpower contractually by working with a qualified architect-engineer. Technical supervision of the architect-engineer's personnel would be by LLNL personnel.

KE's management was initially hesitant to compete for the project because of its resemblance to a job-shop arrangement, with the client supervising the contractor's personnel. However, the revenue potential of the project and realization of the opportunity it afforded to enhance KE's technical staff with additional know-how and new-hires with special skills, were sufficient to offset the concerns regarding technical supervision of KE's personnel by the client. KE submitted its proposal and was selected by LLNL for the project.

The work by KE on the Shiva Nova facility extended over several years, with ultimate contract revenue exceeding $10 million. Shiva Nova was a very complex machine. One of its most complicated components was the structural space-frame that supported all of the laser components, including the amplifiers, spatial filters, and turning mirrors, all of which had to be set to extremely exacting tolerances. Additionally, the entire assembly had to be resistant to the seismic effects of a California earthquake. Dick Miller performed the complex dynamic analysis of the laser assembly and structure using finite element analysis and LLNL's extensive CRAY super-computer installation.

LLNL and Los Alamos National Laboratory alternated in having claim to the world's largest and most powerful computer installation, depending upon which laboratory had most recently received funds for a computer upgrade. Miller said that one of his finest days at LLNL was the time that his calculations exceeded the memory space made available to KE on LLNL's CRAY computer.

KE participated in a number of other projects or tasks under this contract with LLNL. However, the only one of these projects that compared with Shiva Nova in importance was "AVLIS," the Atomic Vapor Laser Isotope Separation Project. AVLIS was a process for enriching uranium that was selected in a national competition to replace the gaseous diffusion process for enriching uranium in the fissionable isotope U-235 for nuclear power plant fuel and weapons-grade material. However, a large-scale AVLIS plant was never built due to the end of the Cold War and a decreased need for highly-enriched uranium.

KE's work on Shiva Nova and other assignments performed under the LLNL engineering services contract extended over several years with revenue in excess of $10 million. Other work by KE for LLNL extended into the early 1990s.

Howard Julian was the LLNL on-site manager for KE, later replaced by Robert Gallattly who in turn was replaced by Harvey Ceasar. Other KE personnel assigned to the LLNL site work included Dick Miller (mentioned earlier), C. S. Patel, Aubrey Silverman, Ralph Reynolds, George Colville, and Young Lee.

## A-E Services Contract with Los Alamos National Laboratory

KE's highly-rated records of performance established under its engineering services contracts with INEL and LLNL were a significant factor in competing for and winning a similar contract with Los Alamos National Laboratory (LANL) in 1993. Work by KE under this contract included design of major modifications to a radiologically "hot" laboratory at LANL. An objective of the project was to reduce the building's energy consumption in accordance with federal government mandates for energy conservation.

Marvin Autio and Ben Evans were KE's on-site project managers. Key engineering personnel included Charles Murphy, Fred Nielsen, and Teddy Jacobs. Jacobs played a key role in re-evaluating energy requirements for many of LLNL's buildings.

## Hanford On-site A-E Services Contract

By far, Kaiser Engineer's largest and most important on-site engineering services contract for the DOE was the 1981-1985 Hanford On-site Architect-Engineer Services contract and its follow-on contract that ran for another four years through 1989. KE formed the new corporate subsidiary, Kaiser Engineers Hanford (KEH), for the initial 1981-1985 project. DOE's selection of KEH for this project was unique in that in the initial competition KEH's proposal came in second place to the C. F. Braun Company. However, the parent company of Braun had been purchased by the Kuwait Oil Company, and this company was unwilling to establish the organizational arrangements required by DOE to separate a foreign owner from a Hanford contractor performing classified work. Accordingly, DOE awarded the contract to the Kaiser Engineers Hanford Company.

Alex Lindsay was President of KEH, and Frank McHugh was Executive Vice President. Ernie Dukleth was Engineering Manager.

The acquisition of the Hanford On-site A-E Services contract represented a new major addition to the range of Kaiser Engineers' years of the contract. In 1984, Frank McHugh elected to retire, and he was replaced as part of an organizational restructuring by Gene Osborne as Vice President of Project Management and Support Services and Glen Hahn, as Vice President of Engineering and Field Services. Both had been project managers and long-term employees of the previous Hanford On-site

A-E organization. In 1985, Dick Maxson retired and was replaced by Len Martinez as Manager of Finance and Administration. Len had been Group Controller of Operations in the KE Oakland office for major KE projects. Don Blankmeyer, previously a project control manager for major KE projects, joined KEH in 1985 as Manager of Project Support Services to upgrade the KEH project control system. Alex Lindsay elected retirement in 1987.

The KEH organization grew from 230 employees to almost 430 during the first four years of the contract. During this period, KEH's architect-engineer services involved approximately 4,000 individual work assignments, with as many as 450 active work assignments in progress at any one time. The cost of KEH services under the contract during this period totaled approximately $100 million.

The KEH contract with DOE was a cost-plus-award-fee contract. With this type of contract, fee amounts were determined as the result of detailed performance evaluations of KEH, not only by DOE personnel, but also by the operating contractors served by KEH. This system provided not only a strong incentive for excellent performance, but also provided constructive (usually) feedback that helped KEH manage the quality of services. For each contract year, a base fee was negotiated based upon projected workload for the year. The maximum-available-award fee was twice the base fee. If the performance rating was considered Satisfactory or What is normally expected of the contractor, the award fee would be 50 percent of the maximum fee (i.e., equal to the base fee). A performance rating in the Very Good range resulted in an award fee ranging from 65 to 90 percent of the maximum, an Excellent rating resulted in award fees above 90 percent of the maximum. Performance evaluations were made every six months.

During the four-year period of the initial contract, KEH's award-fee ratings varied from Very Good to Excellent, and award-fee earnings averaged approximately 83 percent of the maximum.

Early in 1986, DOE solicited proposals for a follow-on architect-engineer-constructor contract that would combine the contract responsibilities of KEH, On-site A-E, and J. A. Jones Hanford, On-site Constructor, into one contract. A major proposal effort was initiated to win this contract, involving personnel of both the KE and KEH organizations. KE's proposal effort was managed by Larry Brighton in KE's Richland office and supported by Don Sahlberg, KE's senior vice president for construction, and Bob Fitzgerald, vice president for industrial relations.

In October, 1986, Alex Lindsay received a phone call from Slade Gorton, U.S. Senator, State of Washington, advising that Kaiser Engineers had been selected for the Engineer/Constructor Contract. KE had been evaluated first over four other major contractors. KEH's record of performance in the preceding contract, plus the qualifications and strength of the personnel proposed for the follow-on contract, were key factors in winning the contract.

The five-year contract for the follow-on work began in March, 1987. DOE estimated the value of the engineering and construction services to be performed over the next five years at $500 million.

## Design of Radioactive Waste Management Facilities

Beginning in 1970, KE started the first major project of many to develop conceptual designs of radioactive waste management facilities. Radioactive wastes can include any materials emitting radiation of any type and at any level of radiation, ranging from slightly contaminated protective clothing to long half-life, highly-radioactive fission products, including the elemental components of spent nuclear power plant fuel rods and defense wastes. The functions and services involved in the management of radioactive wastes can include all aspects of its handling, transporting, reprocessing, and interim and long-term, or permanent storage.

## Civilian Radioactive Waste Management Program

In August, 1970, KE was selected by the AEC's Oak Ridge Operations Office (ORO) to prepare a conceptual design of a radioactive waste repository. This was the AEC's first formal conceptual design project initiated under the Civilian Radioactive Waste Management Program and the first of an almost continuous series of projects undertaken by KE under this program including:

- Radioactive Waste Repository, Lyons, Kansas
- Interim Engineered Storage of Radioactive Waste

- National Waste Terminal Storage-Repository 2
- Nuclear Waste Repository in Basalt

Descriptions of these projects follow:

## Radioactive Waste Repository Lyons, Kansas

On September 1, 1970, at the kick-off meeting for the project in Oak Ridge, Leroy Jackson, Oak Ridge's Engineering Division director, introduced this project by stating that while engineers normally design facilities to last for 100 years or so, design considerations for this repository must extend for thousands of years.

This project was intended to demonstrate a permanent radioactive solid waste repository in bedded-salt for the solidified high-level radioactive wastes generated by the civilian nuclear power industry through the year 2000. The concept consisted of an underground mine in a bedded-salt formation between 1,000 feet and 2,000 feet below the surface for storage of waste; a high-level waste receiving building for unloading waste containers from shipping casks and transporting them via a shaft into a shielded mobile transporter in the mine for burial; facilities for removing mined salt from the repository for surface disposal as crushed rock salt; and auxiliaries and utilities as required at both the mine and the surface levels.

This project required a broad range of engineering disciplines. The project team consisted of Alex Lindsay as project manager; Frank Harris as design engineering manager; John Bader and Walt Gugenheimer for mining engineering; and George Humphreys and Harry Isakari for nuclear engineering, shielding, and safety analysis. Ron Stone of Carey Salt Company served as the consultant on salt mining. Oak Ridge National Laboratory had been performing research and development work for a salt mine repository and thus provided technical input to KE.

A preliminary conceptual design was subsequently completed for a pilot plant repository at a different candidate site near Carlsbad, New Mexico. Frank Harris managed KE's work for the New Mexico site.

Looking back at this initial repository project, it is interesting to note the many changes in requirements and design approach for repositories that have evolved in the years since 1970. Many of these changes have not been constructive and have served to obstruct and delay the program to construct a facility for the permanent storage of civilian high-level radioactive wastes. Examples include changes in the"Waste Form" (the form in which the waste is stored) and the "Waste Package" (the container in which the waste is stored).

## Waste Form

As described above, the Lyons Repository waste form was solidified fission products extracted from spent fuel. During the Carter administration, reprocessing of spent fuel from nuclear power plants was ruled out, presumably to prevent proliferation of nuclear weapons-grade uranium and plutonium. The waste form was changed to spent nuclear fuel elements, containing not only the waste fission products, but also residual plutonium and uranium.

With the disposal of unreprocessed spent fuel elements in a repository, not only would the unused uranium and plutonium as a potential reactor fuel be wasted, but also the number of waste package canisters would be substantially greater than the number of canisters required if the waste form to be stored was that of fission products only. Additionally, with plutonium in the waste, the radioactive hazard would have a much longer life.

## Waste Package

The Lyons Repository waste package was a 10-foot-long stainless steel cylindrical canister containing solidified fission products extracted from spent fuel elements in a reprocessing plant. There would be no significant amounts of plutonium and uranium in the waste canister since these elements would be removed in reprocessing to be recycled. This canister was to be placed bare in holes drilled in the bedded salt at spacing determined by decay heat output from the contents of the canister. Experiments confirmed that the salt would "flow" with the heating from the decay heat to enclose the canister and thus permanently isolate it from the environment. This concept utilizes the characteristics of the salt geology to advantage.

In an effort to improve isolation, current repository designs place the waste canister in a complex waste package, "engineered barrier" system designed to isolate the waste package from the geological environment (whether it be tuff, basalt, or salt) for 1,000 years. While it would be impossible to verify the 1,000-year life, the waste canister has the waste package in both an *engineered barrier* system and the geology of the bedded salt for isolation from the environment.

While one Kansas state politician expressed objections to the prospect of a repository being located in Lyons, Kansas, the NIMBY (not-in-my-backyard) objections became much louder. Also, Congress helped to politicize the process, and no further consideration was given to the Lyons site for storage of commercial nuclear waste.

## Interim Engineered Storage Facility

The initial concept of the Interim engineered storage facility was designed to provide 100 years' storage of the high-level radioactive wastes produced by the U.S. nuclear power plants through the year 2000. Ultimate capacity was provided for storage of 84,000 waste containers, with a total waste heat generation of 200,000 kw.

The second of the Atomic Energy Commission's projects in the Civilian Radioactive Waste Management Program was awarded to KE in August, 1972, by the Richland Operations Office. This project was to develop conceptual designs of facilities for the interim storage of canisters containing high-level radioactive wastes at the earth's surface, prior to permanent storage in a mined repository. The high-level wastes would be the by-products of chemically processing spent fuel assemblies to recover the unused uranium and plutonium that was bred into the fuel assemblies during reactor operation.

## Retrievable Surface Storage Facility

Following President Carter's decision to cancel the United States' planned program to chemically process spent nuclear fuel assemblies, the DOE determined it necessary to develop a plan and concept for the storage of spent fuel assemblies in a retrievable condition so that the unused uranium and plutonium in the assemblies could be recovered for use in new fuel assemblies should such reuse become necessary in the future. This concept was identified as the Retrievable Surface Storage Facility (RSSF).

The DOE selected Hanford, Washington, as the tentative site for the RSSF. Spent fuel assemblies would be transported in large shipping containers to this site by the U.S. nuclear power plants. The retrievable storage concept developed by KE consisted of a large hot cell structure to transfer the fuel elements from their shipping casks into large concrete tanks for long-term, interim storage of the fuel elements. The tanks, each holding 10 to 12 fuel assemblies, would be approximately 15 feet in diameter, standing 22 feet high, and weighing approximately 100 tons each. The tanks would stand on concrete pads located in an open fenced-in area. Fission product decay heat would be conducted through the concrete shielding to vertical air cooling slots in the tank walls and dissipate into the atmosphere. Jack Ritchie was project manager of the RSSF project. The project team included Harry Isakari, George Humphreys, Jack Munro, and Ralph Reynolds.

The RSSF concept developed by KE was not implemented by DOE. However, by necessity, the concept is being used by the U.S. nuclear power utility companies because of non-availability of a national, long-term storage facility that was originally planned to be built and operated by DOE for this purpose.

## National Waste Terminal Storage Repository (NWTSR-2)

In January, 1977, the U.S. Department of Energy Oak Ridge Operations Office authorized the initiation of two parallel conceptual design efforts to provide terminal storage facilities for commercial radioactive waste in geological formations at sites in the United States. One concept was for deep geologic storage in domed salt of high-level waste resulting from the reprocessing of spent fuel (HLW), to be identified as NWTS Repository 1 (NWTSR-1). The other concept was for deep geologic storage of spent fuel (SF) in bedded salt, identified as NWTS Repository 2 (NWTSR-2).

Stearns-Roger Engineering Company was selected to perform the conceptual design of NWTSR-1. Kaiser Engineers was selected for conceptual design of NWTSR-2. The conceptual designs were to be developed in sufficient detail to permit determination of scope, engineering feasibility, project schedule, and cost estimates.

The NWTSR-2 facility was designed to receive, handle, and store, in a mine in a bedded-salt formation, canistered spent fuel assemblies and low level wastes, all from commercial power plants. The principal elements of the facility are waste handling facilities and the mine. The waste handling facilities are located in a 174,000 square-foot, multi-storied reinforced concrete building, providing canistered fuel assembly and low-level waste handling and support areas. The building includes an entrance to the mine through which the waste would be transferred.

The mine is in bedded-salt 2,000 feet below the surface. Transfer casks, containing canistered fuel elements, will move from the waste-handling shaft to the mine rooms on a shielded transporter. The canisters will be placed in vertically drilled holes in the floor of the mine room and back-filled with crushed salt. Canisters containing fuel assemblies nominally 10 years old will be stored in quantities, and in an arrangement that will limit heat generation to 60 kw per acre, averaged over the 2,000 acres of the mine. The mine will have a storage capacity of 242,000 spent fuel canisters and at least 71,000 drums of low-level waste.

After completion of the two conceptual designs Kaiser Engineers and Stearns-Roger project personnel combined to make a Cost Estimate Reconciliation Study. This study provided cost comparisons both between domed salt and bedded salt as the geological formation for a repository and also between high-level waste and the spent fuel element waste forms. In terms of the cost per unit weight of uranium reactor fuel, the total costs for the domed salt repository was approximately twice the cost of the bedded salt repository.

The similar comparison for waste forms indicated that the total cost for high-level waste storage was one-half of the cost of spent fuel element storage in each of the two types of geologic salt formations. This is a clear demonstration of the substantial cost advantage that reprocessing spent fuel provides for total repository terminal storage costs.

KE's project team for the NWTSR-2 study consisted of personnel with prior experience on KE's nuclear projects and especially nuclear waste repository and storage projects. Jack Ritchie was project manager. Other team members included:

| | |
|---|---|
| Joe Busch | Ernie Dukleth |
| Charlie Shie | Frank Caplan |
| George Humphreys | Harry Thayer |
| George Coville | Harry Isakari |
| Dave Watson | Richard Dettman |
| Howard Julien | |

## Nuclear Waste Repository in Basalt

Kaiser Engineers, in joint venture with Parsons, Brinkerhoff, Quade, and Douglas (PBQ&D) was selected by DOE'S Richland Operations Office in October, 1979, to prepare the conceptual design of the nuclear waste repository in basalt. Services under the contract were performed under the technical direction of Rockwell Hanford Operations.

For this conceptual design, KE used the applicable concepts from KE's just completed conceptual design of NWTSR-2 for certain of the surface facilities and certain of the analytical techniques developed during that program. Alex Lindsay was project director, and Jack Ritchie was project manager. KE's project team, with few exceptions, was the same as that for NWTSR-2.

The proposed repository site was on the Hanford Site on the Columbia River in Eastern Washington. The host geological formation is a layer of basalt, a hard volcanic rock, at a depth of 3,700 feet below surface level.

The commercial nuclear power plant waste to be stored in the repository would be canistered disassembled spent fuel assemblies and drummed low-level waste. The waste was to be stored so that it would be retrievable for 25 years.

The significant differences between basalt and salt as the host geological formation are:

- Basalt is a hard rock and is mined by conventional drilling and blasting with rock support provided by rock bolts and shotcrete, while boring machines can be used for salt.
- Salt would be expected to flow and enclose the waste canister when heated by the decay heat of the waste. Basalt would not be expected to flow.
- An acceptable salt formation must be dry. However, water in at least small amounts could be expected in a basalt formation.

Because of the anticipated environment in a basalt repository, it was concluded that the canisters containing the spent fuel should be stored in the repository in an engineered barrier system to protect the canister from a potentially corrosive environment. The engineered barrier system would assure the availability of the 25-year retrievability option and protect the canister for a long period, perhaps 1000 years.

The concept plan developed for the underground facilities of the repository covered an area 2 miles long by 1-1/2 miles wide with approximately 120 miles of openings. The plan divides the total mine area into panels, each designed to provide a storage area for the equivalent of one year's shipments of canisters. The mine development plan provides for concurrent mining and waste storage operations by maintaining a one-panel buffer between these two operations. Mine layout and the mine ventilation systems were designed to achieve this required separation of operations. The mining areas and the waste storage areas have separate, independent ventilation systems.

The basalt repository at the Hanford site was one of the three geologic formations and sites proposed by the DOE for “characterization,” the other two being the Nevada Test Site in tuff and the West Texas site in bedded salt. The proposed program would have included the drilling of a shaft down to the planned storage level at each site to permit detailed examination of its geologic formation and the performance of certain tests. However, DOE’S decision, made in 1986, to proceed with characterization of only the Nevada tuff site ended active consideration of the repository in basalt.

## Radioactive Waste Storage
*(1985-2000)*

The first 20 years (1952-1972) of KE’s nuclear projects’ work were concerned primarily with the design or construction of nuclear reactors which during operation generated radioactive fission products. The nature of these products required that they be safely stored in isolation from the environment and the public. Then, in the 15-year period 1970-1985, with a few years of overlap, KE’s major projects in the nuclear industry nearly exclusively were involved with the planning and design of facilities to store radioactive spent fuel, high-level fission products, and intermediate and low-level radioactive waste.

While isolating radioactive materials from the environment and the public is not an insurmountable technical problem, little or no progress has been made in the U.S. since 1985 to implement a national program for the permanent storage of radioactive wastes. So-called environmental organizations and activists continue to obstruct the program, presumably because they believe a completed repository will destroy their principal argument against nuclear power—that there is no final solution to the nuclear waste “problem.” As a result, the United States has entered the new millenium with radioactive materials being stored temporarily at hundreds of sites throughout the country. They include hospitals, medical research and treatment centers, university laboratories, industrial research centers, and nuclear power plants, instead of a few repositories specifically designed and constructed to store radioactive materials safely.

## Specialized Services for the Utility Industry

Personnel of KE’s Nuclear Projects Division participated in nuclear power plant site selection studies conducted by KE’ s Power Division. These included a major study for a Nebraska public utility and the Long-range Nuclear Power Program Study for the Republic of Korea. This study covered all of the engineering, construction, site selection, fuel supply, regulatory, and economic aspects of a program under which the country would shift entirely to nuclear energy as its source of electrical power generation.

The Thermal Effects Monitoring Program for Pacific Gas and Electric Company’s Diablo Canyon Nuclear Power Plant was designed and operated by KE. The purpose of the project was to determine the thermal effect on sea life of the plant’s condenser cooling water discharge into the ocean. An extensive laboratory with tanks, pumps, sea water heating and cooling equipment, and temperature and monitoring systems was designed. Sea water temperature in the tanks was controlled within a range of less than 10° F. The operation of the laboratory, including test observation and measurement, was performed by other consulting firms under contract to KE. The cost of this program during its 15-year duration was in excess of $20 million. Pat Selak was project manager, assisted by Dick Miller, Charles Murphy, and Aubry Silverman.

The Nuclear Projects Department personnel participated also in preparation of KE’s Corporate Nuclear QA / QC Program, worked in nuclear power company offices in support of licensing activities, prepared quality control programs for utility companies, and audited design / construction activities to determine compliance with the approved QA / QC programs for the Zimmer and Perry Nuclear Power Plants being constructed by KE.

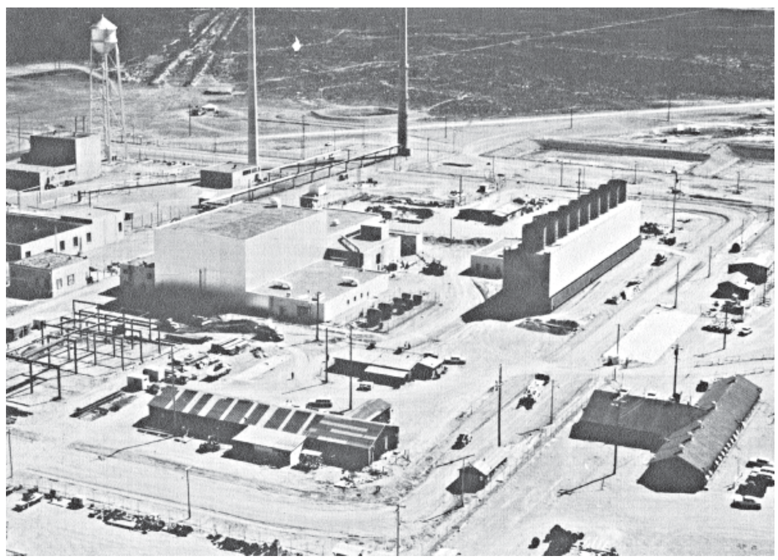
The Hanford Plutonium Production Reactor (foreground) called the New Production Reactor. Built by KE in 1951-1955 for the Atomic Energy Commission, beginning three decades of work at the site.

During 1981-1989, KE performed on-site engineering and construction management services at Hanford with a large force of key personnel and recruited staff. Services revenue aggregated over $600 million.

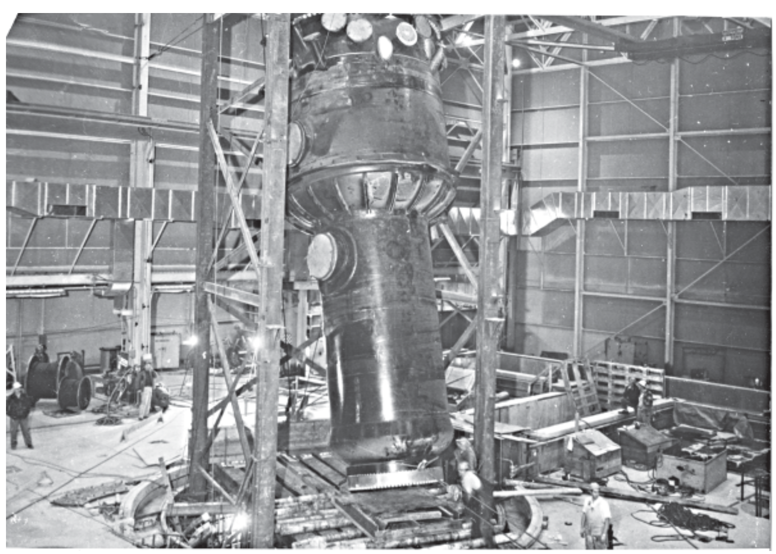
While construction of the New Production Reactor was underway, KE developed its nuclear engineering capabilities by recruiting a key group of experts in the science and technology of nuclear energy.

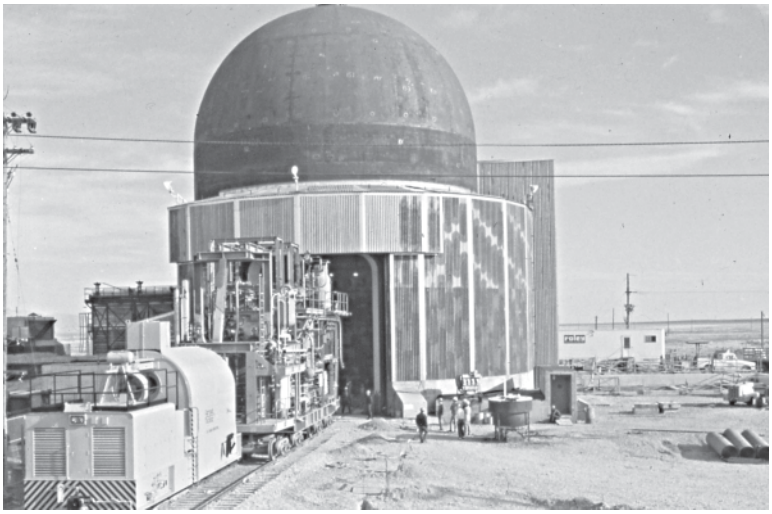
In 1955, KE won its first nuclear energy engineering assignment in a national competition for the contract to design the Engineering Test Reactor (ETR), to be built at the AEC's National Reactor Test Station near Idaho Falls, Idaho.

The ETR was required for the development program for the reactor power plants of Admiral Rickover's nuclear navy and also for an on-going program studying the feasibility of aircraft nuclear propulsion to facilitate long-duration (days) flight.



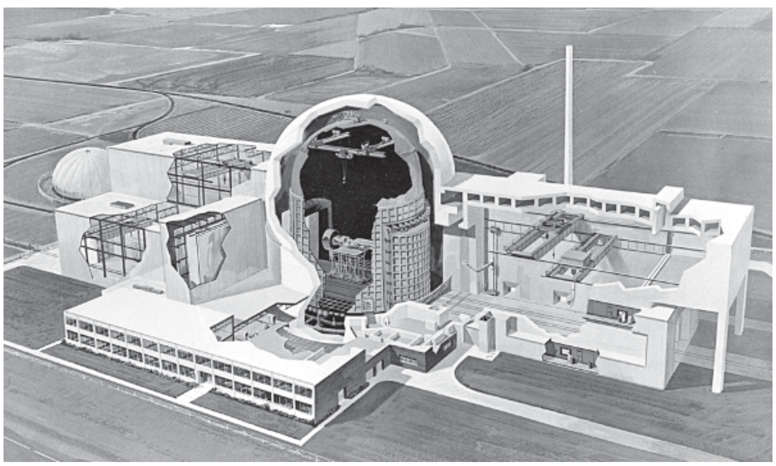
KE also constructed the ETR. Photo shows the 90-ton, 35-foot long reactor pressure vessel suspended from the temporary structural frame used for installation of the vessel. The vessel was lowered through the main floor and sub-floors of the reactor building, placing its bottom head in the control rod access chamber, 42 feet below the main floor of the building.





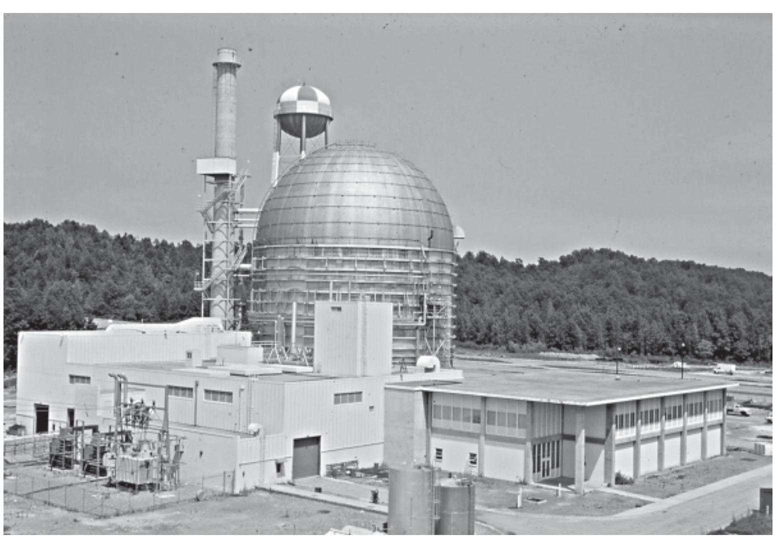
The Loss of Fluid Test Reactor (LOFT) was designed in 1963 as a facility to test a variety of engineering systems to prevent meltdown of the reactor core as a result of loss-of-coolant accidents.

View of test facility and containment structure.



Space Power Test Facility. KE did the conceptual and detail design of this facility for NASA's Lewis Research Center. The facility includes the world's largest space environment simulation chamber, 100 feet in diameter by 122 feet high. It simulates the outer space vacuum at $10^{-8}$ mm Hg and -320 degrees F. The facility was used for evaluation and testing of both nuclear and non-nuclear space propulsion systems.

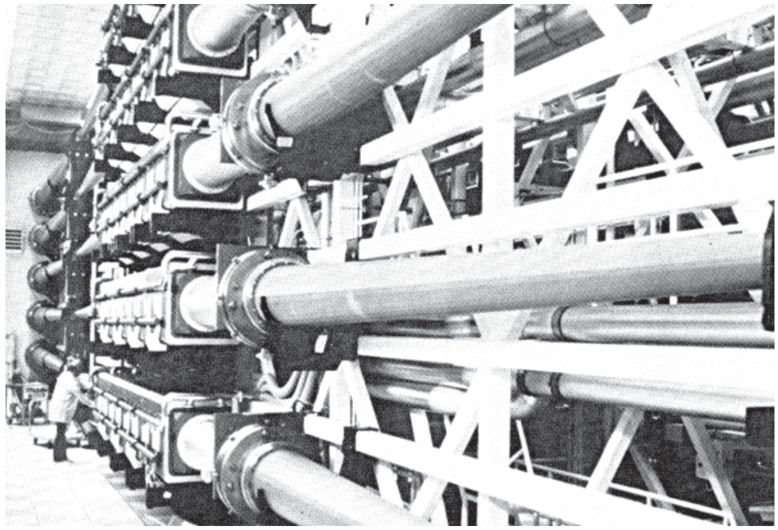
The project was a joint effort of KE's Space and Defense and Nuclear Engineering Departments.



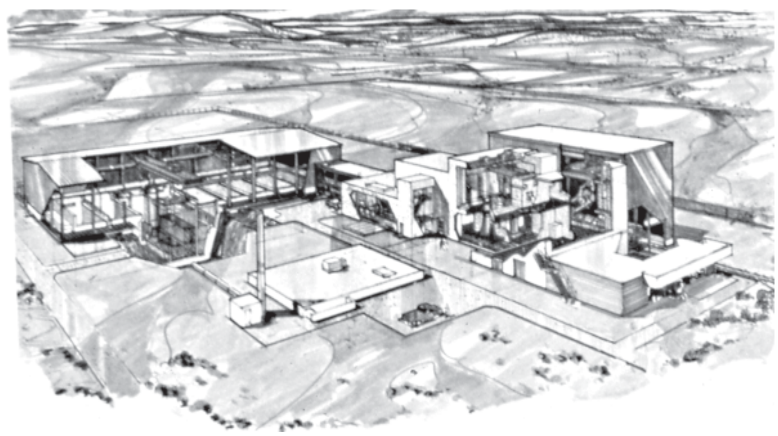
The experimental Gas-cooled Reactor built at the AEC's Oak Ridge, Tennessee Laboratory. It was the first-of-its-kind gas-cooled, power-generating reactor in the U.S.

KE designed the EGCR and performed resident engineering services during its construction.

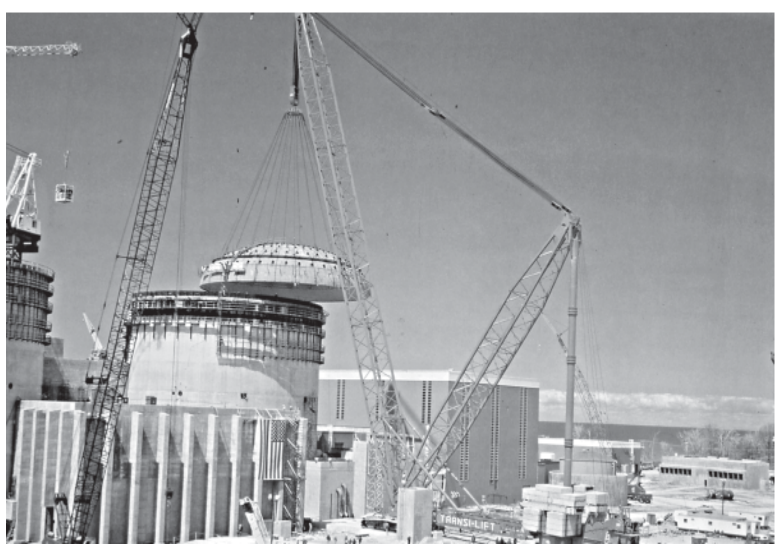
Photo shows a portion of the Shiva Nova High Energy Laser Facility built at Lawrence Livermore National Laboratory. The facility was designed by KE under the technical supervision of Lawrence Livermore personnel. Shown in the photo is a portion of the complex structural space frame that supported in exactingly precise alignment all of the components of the laser machine.



An artist's depiction of the radioactive waste Retrievable Surface Storage Facility conceptually designed by KE. The concept was not implemented by DOE; however, it was used as a model for similar facilities built by the U.S. nuclear power utilities for storage of spent fuel assemblies.



KE performed construction management services for two large nuclear power plants in Ohio. Construction of the $5.2-billion Perry Nuclear Power Plant started in 1974. Shown in the photo is erection of the containment vessel hemispherical head. Special transport and lifting rigs were required to handle and install the 880-ton head.



Chapter 12

# Space, Defense, and Postal Projects

## Overview

This chapter describes KE's engineering projects for U.S. Government agencies, including the National Aeronautics and Space Administration (NASA), the Department of Defense Agencies (Army, Navy, Air Force), and the U.S. Postal Service. Construction work for these agencies is these agencies and had no organized program to obtain such work. In those years, KE was growing and was totally involved in designing and building new and expansion projects for the affiliated Kaiser companies.

At the company's senior management planning conference in Carmel in late 1956, government work, especially defense projects, was identified as one of several new (to KE) market sectors to be pursued for future engineering and construction work. The government market was essentially client-based rather than industry or technology-oriented as in steel, aluminum, cement, etc., and the kinds of projects it contracted for had little in common with the projects KE performed. However, the basic skills and the broad experience of our personnel comprised a very marketable commodity and were the bases for our efforts to compete in this new and different market. An overview of the agencies we worked for and some of the important projects we performed follow.

## United States Air Force

In 1958, KE won the first of a series of contracts to design test facilities for the Minuteman Missile Program. In 1962, the company was awarded a major contract to design the $15-million, three-stand Atlas-Agena Space Launch Complex at Vandenberg Air Force Base in California. These first beginnings got KE in on the ground floor of Air Force defense programs, and more than 30 years of engineering work in a variety of Air Force programs and individual projects followed.

## National Aeronautics and Space Administration

In 1963, in national competitions, KE won contracts to design NASA's Manned Lunar Landing Program Mission Control Center in Houston, Texas, and what would become the world's largest space environment simulation chamber for space propulsion system testing, located near Cleveland, Ohio. Additional work for NASA followed for many years.

## U.S. Naval Shipyards

In 1966, again in a national competition, KE won a $6.2-million "landmark" contract with the U.S. Navy to develop a master plan for modernization of the Navy's nine U.S. Naval Shipyards. KE's work recommended an $828-million modernization program subsequently funded by Congress and implemented. The project was a landmark project for KE, not only because of its success and the national visibility it yielded, but more importantly, because the analytical and planning techniques developed and used by KE in performing the project gave us insight and advantage in competing for and performing future similar projects.

## U.S. Army Munitions Command

In 1969, in a national competition, KE won a $1.9 -million contract with the U.S. Army Munitions Command to develop a master plan for modernization of 27 government-owned ammunition production plants. KE's master plan recommended a $4.5-billion facility and equipment modernization and replacement program. Following this project, KE enjoyed many years of profitable work for this client and also with private firms working in related industries.

## U.S. Naval Sea Systems Command

In 1973, in a national competition, KE won a $1.837-million planning contract for the Navy's $135-million Trident Submarine Refit Facility at Bangor, Washington. Eight years later, again in a national competition, KE won a similar contract to plan the Navy's Trident Submarine Refit Facility at Kings Bay, Georgia. The scope of KE's services for this program was broadened to include overall on-site supervision of construction and equipment installation, training of operating personnel, and implementation responsibility for the entire Kings Bay submarine base. Included was maintenance outfitting of the first two Trident submarines to visit the base. KE's contract revenues for the Kings Bay Program totaled $74.5 million.

## U.S. Postal Service

In 1969-1973, KE, in association with A. T. Kearney & Company, Inc., designed the $62 -million Chicago Bulk Mail Center and five other smaller bulk mail centers ($144 million) for the U.S. Postal Service. Additional engineering work for this agency continued through the 1980s.

Table 12.1 at the end of this chapter is a selected listing of KE's engineering services projects performed for U.S. government agencies. Its work for the U.S. Postal service is described later in this chapter.

KE was prominent in the top ranks of the American architect-engineering firms which competed in the federal government project market-place. Our projects were successful and profitable for a very simple reason—our people. The Advanced Technology Division didn't have any "advanced technologies" or "advanced engineers." What we did have were good managers, project engineers, and engineering specialists, supported by the core strengths of the company—skilled and experienced engineers, designers, estimators, and construction specialists—and the management resources and know-how accumulated over the years since its origins in 1942.

Following are brief descriptions of the Space and Defense Department's history, its organization and personnel, its markets and services, and descriptions of selected major projects.

## Department History

Prior to the company's 1956 business strategy and planning conference in Carmel, KE's engineering work for the U.S. defense agencies had been limited to projects contracted out by the Navy's Western Division, Naval Facilities Engineering Command offices in San Bruno, California. These projects included preparation of a facilities modernization and expansion master plan for Alameda Naval Air Station, subsequent detail design of the new facilities called for by the master plan, and design of an updated electrical distribution system for Mare Island Naval Shipyard. Al Parker and Harold Shandrew handled these projects, supported by George Schumann's engineering department.

The Carmel conference, among other market decisions, identified U.S. government defense projects as a new market for KE and charged KE Vice President Bob Wolf with the responsibility to develop it. The conference attendees recognized the major engineering and construction market presented by the nation's build-up of its intercontinental ballistic missile defense system bases and the need to modernize and rebuild the country's conventional military facilities, worn-out and out-of-date, as the result of World War II and the Korean War. These were the underlying factors influencing the decision to pursue this new market. Wolf hired Jack Desmond to serve in a business development capacity for the defense projects market and assigned Don Daly to manage what was then called the Defense Projects Division, reporting to Wolf.

## Los Angeles Office
*(1958-1967)*

In the mid 1950s, the U.S. Air Force Systems Command established it's Regional Civil Engineering office in Los Angeles to head up and contract for the engineering and construction of Intercontinental Ballistic Missile development, test, and operational base facilities. Contracting for construction of these facilities was handled by the Army Corps of Engineers and the Navy military construction agencies.

In 1958, in recognition of the defense project market potential in the Los Angeles area, KE established a small engineering office near the Air Force offices and the Los Angeles International Airport. E. R. (Bob) Sewell was hired to staff and manage the office. He literally camped on the Air Force doorstep to be considered for engineering work and was soon successful in obtaining some initial contracts. In 1960, Bob Matteson, an architect, was hired to help manage the office's projects. He later transferred to Oakland and participated in a number of KE projects, including the Sheraton Hotels program.

During 1958-1967, the Los Angeles office performed 25 small to medium-size engineering projects and built up an engineering staff of about 30 personnel. This was not a small accomplishment, considering the sizes and capabilities of the established local competition, including firms such as Ralph M. Parsons Company, Daniel Mann

Johnson and Mendenhall, Leo Daly, to name a few. Aside from penetrating the local defense project market, KE's name and its Oakland office resources became known to the Air Force and other military contracting entities in Southern California. KE's Oakland office won several good-size engineering projects contracted by these agencies, including design of a three-stand Atlas-Agena missile launch complex at Vandenberg Air Force Base in California.

In 1965, overflow design work for a Fontana Steel Mill expansion program was reassigned to the Los Angeles office by KE's Oakland design office. This occurred at a time when the Los Angeles design staff office was involved in designing a large Vertical Checkout Facility for the Saturn launch vehicle second-stage engine. This increased workload and reassignment of priorities had an unfortunate effect on the design program for the Saturn Checkout Facility project with the result that its structural design was defective. The deficiency wasn't identified until the facility underwent acceptance testing. As a result, the client exercised the contract's standard Errors and Omissions clause, and KE had to negotiate a settlement of the project's increased costs. In the 35 years of KE's defense projects engineering work, this was the sole occurrence of a defective engineering product. Following this incident, the Los Angeles office design staff was transferred administratively to the Oakland engineering office under Frank Tobias. In 1967, the Los Angeles office was closed.

## Washington Office
*(1980–)*

The Headquarters Office, Naval Facilities Engineering Command, and the Headquarters Office, Naval Sea Systems Command were the contracting and "user client" entities respectively, for KE's contract in 1973 to plan the Trident Submarine Refit Facilities on Puget Sound, Washington. KE was formally commended by both agencies for its performance of this project, but with the observation, informally, that the job would have been easier for all concerned if KE had had the convenience of a liaison office in the Washington, D.C. area. A series of five subsequent annual contracts with the Navy's Strategic Systems Program Office emphasized the need for a local presence. Increasingly, the 3-hour time difference and 3,000-mile distance between the East Coast and Oakland were seen as an impediment to getting and doing work with the Washington, D.C. area-based clients.

In contacts with the Navy prior to the upcoming national competition for the Kings Bay, Georgia, Trident Base planning contract, we were told flat-out that a Washington, D.C. area KE presence would be a key factor in evaluating contractor proposals for the project. After years of recommendations, in 1981 KE opened an office in Crystal City, Virginia, within walking distance of the Navy's offices. Bob Perrine, a retired Naval Civil Engineering Corps engineer, was hired to run the office. By the time the Trident contract was advertised for competition, the office had a small staff and was instrumental in supporting the proposal effort and probably was a key factor in KE's winning the project. KE's project team for the Trident project included five subcontractor firms located in the Washington area. We couldn't have won the project without them, and we couldn't have coordinated and managed their work without a local office.

In 1986, following completion of the planning phase of the Trident Refit Facility, management of the remaining portion of the contract, was transferred to the Washington office. Shortly afterwards, KE was awarded a five-year, $63.6-million extension of the contract for additional services during construction and activation of the Trident Kings Bay Base.

## Organization and Staff

The Space, Defense, and Postal Projects Department was part of KE's Advanced Technology Division, as was the Nuclear Technology Projects Department. This relationship was mutually advantageous. The clientele of each of the departments were primarily agencies of the U.S. Government and had commonality with respect to their contractor selection procedures, contracting methods, and contract terms and conditions. This facilitated efficiency and economy in the management and administration of the division's contracts. Additionally, the interchangeability of the personnel of the two departments was of material advantage in the staffing of their projects with project engineers or managers and engineering specialists.

John Gilcrest was manager of the Space, Defense and Postal Projects Department during most of 1964-1986, except when he served in a full-time capacity as project manager for some of the major Postal Service projects and the first Trident Submarine Refit Facility planning contract. Faithful, hard-working, long-time staff members of the department included the following:

**Project Managers and Engineers**

| | |
|---|---|
| Homer "Flip" Flippen | Warren McMath |
| Jim Templeton | Bill Kumpf |
| Doug Pearse | Dave Brown |
| Don McNeill | Grant McGahey |
| John Hensel | Lew Carpenter |
| Jeffy mcDaniel | |

**Administrators and Secretaries**

| | |
|---|---|
| Adriaan Ten Bosch | Vicky Blackwood |
| Kathy Hoover | Dorothy Lozano |
| Cathy Shrimpton | Susan Watkins |
| Virginia Welsh | Bob Frowein |

**Industrial Engineers**

| | |
|---|---|
| Steve Bradley | Bob Galloway |
| Jim McBeth | George Rohrbach |

**Manufacturing/Equipment Specialists**

| | |
|---|---|
| Ray Branecki | Mike Dobbs |
| Jim Miller | |

## Department Services

KE's Defense and Postal projects market and clientele are described in Chapter 2. The department's services for this market and its clients are essentially the same as the engineering services of KE's industrial divisions for their private clients—planning, conceptual, preliminary, and detail design. However, the nature of the department's projects varied widely, and they seldom seemed to have any significant experience precedent from a prior project. Projects performed included missile launch facilities, ammunition manufacturing plants, bulk mail handling facilities, submarine maintenance facilities, one-of-a-kind test facilities, etc. Some of these projects involved technologies or specialized capabilities that KE did not have, and in these instances qualified subcontractors and consultants would be used. The projects were interesting and individually challenging because of their diversity.

## Market Changes

The NASA and Defense Agency engineering services market in the 1950s-1970s were fueled by a number of factors including:

- President John Kennedy's Manned Lunar Landing Program
- The need to rebuild and modernize the U.S. Defense establishment following World War II and the Korean War
- Base building for the Vietnam conflict
- Design and construction of four generations of land-based Intercontinental Ballistic Missile Defense systems, the Atlas, Titan, Minutema, and MX missile programs, and the Poseidon and Trident submarine sea-launch systems
- The Cold War international scenario.

The federal government market for space and defense projects began to wane in the 1970s, especially for large projects or new programs requiring the capabilities and resources of large architect-engineer-construction firms. By the 1980s, the market for new work had contracted significantly and probably hasn't changed much since then. Influencing factors included:

- Demise of 'the Evil Empire' and the Cold War
- Increasing military reliance on sophisticated electronic warfare and defense systems and equipment rather than conventional land-based systems/facilities within the capabilities of the architect-engineer
- The decline in NASA programs and the fact that its facilities are 'built-out'
- The financial demands of U.S. peace-keeping missions
- The smaller military construction projects that do come along are 'set aside' for small business firms
- The increasing demand for federal money to fund expanding social programs.

KE's space and defense business through the 1970s and into the 1980s was successful and profitable. The company was a recognized member of the top United States engineering and construction firms doing business in this market. Descriptions of several representative KE projects follow.

## Engineered Long-range Modernization Program, U.S. Naval Shipyards, Department of the Navy

In 1966-1968, Kaiser Engineers, leading a team of subcontractors and consultants, won a $6.217-million contract to prepare an engineered, long-range master plan for modernization of the facilities and equipment of nine U.S. Naval Shipyard installations. The program, at that time, was probably the largest and most comprehensive master planning effort yet undertaken by a federal agency. The shipyards covered were in Philadelphia, Boston, Charleston, Norfolk, Puget Sound, Hunters Point, Mare Island, and Pearl

Harbor. The project evaluated the existing facilities of each shipyard and determined additions, deletions, or modifications to the shipyard facilities and equipment required to service, repair, and overhaul U.S. Navy ships.

The highly detailed master plan recommended over 200 individually cost-justified, major, new, or modernized facility military construction projects and more than 1,000 major machine tools to be replaced new or reconditioned / rebuilt. The master plan recommended a 5-year implementation program at an estimated cost of $828 million (a $4 to $5 billion project today). Also provided with the master plan was a Methods and Management Manual for implementing and administering the modernization program.

## Navy Shipyards

The complexity of this project and the engineering and planning challenge it presented can be appreciated by a brief description of the U.S. Naval Shipyards as they existed in 1966. As an industrial complex, they were categorized at that time as the world's largest job shop employing approximately 90,000 civilian specialists in over 100 shop / industrial trades and in nearly all technical disciplines. Its budget was in excess of $1 billion per year. The nine shipyards were all very different from each other with ages varying from 170 years (Boston) to 26 years (Long Beach). Not only were the shipyards themselves different, but they had differing workloads serving the broad spectrum of the fleet, ranging from small auxiliary vessels to attack aircraft carriers. The approximately 900 ships in the active fleet in 1966 were made up of 271 different classes. A ship might visit a shipyard for a variety of purposes (termed an "availability"): for a regular overhaul, overhaul-in-depth, conversion, battery renewal (submarines), recoring (nuclear submarines), emergency repairs, and many other services. Three of the shipyards at that time also were building new ships.

## Shipyard Resources Planning

The Navy made long-range projections of shipyard workloads, forecasting new construction and the ships' visits to each shipyard, the dates of arrival and departure, and the work to be accomplished during each availability. The forecasts also allowed for unscheduled repair or emergency work. However, long-range planning of shipyard resources (facilities, production equipment, and personnel) to accomplish the workload imposed on them was a difficult problem because of the job shop character of the workload. The shops did not produce specific products that could be used as measures of production or for planning of production operations or equipment. Accordingly, a primary objective of the modernization study was to develop a shipyard resource planning system that would solve the Navy's long-standing difficulty in planning shipyard facilities to match the changing needs of the fleet.

## Study Methodology

A unique analytical approach was developed to provide the basis of the modernization recommendations. It involved the development and application of a sophisticated systems analysis methodology for relating shipyard loading, in terms of specific ship types and availabilities, to required shipyard production capability and capacity (expressed in terms of "functional work groups" comprised of facilities, equipment, and manpower required to accomplish defined workload tasks).

Current shipyard capability, capacity, and deficiencies were formulated on the basis of an investigation of the entire U.S. Naval Shipyard complex involving analyses of the yards, both individually and collectively, including industrial production equipment, support facilities, shops, waterfront structures and site infrastructure. Extensive site surveys by KE personnel teams were conducted at each shipyard. Condition assessments of all machine tools and equipment were performed to determine requirements for rebuilding, replacement, or upgrading. The production equipment systems of the shipyard complex included more than 12,000 pieces of major production equipment ranging in complexity from conventional tools to computerized, numerically controlled machines. The investigations included work-flows within shops, material handling procedures, environmental concerns, and current shipyard production and support personnel manning complements.

## Study Recommendations

Recommendations were made to correct existing deficiencies in the waterfront and production equipment systems to enable each shipyard to meet its projected workload efficiently and expeditiously. Additionally, projects to correct support facilities and utility system deficiencies and for modernization improvements were identified and defined. These recommendations, together with the plan for implementation, comprised the $828-million shipyard modernization master plan.

The analytical methodology developed by KE in this project became the forerunner of the Navy's Industrial Planning System (IPS). It provided the Navy with the ability, through use of the IPS and updating of its computer program, to determine required future shipyard capability to meet rapidly changing requirements in ship types, weaponry, electronics, and fleet deployment.

## Project Team

Kaiser Engineers' team included highly qualified specialty firms and consultants selected to provide covering expertise in specific elements of the project and general know-how regarding the unique characteristics of the U.S. Naval Shipyards and their mission of fleet support. The team members were:

**Subcontractors**
H. B. Maynard & Company
Industrial Engineering

Raytheon Company
Electronics & Weapons Systems

**Consultants**
Stetter Associates
Industrial Production Equipment, Machine Tools

Morris Guralnick Associates
Naval Architecture

National Steel and Shipbuilding Company
Shipyard Operations

Vice President Phil Bush was corporate officer in charge of the Shipyard Project. Phil was the originator during this project of the infamous $9.65 per day expense account limitation on meals, laundry, and all other incidentals applicable to all KE and subcontractor personnel when in travel status. Phil never said how he arrived at this amount, and as the years went by, it was never increased.

Harry Bernat was KE's project manager for the first six-month phase of the project. Giff Randall managed the project through its completion two years later. Other key project personnel included Steve Bradley, Lew Carpenter, Homer Flippen, Bob Frowein, Bob Galloway, Alex Lindsay, Warren McMath, Jack Ritchie, and Jim Templeton.

The project was supported by a host of engineering division personnel participating in the on-site shipyard investigations and preparation of conceptual designs for facility and infrastructure projects, estimators, and personnel of the data processing group.

## 'Landmark' Project

Earlier in this chapter, the Shipyard Modernization Project was referred to as a "landmark" project for Kaiser Engineers. It was a large, prestigious, and profitable project that KE performed very successfully with client commendations. But it was a "landmark" project for KE because in developing its analytical planning technology, KE became nearly uniquely qualified to compete for and win future projects in which this planning technology was of importance. Three such projects were the $4.5-billion Army Ammunition Production Base Modernization master plan program and both of the Trident Submarine Refit Facility planning projects.

## Mission Control Center, National Aeronautics and Space Administration Lyndon B. Johnson Space Flight Center *Houston, Texas*

In 1962, NASA held a news conference to announce that Houston, Texas, had been selected as the location for NASA's new Manned Space Flight Center. Vice President Lyndon Johnson was present at the news conference. It was also announced that the Fort Worth District Office of the Army Corps of Engineers would be responsible for the planning, design, and construction of the Space Flight Center. Shortly after this announcement, the Corps issued a solicitation for proposals for selection of a contractor to prepare the master plan of the Space Flight Center. KE, in association with a nationally prominent architect, submitted its proposal for the project, crossed its corporate fingers, and hoped for the best. A few weeks later, the Corps announced selection of Brown and Root, a Houston architect-engineer-constructor, to do the master planning. We were disappointed and resigned to the probability that a local firm had a competitive advantage in winning the project. We went on with our work.

## KE Selected Mission Control Center Designer

A couple of weeks after learning that KE had lost the master planning contract, KE's Jack Desmond received a telephone call from Colonel West, district engineer of the Corps of Engineers Fort Worth District, advising that KE had been selected to design the Mission Control Center. Colonel West asked the question: "Was KE in a position to staff the project?" Desmond knew the right answer, and KE was awarded a project that we hadn't known about. Bob Wolf, Don Daly, and John Gilcrest met with the Corps shortly after the phone call to learn about the project, and within a couple of weeks negotiated a $640,000-fixed-price design contract. KE was told by the District's chief engineer that because of urgency to start design of the project, there wasn't time to conduct a formal competitive selection process. We learned later the real story: the Fort Worth District Office had originally selected KE for the Master Planning Contract. While the District's contractor selection papers were going through the approval process in Washington, D.C., somehow the name of the site master planning firm was changed to Brown and Root. Colonel West, upset that his District's contractor selection had been changed, awarded the Mission Control Center project to KE without competition.

## Mission Control Center

The Mission Control Center (MCC) is a 248,000-square-foot facility consisting of the three-story, 117,000 square-foot mission operations wing and the three-story, 131,000 square-foot administration, wing. Its function is to control operation, direction and technical management of manned space flight in all aspects of ground support, from beginning of the lift-off countdown through flight operations, and recovery. Specific mission operations controlled from the MCC have included the *Gemini* orbital rendezvous flights, the *Apollo* lunar exploration flights, and subsequent manned space shuttle missions. The descriptions below are of the MCC as it was designed by KE in 1962-1963.

The mission operations wing included four mission control rooms and on one entire floor an extensive raised floor area for the computer center and data processing equipment. The computer center consisted of six IBM 7094 mainframe computers with peripheral equipment. It is interesting to note that these computers, operating together, did not have the memory and power of one of today's modern lap top computers. The under-floor area included "hundreds of feet" of data processing system interconnecting cabling in cable trays and an extensive duct work system to supply cooling air to the computers. The room required special acoustical treatment to attenuate noise interference with computer operations.

## Standby Power System

The MCC included the 11,000 square-foot adjoining Building 48 that housed the emergency standby and critical power generating equipment and the air conditioning plant for supply of building and computer cooling air. Emergency standby power facilities included in the design consisted of three 2,000-kw diesel generators for standby supply in the event of a commercial power supply failure. The units were designed to come on-line within 20 seconds in the event of a commercial power failure.

## Critical Power System

The computers and other mission critical systems required 1,200-kw of no-break, failure-free power. Criteria for computer power quality requirements limited frequency and voltage transients to a maximum of plus or minus 1 Hz and plus or minus 1/10 V during both normal operation and during load transfer and switching operations. During the pre-design conference in Houston, the NASA scientists stated that the commercial power system could not meet these quality criteria and that special electrical switch gear would be required to condition the commercial power to these quality requirements. They stated also a requirement for a "fly wheel" kinetic energy storage system, capable of providing 1,200 kw of critical power while the standby power system would be starting up and being brought on-line.

That evening after dinner, Bill Burstedt, the project's electrical design engineer (and in later years KE's chief engineer), disappeared into his motel room and wasn't seen until breakfast the next morning. At breakfast he displayed a sheaf of calculations and sketches and said that he would like to suggest an alternative to the fly wheel system in our meeting with the NASA people that morning. During the meeting, when the discussions got around to the power systems, Burstedt, with a perfectly straight face and apologizing for his very preliminary rough calculations, very tactfully told the scientists that a fly wheel system capable of meeting the critical power requirements might be very costly. He suggested that such a system might require as much as hundreds of tons of iron on a long shaft, rotating at high speed, with a costly drive system to get it up to speed. He then suggested an alternative system made up of standard, off-the-shelf equipment that would meet the critical power requirements at a reasonable first-cost.

The alternative system suggested by Burstedt consisted of three 600-kw generating sets (one set to be an operating standby spare), each comprised of a commercial power-driven motor generator on a tandem shaft with a diesel engine. The system included switch gear and controls such that in the event of a commercial power failure, the diesel engine, turning at the speed of the electrical motor generator set, would pick up the load with only a negligible voltage drop. Bill convinced the NASA people, and this was the system KE designed and built.

The critical power system worked just as intended when a commercial power failure occurred during one of the manned lunar orbital missions. Dr. Robert Gilruth, administrator of the Manned Spacecraft Center, commended KE for its design, mentioning Bill Burstedt specifically. In 1966, NASA awarded a contract to KE to prepare preliminary designs of a family of different sized critical power systems similar to the MCC system for use at other NASA installations.

## Project Personnel

Design of the $12-million Mission Control Center facility was completed on schedule and made a nice profit for KE. KE provided support services during its construction which also was completed on schedule and within NASA's budget. KE's key personnel for design of the MCC were:

| | |
|---|---|
| John Gilcrest | Project Manager |
| Doug Pearse | Instrumentation |
| Wendell VanVleck | Structural Design |
| Bill Burstedt | Electrical Design |
| Harold Hawes | Architectural Design |
| Murray Ullery | Specifications |
| Bob Lundy | Mechanical Systems Design |
| Sterling Bench | Estimating |
| Mid Yezzi | Civil Design |
| Gene Hoggatt | CPM Scheduling |

## Other Projects for the Manned Spacecraft Center

During 1964-1970 KE performed a variety of additional projects for NASA. They included:

- Detailed operating and maintenance manuals for the MCC and all of the other major facilities at the Manned Spacecraft Center.
- Design of a double manlock for the space environment simulation chamber.
- Conceptual design of a 140,000 sq-ft expansion of the MCC.
- Design of new Power Generating Building No. 46.

## Master Planning, Manufacturing Process Development, and Conceptual Design of the Mississippi Army Ammunition Plant, Bay St. Louis, Mississippi

In a national selection process conducted by the Huntsville Division, U.S. Army Corps of Engineers, KE was awarded a $1.9-million cost-plus-fixed fee contract to develop plans for the $403-million, 155-mm, M483 projectile manufacturing facility to be constructed at the Mississippi Army Ammunition Plant in Mississippi.

The client agency was the Army's Munitions Production Base Modernization Agency. KE had performed previous projects for this agency, including preparation of master plans for the $4.5-billion Ammunition Production Base Modernization Program and the Plant Equipment Package Modernization Program. The project is described below as it was planned by KE. It was detail designed and constructed by others under contracts with the Corps of Engineers in accordance with KE's master plan. An aerial photograph of the completed manufacturing complex is included at the end of this chapter.

## Manufacturing Complex

The manufacturing complex was planned to produce 120,000 completed projectiles per month on a 3-8-5 (3 8-hour shifts per day, 5 days per week) shift basis. Production facilities included a 430,000 square-foot projectile metal parts plant, a 219,000 square-foot cargo (grenades) metal parts facility; a projectile load, assemble, and pack complex, consisting of more than 20 buildings sited within a remote 90-acre area in accordance with explosive safety-quantity-distance planning requirements; and associated administrative, site utilities storage, and support areas.

## KE Services

In addition to site master planning and preparation of design criteria for buildings, utilities, and site improvements, KE selected process systems and equipment for the manufacturing facilities. These services included:

- Development of the manufacturing processes
- Preparation of production line layouts
- Selection of major production equipment including process and support equipment
- Preparation of procurement specifications for process and support equipment
- Preparation of a production staffing plan totaling 5,650 personnel working on a 3-8-5 shift basis
- Preparation of a management plan and implementation schedule for subsequent design, equipment procurement, and construction of the project.

KE provided support services to the Corps of Engineers during design and construction of the project. These services included review of design contractor submittals for compliance with specifications.

## Project Personnel

The project was performed under the overall direction of John Gilcrest. Stan Kulp was project manager, supported by Warren McMath, project engineer and project administrator. Manufacturing process development and equipment selection and specification were performed by Ted Smith, Ray Branecki, and Chuck Williamson of Stetter Associates. Their work was supervised by KE's Ralph Reynolds. Harry Thayer was responsible for site development and preparation of design criteria.

## Industrial Engineering and Master Planning of the Trident Submarine Refit Facility, Bangor, Washington, for the U.S. Naval Sea Systems Command

In January, 1973, KE was awarded a $1.837-million contract by the Headquarters Office, Naval Facilities Engineering Command (NAVFAC) to master plan the Trident Submarine Refit Facility (TRF), to be located at Bangor, Washington, on the Hood Canal, Puget Sound. NAVFAC acted as contracting agent for NAVSEA. The mission of the TRF was to provide maintenance and logistic support for the Pacific fleet of ten Ohio-class, Trident submarines. At that time, the Trident program was highly classified, and KE personnel participating in the project were required to have Department of Defense "secret" clearances.

## Trident Program

The Trident submarine was to be the latest addition to Navy Admiral Rickover's nuclear submarine fleet. The Trident would carry 24 sea-launch Trident ballistic missiles. It would be the largest submarine in service at that time, approximately 560 feet long with a beam of 60 feet. It would operate on three-month cycles, including approximately 65 days on station at sea and 24 days at the TRF for intermediate maintenance and logistic support. Each Trident submarine would be manned by rotating "blue" and "gold" crews.

## Getting *Started*

The Trident program in 1973 had a high strategic priority, and the Navy emphasized the need to have the TRF planned, designed, and built by the time the first Trident submarine was scheduled to arrive at Bangor. As a starting point for its planning work, KE's project team required maintenance workload requirements concerning the vessel and its systems and equipment. However, the Trident submarine was still in design when KE was awarded the TRF contract, and little information as to its systems, equipment, and maintenance requirements was available. Accordingly, our start-up guidance from NAVSEA was, "Trident is more than twice as big as any submarine in the current fleet, so assume that Trident's systems and equipment will be at least twice as big as what's in service now." We were referred to Trident's builder, the Electric Boat Division of General Dynamics Corporation, and were able to establish a close working relationship with their personnel. KE's project team included as consultants a retired submarine engineering duty officer and a former shipyard commander. They participated with the project team in development of a preliminary maintenance workload base-line for the Trident submarine, which later validated, enabled the industrial engineering and facility master planning work to proceed as scheduled.

The $130-million Trident Refit Facility complex, as developed and planned by KE, included the following facilities:

- An offshore, piling supported delta-shaped wharf structure comprising a 70,000 sq-ft drydock and two 750 ft long refit berths. Causeways connect the Delta structure with the shore. Included on the Delta is a 40,000 sq-ft waterfront support facility and three 25-ton capacity traveling Portal cranes. An aerial photo of the Delta is included in the illustrations at the end of this chapter.
- A 260,000 sq-ft industrial building comprised of industrial shops, electrical/electronics shops and supply and management support facilities. Included was identification of all industrial production equipment and material support systems required to accomplish the Trident submarine refit workload. A maintenance and repair workload management, scheduling, and control system was included.
- A 130,000 sq-ft supply support system building including storage and issue areas, automated bin storage and retrieval systems, and a cold storage facility. Included were related material handling equipment.

KE's work included development of the management, organization, and operating concepts and procedures for the facility; development of the facility concepts; selection of industrial shop production equipment; preparation of a construction budget, project construction, and activation program; and development of a phased manning schedule for operation (1,100 personnel).

## Project Team

John Gilcrest was project manager. Key team personnel included Homer Flippen, Warren McMath, Jim Templeton, Joe Hilton, and industrial engineers Steve Bradley, Bob Galloway, and George Rohrbach. KE's Technical Reports Department did a great job printing and assembling the project's eight-volume final report which included over 1,500 pages of text and 250 tables, figures, and drawings.

## Master Planning, Conceptual Design, Logistics Support, U.S. Naval Sea Systems Command, U.S. Naval Submarine Base, Kings Bay, Georgia

Kings Bay, Georgia, was selected by the Navy to be the home port for the Navy's Atlantic fleet of ten Ohio-class Trident ballistic missile submarines. In late 1981, KE won a $10.9-million contract to perform planning, engineering, and support services for the Trident Submarine Refit Facility (TRF) to be built at the base.

## Kings Bay Trident Refit Facility
*(1982-1983)*

The first two-year phase of the contract involved industrial engineering and master planning of the TRF, essentially the same as the work KE performed for the Trident Refit Facility at Bangor, Washington, in 1973-1974. The 24-facility Kings Bay TRF complex, as planned by KE, included a 70,000 sq-ft drydock, 2,900 linear feet of refit wharves, and 775,000 square feet of shops, warehouses, services, and administrative facilities. The construction cost of the TRF facilities was $320 million. The cost of the industrial plant equipment was $126 million. An aerial perspective view of the Kings Bay drydock and refit wharf area is included following these pages.

## KE's Project Team

Homer Flippen was project manager for the industrial engineering and master planning phase of the TRF complex. Project personnel included Warren McMath, Jim Templeton, Jerry McDaniel, Bob Hyer, Don McNeil, Paul Kleinen, John Hensel, Ray Branecki, Jim Miller, Bob Galloway, Steve Bradley, and Jim McBeth. Dorothy Lozano and Kathy Hoover were project secretaries.

## TRF Acquisition, Activation Services
*(1983-1986)*

Upon completion of the first-phase master planning work in 1983, the KE team performed acquisition and activation services for the TRF until 1986. These services were initiated in KE's

Washington office and subsequently moved to a Kings Bay office. They included the following:

- Preparation of a TRF acquisition and activation management plan.
- Design review of all TRF facilities construction plans and specifications.
- Technical assistance in procurement of industrial production equipment.
- Participation in recruitment and training of civilian personnel.
- Provision of engineering training assistance for industrial training courses for an industrial manning complement of 1,900 personnel.

## Trident Systems Support Contract
*(1986-1992)*

In 1986, KE was awarded a $63.6-million contract to provide systems support services to manage and integrate the planning, acquisition, activation, and certification of the Trident Refit Facility and the 522,000-square foot Trident Training Facility. Services required under this contract included:

- Receipt, warehousing, installation and acceptance testing of $126 million of Trident Refit Facility shop industrial production equipment and $691 million of Trident Training Facility training equipment.
- Implementation of the Trident Training Facility acquisition and activation plan.
- Logistics support and outfitting of the Training Facility's 52 major training laboratories.
- Provision of integrated logistic support and outfitting responsibilities for more than 25,000 items of submarine onboard repair parts and 3,000 items of onboard support items for the first two Trident submarine arrivals at the base.
- Industrial engineering and management of design, construction, and activation of the 41,000-sq-ft Trident Strategic Weapons Maintenance Shop.

## Systems Support Contract Project Team

Kaiser Engineers' project team for the Systems Support Contract included several subcontractor firms with specialized experience and personnel resources in management and performance of naval systems, integrated logistics support services, and also the management and integration of large military technical and operational training facilities. Jim Weir was KE's project manager for the Systems Support Contract, headquartered in KE's Washington, D.C. office. Dave Brown was the office manager. Supporting KE personnel in the Washington office were Jim Clayton, program integration manager; Nick Delaplane, training manager; Cliff Hall, ship support manager; and Bill Robertson, facilities manager. Other personnel included Bob Perrine, Cal Smith, Ron Hartman, Lewis Johnson, and manufacturing engineers Gregg Kloberdanz, Tom Knip, and Greg Swann.

Cliff Gambs managed KE's field offices at Kings Bay. He was followed by Charles Clements, a retired Navy base supply officer. Other KE personnel in the Kings Bay office included James Gant, Dale Herbeck, Cal Smith, and Carlos Lopez.

Homer Flippen managed a KE Oakland office support team that included Steve Bradley and Jim McBeth, industrial engineers; Mike Dobbs and Jim Miller, manufacturing engineers; and Don McNeil, Arvind Garde, and Les Henry, facility engineers.

## Systems Support Services Contract a 'Navy First'

The Trident submarine bases at Bangor, Washington, and Kings Bay, Georgia, were the first large green-field installations built by the Navy since World War II. Harry Hall, the Navy's Kings Bay project manager, approached John Gilcrest in 1982 and asked how Kaiser Engineers would manage and organize a project the size and complexity of the Kings Bay Base. He described the problems and delays that were encountered by the Navy in building the Bangor Base. Gilcrest described the elements of single-responsibility project management as used by KE. Hall asked if KE would informally lay out the elements of a single-responsibility management plan for the Kings Bay program on paper, without identity of origin, and mail it to him at his home address. This was done, and in 1985 the Kings Bay Systems Support Services program was organized and contracted out to KE and its subcontractors in a manner much like the informal plan that had been suggested. This was a first for the Navy, delegating to an engineering contractor the degree and extent of program management, acquisition, implementation, and startup responsibility that was included in the contracts awarded KE for the Kings Bay Navy submarine base.

## Engineering and Design Services, Bulk Mail Processing Centers, U.S. Postal Service, *1969-1973*

In 1969, the United States Postal Service announced plans to build a $950-million nation-wide network of 21 bulk mail processing centers. The network would include 2 large-volume centers, one each in New York and Chicago, 5 medium-volume centers, and 14 small-volume centers. The announcement stated that the new building program would result in vastly improved mail service but also in reduced operating and transportation costs when the planned network was in operation.

## Background

In 1969, USPS bulk mail generally consisted of packages of varying size and dimensions, sometimes poorly wrapped with nearly illegible addresses. Bulk mail was moved between local and regional post offices and general mail processing centers in canvas sacks, canvas hoppers on wheels, or larger bulk containers. Handling and sorting was done manually in a very labor-intensive manner.

USPS Regional offices generally would contract with architectural firms for their facility design work. The USPS headquarters offices in Washington, D.C., included an engineering staff which would do in-house work within their capabilities, but would also contract with management consulting firms for general planning of mail handling facilities. Equipment manufacturers did much of the mechanized mail handling system design work (system designs based on the proprietary equipment they sold).

## New York Bulk and Foreign Mail Center

Shortly after announcement of plans to build the nation-wide bulk mail center network, the headquarters office of the USPS selected A. T. Kearney, Inc. (Kearney), a Chicago-based management consulting firm, and another company to prepare simultaneously 3-month, competitive conceptual designs of the New York Bulk and Foreign Mail Center. The New York center incorporated a foreign mail unit because of its proximity to Kennedy International Airport. The New York Center was to be located in the Meadows area, between Jersey City and Newark, New Jersey.

Kearney selected KE for conceptual design of the bulk mail building and site infrastructure. Kearney prepared the mail handling system arrangement and selected its equipment. KE prepared the arrangement drawings and the estimate of cost for the overall project. Kearney put the package together and submitted it to the USPS. A couple of weeks later the USPS announced its selection of the other firm to design the New York project. The KE/Kearney estimate was said to be about $20 million higher than the other firm's estimate.

During construction of the Chicago BMC, KE learned that the low construction bid submitted for the New York facility exceeded the other firm's engineers' estimate by more than $20 million. An added complication for the project was the discovery during excavation that the site had a severe methane gas emission problem which required a few more millions to cap and contain it.

In March, 1970, Stewart Files, Kearney's vice-president, called Phil Bush to advise that the USPS had selected the Kearney/KE team to design the Chicago Bulk Mail Center. Bush accepted File's invitation to KE to participate in the project with Kearney.

## Chicago Bulk Mail Center

Under subcontract to Kearney, KE prepared the conceptual, preliminary, and final design of the project. Its mechanization was designed to handle 877,000 pieces of bulk mail per 15-hour day, sorting it to more than 1,645 national and local service area destinations. Some of the design features of the Chicago BMC reveal the extent of its mechanization and the complexity of the design task. The building was approximately 500 feet by 1,000 feet long, with 520,000 square feet of area. The mechanization included:

- 567-individual transfer, surge and run-out belt conveyors with individual drives, and a total length of over nine miles.
- 7-tilting tray sorting machines with a total length of 9,700 feet, computer controlled, performing the actual sorting operations.
- 14,400-linear feet of in-floor towlines for transport of containerized mail within the BMC.
- A computerized instrument control system integrating all of the mechanization systems and equipment into a single automated operating system.

The Chicago District, Army Corps of Engineers, had construction responsibility for the Chicago BMC. Construction bids for the project totaled $61 million. KE's estimate was $62 million. KE performed engineering support services during construction of the project.

John Gilcrest was project manager for the Chicago Bulk Mail Center project. Bill Zimmerman was engineering manager. Design of its mechanization and control system was a challenging and well-done accomplishment by KE's material handling specialists.

## Medium Volume Bulk Mail Centers

In 1971, A. T. Kearney, with KE as its subcontractor, began a series of engineering activities to design the five medium-volume bulk mail centers to be located at Pittsburgh and Philadelphia, Pennsylvania; Springfield, Massachusetts; Dallas, Texas; and Los Angeles, California. They were grouped together from a design standpoint because of similarity of operations, each handling about 575,000 parcels and 55,000 sacks of mail in a 15-hour workday. Engineering included preparation of modular building arrangements and standard equipment layouts to take advantage of equipment standardization. KE made standard designs of 20 categories of selected processing equipment (conveyors, chutes, slides, etc.) including shop details, to permit shop fabrication directly from the standard design drawings. These mechanization standard designs were used also for the mechanization systems in the 14 small-volume bulk mail centers designed by others. *(Authors' Note:* The large USPS building along the East Shore Highway 580, adjacent to Golden Gate Fields, in Richmond, California, is one of the small-volume BMC's.)

Separate bid packages for 20 different types of mechanization equipment were prepared by KE covering the total requirements of the five BMCs. Individual building construction bid packages and equipment installation bid packages for each BMC were prepared. The Army Corps of Engineers handled equipment procurement and construction of the BMCs, and KE provided support services during construction. A summary comparison of KE's estimates and the contract award amounts is as follows:

| Description | | KE Estimates | Awards |
|---|---|---|---|
| 20- | Mechanization Procurement Packages (-6.2%) | $35,853,000 | $33,636,000 |
| 5- | Building Enclosure Packages (-1.6%) | 13,139,000 | 12,923,000 |
| 5- | Building Completion & Mechanization Installation Packages (-6.7%) | 94,152,000 | 87,814,000 |
| | Grand Total (-6.1%) | $143,144,000 | $134,373,000 |

The excellence of KE's engineering and estimating in its designs of the five medium-volume bulk mail centers is illustrated by the comparison of estimates and contract award amounts shown above. The many KE project and engineering personnel that participated in the USPS projects are too numerous to be recognized individually. However, KE's mechanical engineers and material handling specialists who designed the exceedingly complex mechanization systems of both the Chicago and the medium-volume BMCs include the following:

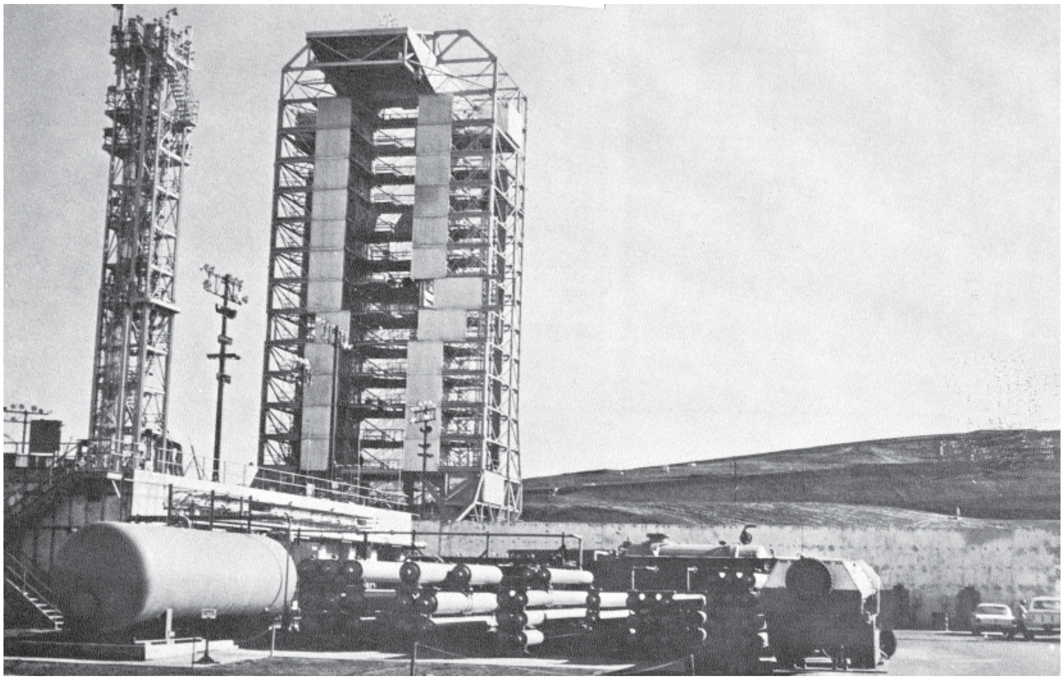
| | |
|---|---|
| Dana Adams | Mustafa Inci |
| Bob Nomura | Jorge Brown |
| Les Krettingen | Frank Purdy |
| Shashi Bubna | Karl Lehman |
| George Trnka | Jack Delaney |

The U.S. Postal Service was a valued client of Kaiser Engineers. Engineering services revenues during 1969-1988 for projects subcontracted through A. T. Kearney, Inc. or contracted directly with USPS headquarters or their regional offices totaled over $31 million.

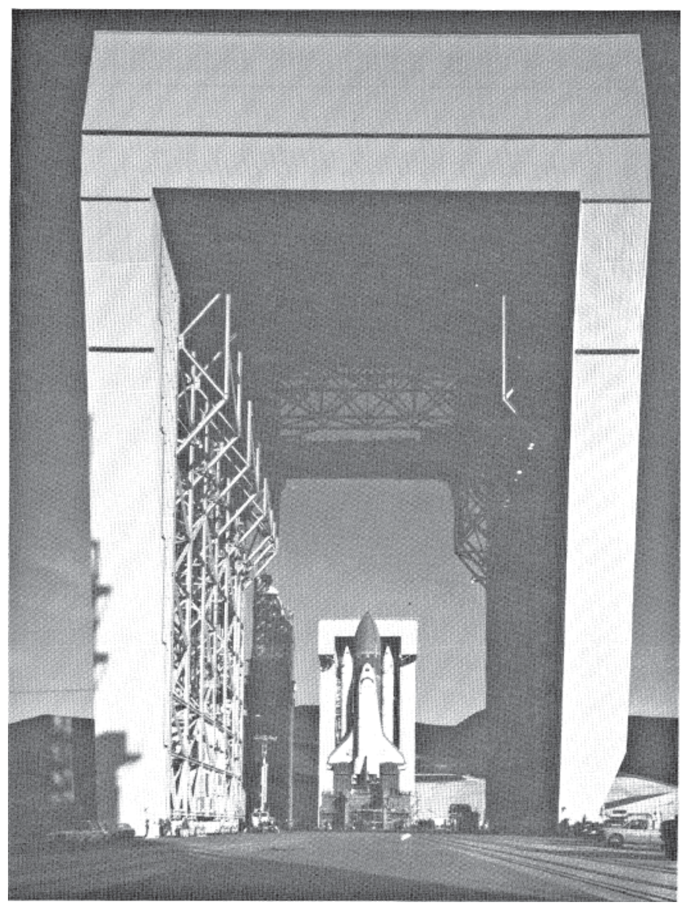
**Table 12.1**
**Selected Space, Defense, and Postal Projects**

| Job No. | Project Name | Client | Location | Project Value $1,000s |
|---|---|---|---|---|
| 1950-54** | Naval Air Station Expansion | US Navy | Alameda NAS | 26,851 |
| 5816 | Guided Missile Maintenance Fac | US Navy | Concord NAD | 1,700 |
| 1958-59** | Minuteman ICBM Test Complex | US Air Force | Edwards AFB | 1,482* |
| 6046 | Atlas/Agena Missile Launch Complex | US Air Force | Vandenberg AFB, CA | 15,600 |
| 6244 | Apollo Mission Control Center | NASA | Houston, TX | 12,000 |
| 6301 | Space Propulsion Test Facility | NASA | Ohio | 28,400 |
| 6410 | Saturn S-2 Stage Vertical Test Stand | NASA | Seal Beach, CA | 2,200 |
| 6451 | Army Hospital | US Army | Fort Irwin, CA | 1,650 |
| 6618 | US Naval Shipyard Modernization Program | US Navy | 9 Navy Shipyards | 828,000 |
| 6944 | Army Ammunition Plant | US Army | 27 US Ammunition Plants | 4,500,000 |
| 6947 | Robins AFB Master Plan | US Air Force | Georgia | 149* |
| 1970-72** | Chicago Bulk Mail Center | USPS | Chicago, IL | 61,000 |
| 1971-74** | 5 Med-volume Bulk Mail Centers | USPS | PA, MA, TX, CA | 143,000 |
| 7138 | Operational Communications Station | US Navy | California | 1,968 |
| 7302 | Trident Submarine Refit Facility | US Navy | Bangor, WA | 130,000 |
| 1974-80** | Trident Strategic Weapons Maint. Facility | US Navy | Bangor, WA | 1,562* |
| 75062 | Mississippi Army Ammunition Plant | US Army | Mississippi | 403,000 |
| 75086 | Ammunition Plant Process and Equipment Modernization Program | US Army | 48 US Plants | 3,835 |
| 77059 | Ammunition Storage Facilities | US Army | Sierra Army Depot, CA | 7,395 |
| 79058 | MX Missile Assembly Building | US Air Force | Vandenberg AFB, CA | 21,300 |
| 1981-92 | Trident Submarine Refit Facility | US Navy | Kings Bay, GA | 10,400* |
| 83202 | Space Shuttle Power Plant | US Air Force | Vandenberg AFB, CA | 15,600 |
| 84026 | ICBM Silo Superhardening Program | US Air Force | Yuma, AZ | 43,065 |
| 84213 | Harpoon Missile Maintenance Facility | Saudi Navy | Saudi Arabia | 50,000 |
| 86019 | Trident Refit Facility | US Navy | Kings Bay, GA | 63,600* |
| 87006 | Trident Strategic Weapons Maint Facility | US Navy | Kings Bay, GA | 4,000 |
| 85133 | Production Plant Modernization, M-16 Rifle Manufacturing Plant | Colt Industries | Hartford, CT | 261* |
| 82130 | M-1 Battle Tank Engine Manufacturing Plant | Avco/Lycoming Division | Stratford, CT | 135* |

* Engineering Services Only
** Years of Performance for Several Related Projects



In 1960, Kaiser Engineers designed Space Launch Complex No. 4 at Vandenberg Air Force Base, California. The facility was the launching platform for the Atlas booster rocket and the *Agena* vehicle. The missions of the *Agena* vehicle involved surveillance photography while in orbit. Shown in the background is the 160-foot high, retractable, self-propelled missile service tower. At the left is the 95-foot high umbilical mast for servicing the *Agena.*

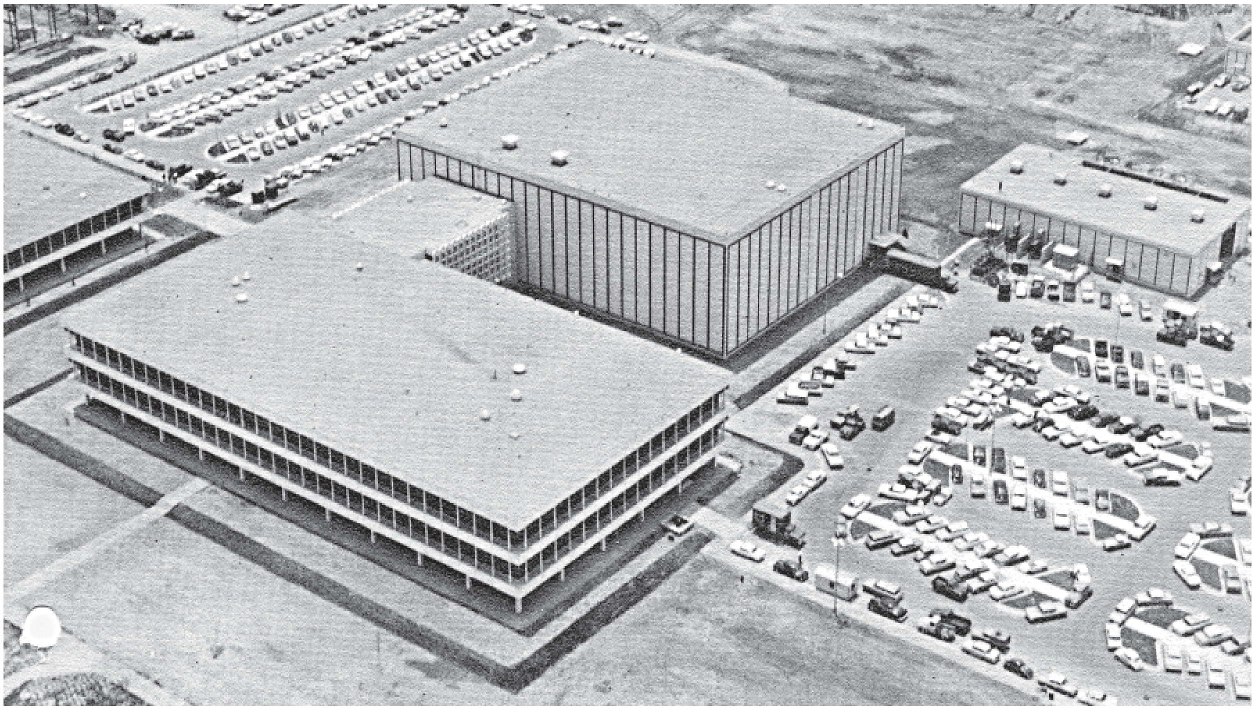


At right is the $44-million, 25-story high Space Shuttle Assembly Building built by KE's Construction Division in 1983-84 at Vandenberg Air Force Base. The 4,500-ton, self-propelled structure travels on tracks to mate with the mobile service tower and enclose the Space Shuttle and its launch vehicle during their assembly.

Appearing in the distant background, looking through the portals of the Shuttle Assembly Building, is the space shuttle vehicle *Enterprise,* assembled on its launch vehicle and second-stage rocket engines, mounted on the launch pad.

KE completed this complex project on schedule under its estimated cost and was formally commended by both the Air Force and the Corps of Engineers for its accomplishments.

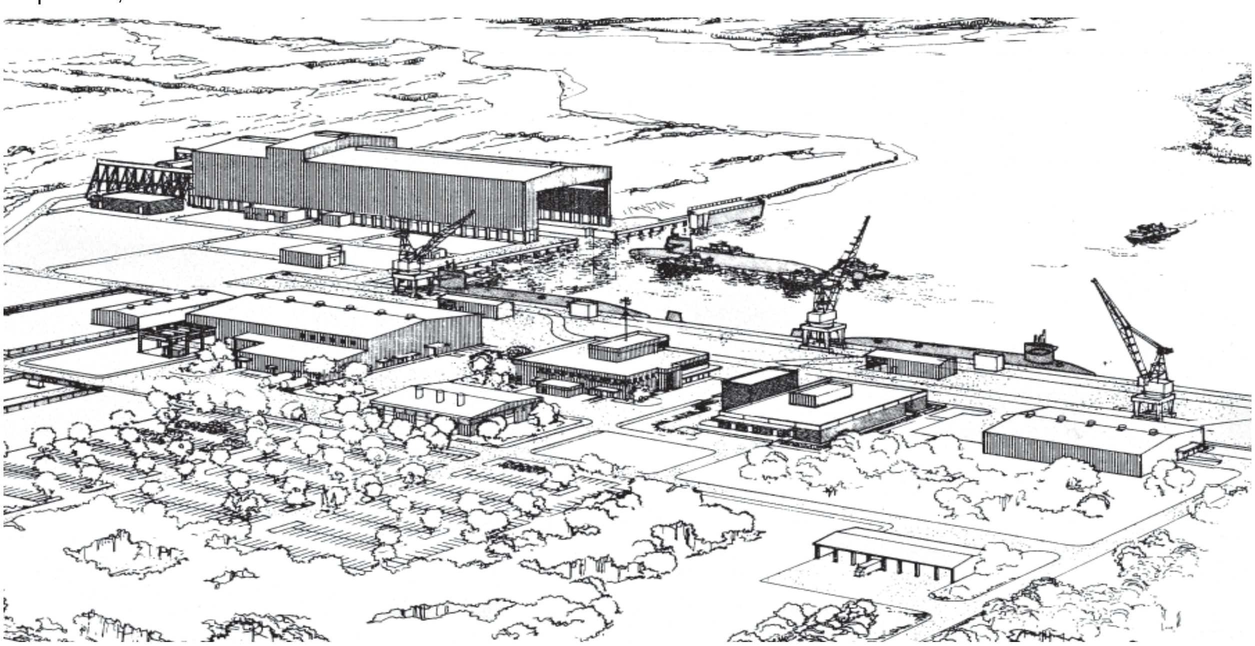
In 1983, under a separate contract with the Corps of Engineers, KE designed the $16.5-million critical power system power generating plant for the Space Shuttle Launch Complex at Vandenberg Air Force Base.



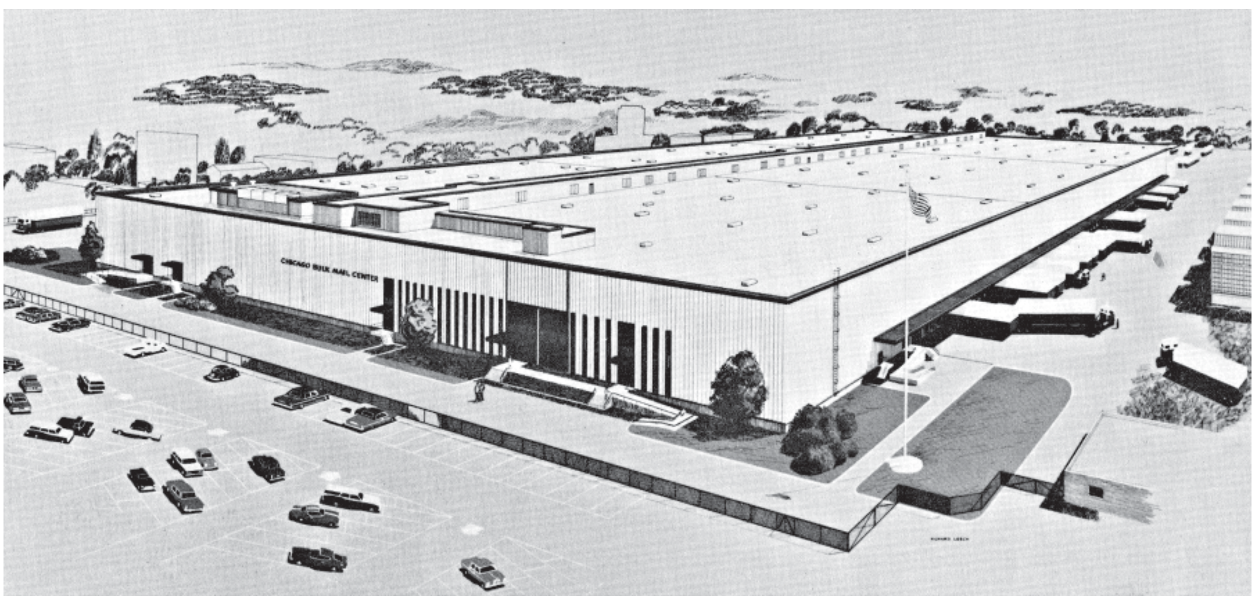
KE designed NASA's Mission Control Center in 1963. The facility consists of the 3-story, 117,000 square-foot Missions Operations Wing (above, without windows) and the 131,000 square-foot Administration Wing. The Mission Control Center controls operation, direction, and technical management of manned space flight in all aspects of ground support, from beginning of the lift-off countdown through flight operations, and recovery.

Shown above is one of the four Mission Control rooms in the Mission Operations Wing. The original computer center and data processing system, as installed in 1964, consisted of six IBM 7094 mainframe computers taking up the entire first floor of the Missions Operations Wing. Those six 1960s-era computers working together didn't have the power of one of today's modern lap top computers. Missions controlled from the Mission Control Center have included the *Gemini* orbital rendevouz flights, the *Apollo* lunar exploration flights, and the subsequent Space Shuttle missions.

In 1973, KE performed industrial engineering and master planning of the Trident Submarine Refit Facility at Bangor, Washington, on the Hood Canal, Puget Sound. The base was planned and built to be the home port for the Pacific fleet of 10 Ohio-class *Trident* submarines. Each carried 24 sea launch intercontinental ballistic missiles. The $130-million complex included 390,000 square feet of production shops and storage facilities located in the industrial area ashore. The waterfront facilities, shown above, were located on an offshore piling-supported, delta-shaped structure comprising a 70,000-square-foot drydock, two 750-foot-long refit berths, a 40,000-square-foot shop, and three 25-ton traveling cranes. In 1981, KE won a $10.39-million contract to perform the industrial engineering and master planning of the Trident Submarine Refit Facility at Naval Base, Kings Bay, Georgia, home port for the Atlantic fleet of *Trident* submarines. The base's waterfront area (below in perspective) included a 70,000-square foot covered drydock, refit wharves, and shops. Included in the industrial area (not shown) were 775,000 square feet of shops and other facilities planned by KE. Following completion of the planning contract, KE was awarded a 5-year, $64-million contract to manage planning, acquisition, and activation of the base.



In 1973-74, KE master planned, developed the manufacturing processes, and performed conceptual design of the $403-million, 155 mm, M483 Projectile manufacturing complex at the Army's Bay St. Louis, Mississippi, ammunition plant. The complex was planned to produce 120,000 completed projectiles per month. Production facilities included the 430,000-square-foot projectile metal parts plant and the 219,000 square-foot grenade metal parts plant (shown above). The projectiles were loaded, assembled, and packed for shipment in facilities sited in a remote 90-acre area located in accordance with explosive safety-quantity distance planning requirements.




In 1970, in association with A.T. Kearney & Co., Inc., KE designed the building facilities and mail processing systems for the U.S. Postal Service's 520,000-square-foot Chicago Bulk Mail Center. The Center was designed to handle 877,000 packages per day, sorting them to 1,645 national and local destinations. The Center's mechanization included 567 individual belt conveyors totaling over 9 miles in length, 9,700 feet of tilting tray sorting machines, and 14,400 feet of in-floor towlines. In a follow-on contract, KE designed the mail handling systems and equipment and made building conceptual designs for five medium-volume bulk mail centers located in Pittsburgh and Philadelphia, Pennsylvania; Springfield, Massachusetts: Dallas, Texas; and Los Angeles, California.

Chapter 13

# Municipal and Industrial Water and Waste Water

## Overview

As the title of this chapter implies, this industry deals with the supply of water for municipal, agricultural, and industrial use, including treatment and distribution, and the collection, treatment, and disposal of waste water from municipal and industrial sources.

Processes and facilities for water supply include the location and development of sources of supply, pumping stations, aqueducts, reservoirs, water treatment facilities involving chemical mixing, flocculation, sedimentation, filtration, and chlorination, and treated water distribution and storage facilities. Waste water involves collection, including pump stations, treatment facilities (biological or physical / chemical), and outfall systems for disposal or reclamation and reuse.

Kaiser Engineers' involvement in the water / waste water field came from two directions. One was as a support service to other KE industry groups, primarily aluminum and steel, both having significant requirements for water supply and waste water treatment and disposal. The second, and the focal point of this chapter, was projects obtained by Kaiser Engineers where water supply and waste water disposal were the end products of the project. Principal clients included the East Bay Municipal Utility District in the San Francisco Bay Area; the State of California Water Resources Control Board, the City of Vallejo, the Napa Sanitation District, and Sierra Pacific Power Company.

Marketing for water / waste water services included a number of methods (haphazard would describe them precisely). Initially, marketing was a one-man operation by Larry Thackwell in the mid-1940s when he obtained water supply and water treatment plant contracts from Publishers' Paper Company in Oregon and from the cities of Eureka and Vallejo in California. The latter remained a KE client for over 40 years, and the services performed are described later herein. Most of the marketing activities for new business were performed by the industry project personnel. In one instance, a Kaiser Industries Corporation contact reported that Sierra Pacific Power Company in Nevada had purchased some Kaiser Industries Corporation land on which they proposed to construct a water treatment plant. Follow-up on this report led to a study, design, and construction management contract for the 25-mgd Glendale Water Treatment Plant in Sparks, Nevada.

Another marketing effort was a visit by a Mr. O'Brien from Amador County, California, who thought he knew someone at Kaiser Engineers. The result was the Jackson Valley Irrigation District project, a $2,000,000 (in 1959), gravel-fill dam and irrigation distribution system.

Two examples of a formal marketing effort (both of which were joint ventures) were the SF Bay-Delta Water Quality Control Program for the State of California (further described later) and the Susquehanna River Basin Study in Pennsylvania.

## Those Who Did the Work

Over the years a multitude of key personnel were involved in this industry. Some were associated with one or two projects, and others were involved with many.

Key personnel included Bill Ball, Don Barrie, Shalom Blaj, Frank Harris, Fred Nielsen, Dick Ringwood, Harold Shandrew, Dick Socolich, Gene Stann, Larry Thackwell, and A. H. (Wink) Winkler. A host of KE personnel participated in these projects, including those from the engineering, design, and estimating groups.

A partial listing of water / waste water projects follows:

- San Francisco Bay and Sacramento-San Joaquin River Delta Water Quality Control Program.
- Lahontan Basin (CA) Water Quality Study.
- Truckee River (CA) Water Quality Survey.
- Susquehanna River Basin Study, Pennsylvania.
- Study and design of multiple municipal water system improvements for the City of Vallejo, California.
- Design and construction supervision of major improvements to the East Bay Municipal Utility District water supply system in northern California.
- Study, design, and construction management of a dam, outlet works, and

irrigation system for the Jackson Valley Irrigation District in California.
- Design of water treatment and storage facilities for the Oroville-Wyandotte Irrigation District in California.
- Agricultural Irrigation System Study for the Republic of Ghana.
- Study, design, and construction management of a 25-mgd municipal water treatment plant for Sierra Pacific Power Co., Nevada.
- Design of a marine waste water outfall system for Kaiser Aluminum and Chemical Corporation's magnesia plant at Moss Landing, California.
- Master Plan for waste water treatment and disposal and storm drainage disposal for the Vallejo Sanitation and Flood Control District, California.
- Conceptual design for tertiary waste water treatment at NASA's Manned Spacecraft Center near Houston, Texas.
- A management study, design, and construction supervision for a 15-mgd waste water treatment plant and related facilities for the Napa Sanitation District, California.

Major projects from the above list are described briefly in the following pages.

## East Bay Municipal Utility District

The East Bay Municipal Utility District (EBMUD) serves an area of over 250 square miles and a population in excess of 1 million people in Alameda and Contra Costa counties in the metropolitan East Bay area. In the early 1960s, to accommodate anticipated population growth, EBMUD instituted a 10-year construction program to provide a water supply adequate to meet its needs to the year 2000. Kaiser Engineers was selected to provide engineering services, including detail design for four of the district's projects valued at $26 million in 1960 dollars.

## KE Projects for EBMUD

The principal project performed by Kaiser Engineers and the largest project in the district's program was the Briones Dam, a 330-foot high (above bedrock) and 2,100-foot long earth-fill structure with a reservoir capacity of some 22 billion gallons. Briones Dam is located near the town of Orinda just east of the Oakland-Berkeley hills. The second project, an integral part of the Briones Dam program, was Lafayette Tunnel No. 2, a 114-inch diameter water tunnel approximately 3 miles long extending from Lafayette to the vicinity of Orinda. The tunnel is the final leg of the district's Third Mokelumne Aqueduct originating at Pardee Dam on the Mokelumne River in the Sierra. The other two projects performed by KE were the Sobrante Outlet Works and the Central Reservoir.

The Sobrante Outlet Works provided an additional outlet in the district's existing San Pablo Reservoir to serve as a supply to a proposed new water treatment plant. Kaiser Engineers recommended revamping an existing glory-hole spillway and tunnel, which had been replaced by a conventional spillway adjacent to the existing dam embankment. The design covered installing control valves in the existing spillway tower, a covered operating platform above the tower and a 76-inch outlet pipeline in the existing tunnel. For the Central Reservoir, Kaiser Engineers investigated and designed a reservoir roofing and lining system for the district's largest treated water storage reservoir in the City of Oakland. Central Reservoir has a surface area of 16.5 acres and a capacity of 154 million gallons.

## Briones Dam

The engineering and construction challenge of this project was the poor quality of available building materials. Local materials consist primarily of shales with siltstone, sandstone, and conglomerates, which become less stable when saturated. The sandstone was the best available material but was in limited supply in scattered areas. The poor quality of the available material ruled out a conventional embankment with an impervious central core. Instead, Kaiser Engineers specified an impervious blanket on the upstream face of the embankment consisting of alluvial material stripped off the bedrock at the site. The impervious blanket is underlain by a filter blanket that drains into another filter blanket under the entire embankment. The system drains off any water that penetrates the impervious facing, thus keeping the main embankment free of seepage water.

The available sandstone material was placed under the filter blanket on the upstream side of the embankment and on the downstream side; the less stable Orinda shale material was placed in the center of the embankment in the form of an inverted cone. To place the upstream 8-foot filter blanket, the construction contractor devised a traveling conveyor system to place four filter layers ranging from sand to 1 1/2-inch rock.

Other features of the design included a 60-foot-wide overflow spillway and a 350-foot-high inlet-outlet tower with hydraulically controlled gates, and a 90-inch-diameter tunnel and aqueduct system connecting to the base of the tower to provide for water storage and withdrawal.

Unique construction procedures included the use of nuclear testing for soil density which provided faster results than the standard sand cone method and provided early warning of variances in fill density and moisture content. Also, pore pressure piezometer devices were installed during construction to detect excessive pore pressures in the embankment. Fortunately, recorded pore pressures have not been significantly high to warrant concern.

### Lafayette Tunnel No. 2

Lafayette Tunnel No. 2 was an integral part of the Briones Dam project. Kaiser Engineers established the tunnel location, prepared the detail design and specifications, and provided assistance during the award of the construction contract and during construction. In addition to the 3-mile tunnel, the project included a tunnel outlet works, which permitted the flow to be released to San Pablo Reservoir, or diverted to the district's existing Orinda Filter Plant, or pumped into Briones Reservoir via a 25-mgd pumping plant. Flow can also be reversed through the tunnel to deliver water from Briones Reservoir to areas upstream from the tunnel.

### Who Did the Work

Kaiser Engineers' key personnel were Bill Ball, Einar Larsen, and Dick Ringwood. P. C. Rutledge of the New York firm of Mueser, Rutledge, Wentworth & Johnston acted as a consultant to Kaiser Engineers for the dam's basic configuration. Other key Kaiser Engineers personnel included George Gerdes, Kong Go, Sam Nash, Fred Nielsen, and Bill Sproule. EBMUD principals were J. D. Costa, general manager and chief engineer; W. R. McLean, project manager; and Hugo Hansen, resident engineer.

All of KE's projects for EBMUD have successfully withstood the test of time to the year 2000 target initially envisioned by the district. This has included periods of drought during the late '70s, winter floods, and earthquakes. Briones Dam represents a unique approach to earth-fill dam design and was featured in the February, 1964, issue of the *Engineering News Record.* It is a recognized landmark in the East Bay Area and is accessible via a perimeter hiking trail subsequently constructed by the district. A final comment is pleasurable recollection of the multi-martini lunches enjoyed by the project participants during construction at a popular Orinda restaurant.

## City of Vallejo Water Supply System

### Overview

Kaiser Engineers' engineering work for the City of Vallejo covered a period of more than 40 years starting in the late 1940s. It began with KE's Larry Thackwell around 1946 when he secured a contract for Kaiser Engineers to investigate sources of a future water supply for the City of Vallejo, located north of the Carquinez Bridge in Solano County, California. Until then, the city had relied on wells and three small lakes, Frey, Madigan, and Curry. The lakes continue to supply a small portion of the city's water. The city, with a current population of over 100,000, also supplies treated water to Mare Island and Travis Air Force Base in Fairfield.

As a result of the initial study, Cache Slough, a tributary to the lower reaches of the Sacramento River, was selected as the source of supply. This was the first step for Kaiser Engineers in its 40-year program of municipal water system development for Vallejo.

### Engineering Services for Vallejo

KE's work for the City of Vallejo covered the complete range of engineering services from initial investigations through plant start-up. These services included master planning, feasibility studies, mathematical modeling, conceptual and detail design, construction contract document preparation, contract bid review and award assistance, assistance with preparation of the project bond and financing documents, and engineering and inspection services during project construction.

### Initial Projects for Vallejo in the 1950s

Water supply system projects performed for Vallejo included four reservoirs, nine pumping stations, three major pipelines and numerous distribution system pipelines, and three water treatment plants. A number of these facilities involved successive projects for the purpose of increasing capacity and incorporating new performance requirements and technological developments. The first projects undertaken for the city, following selection of Cache Slough as the source of supply, included:

- Cache Slough Pipeline - 24 miles of 36-inch pipeline conveying raw water from Cache Slough to Cordelia Reservoir.
- Cordelia Reservoir and Pump Station - A 15 mgd concrete lined reservoir with two vertical turbine pumps capable of delivering 27 mgd of raw water to the site of the new Fleming Hill Treatment Plant in Vallejo.
- American Canyon Pipeline - A seven-mile long, 27- inch pipeline from Cordelia to the site of the new Fleming Hill Treatment.
- Fleming Hill treatment Plant - A 21-mgd treatment plant incorporating chemical mixing, flocculation, sedimentation, and filtration.
- Travis AFB Treatment Plant - A 4.5 mgd treatment plant taking raw water from the Cache Slough pipeline, and supplying the Air Force Base. Treatment consisted of chemical mixing, flocculation, sedimentation and filtration and was one of the first fully automated plants ever constructed.
- Trans-Vallejo Pipeline - A 5-mile long, 24 inch pipeline conveying treated water from the Fleming Hill Treatment Plant to the city's existing Swanzy Reservoir.

## 20-year Master Plan

The initial City of Vallejo projects were completed during the 1950s. In response to increasing population and water demand, the city commissioned Kaiser Engineers to prepare a 20-year master plan to identify future system requirements. The recommendations of this master plan, completed in 1962, led to the following projects designed by Kaiser Engineers:

- Summit Reservoir - A 65 million gallon, asphalt lined, raw water storage reservoir located upstream from the Fleming Hill Treatment Plant.
- Skyview Reservoir - A 6-million-gallon, pre-stressed concrete construction, treated water storage reservoir.
- Monticello Pump Station -Two vertical turbine pumps delivering 13.9 mgd of raw water to the Fleming Hill Treatment plant through either the Cache Slough pipeline or the city's original Gordon Valley pipeline.
- American Canyon Pump Station -Three 600-hp vertical turbine pumps with a combined capacity of 27.2 mgd. Located on the American Canyon Pipeline, this pump station boosted the capacity of the Cache Slough/Fleming Hill raw water system.
- Fleming Hill Treatment Plant Expansion Program - This project was a highlight of Kaiser Engineers services to the city. The *Master Plan Report* previously referred to identified the need to increase the capacity of the treatment plant from 21 mgd to 35 mgd to meet the year1980 projected demand. Initially it was planned to expand the plant by duplicating two-thirds of the existing treatment plant facilities.

Before initiating design, Kaiser Engineers advised the city of recent developments in high-rate sedimentation-filtration systems. KE's recommendation that this technology be utilized in the project was accepted by the city with the result that a plant capacity of 39 mgd was achieved by converting only one-half of the existing plant.

Conversion of the existing Fleming Hill Plant involved reworking three of the six original sedimentation basins to incorporate secondary flocculation and conversion of each of the other three basins into a four-cell, vertical sedimentation unit with corrosion-resistant collection troughs and continuous mechanical sludge collection equipment.

High-rate filtration capacity was achieved by replacing the media in six filter beds with a mixed media of anthracite coal, silica sand, and garnet. The cost, including $410,000 to refurbish elements of the unconverted half of the plant, came to $1.35 million. The cost to expand the plant as originally envisioned, including the necessary structural additions, was estimated at over $2.4 million.

## Projects for Vallejo in the 1970s and 1980s

Numerous projects for the city followed during the 1970s and 1980s, the larger of which included:

- Swanzy Reservoir - Lining and roofing of an existing 4-acre treated water storage
- Fleming Hill Pump Station - A 32,000-gpm natural gas driven pump station, which is automatically controlled to modulate engine speed in response to distribution pressure.

- Cordelia Reservoir Pump Station - An 800-gpm diesel engine driven pumping station to serve as standby for the existing electric motor driven pumps.
- Fleming Hill Sludge Dewatering Ponds - Three-cell, 2-acre sludge dewatering ponds and reclaimed water pump station serving the Fleming Hill Water Treatment Plant.
- Travis Air Force Base Pump Station - Three 75-hp vertical turbine pumps taking water from the recently completed State of California North Bay Aqueduct to supply the Travis Air Force Base Water Treatment Plant.

### KE Personnel for Vallejo Projects

For Kaiser Engineers, there was a cast of many, beginning with Larry Thackwell. KE's key people following Thackwell included Dick Ringwood, Dick Socolich, Wink Winkler, and Don Barrie. Winkler played the principal role in many of the projects described above and was responsible for the Fleming Hill Treatment Plant conversion to high-rate sedimentation/filtration. Principal City of Vallejo officials included a Mr. Kilkenny, the city's director of public works, when it all began. He was followed by Glenn Harris and John Duanne, the current director.

Thackwell, in his efforts to market KE's services to the city, regularly attended the meetings of its Public Works Commission. Sam Ruvkun recalls a "Thackwell legend" regarding his efforts to land KE's first project with the city—he treated a sample of turbid, raw water on stage before the city officials, then drank the clear effluent!

For Kaiser Engineers, the City of Vallejo projects were perhaps the longest floating crap game in town, extending for a period of over 40 years. One of many accomplishments was the fact that the City of Vallejo constructed its own North Bay Aqueduct (the Cache Slough system) nearly 30 years ahead of the State of California program, which did not reach the Vallejo area until 1986.

## San Francisco Bay and Delta Water Quality Control Program

### Background

Aware of the growing national concern over pollution of the environment and the damages already caused to the rivers, lakes, and estuaries of the East and Midwest by increasing urbanization and industrial development, the people of the San Francisco Bay and Delta area,s and the State of California began demanding protection of their water resources and restrictions on polluting activities. This resulted in passage of the California Water Pollution Control Law of 1965, authorizing the State Water Resources Control Board to conduct a comprehensive study of the effects of waste water and drainage discharges into the Bay and Delta and to develop the basic features of a comprehensive plan for the control of water pollution.

### KE Wins the Study Contract

In October, 1966, the Water Resources Control Board solicited proposals in a national competition to select a contractor to perform a study and develop a comprehensive master plan for control of water pollution in the Bay and the Delta. In November, the state board selected and entered into a contract with Kaiser Engineers as master contractor and head of the multi-disciplinary team KE had organized for the project. The team included the following companies and consultants:

- Engineering Science, Inc.
- Water Resources Engineers, Inc.
- North American Rockwell Corp.
- Baxter, McDonald & Co.
- Stone & Youngberg, Inc
- the Center For Real Estate and Urban Economics, University of California
- Dr. Erman A. Pearson, Principal Consultant

The principal study area comprised the San Francisco, San Pablo, and Suisun Bays and their watersheds, and the Sacramento -San Joaquin River Delta. As thus defined, the study area included portions of the twelve counties contiguous to the Bay system. Secondary study areas comprised the remainder of the watershed draining through the Bay-Delta system (essentially the entire Central Valley of California) and coastal ocean waters that could be affected by alternative disposal systems.

It is impressive to recognize that the total watershed that drains through San Francisco Bay and its Golden Gate comprises approximately two-thirds of the surface area of the State of California.

### Study Objectives

The study had three major objectives to be accomplished:

- The determination of the effects of waste water and drainage discharges into the waters of the Bay and Delta.
- The need for and the feasibility of a comprehensive multi-purpose waste collection and disposal system serving the entire area as well as other measures for maintenance of water quality.
- The development of the basic features of a comprehensive plan for the control of water pollution in the Bay and the Delta regions.

### Study Program

Kaiser Engineers managed and directed the 2-1/2-year study program and performed the system and facilities planning and design, cost estimating, economic analyses and report preparation, public presentations, and participated directly in many of the specific program studies.

The program involved a systems approach to a multi-disciplinary study which included civil and sanitary engineering, oceanography, biology, demography, finance, government, and economics. Advanced techniques of mathematical modeling and computer simulation were utilized to simulate and predict waste disposal and hydraulic flow characteristics of the extremely complex estuarine system formed by the San Francisco Bay and the Sacramento-San Joaquin River Delta.

### Study Results

The program resulted in the development of new parameters of waste disposal and waste effects, which had never before been used in the planning and design of a major waste water management system. In addition, the flexibility built into the recommended 50-year plan permitted a choice of alternatives at key decision points, depending upon future economic and technological developments. The study extended from December, 1966, through June, 1969, including a series of public hearings and presentations. The final program report contained more than 500 pages, and the contract value was $2,022,000.

### Project Organization, Participants

Aside from the project's technical challenges, a major challenge for Kaiser Engineers was managing and coordinating the work of the seven-company project team, the numerous project consultants, and the participating state agencies. Many were "off and running" before they knew where they were going, and others had to be pushed out of the starting gate. Needless to say, much effort was focused on scope, schedule, and budget. Gene Stann, as project manager, deserved the major credit for the success of the program. He was able to manage and control the several prima donnas among the project team who each initially sought to run the program all by themselves! The management challenge of this project team was well depicted by its Organization and Responsibilities chart.

Gene was ably supported by Dick Ringwood, deputy project manager, and by Phil Bush, corporate officer in charge, who spent the necessary time to ensure that the project team functioned in a responsible and coordinated manner. Other KE personnel who played a prominent role included Dick Socolich, Shalom Blaj, Stan Smith, and John Gilcrest. John was responsible for the KE team proposal, including the project's comprehensive multi-task work plan.

The Bay-Delta Study and the way it was conducted by Kaiser Engineers served as the forerunner for many similar study programs in other parts of the state and the country. Kaiser Engineers subsequently participated in the Lahontan Basin Study in California, which included Lake Tahoe, and in the Susquehanna River Basin Study in Pennsylvania in a joint venture with a Pennsylvania-based consulting firm.

## Jackson Valley Irrigation District Project

### Overview

In 1959, the newly formed Jackson Valley Irrigation District sought financing for their proposed dam under the provisions of the Small Reclamation Project Act administered by the U.S. Bureau of Reclamation. The initial step in their proposal was to perform the necessary geotechnical and hydrological investigations to support the viability of the project. One member of the district's board of directors thought he knew someone at Kaiser Engineers and proceeded to contact us to provide these services. Whether he did know anyone at Kaiser Engineers is unknown, but his meeting with Vice President Einar Larsen was the beginning of Kaiser Engineers' unexpected project. Following the successful completion of the preliminary investigations, Kaiser Engineers was awarded a contract for final design, preparation of plans, and specifications and construction management for the district's project.

The dam is located on Jackson Creek near Ione in Amador County. The reservoir impounded by the dam has a capacity of approximately 26,000 acre feet of water and is capable of providing 10,000 acre feet annually to irrigate about 3,000 acres of arable land in the district. The dam has a height of 182 feet above the streambed and a crest length of 1,120 feet. The dam has a central core of alluvial material taken from the valley floor. The upstream and downstream portions of the embankment are constructed of rock and gravel dredger tailings (over 1.3 million cubic yards) left over from earlier gold mining operations in the area.

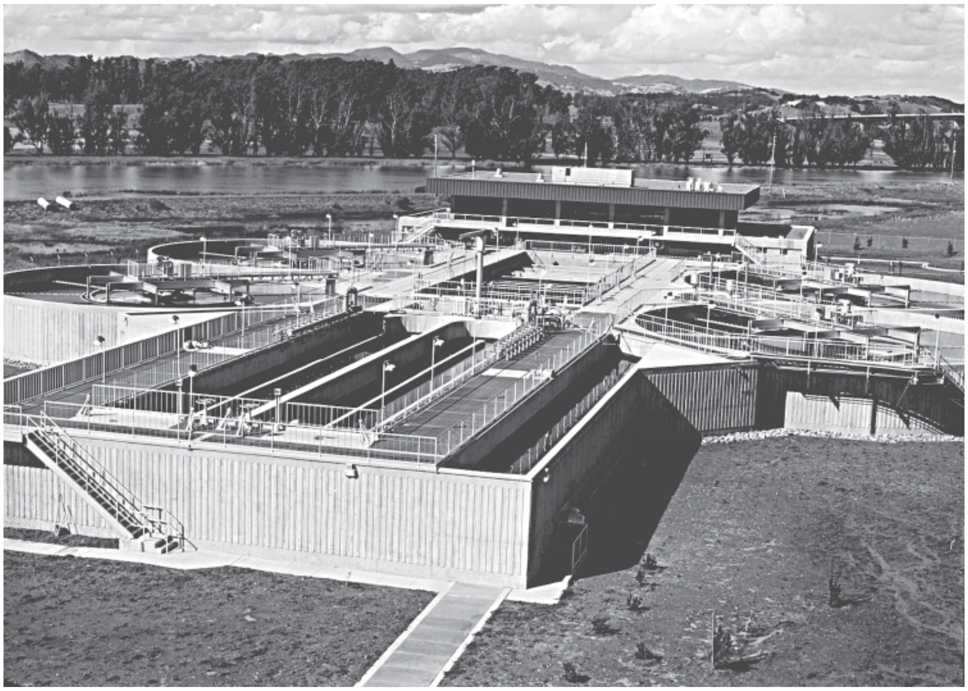
The project includes a concrete overflow spillway, an outlet works consisting of an intake structure, an emergency shut-off valve in the center of the embankment that is accessible by tunnel, an outlet pipe through the tunnel, and an outlet control valve capable of releasing water directly to Jackson Creek or to the district's irrigation distribution system consisting of nearly 5 miles of pressure pipeline.

The project was completed on schedule and within its $3-million budget. In year 2000 dollars this project would have cost over $7 million.

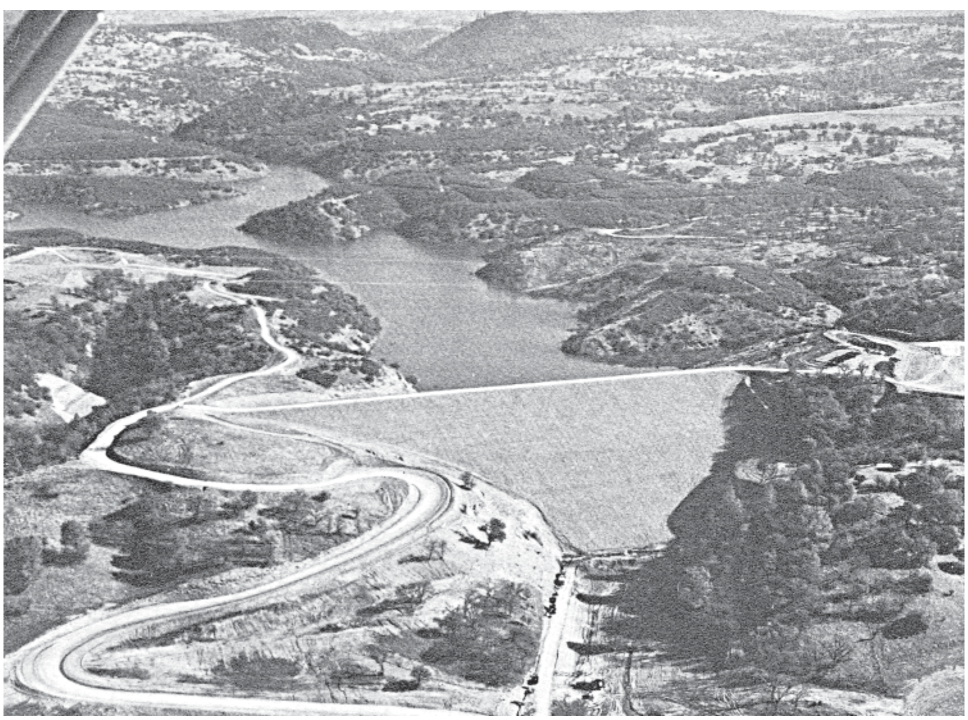
## Project Participants

Kaiser Engineers' project participants included Bill Ball, Einar Larsen, Frank Matthias, Cliff Meisner, Dick Ringwood, and Harold Shandrew. One of the main challenges faced by the project team was working with a divided and contentious district board of directors. A lot of non-reimbursable hours were accumulated in attending frequent board meetings from 7 p.m. to midnight or later. In contrast, one pleasant recollection is the progress meetings hosted by Clarence Scully, president of the District Board, at his home in Ione and attended by Kaiser Engineers, the contractor, and the representative from the Bureau of Reclamation. The meetings would take place on the lawn under a large shade tree. As the meeting got underway, Clarence would pass around a bottle of Old Crow bourbon. By the time the meetings were over, everyone was in complete agreement—even though they might not remember the next day what was agreed upon.

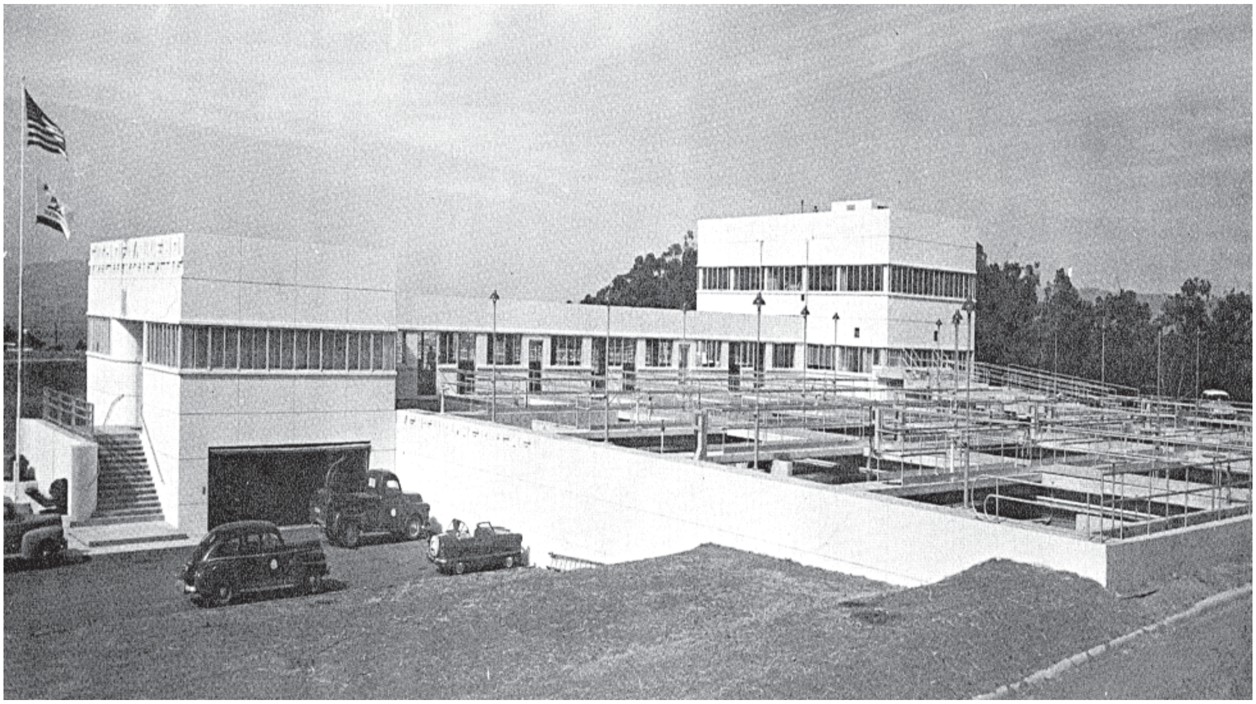
The Irrigation District has gone into the recreation business with the addition of campgrounds and boat launching ramps on the shore of what is now known as Lake Amador and the construction of a fish hatchery on the downstream side of the dam. KE



15 mgd Waste Water Treatment Plant (above) for Napa-American Canyon Sanitary District, California. Management study, design, and construction supervision by KE, 1974-1975. Waste water projects by KE included collection systems, pump stations, treatment facilities (biological or physical/chemical), and outfall systems for disposal or reclamation/reuse.



The Jackson Creek Dam (above) designed by KE for the Jackson Valley Irrigation District in Ione, California. KE's services included also field explorations, a feasibility study, preparation of plans and specifications, and resident engineering services during construction. The Jackson Creek Dam is located in the western foothills of the California Sierra Nevada.



Kaiser Engineers' involvement in the water/waste water field was initially as a support service to other KE industry groups, primarily aluminum and steel, both having significant requirements for water supply and waste water treatment and disposal. In doing this work, KE's civil engineers accumulated extensive experience and capabilities in the water/waste water technologies. Shown above is a view of the Fleming Hill Water Treatment Plant, designed by KE for the City of Vallejo in the early 1970s. Water supply projects performed by KE included location and development of sources of supply, pumping stations, aqueducts, reservoirs, treatment facilities, and treated water storage and distribution systems. Early on, KE's management sought to capitalize on this knowledge, and it employed Larry Thackwell in early 1948 to develop opportunities to do sanitary engineering for local municipalities. His first success was with the City of Vallejo in the San Francisco Bay Area. At his meeting with the City Council, he brought a pail of turbid raw water and his homemade chemical processing laboratory. On stage, before the city officials, he proceeded to treat the raw water, finally filtering the effluent into a clean beaker. Then, with great gusto, he drank the effluent. He got applause and got the job.

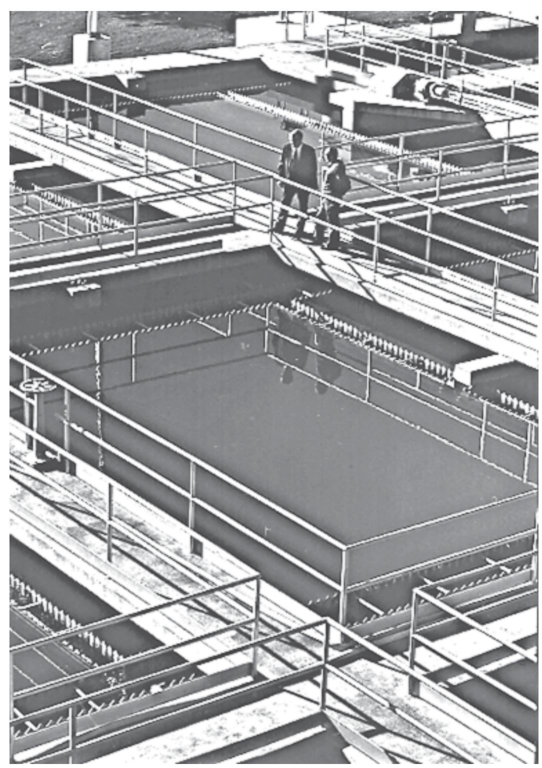
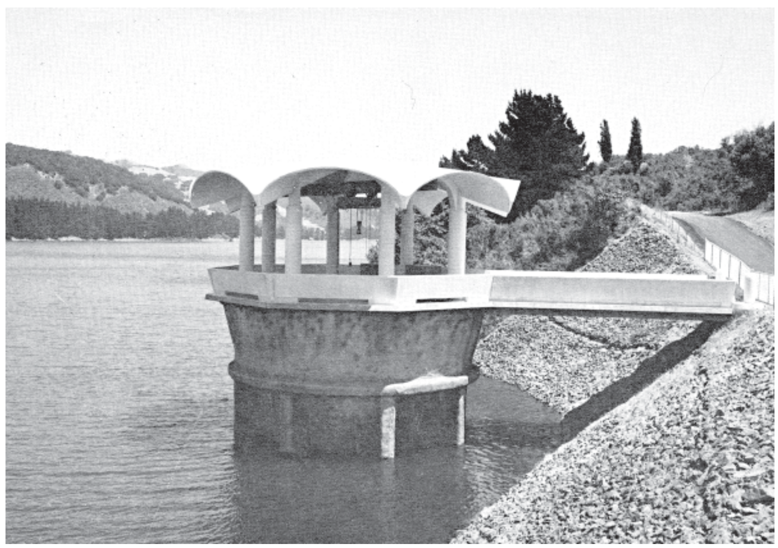


Photo at the right is a view of the sedimentation/filtration basins of the 25-mgd Glendale Municipal Water Treatment Plant at Sparks, Nevada. Designed and construction managed by KE for the Sierra Pacific Power Company (1975-1979).

Briones Dam, designed for the East Bay Municipal Utility District in 1960 by KE's municipal and industrial water supply experts working out of Oakland. This was a separate group from the KE personnel that later developed hydro projects in Africa and Brazil.

El Sobrante Outlet Works, San Pablo Reservoir, East Bay Municipal Utility District. Designed and construction supervised by KE. The outlet works were constructed without draining the 14-billion-gallon reservoir.



A water supply project built by KE in Ascuncion, Paraguay, in 1956. This project included reservoirs, pipelines, and water treatment. All parts of the project were designed by others. KE provided a supervisory crew to direct the work of local forces. Financed by the Export-Import Bank.

Chapter 14

# Air Pollution Control Engineering

## Overview

The Air Pollution Control Department and the Water Supply and Waste Water Department were both organized within KE's Advanced Technology Division. Additionally, both of the departments performed work that involved elements (although not the same) of the environment. Accordingly, when the editors of this book were planning the organization and content of the book's chapters, it was suggested that both departments should be covered within a common chapter describing KE's "environmental " projects. However, it was decided to present each department individually with its own chapter. It was noted that the respective clients and markets of the two departments were completely different. Additionally, much of the Air Pollution Control Department's work was performed in support of projects sponsored and managed by other KE industry groups, i.e., Steel, Aluminum, Cement, etc. The Water Supply and Waste Water Department contracted directly with outside clients for essentially all of its work.

This chapter describes briefly the history and services of the Air Pollution Control Department, its services, and its key personnel, followed by a summary of some of the first-of-a-kind (at least to KE) or otherwise notable projects in which these personnel had significant roles.

## History of the Air Pollution Control Department

### Dave Wheeler Starts the Department

Kaiser Engineers' concerns with air pollution control stem from the late 1940s and early 1950s when significant air pollution problems resulting from the industrial emissions of Kaiser Steel's Fontana, California, steel mill and the Kaiser Cement Plant at Permanente began attracting much public and private criticism. KE's George Havas, as chief engineer for these affiliated Kaiser companies, initiated some early engineering programs for control of the emissions from these plants. Emission control systems and equipment, although primitive by modern standards, were built at each of these plants. The Cottrell electrostatic precipitator that was installed at the Permanente (Cupertino, California) Plant in 1951 reduced significantly its stack dust emissions.

KE's Air Pollution Control Department had its origins in the vision of Bob Wolf, hired by George Havas in 1955 to head up the company's work in the steel industry. Bob recognized the important role air pollution control would have in the future of executing engineering and construction projects for the steel industry. He worked closely with Dave Wheeler who had been hired to head this new initiative because of his superb technical background and respect within the pollution control industry. Dave was the chief engineer at the Western Precipitation Company, which had been founded by the inventor of the electrostatic precipitator and was the premier air pollution control equipment manufacturer in the U.S. Previously, Dave had been the chief engineer at Cowell Cement Company, and the plant's stack is still standing in the midst of a housing development and clearly visible from Ygnacio Valley Road in Concord, California. Dave earned a civil engineering degree from College (now University) of the Pacific in Stockton, California.

The first task was to transfer Dave's credentials to KE, the Steel Division in particular, and KE's credentials to Dave. He made a concerted effort to deliver papers and presentations on air pollution control at the conferences known to attract attention of the steel company executives, engineering VPs, and corporate and plant pollution control personnel. In the end, this task was so successful that even on the occasions when KE was not awarded the work for an overall steel project, Dave would be asked by the owner's home office engineering and / or in-plant environmental staff to "bless" the pollution control portion of the work performed by our competitors. Dave would do this as a favor to them, and KE was reimbursed for his efforts. However, the big dividend of this effort came when the cyclical project work was slow in the steel industry, and KE would pick up many of the odd in-plant de-bottlenecking and pollution control projects, which would help carry the Steel Division through the lean times.

## Department Services

This background covers what the air pollution control business at KE was all about and the importance of moving air through the process plants for the cement, aluminum, power, ferrous, and non-ferrous industries' projects. More tons of air went through those plants than all the other feed materials combined. All the air and related exhaust gases had to be cleaned after going through the plant. It was not uncommon to have the air pollution control systems account for more than 25 percent of the total installed cost of a new plant, and for modernization of existing plants, the percentage could be much higher. The Air Pollution Control Department would:

- Determine the correct amount of gases that would go through the plant.
- Determine size and configuration of the fans and blowers to move the gases.
- Design the ductwork to get the air and gases from here to there.
- Evaluate the regulations to determine the allowable emission limit.
- Specify the baghouses, electrostatic precipitators or scrubbers, including negotiations with the vendors to assure the plant personnel would be able to access and maintain the equipment during years of near-continuous operations.
- Develop appropriate methods for disposing or recycling the captured pollutants.
- Prepare the fugitive emission control measures for the materials handling systems and operations, e.g. conveyor transfers, truck dumping, open storage piles, crushing, screening, shiploading.

If the handling or cleaning of the process gases were not correct, the plant would suffer during start-up, commissioning, and production. Through the 1970s and early 1980s, which may have been the golden age of engineering for the smokestack industries, the owners relied on KE to select individual pieces of production equipment from the different vendors and to integrate these pieces into a complete working plant. The various KE divisions worked the mineral and metals flows, and the Air Pollution Control Department would work the air and heat balances. (By the 1990s, the owners favored buying the equipment and related engineering from the vendors, and the design-construct engineers would do only the balance of the plant. Today, early in decade 2000, the trend may be reversing as the owners start to realize that one vendor does not have all the optimal equipment in its catalogue.)

## Key Personnel of the Department

By 1970, Dave was leading a group of engineers including:

- Al Tyrrill, Bud Duling, Jim Murray, and Dave Shrimpton in Oakland.
- Deane Sensenbaugh and Ron Stoker in Chicago.
- Don Alton in Pittsburgh.

Steel projects were worked from Oakland, Chicago, and Pittsburgh. The projects and studies for the other commodities were mainly worked from Oakland. Also by this time, the Oakland group was deeply involved in providing tunnel ventilation support to the rapidly growing number of subway projects undertaken by the Transportation Division.

Dave's group, the Air Pollution Control Department, was part of Phil Bush's Advanced Technology Division. Within Phil's Advanced Technology Division, the Air Pollution Control Department was parallel to the Water and Waste Water Department. It is interesting to note the degree of foresight (or pure blind luck) that placed these pollution control departments in the Advanced Technology Division. The two environmental departments were not associated organizationally with any of the specific commodity divisions or departments (e.g., ferrous, aluminum, industrial minerals, non-ferrous, etc.) at KE. More than once this arrangement paid dividends when an environmental "expediency" was pursued by one of the commodity divisions or their clients that was running counter to the burgeoning federal, state, and local laws and regulations. On several occasions, the differences had to be resolved at the executive levels of the divisions or departments involved. However, in the overwhelming majority of the work, the cooperation and cohesion amongst the different departments were excellent.

## Tyrrill

Al Tyrrill was a chemical engineer with his early years in the pharmaceutical industry. He came to KE from Fiberboard Corporation in Antioch, California, where he then worked for Bob Hallanger (who would later form his own engineering company, which was still later purchased by KE). Al knew the pollution control equipment well, and he was part of an advisory group that oversaw some of the scrubber research by Conrad Semaru at SRI, and that work is still the most often referred to by the practicing pollution control engineers world-wide. However, Al's most consistent contribution to KE's projects was his strength in calculating the heat and mass balances for the process plants, which were fundamental for estimating the size of the air pollution equipment. Most of his career was before the hand calculators, and these heat and mass balances were onerous tasks; he knew every trick in and out of the books.

Most of Al's contemporaries would scale (e.g. twice the ore throughput would lead to a fan of twice the flow) from previous jobs. However, the ore and chemistry were never the same, and Al's perseverance would lead to air pollution control equipment that was more optimally fit for the purpose. (Remember that more than 25 percent of the total installed costs were riding on this call.) Al's most annoying habit was that he was right when he sensed a project had a conceptual or technical problem. Sometimes it would take him days to understand what was (or was going to be) the root cause of the problem. Often, it would take days to catch up with his thinking to understand the problem well enough that one could implement a solution. However, it was reckless for any co-worker to neither listen through nor resolve the problems he would sense.

## Duling

Bud Duling, Yale graduate with a B.S. in physics, had a career path similar to that of Dave Wheeler. Bud worked for Western Precipitation Company, often as a field engineer. One of the more unique electrostatic precipitators he built was an all-wood unit (except for the discharge electrodes or hanging wires) for Lone Star Cement at the Port of Redwood City, California. He later worked for Calaveras Cement and was with them during the building of their original Redding Plant near Lake Shasta in Northern California.

Bud was a certifiable genius by most everyone's standards. While on the Redding job, he taught himself by trial and error to play the concertina from a 100-page sheet music book. To this day when Bud is playing, somebody will call out any number from one to 100, and Bud will knock out the song. A card deck has only 52 cards; Bud's photographic memory made him a Masters at Bridge. At work with this memory, Bud could sight along hundreds of discharge electrodes in dozens of gas passages in an electrostatic precipitator and write a report for the maintenance-repair detailing which wires had to be repositioned and by how much. When he made these inspections on the dust collectors for the open-hearth furnaces, the fine iron oxide dust particles would get in the pores of his skin, and the dust would not wash off; Bud would be red for more than a week at a time.

Bud had a real knack for organizing data, as well as vast contacts amongst the owners' organizations. This was invaluable when new products were starting new fads. For example, when Nomex was first being introduced as a high-temperature filtering media in clinker cooler baghouses, Bud's cement industry-wide investigation quickly revealed that the fabric was being over-rated; KE's clients were appreciative that by following Bud's and KE's recommendations, they avoided both costly retrofits and air agency penalty citations.

## Murray

Jim Murray was a mechanical engineer with bachelor's and master's degrees from Stanford. He was hired into KE from a small air pollution measuring company in Palo Alto, California, where he had become experienced in organizing field operations, air sampling, as well as air dispersion modeling of stack emissions. He was introduced to the realities of working for KE when he was told to report to work on his first day with suitcase in hand and within two hours was on an airplane with Dave Wheeler to prepare a proposal to control the dust emissions from Ford's parts casting facility in Cleveland.

## Shrimpton

Dave Shrimpton first arrived at the Air Pollution Control Department during his intern rotation after graduation with a master's in chemical engineering. He continued with the department becoming a very strong project manager. Dave (or sometimes Little Dave in deference to Dave Wheeler) made very good impressions on the clients except any Monday morning after a rugby match or rock climbing when we would never know what might be broken, swollen with purple bruises, or bleeding. He would bring his awesome intensity for sports to a job, especially if it had never been done before. Dave, starting from the researchers' concepts, managed the design, construction, and start-up of operations of the EPRI Testing Facility located south of Denver.

## Sensenbaugh

Deane Sensenbaugh was the mainstay of the Chicago office. He would work closely with Dave Wheeler to cover the pollution control aspect of the all-steel projects that KE was executing from either the Chicago or Pittsburgh offices. From time to time, there would be studies or projects with such a large pollution control content that the Chicago Air Pollution Control Department would take the lead in running the job, supported by the designers and engineers of KE's Chicago Steel Division. He served on the editorial board of the Air Pollution Control Association (APCA) magazine for years. His dedicated years of service to APCA as well as his peers' recognition of his solid knowledge of pollution control equipment and how to apply it to the air pollution control industry, in general, and the steel industry, in particular, led the Air and Waste Management Association (the successor to the APCA) to memorialize him with the J. Deane Sensenbaugh Award. This award is presented annually "to recognize a company or an individual outstanding achievement in the fields of air pollution control or waste management."

## Stoker

If Sensenbaugh was the "Wheeler" for the Chicago Office, Ron Stoker was the "Tyrrill." Ron was a chemical engineer. When there was a major steel project (e.g., replacing an open-hearth furnace with a basic-oxygen furnace), Ron would take care of the pollution control, gas cooling, and waste heat recovery equipment as an area project engineer. On other occasions when the project would start as a study of the modifications to a steel mill's pollution control systems, Ron would be the project manager, and the Steel Division would supply the project engineers and design engineers to assist the Air Pollution Control Department.

## Alton

Don Alton was the type of engineer that could be assigned to a project and be relied upon to fill any gap. He would float between Chicago and Pittsburgh. He would handle the air or waste water side of the business. For example in the late 1970s, the SEC ruled that all public corporations had to report their outstanding financial liabilities due to outstanding or reasonably anticipated pollution control expenditures. A Fortune-500 company with about 80 manufacturing plants around the U.S. asked KE to assist the company's outside legal counsel. Don had to follow some hotshot, Los Angeles law firm partner and "very attractive female" associate to about 40 plants in three weeks. The attorneys flew first class; Don was in the back of the airplane. (Remember the Air Pollution Control Department was subject to Phil Bush's Advanced Technology Division travel rules.) The attorneys stayed in the top hotels like the Fairmont chain; Don would find a nearby Holiday Inn or HoJo. The schedule would have the last plant on Friday be at someplace like New Orleans, and the attorneys would play over the weekend. Because Don knew it would save the Fortune-500 company a few bucks, he would fly home for the weekend for clean laundry and catch-up with a bleary-eyed pair early Monday morning.

## Wheeler Retires

Big changes occurred by 1972. Dave Wheeler reached the mandatory retirement age of 65 years. He and his wife, Elsa, moved back to the Los Angeles area to be close to his family. Everyone missed Dave's quiet, gentlemanly style and warm smile that made him the consummate professional engineer and leader. He is best remembered for his continual mentoring. Working for Dave, with his famous double-ended red and blue pencil, one would learn more in one month than five years of hard knocks. ("Red" meant that you must make the change, and "blue" meant that you would have to explain, to Dave's satisfaction, that you knew what you were doing.)

## Jane Haire

With Dave's departure, the Air Pollution Control Department soon lost Jane Haire as its lead secretary. Jane had come to KE and Oakland from Harley-Davidson. Jane was the epitome of the professional secretary. She could type dozens of pages each with six carbon copies without an error. (To those young readers that only have known computerized word processors and copy machines, you should try typing a page while making carbon copies sometime, if you can even find a typewriter.) Jane and Dave worked as an excellent team. She understood his mind when she set up the filing system that would store the paper work from the large variety of jobs coming through the Air Pollution Control Department. Most importantly, the filing system provided for instant retrieval of the documents. Although never stated, it was widely believed that Bob Wolf sent Jane to work for Dave as part of his original plan to afford all the trappings of prestige that he could to Dave's position within KE. Having one of the best secretaries within all of the Kaiser Empire was one subtle way of doing just that.

## Departments Consolidate Under Lagarias

KE went outside to replace Dave. Jack Lagarias was recruited to be manager over both the Air Pollution Control and Industrial and Municipal Water / Waste / Water Departments. Jack had distinguished credentials in the environmental community and an outstanding reputation in the air pollution control community. He was president of Resources Research, Inc. immediately prior to joining KE, where among other notable accomplishments he helped author the *US EPA Emission Factors Handbook,* the so-called AP-42, a fundamental reference for the air pollution control engineers. Prior to the work at Resources Research, Inc., he headed the research facilities for Koppers Company, Inc., which included Research Cottrell.

Research Cottrell was the East Coast sister of the Western Precipitation Co. where Dave Wheeler once worked. Jack was a past-president of the American Air Pollution Control Association and organized and / or chaired several significant international conferences. After his retirement in the mid-'80s, Governor Dukmejian appointed him to the California Air Resources Board where he served several terms.

## Emmet Spencer

Emmet Spencer was hired to head the Air Pollution Control Department after Dave Wheeler's retirement. Emmet was from FMC and previously with the Los Angeles Air Pollution Control District. The LA Air Pollution Control Department was one of the finest in the U.S., and served as a model for the formation of the U.S. EPA and the California Air Resources Board, among many others. While at Los Angeles, Emmet was a contributor to the chapters on Metallurgical Equipment and Chemical Processing of the *Air Pollution Engineering Manual,* the so-called AP-40, which remained a bible to professional air pollution control engineers for about 30 years.

## Environmental Permitting Begins

Also in 1972, the environmental regulations started to kick-in with complex permitting and environmental assessment requirements that had to be met before construction could begin on the ferrous, non-ferrous, and cement projects. One of the requirements of the permitting process was a complete technical description of the proposed facilities and all the related emissions and effluents. It was a natural choice that KE's Air Pollution Control Department would provide the permitting support to the other divisions. The Air Pollution Control Department's goal on these projects was to obtain the permits rapidly enough that no construction date would be delayed because a regulatory agency had not issued a permit. In order to maintain these aggressive schedules, the Air Pollution Control Department had to make preliminary process calculations, which were used as the basis for the environmental permit applications. These calculations had to be sufficiently accurate that they could be reconciled with those that would later be prepared and guaranteed by the process equipment suppliers during the procurement activities. For a while, the Cement Department reasoned that if the Air Pollution Control Department personnel would pull in the permits, help put the process together, monitor the process vendors for compliance with permit conditions, specify the pollution control equipment and fans, and draft the operating procedures, they might just as well do the start-up, which we did. Besides, the Air Pollution Control Department personnel would have to be on-site anyway because the start-ups were becoming heavily weighted to environmental compliance and stack testing.

By the mid-'70s, the Oakland staffing had grown to about 25 to handle the increased work associated with the increased business in the other KE departments as well as the new roles of the environmental base-line assessments and permitting processes.

## Creative Budgeting, Reporting

By the latter years of the 1970s, Jim Murray had become the manager of the Air Pollution Control Department. Because the Air Pollution Control Department was doing many unique assignments, it took on several characteristics. It was a profit center, but 50 percent of its work was for internal "clients." However, because of the KE's accounting system rules, the Air Pollution Control Department did not receive any profit for the work it did for its internal clients. Therefore, Alex Lindsay, now the vice-president over the Advanced Technology division, and Bob Frowien had to invent some rather creative financial budgeting and reporting approaches to keep the Air Pollution Control Department off of the KE accountants' radar screens. Teresa Rayacich and Singh Arora would create the financial story for Jim, and Bob and Alex would sell it to a receptive upper management. In this manner, the Air Pollution Control Department would meet its financial goals usually by early spring of each year and be free to technically assist the other Divisions in the required amounts without fear of pulling engineers off in order to help the Air Pollution Control Department's bottom line. During a couple of years, the Air Pollution Control Department would fall short of the mid-spring target, but Arnold Kackman would breakout a couple of environmental pay items from his Industrial Minerals Division projects, and with those independent bookings, the Air Pollution Control Department was again whole for that year and able to concentrate on the internal clients.

## Young Department Staff

Another comment about the Air Pollution Control Department concerns the average age and salary of its personnel. It was only in the early 1970s that the EPA started promulgating the nation-wide ambient air quality standards, stack emission regulations, and environmental study requirements needed for permits to start construction. As a result, there was not the normal succession of engineers in the Air Pollution Control Department that one would find in, for example, in the Cement Division or the Steel Division. The environmental regulatory climate was changing so rapidly that there was not time for the college hires to learn from those with 10 years experience, who in turn were learning from those with 20 years experience, etc. to those with 30-40 years experience and ready for retirement. Instead, the department had a few individuals with limited overlap with the "old guard" of Wheeler, Tyrrill, Duling, and Sensensbaugh to learn how the pollution control systems were integrated into the overall plant. As a result, the old-timers in the Air Pollution Control Department had only 5 to 10 years experience with the engineering and permitting as compared to individuals in the other KE departments with up to 40 years experience. Furthermore, there was nobody who could be hired off the street with that experience. Therefore, the Air Pollution Control Department had the youngest average age for a department with KE.

In general, the department personnel were selected because they would be quick learners, and there were ample assignments to challenge continually these high performers. Phil Bush and Alex Lindsay, the vice presidents overseeing the Air Pollution Control Department, allowed its salary to reflect the achievement and potential (rather than time-in-grade), which resulted in some of the youngest engineers and scientists in KE's higher salary grades. That sort of management recognition, as well as the peer recognition, made for very high morale and cohesion.

## Jim Murray Leaves KE

Jim Murray left KE in 1980, and reins for running the Air Pollution Control Department went into Chris Rayner's capable hands. During the early 1980s, the Air Pollution Control Department continued its close relationship with the Cement Department, and power projects became a new arena to apply pollution control and permitting skills. Unfortunately, business slackened during the 1980s. Through questionable vision and business plans on the part of the succession of KE's new owners, the overall company quickly drifted into a series of situations that were not viable. The resulting new company could no longer sell or execute the major industrial projects that the Air Pollution Control Department had for so long faithfully supported. The Air Pollution Control Department personnel wound up being used to remediate leaking underground storage tanks (LUST) at corner gasoline stations, a most sad demise.

## Cement Plants

### Pre-1973 Oil Embargo

In the years before the 1973 Oil Embargo, the Air Pollution Control Department had a closely-knit working relationship with KE's Cement Department as well as with the Kaiser Cement and Gypsum Company. During this time, because of a perceived intertwined management between Kaiser Cement and KE's Cement Department via the Kaiser Industries connections, KE's clients were either Kaiser Cement or those cement producers outside of the Kaiser Cement marketing area. The relationship was in part due to Dave Wheeler's and Bud Duling's history with the cement industry as well as the air pollution control suppliers. During this time, the cement industry was fuel inefficient because fuel was very cheap, and reducing labor costs was the main concern in both the new plants and the modernization projects. Most cement plants would use the long kilns, and the recovery of the waste heat from the exhaust gases was seldom considered. As a result, the major air pollution control equipment could be specified with information from the kiln suppliers and historical ratios.

The cement plants of this era would have a low efficiency electrostatic precipitator (ESP) for the control of the gasses venting from the kiln and a cyclone or multi-clones for the clinker cooler vent. The rule-of-thumb was that if the dust collectors were about 95% efficient, the recovered product value would offset the costs of owning and operating the dust collectors. In several instances, the cement plant would be close to populated areas, and the higher efficiency baghouse would be installed. When used, the baghouse would filter out about 99.5% of the dust. As the pollution control agencies started to regulate the cement manufacturing industry, the baghouse became the standard dust collector, and the ESPs started increasing in size (plate area) and reliability to match the performance of the baghouses. Fugitive dust collection for the materials handling equipment started being required, and as many as 30 individual small baghouses would be located around the plant for the purpose.

The Cement Department would design and build the process equipment, and the Air Pollution Control Department would work around the production design to handle the fans, ductwork, electrostatic precipitators and / or baghouses. This worked very smoothly, and Al Tyrrill once quipped that the greatest compliments the Air Pollution Control Department would receive were:

> Question: How did the pollution control equipment work?"
> Answer: "What pollution control equipment?"

Everything was running so well that the start-up engineers and the operating personnel would not even know that it was there. The Air Pollution Control Department would take additional pride when the Cement Department personnel would return to the plant after several years, and there would be the same question with the same answer.

### Learning Experience at Lyons, Colorado

One exception to the simple long kiln cement plants of this era was the 1971 grass roots' project for the Martin-Marietta Cement and Lime Company facility at Lyons, Colorado. If one were superstitious, one could make the case that the project was cursed. The kiln for the plant was on order to be delivered to an earlier project in Michigan, but the raw materials were so high in sulfur that it would not meet the existing air quality regulations. Martin-Marietta found another property at Lyons. However, one of the raw materials at Lyons contained kerogens, this was similar to oil shales found in other parts of the Rocky Mountain region. Hoke Garrett was the KE project manager and knew that uppermost shales were low in the kerogens, but it would last only a few years before the shale would have to be treated. With no data, Al Tyrrill, using only experienced judgment, sketched a circuit partially in series with the ancillary equipment upstream of the cement kiln, which was being transported from Michigan. This part of the plant was called the Dryer-Roaster-Cooler (DRC), and it had to dry all the raw materials. When the batches of kerogenous shales exited the dryer, they would be sent through a rotary roaster that would burn the kerogens. After roasting, the shale would drop into a rotary cooler to reduce the temperature low enough to not damage the rubber of the belt conveyors.

The whole of the DRC circuit was a full-scale pilot plant. According to the conclusions of a study of 44 megaprojects by the Rand think-tank, "Incorporation of new technology in a megaproject almost ensures that the project will make more mistakes than money," and "megaprojects are inappropriate vehicles for experimentation." Thus by all odds, the DRC should not succeed, and at first, the DRC would not work. Because Al's heart was acting up again, Hoke Garrett next took Jim Murray to Lyons to help with the start-up and sort out the start-up mechanical problems from the process problems. For starters, the fuel value in the shale was greater than expected and would generate more and hotter exhaust gases. The dryer now had to serve double duty, simultaneously being a rock dryer and an evaporation chamber to quench the hotter exhaust gases, and an additional 300 gallons per minute of spray water had to be added in the dryer to keep from burning the fabric filters in the baghouse. Jim determined that the baghouse vendor would have to come back on-site because several miles of seal welding had to be added to stop dust leaking from the baghouses. The rotary speed of the cooler had to be increased by a factor of four to move the shale through. About 100 gallons per minute spray water had to be added to the cooler to supplement the cooling air.

To keep up with all these process changes, the data gathering and reduction tasks became overwhelming, and Dave Shrimpton was called to help. The roaster would not burn enough of the kerogen, but the kerogen would burn in the cooler, which resulted in even more spray water being required. Plans were readied to speed up the roaster to thin out the bed of shale when Hoke noticed that every once in a while the bed would shake on its own, and flames would suddenly dance on the bed. We had to stir the bed to get raw kerogen to the surface and oxygen into the bed. Tumbling ledges were added to the roaster, and when the next shale was added to the roaster, the kerogen lit off. Within seconds, the additional heat load now in the exhaust gases carried into the dryer, and the additional sprays came on to keep the baghouse fabric within design temperature limits. The product from the cooler was within the design limits of the belt conveyor. The DRC circuit was working. This was rewarding because three engineers working 12 to 18 hours per day for three months, with a host of support from the rest of KE and the Martin Marietta plant people, had beaten the odds laid down by the Rand study. Martin Marietta realized an important side benefit because the shale was now partially calcined, and the fuel requirements of the cement kiln were reduced.

A real benefit to KE was a database, and the confidence in their technology to tackle the next two generations of cement kilns with waste heat drying. This technology would be of critical importance for the balance of the decade because of the cement industry clients' emphasis on reducing fuel costs paramount to reducing the cost of electric power and labor.

## Post-1973 Oil Embargo

The first project of this era was Medusa Cement Company's plant modernization at Clinchfield, Georgia. The challenge was to integrate a Fuller preheater (short) kiln with a Raymond vertical roller mill. This was a first of-its-kind for Raymond, and Fuller had a turnkey project running in parallel with Clinchfield, so they assigned a second-string team. Jim Murray and Al Tyrrill worked out a ductwork, dampers, and fan arrangement, which was a first of-its-kind for the cement industry. The trick was to be able to start and stop the roller mill's 1500-horsepower fan, which was located in the kiln draft circuit, without even bumping up or down the steady airflow through the kiln. It worked so well that it later became a standard arrangement for the rest of the industry. There were many start-up problems that had to be worked through, but the plant was running above rated capacity in about five months.

The plant Fuller designed and constructed at the same time had gas-handling problems and took about 18 months to approach rated capacity. Allis Chalmers, another kiln equipment supplier, was designing and constructing two similar plants in the same time frame, and seven years later neither could even approach rated capacity. Again, KE had beaten the odds in the Rand study, and the lessons learned at Clinchfield would carry through the balance of the cement plant projects supported by the Air Pollution Control Department.

## KE Meets Permit Acquisition Deadlines

By the mid-1970s, the U.S. Environmental Protection Agency (EPA) was starting to tighten the air pollution permitting requirements. The Clinchfield plant had a rather simplified EPA and Georgia review process prior to issuing the permit to construct. KE was awarded a project to modernize the OKC cement plant at Pryor, Oklahoma. Chris Rayner and Jim Murray were flying on a Tuesday to OKC headquarters to kickoff the permitting work for the Pryor Plant. While in the air, they realized a new set of rules would start that Friday, and OKC would be treated under the old rules if they could submit the application to EPA by 3 p.m. that Friday. The only thing about the plant that was fixed was the production capacity, but meeting the deadline would save 6 to 12 months on the permitting cycle because of additional baseline data, air dispersion model, other impact analyses, etc. They had to estimate the process, write a project description, create an air pollutant emissions inventory, adopt the air dispersion results from a power plant about 30 miles away, and prepare the application in the EPA format. This task was usually allotted three months on a project schedule. (In today's world, the allocation is 18 to 30 months.) OKC's CEO, Cloyce Box, put all his resources, including his personal secretarial staff at Jim's and Chris' disposal, and they hand-delivered the application to the EPA Regional Office in Dallas 30 minutes before the deadline. From that point forward, it became a matter of Air Pollution Control Department honor that the acquisition of environmental permits would never delay the start of construction for a cement plant project.

## Murray Sets a Record

Lone Star Cement had expansion plans, but they were not certain of the location that would best fit the market needs. Their solution was to get environmental permits in several locations around the U.S., and this would keep their competition guessing where they were moving next. Chris Rayner, Jim Murray, Mark Strehlow, Kirit Patel, Lee Kuhre, and Chandra Khatri participated in various aspects of the permit acquisition exercise for potential plants in Texas, Utah, and Alabama. Jim and Mark prepared the permit application for the proposed plant near Georgetown, Texas. That permit was vehemently opposed by one of the local citizens, who connected with a local attorney that had recently left the State Attorney General's office and appeared to be making a name for himself in private law practice. In the ensuing quasi-judicial, contested public hearing in front of an administrative law judge, Jim earned the record for being examined and cross-examined longer than any witness in front of the Texas Air Control Board. The testimony covered over 11 hours in two days, and towards the end, the TACB was rotating its permitting engineers into the hearing room just to observe the show.

## Other Challenges for Cement Projects

There were many other cement projects, and some had unique challenges:

The Ciments Français plant project at Coplay, Pennsylvania, started with a weekend phone call from Ray Krekel, a senior project manager from KE's Cement Department, to Jim Murray warning him to be prepared for the kick-off meeting on the next Monday and be ready to have all the major equipment committed by Friday. A new kiln with planetary clinker cooler, burners, roller mill, main electrostatic precipitator, and kiln and mill draft fans were all purchased from separate vendors. KE had to integrate major equipment from five separate vendors. The Air Pollution Control Department was responsible for the gas flows and heat balance aspects coming together while being able to acquire the necessary permits on a fast-track basis. The Cement Department made the procurement commitments by the Friday deadline. In addition to making process contributions, by mid-week Jim had started feeding the process information to and from the Air Pollution Control Department to get the environmental permit applications. Bob Schenker, Barbara Cohrssen, Kirit Patel, and Rick Walker worked the permitting issues. The permits were received on schedule, and the gas flows and heat balances made the various vendors' equipment work in harmony.

Medusa Cement Plant at Charlevoix, Michigan, had the (then) largest roller mill to be installed in the U.S. and rather strict $SO_2$ requirements that went beyond the KE and vendors' abilities to predict emissions. Jim Murray, Chris Rayner, and Rich Walker looked after the process integration, permitting, pollution control, and eventually the start-up, which was in the '79-'80 winter. As the knowledge of the $SO_2$ emissions and regulations evolved, Jim and Chris would be answering new questions about this plant and its $SO_2$ emissions through the early 1990s.

The Marquette Cement plant at Cape Girardeau, Missouri, used waste heat from the clinker cooler (instead of the kiln) and the clinker cooler vent baghouse with a 4000-hp fan located over 100 feet above the ground on top of the kiln feed silos. Kirit Patel worked the heat balances for the clinker cooling and waste heat drying. Chris Rayner worked fan issues, which included controlling the potentials for vibrations and harmonics of the silo roof and wall structures.

# Steel

## Steel Industry Becomes Poster Child for Pollution

As mentioned earlier, the origins of the Air Pollution Control Department were closely tied to

Bob Wolf and the Steel Division. Smoke from the steel mills' stacks was America's symbol for the industrial strength that won the Civil War for the North, tipped the balance in World War I, and was the "arsenal for democracy" leading to the Allies' eventual triumph in World War II. However, by the start of the last half of the 20th century, the U.S. steel industry had become associated with rather dirty sky images, with Donora, PA's 1948 smog attack, the 1949 Canadian complaints about the pollution from Detroit, and in October, 1954, the shutdown of both industries and schools in the Los Angeles basin.

In the late 1960s as Los Angeles became aware of its smog problems, it first focused on grit and dust. The Los Angeles District Office of the Army Corps of Engineers contracted with KE to survey the gray iron foundry industry as there were some 40 foundries operating within Los Angeles County. KE's report proposed the first significant regulation that related the permissible emissions to the tonnage of gray iron being produced. The regulation was specific to the gray iron foundry industry but was widely copied throughout the country as a model ordinance. That is, except for one county in Iowa which adopted the ordnance for all industries except gray iron foundries because they *had* a gray iron foundry.

The steel industry was becoming the poster child for pollution. The open-hearth furnaces were requiring more efficient dust collection or replacement with the basic oxygen furnaces, which also required high-efficiency electrostatic precipitators. Because of KE's patent position with the basic oxygen furnaces, KE would be able to do much of the engineering, and the Air Pollution Control Department's personnel in the Chicago office (and sometimes there was a Pittsburgh office also) would do the pollution control work for these projects.

## Japanese Influence on the U.S. Environmental Protection Agency

There were several interesting geopolitical aspects about the U.S. EPA's tightening of pollution control rules for the steel industry. The steel industry in North America was fighting a losing battle with the Japanese over costs and market share and was in desperate need to modernize its plants to reduce the labor costs. Whenever there was a prolonged strike, the Japanese would increase market share during the ensuing steel shortages. Furthermore, the Japanese steel-makers were touting their superior pollution control systems. Any excess capital that could be accumulated by a steel company in the U.S. had to be spent on pollution control equipment, rather than being available to spend on modern production equipment. Also, the unions were not keen on modern equipment because far fewer workers would be needed. The unions formed an unholy alliance with environmental activist groups to force the EPA to continue promulgating ever more onerous pollution control regulations.

The following describes an example of how the Japanese steel industry used the U.S. EPA to weaken the U.S. steel industry. The Japanese steel-makers were bragging that they were covering the runners and launderers in the cast house and enclosing much of the coke ovens. Deane Sensenbaugh went to Japan on two separate EPA-led expeditions. The first tour was to observe the covers in the cast house. The entourage was carefully herded on a circuitous route to the cast house. Before each tap, the workers were seen using the overhead crane to move dozens of refractory lined covers over the runners and launderers in the cast house floor. Although labor intensive, they were very effective.

The second tour was several months later to observe the control of fugitive fumes and dust while pushing coke out of the ovens. Again, there was a similar drill about a circuitous route to get to the coking batteries. Suspecting a rat, Deane lined up last, "somehow got lost," and just happened to wander past the cast house of the previous tour. Although they were tapping, the covers were stacked neatly off to the side, and fume looked just like that typical of any US cast house. His host quickly found him, and after a scolding, hustled him back to the coke battery to watch an enormous hood move back and forth with associated ductwork and fans trailing after it. The fugitive emissions from the coke pushing operations were being controlled.

Ever astute, Deane recalled that while in the cast house during the first visit, he saw the periodic, large fume puffs from the coke area typical of uncontrolled pushing. Deane's conclusion was that the only time the Japanese steel industry would use these cumbersome, labor-intensive control systems was when US EPA was in town. Nonetheless, EPA promulgated regulations forcing the continuous use of these concepts on the U.S. steel industry. Thus, the domestic steel industry was further disadvantaged because its limited capital was spent on expensive, labor-intensive pollution control equipment instead of improved production facilities.

Jack Lagarias notes that Bob Wolf's close association with the steel industry caused some difficulties in the early '70s when the environmental regulations of the EPA and foreign steel-making competition adversely affected the entire industry. He discouraged attempts by KE's Air Pollution and Waste Water Departments to work for or with EPA because of the antagonism between the industry and the federal regulatory agencies. In 1973, the EPA hired Cyrus Rice, Inc. of Pittsburgh, Pennsylvania, to survey and make a report of steel industry wastewater treatment processes. The industry commissioned a number of engineering firms to review the report and attack its credibility. Most of the major engineering firms working for the steel industry, including KE, participated and attacked the report's finding. KE's report initially showed that some of the Cyrus recommendations were already being used, and it was worded so as to not antagonize the angry steel companies who wanted nothing less than a complete "gutting" of the Cyrus Report.

## Aluminum, Chemical

### Aluminum

The evolution of pollution control in the aluminum industry followed a different pattern compared to the other heavy industries. For the cement, steel and non-ferrous industries, KE had a leadership role in working with the vendors and prodding them about where and/or what the innovations and new technologies should be to meet the burgeoning regulations. With the aluminum industry, the major players, Alcoa, Reynolds and Kaiser Aluminum, developed their own (or copied each other's) control technologies. (See Chapter 5 for a description of the dry scrubbing of the aluminum smelter emissions.) The Air Pollution Control Department personnel supported these efforts by contributing their expertise in working with high dust loads in baghouses and the material handling of the alumina.

The new technologies being developed were best suited for the prebake pot design, but could be adapted to the older Soderberg technology. However, even into the 2000s, not all of the Soderberg smelters had been converted to the dry scrubbers. Therefore, in the 1970s many of the older plants were trying optimistic suggestions by equipment peddlers in attempts to avoid the expense of a dry scrubber retrofit. The Air Pollution Control Department would get calls from many of these smelter owners asking us to come look at their miraculous scrubbers to see if there was anything that could be done to get them to work.

For example, one solution was to induce a very large flow of gas from the smelter through a wet scrubber. Conventional wisdom says that a large pressure drop is required in the scrubber to make enough water surface area to absorb the pollutant gases from the gas stream, and conversely, one could spend the energy making a fine spray; but there is no free lunch. One vendor was offering a free lunch to the aluminum industry; their scheme was to add thousands of ping-pong balls inside a scrubber housing and, thereby, provide an extended surface area for water contact with the pollutants in the exhaust gases. Bud Duling was asked to visit one such smelter in the Ohio Valley to determine why the scrubber they had purchased would not approach the anticipated scrubbing efficiency. All the ping-pong balls were cemented together by the trace amounts of pollutants collected in the scrubber liquors. Although Bud had trouble finding a block of balls small enough to fit on the airplane, he returned with a pyramidal block of ping-pong balls about 2 feet on a side. Apparently, the pilot testing had been done without recirculating, and the scrubber liquor, therefore, was always clean and would not cause the balls to stick together. Now, the energy the smelter folks thought they would save on pressure drop or making fine spray had to be spent cleaning a large flow of water. That block of balls stayed in his office for several years as a subtle reminder that vendor claims had to be carefully evaluated. For years after, there would be more phone calls asking for help, which was usually given during the phone call. Later, Chandra Khatri was invited by these smelter folks to help with the water treatment of the liquor and stabilization of the resulting sludge. There was no free lunch.

In the 1980s, Chandra would travel with Orhan Caglar to the smelters in the Columbia River Basin, Washington to help upgrade their large wet scrubbing systems to obtain a few more years' life on those plants that already were past the end of their economic life.

### Refractories

New pollution control regulations required that the Kaiser Refractories Plant at Moss Landing, California, have more efficient dust collection on its kilns. It was planned to equip the dolomite kiln with a rather straightforward baghouse. However, its vendor was having problems obtaining and holding competent engineers. Al Tyrrill spent weeks showing the vendor how to design the baghouse they had sold. The tricky part was the design of a high-efficiency venturi scrubber for the periclase kiln. It was common to conduct pilot testing on scrubbers to determine the relationship between pressure drop and the duct collection efficiency. Joe Busch and Warren McMath commuted to Moss Landing to run the pilot tests. The results led to a recommendation for the scrubber. Because there was limited space available, they also had to do a series of trade-off studies to get a configuration that would fit the space and budget.

Based on all of the collected efficiency data, plant configuration alternatives and related cost estimates generated during this successful project, they wrote a paper that appeared in three consecutive issues of an air pollution control magazine. This made them the definitive experts on the practical applications of scrubbers. This experience led to a later project to design and install a similar installation for a Dow-Corning plant in Pascagoula, Mississippi.

## Transportation

### Subway Environmental Design Handbook and Subway Environmental Simulation Study

Because the Air Pollution Control Department had engineering experience in handling large amounts of air flowing through ducts, the Transportation Department used this talent to ventilate the large amounts of air flowing through subways. Al Tyrrill headed the first such task on a preliminary study for a subway system in Los Angeles in the 1960s. By 1970, KE had sufficient recognition within the industry that it was invited to become part of a joint venture with Parsons, Brinckerhoff, Quade and Douglas, Inc. and Deluew Cather, Inc. for the $5-million study on subway ventilation. In early 1971, Al's heart doctor recommended that he relinquish his leadership role in the study, and it was turned over to Jim Murray, who by this time was heavily involved in assisting the Industrial Minerals (Cement) Department. Jim, who had ridden a commuter train one trip in his life between Palo Alto and San Francisco, had never seen a subway, but under intense tutelage by Al and the Transportation Division's Farrell Schell, there was an apparent seamless transition, and the joint venture was not slowed a bit.

There was an enormous amount of literature searching required by all the joint-venture partners, and Barbara Cohrssen (with a bachelor's degree in Ceramics Engineering and a master's degree in Library Science) was "borrowed" from the Advanced Technology Division. With her contacts in the Library of Congress, she could find reference materials and obscure reports in several hours that the joint venture partners had spent months unsuccessfully trying to find.

### Human Environmental Criteria

Jim and Barbara were the start of one the most eclectic engineering teams ever assembled. Jim soon asked Barbara and Harry Isakari to help define what made passengers feel too hot or too cold in the station or cars. Without criteria, how else would the engineers know how to design the stations and the vehicles to the transient conditions of a patron sweating (or freezing) on the street, standing a few minutes on the platform, and sitting in the car? This Relative Warmth Index was completed and reduced to simple equations for the subway industry designers before the air conditioning engineering society started using the concept. Joe Busch developed simple nomographs about how fires would behave in the subways, and these remained as the best, useful data available to the subway and vehicular tunnel ventilation engineers well into the 1990s. All this was incorporated into Part 2—*Human Environmental Criteria of the Resulting Subway Environmental Design Handbook.*

Jim wrote Part 3—*Subway Environmental Evaluations and Design Strategies* which translated the Criteria to flow sheets setting fans sizes, vent shafts sizes, and locations, and station air conditioning requirements. Jim borrowed Bill Kumpf and Al Rauthier from the Advanced Technology Division to engineer example mechanical HVAC systems, and together they wrote the fourth and final part of the Handbook—*Application of Equipment and Structures for Environmental Control.*

The dedication of the KE secretaries to the project was superb. Of the four chapters in the original *Handbook* that resulted from all these efforts, KE had the responsibility of writing three of them. They contained about 500 pages of text and numerous graphs and pictures. Also, this project was performed in the days when its work product consisted of stenciled mattes used for the mulitlith printing process. Review comments continued to come in for about a nine-month period from joint-venture partners, about a dozen subway properties in the U.S. and Canada, and the federal governmental agencies. While Jim was busy working on the cement plant in Clinchfield, Georgia, Lillian Kieslich took over the *SES Handbook* editing and keeping track of the 500 stencils. She was so efficient and organized; it was good that Jim was in Georgia.

Also, KE needed to establish the maximum air exhaust velocity criteria through the subway vents in the sidewalks. The concern, of course, was the "Marilyn Monroe" effect with hemlines billowing well above modest heights. Mary Fenity, in this era of extremely short mini-skirts, recruited about a half dozen volunteers, who still had long skirts. The U.S. Department of Transportation included the cost of this testing in the budget because the large grating areas would lead to large capital expenses. However, before the tests were conducted, a lower cost alternative was found to establish the criteria. Both the secretary volunteers and the male engineers setting-up the testing program were disappointed at Murray's intuition and Cohrssen's literature search skills.

Before the Subway Environmental study was even completed, the U.S. Department of Transportation recognized that the study had already more than paid for itself in savings to the federal government's contribution to the capital costs of the Washington, D.C. Metro Subway projects.

Chris Brittle performed some of the in-station people movement analyses for this study. He later became the Manager of Planning for the Bay Area Metropolitan Transportation Commission and reminisced that he had never seen so many people doing first-of-a-kind work, with its only guidance being Murray's intuition.

During the course of the *Subway Environmental Simulation Study*, the various joint-venture personnel were all in Oakland for some meetings. In 1972, Frank Mathias, Vice President of the Transportation Division, invited all to lunch at the 28th-floor Executive Dining Room. All the Kaiser companies used the dining room. At the last minute, Barbara Cohrssen had to be dis-invited because the policy was "no women." The policy was instituted to keep the wives of VPs from stopping by for lunch, and no one had dreamt that a woman would rise high enough in the organization to dine there based on her own merits. Within a week, Frank had the policy changed, and Barbara broke another discrimination barrier when they had lunch on the 28th floor. Afterwards, Barbara commented that some of the Kaiser executives could have gotten whiplash when their heads quickly snapped around catching sight of a woman in their midst.

After leaving KE, Barbara formed her own consulting firm and went on to be a co-editor of *Patty's Toxicology, 5th Edition*. That edition is comprised of about ten volumes and is as important to the medical and industrial hygiene field as *Webster's Dictionary* is to the rest of the world.

## Montreal Fire

In recognition of KE's unique approach to handling of flow calculations and fire emergencies for the SES study, the Montreal Urban Community Transportation Commission requested Jim Murray to undertake a review of the fire emergency procedures in their rubber-tired Metro subway. The Metro had two recent fire events resulting in the loss of five trains and one fatality. With help from Bob Murphy in the Transportation Division, they stretched the limits of the one-dimensional SES computer program to two-dimensions so it would cover the buoyancy of the subway ventilation air due to the hot air rising. After buy-in from the dozen or so fire chiefs, the fire emergency response procedures were re-written, the car specifications were re-written to control the amounts of combustible materials allowed, and a computer program was developed to turn ON every fan in the subway system in a predetermined supply or exhaust mode. This novel approach of using all of the fans and not waiting for a fire chief's instructions caused considerable debate in the subway ventilation industry.

About two years after the new procedures were fully operational, Montreal's Metro had another fire. Jim heard about it on the late-night news, and by 7:30 the next morning, the Metro's chief engineer was on the phone to say the new emergency response procedures worked exactly as anticipated, and that he and the fire chief were convinced that the fire did not spread to other trains because of the automatic operation of the emergency fans. The approach was adopted worldwide and by train systems with rubber-tire designs that copied the Paris Metro System, and many of the steel-wheeled subway systems, also.

As a result of KE's work in subway ventilation, in 1979, BART called KE to review and revise their emergency procedures after the fire in the Trans-Bay Tube.

## Transportation Environmental Impact Reports

The Air Pollution Control Department supported the Transportation Division by preparing EIRs while Transportation would be preparing the feasibility or alternative studies for several projects. Dave Shrimpton ran a couple of these, and the first was for the Port of Oakland. Ever since the BART system was conceived, the Port Commission wanted a direct BART connection to the Oakland Airport. BART thought a light rail or monorail shuttle would be more appropriate, and AC Transit thought this should be a bus route. The environmental groups were concerned that any rail connection would threaten the endangered shore birds, foxes, and pickle weed. The "do-nothing" alternative seems to have prevailed to the present; i.e. the existing bus routes have been retained, supplemented by a shuttle bus from the BART Coliseum Station. This was the Air Pollution Control Department's introduction to mitigating endangered species' habitat.

The next assignment came when the Golden Gate Bridge and Highway District decided that it should be in the ferry business. One of the selected terminal sites was at Larkspur. It was rather late in the design implementation that the district realized that it had to have an EIR. Dave Shrimpton again had to cope with the pickle weed. However, there was a serious concern about the wakes caused by the ferries in the relatively narrow channel between the Bay and the terminal. It turns out that the wakes would cause erosion along the channel and disturb the pickle weed. As a result, the ferries would have to be slowed, and the commute times are forever longer.

In 1979, KE's Marine Terminals Department had a contract to prepare the EIS for the Louisiana Offshore Oil Port (LOOP). Barbara Cohrssen, Bob Schenker, Lee Kuhre, and other Air Pollution Control Department personnel participated in preparation of the EIS. LOOP provides tanker deepwater offloading and temporary storage for some of the largest crude oil tankers in the world. Completed in the early 1980s, LOOP is connected via pipelines to over 30 percent of the U.S. refining capacity and is moving approximately 250 million barrels per year or about 11 percent of all crude imports entering the U.S.

The Marine Terminals Department was also in the garbage business. There were several studies made that considered the transfer of Bay Area garbage by truck and train to the Delta or Northeastern California. The Air Pollution Control Department prepared conceptual designs for the odor control and materials handling aspects of the studies.

## Energy

### Electric Power Research Institute

The Air Pollution Control Department's hands-on experience with baghouses and electrostatic precipitators coupled with Jack Lagarias' research experience and contacts within the power industry led to the EPRI awarding KE study, research, and demonstration contracts. The Air Pollution Control Department designed, built, and operated the EPRI's Arapaho Advanced Particulate Control Test Facility just south of Denver, Colorado. The facility was fed a slipstream from the adjacent Arapaho coal fired power plant. Testing was performed to quantify the effects of gas conditioning, pre-ionizing gases to both baghouses, and electrostatic precipitators, and a myriad of other state-of-the-art particulate collection ideas. This knowledge gave KE a competitive advantage across all business lines and considerable credibility when dealing with the various air pollution control agencies on behalf of the owners of the industrial design-and-build projects.

Dave Shrimpton, Mark Strehlow, and Chris Rayner worked with the EPRI research staff to determine how to modify the test facility for the next round of testing. Jack Lagarias reviewed the scientific aspects of the test programs with respect to their theoretical bases. Jim Murray performed similar reviews to determine whether the testing parameters would allow engineers from the design-build companies to apply the results from the engineering data that would be typically available to a design team.

### Uranium

During the 1970s, there was a rush to open private uranium mines in the U.S. in anticipation of a burgeoning market forecast by the commercialization of the nuclear power industry. In addition, the traditional petroleum companies were moving into uranium and coal to hedge their bets after having experienced an oil embargo. Bob Schenker took the lead for the Air Pollution Control Department while supporting the KE teams engineering the Pioneer Nuclear, Chevron Panna-Maria, and Church Rock mining and milling projects. Some of the help went to the clients' environmental consultants in defining the source of emissions and effluents, and some of the efforts were to define the design criteria and / or details for the scrubbers and water treatment facilities. One of the most challenging aspects of these projects was educating the client's project managers and other technical staff that little of their petrochemical experience was transferable to mining. As an old-timer piping engineer once mused to them in a meeting, "Piping slurry ain't like pumping Vaseline."

## Coal

Kaiser Resources went into the coal market with much of the old Kaiser Industries flair using some of the largest haul trucks and draglines. The poor performance of the scrubber for the coal cleaning plant dryer stack was causing Kaiser Resources and the Provincial government's pollution control agency some concern. A fire in the dryer and scrubber allowed the scrubber vendor to walk away from any contractual obligations to guarantee its performance. The Air Pollution Control Department's Jim Murray and Chris Rayner went to Fernie, B.C. The first task was to develop a quick fix to keep the plant in operation because several unit trains of coal were being shipped daily. The second task was to develop a range of permanent long-term solutions. The range covered low capital and operating cost modifications with some logic for success (but success could not be guaranteed) to proven technologies with commensurate higher costs. Chris would return off-and-on to Fernie for several years using his considerable skill and some luck to incrementally increase the performance of the low-cost solutions to an acceptable level.

Also, the resulting oil shortages caused the electric power generators to start thinking about alternative fuels. Dave Shrimpton prepared an EIR for a coal-importing terminal along the Carquinez Straits at the demolished ASARCO Smelter site at Selby, California. (Ultimately, this site came to be used to import MTBE, another environmental delight.)

## Coal Gasification

Beulah, North Dakota, is home to the only operating commercial coal gasification plant in the U.S. The Air Pollution Control Department supported other KE divisions through the permitting and design phases of the project. Bob Schenker, with support from just about everyone in the Air Pollution Control Department Oakland office, was on this project for long periods of time. Chris Rayner, Singh Arora, and Chandra Khatri made fugitive dust estimates for the coal and ash handling systems. Kirit Patel and Chandra looked after the water treatment and cooling. This information was needed in the early days of the project to evaluate environmental impacts. The client's team preparing these environmental documents also often needed the information before the engineering designers could define the site plan, much less the air emissions and water effluents quantitatively. The Air Pollution Control Department personnel developed "straw man" designs to make intelligent approximations as to the ultimate design in order to keep the environmental permit aspects of the project on schedule.

## Reclamation Planning

Lee Kuhre and Wilma Dreeson looked after some of the permitting issues. One of the key permitting issues dealt with reclamation planning. Lee Kuhre would handle much of the flora and fauna aspects of the EIR preparation work as well as the associated reclamation planning on all of the Air Pollution Control Department assignments. He joined the Air Pollution Control Department after a stint at Anschutz Energy Co. While working full-time at KE, he entered a newly formed Masters Degree for Environmental Studies at the University of San Francisco. After receiving his advanced degree, he stayed with the program as a part-time instructor. Because of his experience with KE's mega-projects, he brought a unique background to the Environmental Studies Program.

## Co-generation

The oil crisis following the Iranians taking embassy personnel hostage led to many new regulations, which made co-generation projects attractive investments for the local colleges. Mark Strehlow prepared the EIRs and permit applications for the Stanford University's Cardinal CoGen and SLAC 6 Projects and the Merritt-Peralta Hospitals' CoGen Project.

## General Motors

The General Motors plant in Fremont, California, had a requirement to reduce the hydrocarbon emissions from the ovens that baked (cured) the paint on their assembly lines sufficiently to meet newly implemented rules from the Bay Area Air Quality Management District. They had to use the (then) conventional paints in order to meet the quality control requirements for the paint finish. Jim Murray met with the GM plant engineers and found that the whole job had to be finished during the August shutdown when the entire plant would be converted for production of the next model year vehicle. Jim got the fume incineration equipment flow sheets to balance based on catalytic combustion and was scrambling to find someone within KE who had commercial project experience. Bill Kumpf, who had helped on the subway ventilation study, was made available again and proved an invaluable asset to the project. The private sector commercial work practice relied on the mechanical and electrical contractors completing the details to a much greater degree than was the normal practice at KE for its heavy industrial projects (e.g., steel, cement) or the government work (e.g., post offices). Bill knew the distinction and how it varied among the Bay Area contractors compared to the Los Angeles area contractors, etc.

GM met the hydrocarbon emission control efficiency requirements and at the anticipated reductions in supplemental energy consumption. They made their production line start-up goals. This success led to a string of other tasks for KE at GM's Fremont and Van Nuys, California, assembly plants. GM was very impressed with Bill's abilities, and even after he left KE, GM would award work to Bill at his subsequent employers.

## Industrial Hygiene, Occupational Safety and Health Administration

### St. Joe Minerals

In-plant air pollution became as critical as ambient air quality during the 1970s. The Air Pollution Control Department participated in many first-of-its-kind studies and projects. Ron Stoker from the Chicago office did a survey or audit of the St. Joe Minerals lead mining and smelting operations in Missouri.

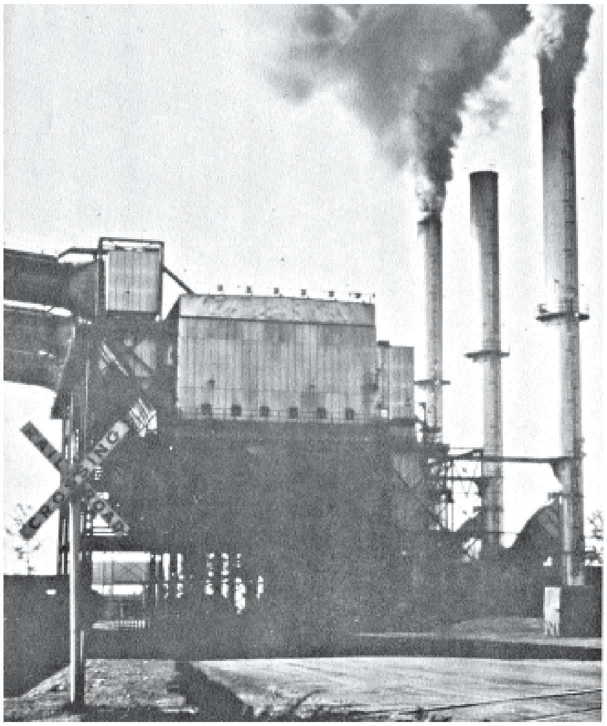
### ASARCO

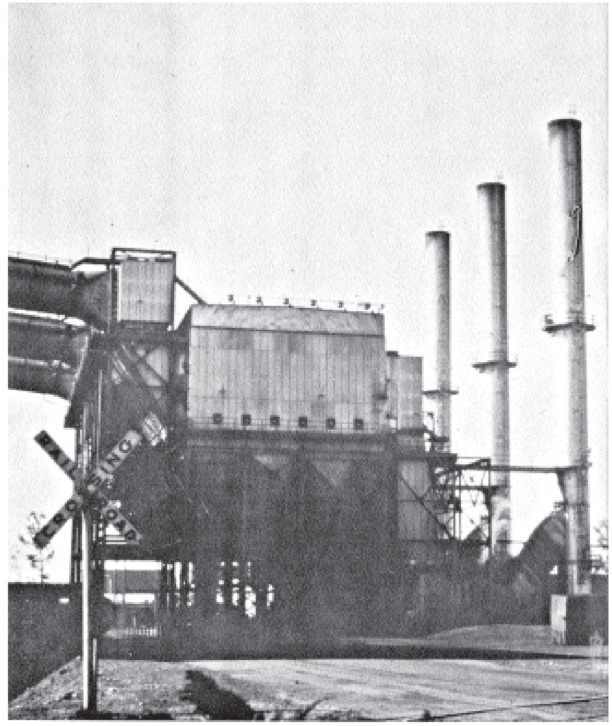
The ASARCO copper and lead smelter in El Paso, Texas, had an air pollution problem when unloading the lead and copper concentrates from gondola cars. Their solution, which was approved by the Texas Air Pollution Control Board, was to enclose the unloading area. In the meantime, OSHA promulgated very stringent indoor lead standards to protect the worker, which made unloading gondolas indoors virtually impossible. According to the regulation, the facility had to be "designed or engineered" to meet the regulations meaning a) respirators were not to be used as a means of compliance, and b) cost was to be no object. KE's Non-Ferrous Division quickly handed this to Jim Murray in the Air Pollution Control Department. Because the contract was not signed, the first task was to get the Legal Department to understand the technical problem, so they could craft the appropriate liability protection for KE. Working this out with the ASARCO attorneys lasted almost to the end of the construction period of the project, but their contractual language was brilliant and is used by some as a model today.

At the time of the design effort, Chris Rayner was the mechanical engineer in the Design Division assigned to the indoor unloading hoppers, the ventilation of which held the key to an engineering solution that would satisfy the stringent OSHA requirements. Jim and Chris worked very closely on this area, and Jim was so impressed by Chris' insight, talent, and perseverance that Chris was transferred into the Air Pollution Control Department as soon as the task was completed.

Chris' university schooling was in physics, and his name would become synonymous with the Air Pollution Control Department's support to KE's Cement Department and to the U.S. cement industry in general. Later, the Institute of Electrical and Electronics Engineer's (IEEE) Cement Technology Division and the American Portland Cement Association, the two organizations that cover all the technical aspects of building cement plants, recognized his capabilities and leadership by electing him to be the Chairman of the West Coast Section. As mentioned earlier, Chris would become the last Manager of the Air Pollution Control Department.

It is somewhat ironic that the department's founding and end would have deep roots in the cement industry and that Chris' calm, professional style was even reminiscent of Dave Wheeler's. Further, visionaries in senior management brought the department into being, and lack thereof in senior management ultimately brought it down. In the intervening decades, we built a better, cleaner world, and we had fun. KE



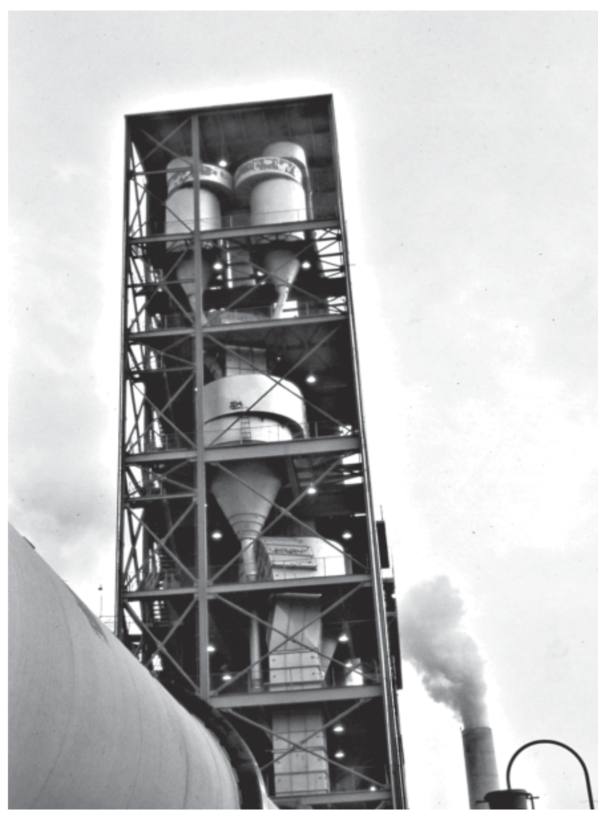


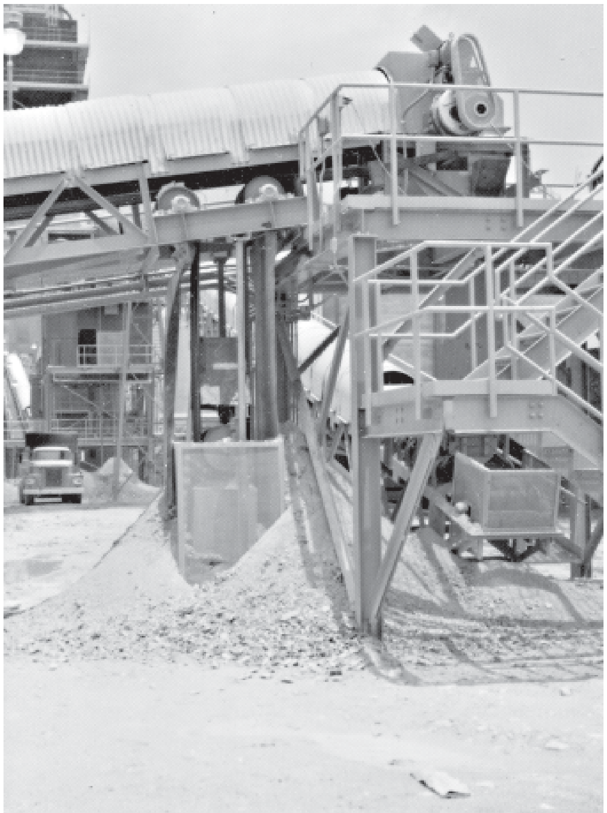
From the time KE started to design industrial plants in the early 1940s, protecting the environment was of paramount importance to KE's design teams. On design of the Fontana Steel Mill, it became apparent that city and state authorities were concerned about air and water problems in the Los Angeles Basin.

Electrostatic precipitators (ESPs) help to reduce industrial air pollution in the Los Angeles Basin. Photo (left, above) shows the stack emissions from the L-D Steel-making Plant at Kaiser Steel's Fontana, California, steel mill when the ESP power was OFF. On the right (above), the ESP power has been restored.

Aware of the concern about air pollution, KE retained staff to advise on such matters early on. Out of the concern for pollution at cement plants and steel mills, air pollution control specialists were hired, and the Air Pollution Control Department organized. Most of the early assignments were to assist project staff in designing cleaner facilities. Later the Air Pollution Control Department provided its services to outside clients as stand-alone services.

Photo on the right shows a comparison of cement kiln stack emissions. On the left, there is no visible plume from the kiln stack at the top of the new preheater tower at the Medusa Cement Company Plant at Clinchfield, Georgia The emissions are controlled by a baghouse that is located behind the tower. To the right, there is a visible plume from an older kiln that uses a relatively low-efficiency electrostatic precipitator to control dust emissions.





Cement plant owners would commonly spend $4 million to install a single high-efficiency electrostatic precipitator or baghouse with dust collection efficiencies of 99.97 percent or higher. However, the most troublesome sources of pollution are often poorly designed conveyor transfer chutes and/or $4,000-belt scrapers.

The photograph (left) of the belt-to-belt transfer station shows a pile of fallen dust and dribble on the ground, the result of a poorly designed transfer system. Wind or other disturbances kicks up a fugitive dust source for air pollution. To avoid such sources of pollution, KE's air pollution control engineers worked actively to improve KE's material handling systems standard designs.

The photo (below) shows KE's Air Pollution Control Department's Dave Shrimpton with Bay Area Rapid Transit District (BART) train operator, Richard Banks, at the controls of one of two BART trains modified specifically to operate at speeds up to 80 mph. Dave was in charge of the detailed planning and two days of testing to determine the steady state and transient air flows, temperatures, and pressures generated by trains as they traveled through the Berkeley Hills BART Tunnel. These full-scale tests provided better flow and drag coefficients much faster than Cal Tech's scientists who were dropping weighted styrofoam drinking cups down a 3-story pipe to simulate the effects of a BART train passing through a tunnel.

Chapter 15

# Institutional Projects

## Overview

This chapter describes KE's projects in the planning and design of medical facilities, hotels, correctional facilities, and similar non-industrial institutions.

The Institutional Projects Group was organized and began its work in the early 1960s. However, there was much similar work going on for many years before this group was started up. To tell this story, it is necessary to identify a couple of KE architects whose company origins began in the Kaiser shipyards during World War II.

Morry Wortman was KE's Chief Architect. Before the beginnings of Kaiser Engineers, he designed all of the offices, housing, and medical facilities in the Kaiser Shipyards in Richmond. For two or three decades after World War II, all KE institutional work had the footprint of Morry. All of the offices, housing, or medical facilities that were part of KE's industrial projects were designed by or designed under the supervision of Morry. He was the individual that Kaiser company executives would call on when they needed something of an architectural nature. Henry Kaiser called on him often. When Kaiser Permanente Hospitals bought the old Fabiola Hospital at Broadway and MacArthur in Oakland, Morry worked closely with Mr. Kaiser in designing its facade. Its aluminum cladding still stands as he designed it, under Mr. Kaiser's direction.

Frank Sparks was also one of KE's earliest architects. He was an MIT graduate who was recruited for work as an architect in the Portland, Oregon Kaiser shipyards. Following the war, he joined KE when the company was headquartered in the Latham Square Building in Oakland. He, too, left his architectural footprints in many of KE's early projects. With Morry Wortman, he participated in the design of Henry Kaiser's home in Lafayette, California. He had the lead architectural role in designing the 12th floor executive offices in the 1924 Broadway Kaiser Building in Oakland. He participated in the management of the Armco 600 Project, and for nine years was manager of KE's engineering office in Butler, Pennsylvania.

## Medical Facilities Projects

Kaiser Engineers launched the Institutional Projects activity in the early 1960s with the advent of Kaiser Foundation Hospitals' (KFH) major facilities expansion program.

Hospitals were designed and built in San Francisco, Los Angeles, Bellflower, Santa Clara, and Sacramento based on Dr. Sid Garfield's innovative and sometimes unorthodox planning concepts. Then, in 1965, in anticipation of much more stringent state codes, KFH selected KE to design the first of the new generation of hospitals, the Oakland Tower medical center located at Broadway and MacArthur Boulevard, Oakland, California. This 12-story building provided facilities for a complete medical center with 425 acute care beds. Due to a restricted site, the building was built on top of an existing clinic facility that needed to remain in operation throughout most of the construction period.

This project was Kaiser Engineers' first use of computers to prepare the structural design. As with most initial efforts, there were glitches, but, fortunately, the only significant one was caught during the steel-detailing phase and was corrected without significantly impacting the project. Art Holden was the project architect for this important building, and the success of the project led to KFH awarding a series of new medical center projects to KE in California. These included medical centers at West Los Angeles, San Diego, Sacramento, and major additions to the existing facilities at Santa Clara, Bellflower, and Redwood City.

In recognition of the massive scope of this program, KE organized a Medical Facilities Projects department under the supervision of Col. Fred Hastings, who had just retired from the Army's Medical Service Corps, where he had responsibility for the design and construction of the new Letterman Army Hospital at the Presidio of San Francisco. Fred set about assembling a staff of experienced hospital architects and planners who could help KB carry out the work. Some of the key personnel included architects Herb Wulfekamp, Bob Lundy, Raul Paabo, Manny Huertas, Bob Nielson, and medical planner Gene Smith, who was perhaps best known for his skill at turtle racing at Zaks. Fred Porta was the administrative engineer. Toby Tobias was the department's vice president.

Despite KFH's penchant for massive and continual change orders, work continued aggressively until about 1976, when the IRS somehow noticed that the non-profit Kaiser Foundation Hospitals was awarding large sole-source contracts to Kaiser Industries Corporation / Kaiser Engineers.

Although there seemed to be no hospital work, in the domestic private sector, KE was able to secure medical planning projects in the West Indies, Venezuela, and Indonesia, plus a few projects with the U.S. Veterans Administration, including an innovative 150-bed nursing care facility in Palo Alto-Menlo Park, California. Manny Huertas was the project architect.

## Hotel Projects

In 1968, the Sheraton Hotel Group launched an $865-million worldwide expansion program. KE was retained to provide preliminary architectural and engineering concepts, cost analyses, general and detail design, specifications, materials procurement, construction management, and inspection services. Stan Kulp was the project manager, Warren Evans was office engineer, and Al Smith was the chief inspector. This enormous program eventually involved more than 150 facilities throughout the world. KE's architects carried out conceptual designs of motels, motor inns, mid-rise and high-rise hotels and convention centers, as well as the development of standard modular elements to be included in all applicable Sheraton properties. KE provided design, CM and inspection services for major hotels in Honolulu, Hawaii; Rio de Janeiro; Worchester, Massachusetts. Unfortunately, when the Sheraton Group was purchased by IT Corporation, halfway through the program, the expansion program was cut back, and KE's contract was cancelled. *(Editor's Note:* See Burr Tupper's Oral History, subhead "Sheraton Hotels," where he describes how we got the job.)

## Projects in Saudi Arabia

In the late 1960s and early '70s, the Persian Gulf states began to spend their new oil wealth on a series of massive industrialization and modernization programs. Kaiser Engineers seemed to be locked out— allegedly on the Arab "blacklist" because of the former Kaiser Jeep's activity in Israel and perhaps because of KE's involvement in the Dead Sea Dikes Project. After watching Bechtel, Fluor, and Ralph M. Parsons dominate the 'oil patch' for several years, KE management became more and more determined to penetrate this very lucrative market.

Roland Tripp won a project to provide management-consulting services on helping develop a broad-based housing industry in the Saudi Arabia kingdom. Unfortunately, the vast cultural differences, such as the opposition to interest-bearing loans, which were viewed as usurious and, therefore, prohibited by the Koran—and a reluctance to copy U.S. governmental institutions such as the FHA and FNMA, doomed the effort.

It became very clear that, despite official denials of a blacklist, KE would continue to be shut out unless we retained a strong and powerful local associate. Bob Bernard went to Saudi for a prolonged trip and eventually returned with a partner—the bin Ladens! Salem bin Laden, the former public works minister under King Ibn Saud, created the largest and most respected civil construction company in Saudi Arabia. Unfortunately, Salem died prematurely, and his several sons were deemed too young to manage their father's massive company. In an effort to demonstrate their ability and maturity, the sons formed the bin Laden Brothers for Construction. They were our partners—but were not the "real" company.

A few months after the agreement was negotiated, the first project appeared, a development plan for the summer capital of Taif. This relatively cool and pleasant town was destined for explosive and up-scale development. KE engineers and planners worked busily at the behest of the bin Ladens. Plans were drawn, palaces were conceived, a theme park was studied, and a huge model was constructed. Unfortunately, the political / tribal issues were not adequately dealt with, and the program died. Development went ahead, but KE was not involved.

## Jeddah Hilton Hotel

Then came the Jeddah Hilton Project. The bin Ladens had led an investment group for a 450-bed, five-star hotel in Jeddah. A French-Lebanese architectural firm did the conceptual design, and construction bids were solicited, but came in well over the budget. Someone suggested that it was because of the "greedy Western contractors, and wouldn't it be a good idea for a Saudi contractor to build the project." The bin Laden's chief engineer said, "Don't do it!" The English quantity surveyor said, "Don't do it!" So the earnest young bin Laden in charge said, "We'll do it!" and a firm, fixed-price contract was signed. It was a disaster!

The bin Ladens had never built any structure larger than a small office building. There were no working drawings. There was no structural design. There were no interior designs. Worst of all, there was no escalation clause—in a period of double-digit escalation. The site was a few blocks from the seashore, and a pile foundation was required. Despite the lack of a design, a pile-driving contract was awarded to somebody's cousin.

Soon, it became evident that professional help was needed. KE's personnel were able to convince the bin Ladens that a set of working drawings was really needed. A team was sent to KE's London office (in Twickenham) to prepare them. Warren Ng was the project architect, and Dave Campbell was the structural engineer. Things got sticky when Campbell insisted that he would not stamp the drawings unless they contained a few shear walls, an element that the New York City engineers who did the conceptual design had neglected, even though a major fault was only a few meters away from the building.

The Saudis didn't see the need for *unauthorized changes*. Words were spoken, and KE's invoices were not paid. Fortunately, Warren had ordered a mock up of a typical guest room. When the Prince and the bin Laden scion came through to look at it, they were concerned. There was no bidet in the bathroom. "Put one in!" "But sir, the bathroom is too small." "Make it larger!" "But sir, we would have to make the whole building larger." "Well, just do it! We will approve the extra for the bath. And have your structural engineers make the necessary changes for the bath. Charge us for the bath—do the right thing—but don't tell us about an extra for those shear walls." A wonderfully "tribal" solution!

The next phase was to finish the working drawings. Warren Ng and Shalom Blaj needed to return home, so Fred Porta was sent over for a 3-month assignment as project manager. The bin Ladens started to pay the invoices again, and work on the drawings commenced.

A year later the drawings were almost done, the unpaid sub-consultants were lured back, and the 95-percent drawings were signed. A contract change order was signed to cover the completion and coordination of the final drawings. The design work was completed, but the bin Ladens never paid the final invoice. Neither did they pay the contractor, and neither did the construction work ever proceed beyond the third level. What a waste.

## New Town Projects

In the 1960s under President Johnson, there was a great flurry of activity in the development of "New Towns" and urban renewal programs. Edgar Kaiser was very active in Democratic politics, and perhaps coincidentally, in 1968, the Housing and Urban Development (HUD) Agency awarded the "In Cities Experimental Housing Research and Development Program" to a Kaiser Engineers team. Phase I of the program involved engineering and economic studies in 25 cities to determine ways of fostering additional residential construction to serve low and moderate-income families.

The Phase II effort included land acquisition and construction of 400 units in Miami, Florida, and the planning for the Lake Ponchetrain New Town, near New Orleans. Kaiser Engineers had hired a number of specialists in housing and urban planning, but we did not fully appreciate the incredible complexities (i.e. corruption) of the local politics, and the project resulted in only a few units being constructed. Pat Bedford was the project manager. Some of the key engineers included Stan Kulp, Doug Pinkham, and W. Robert (Bob) Richards.

## Hunter's Point Housing

In 1971, KE was awarded a contract for comprehensive management services for a 650-unit, 35-acre housing project at Hunters Point in San Francisco. That was the company's introduction to urban renewal and the very messy politics and sensitive race relations that went with it. The company hired a number of black drafters and secretaries, and a serious effort was made to implement a meaningful affirmative action program.

Later, under Lee Misner, an effort was made to set up a professional Urban Planning Group. Key people from the design department joined the group and a well qualified city planner was hired. A number of proposals were prepared and submitted with mixed results. Drawing on Kaiser Foundation's excellent reputation for working in Nigeria during its civil war, KE was selected to design the new Federal Capital of Nigeria—twice. Unfortunately, we were too naive to realize that our local Nigerian partner was from the WRONG tribe, and KE management had no stomach for the gross bribery that was seemingly required to do business in Nigeria. In retrospect, that was one of the most fortunate rejections imaginable.

## Corrections Facility Projects

In 1975, KE teamed with the respected architectural firm of Hellmuth, Obata & Kassabaum (HOK) for the preliminary planning study of Alameda County's Pre-sentence Detention Facility requirements. This was an urgent project because the courts had ruled that the old Navy disciplinary barracks at Santa Rita were so bad that they must be abandoned as soon as possible. Indeed, these World War II wooden barracks were so dilapidated that on one occasion, the inmates simply pushed down the wall and walked out into the compound. On a more serious level, the rapid growth of the population awaiting trial resulted in terrible overcrowding and a loss of control by the sheriff's department. Violence, including beatings, rape, and murder within the jail was all too common. Since pre-sentence detainees (those persons awaiting trial and sentence) are technically innocent, the federal courts felt strongly that the county must provide a physically safe environment for them.

The planning study went very well and resulted in recommendations for a new 15-department municipal court building and a 575-bed pre-sentence detention facility in Oakland, and a 500-bed detention facility in Hayward. A contract for the design work was awarded to the HOK-KE team. HOK was the prime, with Pat McLeamy as the HOK project architect-project manager. KE provided the structural design services, with Marv Larson as the engineer of record. Fred Porta was KE's project manager. Bentley Engineers carried out the mechanical and electrical design.

## Oakland Pre-sentence Detention Facility

The design phase did not go smoothly. HOK initiated a new system of "layered drawings" using a pin registration system. The idea was great, but the reality was that in order to run a set of progress prints, ALL of the original drawings had to be sent to the printer and no one was able to do any work until the originals came back. This was very time-consuming, so very few progress prints were made, and there was very little coordination between the disciplines. In addition, the architects decided on an exterior window pattern that left very little room for the reinforcing steel, despite a massive upgrade in the seismic code.

At the last moment, it was determined that the county had failed to coordinate some survey data regarding the bridge between the court and the jail, and it became necessary to either raise the building or lower Oakland. We chose the latter course—and lowered the street and some underground utilities so that trucks would have enough clearance under the bridge. Due to a number of factors, the cost of the project grew substantially, and so the Hayward facility was eliminated because of lack of funds and because of local opposition to having a detention facility "in my back yard."

The construction contract was awarded to an East Coast firm noted for their very aggressive change order practices. When the first man on the site turned out to be the claims engineer, we knew we were in for trouble. Virtually every detail was challenged and claimed to be "unbuildable." Outside consultants in concrete mix design were retained in order to develop strategies for dealing with the very congested rebar cages. The contractor had purchased an expensive set of used steel forms that seriously restricted his flexibility and also did not have adequate pour windows. The construction work proceeded very slowly and was of poor quality. The final blow was a batch of contaminated concrete from the supplier that had to be laboriously jack-hammered out of major portions of the building. Claims! Claims! Claims! Lee Misner, who had declined to provide CM services for the project, coordinated an excellent claims defense analysis prepared by Don Barrie.

## Commercial Projects

In 1974, Fred Hastings left KE, and Ken Polly was asked to study the potential and recommend what to do with the Medical Facilities Group. Based on Ken's suggestions, the portfolio expanded to include both medical and commercial-type (i.e., non-industrial) buildings. Some of the key people included Lee Misner, vice president; Herb Wulfekamp, department manager; Manny Huertas, medical facilities projects; Fred Porta, commercial projects; Bob Lundy, architect; Raul Paabo, architectural design; Larry Hedrick, electrical engineer; Marv Larson, structural engineer; Emory Ficzere, civil engineer; and John Castle, mechanical engineer.

## UC Berkeley Seismic Design Upgrades

One of the most interesting projects to be carried out during that period was a planning study at UC Berkeley. In 1975, the university had just completed a seismic evaluation of the buildings designed prior to the Field Act of 1935 that established the first modern seismic code in California. KE was asked to study these buildings to determine what additional changes would be required to bring them up to current codes with respect to lighting, ventilation, handicapped access, fire prevention, energy conservation, etc. Under Fred Porta's coordination, KE prepared planning studies and cost estimates for 30 buildings, including such landmarks as Wheeler Hall, Doe Library, International House, the Life Sciences Building, the Hearst Mining Building, Cory Hall, and University Hall. Although the state was very slow to fund the work, a large portion of KE's recommendations were eventually implemented.

## Kings County Government Center

In 1976, the County of Kings embarked on the planning and design of a new Government Center in Hanford, California. KE performed site selection, master planning, preliminary and detail design, and construction administration. The project centralized the County's administrative and criminal justice functions on a 100-acre site with an attractive campus-style complex of nine new buildings and two remodeled existing buildings. The project was very successful, and in 1988, KE was awarded the contract for a $6-million court building expansion. Key team members included Fred Porta, Bob Lundy, and John Talamo.

The Oakland Tower of Kaiser Hospital at Broadway and MacArthur Boulevard in Oakland was designed by KE in 1965. This was the first of a new generation of hospitals, followed by those in West Los Angeles, San Diego, Sacramento, Santa Clara, Bellflower, and Redwood City. By 1976, activity for Kaiser Hospital ceased as the IRS declared it a conflict of interest for KE to do the design.

The Los Angeles Kaiser Foundation Hospital built previously in 1957 before the new generation of hospitals.

Alameda County's Pre-sentence Detention Center facility, designed by KE in association with a local architectural firm (1975).

Chapter 16

# Automotive

## Background

This chapter describes the two automobile assembly plants built by Kaiser Engineers in Latin America. They are the IKA plant which is an acronym for Industrias Kaiser Argentina and the WOB plant, which is an acronym for Willys Overland do Brasil. Both plants were partially owned by and managed by Kaiser Industries.

The background and antecedents of these plants were a result of the failure of the Kaiser-Frazer Corporation to survive in the United States. This background section has two purposes: 1) It is instructive to see the origin of the technical personnel who operated the plants and the availability of surplus equipment for the plants, and 2) it is especially noteworthy to show the number of executives who migrated from the Kaiser-Frazer team to Kaiser Engineers and who became an integral part of KE's management.

## Kaiser-Frazer

At the completion of World War II, Henry Kaiser maintained his keen interest in going into the automobile business. He had played around with research into designing a new automobile just as the war was coming to a close. It was in 1946 that he was put into contact with Joe Frazer who had been in the auto business for several decades before the war. Frazer had a small manufacturing business but had invested in producing a newly designed automobile and had had a thoroughly researched marketing plan.

Frazer had previously been involved with the Jeep automobile manufacture, but he did not have the management organization nor the financial strength to go into big-time auto manufacturing. Kaiser, on the other hand, had a reputation for building things, even when he did not have a traditional experience in them. And he had a large cadre of staff available from the shipyards in Richmond and in Oregon. He also had financial backing as well as profits available from his successful shipyard activities. But most importantly, he had a keen interest and his famous drive and will to succeed. Thus a successful marriage was arranged to form the automobile firm known as Kaiser-Frazer.

As a first step in the new venture, K-F was able to negotiate an attractive lease arrangement for the huge Willow Run aircraft factory. This plant was built by Ford for the production of Liberator bombers during the war. It was now surplus. The bomber plant is 3,200 feet long by 800 feet wide, adequate to do most any kind of assembly plant manufacture. It is located just 5 miles from the city of Ypsilanti, Michigan, and some 300 miles west of Detroit. It was thus in the heart of the automobile industry and the suppliers of parts for the manufacture of cars.

Later K-F was able to purchase the Willow Run plant from the War Assets Board under favorable terms. Negotiations were handled by Hickman Price, a nephew of Joe Frazer, who was a senior executive of Kaiser-Frazer. (As a sidebar to this negotiation, Hickman Price gave great credit to the K-F plant engineering department, which provided detailed background evaluations, showing how excessive wartime plant construction costs, including those of the plant's extreme ceiling heights were not applicable as a basis for determining current facility and equipment valuations. The evaluations also considered the effects of specific surplus bomber plants on facility and equipment values. The analyses were made by Harry Bernat and Sam Ruvkun).

## Auto Assembly Operations

From 1946 to 1955, Kaiser-Frazer was a viable manufacturing company producing cars under the labels Kaiser and Frazer. The Frazers were a more deluxe model of the Kaiser. At the time, K-F produced the only all new, modern design automobile. The big three—Ford, General Motors, and Chrysler—rushed into the manufacture of prewar models. There was such a built-up demand for anything that would run that they could sell anything they produced.

Not only could they sell everything, all cars were on allocation. Waiting times to buy a car were six months or more. Along with the shortage of the end product, there was the shortage of parts, steel, and other materials, and a shortage of well-trained workers.

Kaiser-Frazer suffered from the shortages worse than the old-time automakers. Suppliers favored their old customers, so that K-F had to resort to ingenious methods of finding parts and supplies. Despite the drawbacks of lack of supplies and lack of well-trained workers (workers would strike or slow down production at the least provocation), serviceable vehicles were produced.

Some negative comments were made in the press when quality flaws showed up in the Kaisers and Frazers. But the Big Three got a free pass on their flaws. When a Kaiser door leaked in a rainstorm, it was reason for complaint. When it happened to Ford or General Motors, it was an unfortunate event that everyone knew would be corrected later. Soon, though, quality was no longer a problem.

While the organization got kudos for its modern styling, the cars had a strategic flaw. They were powered by a prewar engine built under license from Continental Motors. It was well known to have been under-powered for K-F's cars. A serious effort was made to build a new engine plant with a newly designed engine. Financial negotiations were well along for a substantial stock offering to finance the project, when the prime financial institution backed out of the deal. It was never clear why this happened, although some thought it was pressure from the Big Three. After litigation attempts failed, the project was dropped. With it, K-F's last hope to become a big-time automaker failed.

About the same time, about 1955, Mr. Kaiser was invited to make an *invasion* of Latin America to seek other business opportunities. Teams accompanied him in missions to Argentina, Brazil, Colombia, and Peru. In the final analysi, he was able to negotiate deals in Argentina and in Brazil where surplus K-F equipment, tools and dies, and a trained cadre of automobile professionals were available.

## K-F People Who Joined KE Management

The second noteworthy thing about the Kaiser-Frazer experience is the number of key KE executives who migrated from K-F to KE. KE cannot lay claim to designing any of the Kaiser-Frazer facilities in the United States because the facilities were purchased and renovated by an in-house K-F crew of talented people.

KE performed several minor studies for the K-F facilities in the U.S., but it did do the IKA and WOB plants as described later.

As operations came to a close in the United States, some of the people went to Argentina, some to Brazil, and some to other Kaiser companies. KE got its share of talent, and at completion of the plants in Latin America got some more. Most of the people were old-time Kaiser hands, having started either at dam projects or in the shipyards. The following are the names of the K-F personnel who joined KE's management:

Harry Bernat
Vic Cole
Joe Friedman
Clarence Granger
John Hallett
John Heffernan
Jim McCloud
Don Mielbeck
Carl Olson
Bob Rice
Sam Ruvkun

## IKA, Industrias Kaiser Argentina

### Background

In the mid-1950s, the Kaiser-Frazer Corporation underwent a major corporate restructuring. Willys Motors, Inc. was acquired, Kaiser-Frazer's Willow Run plant was sold to General Motors, and a new company, Kaiser Motors Corporation, emerged that made its headquarters in Toledo, Ohio, the location of Willys' main plant and principal offices. The corporate restructuring also involved a change in production planning when the decision was made to concentrate on the Jeep utility vehicle lines only and to withdraw from the production of the Willys, Kaiser, and Frazer passenger vehicle lines. This decision made redundant the Detroit Engine Division, the Dowagiac, Michigan, Foundry, and the Shadyside, Ohio, press plant. These three facilities had been dedicated to supplying engines, stampings, and other machined parts to the K-F assembly plant at Willow Run.

An opportunity was presented in Latin America to utilize the production equipment that these three plants contained together with the special vehicle assembly tooling and stamping dies located at Willow Run and various vendor plants. This package of production equipment and tooling would permit, together with the normal purchased parts such as transmissions, axles, etc., that Kaiser-Frazer normally obtained from vendors, the integrated manufacture of autos.

In 1954, there were no automobiles or trucks manufactured in Latin America. The countries and their populations were dependent for their transportation needs on the import of completely built-up vehicles or, as was the case in two or three countries, assembly plants existed that assembled vehicles by importing CKD (completely knocked down) boxes of parts. In Argentina in particular as well as in Brazil, Mexico, and other Latin American countries, the availability of foreign exchange regulated imports and, as a consequence, the import volume of vehicles was abysmally low when compared to the transportation demands of the citizens of these countries.

## Investing Equipment in Argentina

The concept for the investment of Kaiser's surplus manufacturing facilities someplace in Latin America originated in International House - an entity that served as a meeting place and sounding board for Latin American public and private sector contacts, located in New Orleans. One of the prime motivators of International House was New Orleans' Mayor DeLesseps "Chep" Morrison who later became U.S. Ambassador to the Organization of American States. Mayor Morrison was well acquainted with Henry Kaiser and had worked very closely with the Kaiser interests in the setting up of Kaiser Aluminum's activities in the State of Louisiana.

Morrison proposed that Henry Kaiser visit the principal countries of South America (Mexico and Central America were not to be included for various reasons) and investigate investment possibilities for Mr. Kaiser's first trip throughout South America, which took place in August, 1954. He was accompanied by Mayor Morrison, Mario Bermudez, director of International House, William Weintraub, Bob Elliott, assistant to Mr. Kaiser, and their respective spouses. The group visited Argentina, Brazil, Colombia, Chile, and Venezuela, but not in that particular order. The Kaiser entourage was welcomed everywhere, and business meetings and social affairs were held with the various heads of state.

Argentina, in particular, welcomed the group very warmly and the first trip there was followed by a second one in which a definitive investment proposal was presented to President Peron in October, 1954. In brief, the proposal called for the creation of an Argentine publicly owned corporation with an initial capitalization of 360 million Argentine pesos, supplemented by an Argentine Industrial Bank long-term loan of 200 million pesos, and the profit from the sale by the new company, of 1,000 new Kaiser Manhattan sedans that would be imported under a special permit dispensation. (On the open market in Argentina, such automobiles sold at a premium, yielding a substantial "subsidy" to the new company). With the official exchange rate at the time of 14:1, the total project start-up value amounted to approximately U.S. $42 million and broke down as follows:

| | U.S. $millions | Ownership % |
|---|---|---|
| Kaiser invested equipment | 8.995 | 35 |
| Argentine Airforce invested equipment | 4.112 | 16 |
| Argentine public - shares for cash | 12.593 | 48 |
| Total invested capital | 25.700 | 100 |
| Industrial Bank Loan | 14.285 | |
| Profit from sale of 1,000 autos | 2.000 | |
| Total | 41.985 | |

The cash portion of the above tabulation, which came from the sale of shares in the corporation, the loan and the profit from the sale of vehicles amounted to $29 million. It would be dedicated to initial plant construction and the working capital required to defray production start-up costs until cash flow became positive. The proposal was accepted by the president and the committee that had been appointed to negotiate the contract. The proviso was made that the tooling and production equipment proposed for investment by Kaiser and the Argentine Air Force be subjected to inspection and corroboration of their proposed values by a Mixed Valuation Commission of six persons, three appointed by Kaiser and three by the government.

The commission's work was completed by December of 1954, and the differences of opinion that arose as to the investment credit to be allowed for particular items was settled by negotiation. A Presidential Decree approving the foreign investment by Kaiser was issued, and incorporation of the new company, which was named Industrias Kaiser Argentina, S.A., (IKA) took place on January 19, 1955. The Kaiser interests were given the responsibility for the start-up and on-going management of the new company.

## Project Summary

Kaiser Engineers' participation in the IKA project began in mid-year 1954 when it was called upon to prepare a brochure, which in broad outline described the investment that Kaiser was prepared to make, and the implementation of the automotive manufacturing venture. The presentation brochure was to be used by Henry Kaiser in his projected swing through South America. The proposal team that developed the brochure and later the definitive proposal was led by George Havas and included Lloyd N. Cutler, Washington Counsel, Kaiser Engineers' Jack Hughes, T. A. Bedford, John Banks of Willow Run Assembly operations, and J. F. McCloud, Detroit Engine Division. The proposal team was supported by tool engineers and plant engineers from Detroit, Willow Run, and Toledo.

The definitive proposal outlined the financial and technical requirements for the organization of a publicly owned Argentine corporation, which would integrally manufacture 40,000 vehicles per year. This would reduce the imported content in each vehicle produced to no more than 10 percent by value over a five-year period starting from the initial incorporation of the new company in January, 1955. During the course of preparing the proposal, it became evident that a survey of the vendor potential for parts production would have to be conducted in Argentina. John Banks and Jim McCloud were sent to Argentina and spent two weeks investigating potential supply sources. The survey showed that manufacturers of the normal "off-the-shelf" items such as tires, batteries, electric motors, and paint existed with sufficient production capacity. But the supply of important manufactured items, such as heavy forgings, cored castings, transmissions, axles, brake assemblies, etc. would require either vertical integration of these items within the new company or vendor development, or both, as eventually proved to be the case.

## Project Description

The initial facilities built consisted of a major machine shop in which engines, steering gear, and other machined components were manufactured; a press plant which produced all the body and frame stampings; a trim shop for upholstery and trim items; and an assembly plant that included body-in-white assembly, paint ovens, final trim, assembly, and test lines. The production complex was supplemented by warehouse and office areas. Due to the Argentine government's decentralization policy, an inland site had to be selected, so that the Santa Ysabel suburb of the City of Cordoba was chosen, which is located 400 miles northwest of Buenos Aires.

Construction began in April, 1955, and the first Jeep rolled off the final line in May, 1956. Not only was the short construction time noteworthy, but probably more significant was the fact that this first Jeep contained an engine manufactured in the new plant. It was the first engine produced on a mass production basis in Latin America.

The KE team was headed by Jack Hughes, project manager, and included, among others, Wright Price, construction manager; Bill Ball, Bob Hammersmith, and George Schumann as well as many Argentine engineers, architects, and draftsmen. Working in parallel with the KE organization, IKA's Procurement and Traffic Department headed by D. L. "Pete" Mapes, handled the thousands of tons of machinery, tooling, and dies brought into the country from the U.S. and Europe as well as the local procurement requirements, delivering these items to the plant site. Under plant manager K. J. Flood, IKA's Works Engineering, Plant Engineering, and Product Engineering departments produced layouts of machine and press lines, conveyers, paint ovens, paint booths, and body assembly fixtures, and fed these specifications to KE engineers who, in turn, designed foundations, electrical, and piping systems to suit, and the various buildings to house these facilities.

Construction was on a fast track following design and specification release very closely. The principal civil works contractor was Barsanti & Company with other specialty contractors being used as required. Much force account work was done, particularly in the installation of the engine plant and press plant equipment. As soon as floor foundations and building cover were provided, machines were installed, hooked-up, and tried out by IKA production personnel. Thus, it was possible to begin Jeep production prior to first-phase plant completion.

## Description of Major Facilities, 1st Phase

### Assembly and Machining Building

One and one-half million square feet in area. Sawtooth roof with concrete columns and light-weight steel trusses with very wide column spacing to allow for layout flexibility.

### Press Plant,Tool and Die Maintenance Building

Contained two bays of two press lines each. Heavy concrete foundations on piling. Unique design by KE that provided for placement of presses on heavy steel beams to allow for future additional presses and flexibility to change press spacing at times to suit production runs. Complete bridge crane coverage for die set-up and sheet steel movement into and out of presses.

### Cut and Sew Building

Reinforced concrete construction, approximately 80,000 square feet, two stories, to house sewing machines and other equipment for the production of seats and vehicle trim materials.

### Support Facilities

Supporting the production plants were warehouses strategically located, truck and railroad docks, boiler plants for process steam, substations, and transformers for in-plant electrical distribution. Due to time constraints and non-availability of import permits, it was necessary for the IKA and KE design teams to design and build locally items such as conveyors, paint ovens, spray booths, and many other production-related facilities. In the U.S. these would have been purchased from the proprietary manufacturers. This substantially increased the complexity of the design and construction effort.

## IKA Expansions

The first-phase facilities were completed in approximately 16 months under the direction of KE. The KE cadre of expatriates returned to the U.S. at this time, leaving Argentine engineers, construction managers, and draftsmen who remained on the IKA payroll. This group, under the supervision of Natalie Lucioni, continued on as the Construction Division of the company, to design and construct the various plant expansions demanded by sales expansion, new model vehicles, and the vertical integration of parts manufacturing. IKA was in a constant process of expansion for practically all of the 12 years it was under Kaiser management. Its in-house construction department, trained by KE, was responsible for a number of projects at the Santa Ysabel site:

- Major expansions to the main assembly plant.
- Forge Plant complex, the largest in Latin America at the time
- Chrome Plating Plant.
- The IKA Technical Institute, a trade school for tool engineering and die making skills that had a student body of 600.
- An employee cafeteria, vehicle service buildings for customer driveaway, spare parts warehouse for dealer stock.

And at other sites this group built the following:

- Major expansion and modernization of foundry facilities at an IKA subsidiary, Metalurgica Tandil, located in the province of Buenos Aires.
- Plant and manufacturing facilities for Transax, S.A., an IKA subsidiary that manufactured differential axle assemblies for IKA and other vehicle producers.
- Plants for two divisions of IKA– Industrial Products (D.P.I.) and Tool and Die production (D.P.M.).
- Arguello Academy, an IKA sponsored bilingual primary and secondary school, with an enrollment of over 500 students. Contained classrooms, sports facilities, library and administration buildings.

## ICKSA, Ingenieria y Construcciones Kaiser Argentina

As the pace of IKA's various expansions slowed, IKA and KE together organized a joint-venture engineering and construction company to pursue outside work. ICKSA was built around IKA's construction division and various expatriate specialists as required. Al Hilleland was transferred from Brazil to Argentina to become vice president and general manager of the new company, with Natalie Lucioni as construction manager and Luis Allende, an Argentine engineer who was working in the Oakland office, returned to assume the duties of administrative manager of the new company.

Examples of ICKSA's work included a green-field manufacturing plant for Food Machinery Corp., in the Province of Cordoba, a major apartment complex in Avellaneda, and highway and bridge construction in interior provinces.

ICKSA's presence did not lessen business development activities for projects that would be best handled out of Oakland by Sam Ruvkun. An example was the SOMISA project, a major expansion and modernization of an Argentine steel mill. By having an operating entity in the country KE's awareness of project possibilities was enhanced.

## Kaiser Leaves the Automobile Industry

A corporate decision was taken by Kaiser Industries in 1967 to leave the automobile industry and dedicate its efforts completely to its various raw material and engineering efforts. In Argentina the Kaiser equity in IKA was sold to Renault of France, in Brazil the equity in WOB sold to Ford, and in the U.S. the Jeep company was sold to the American Motors Corporation. With the retirement by Kaiser from the managerial responsibility of IKA, the connection with ICKSA was broken, and ICKSA was eventually dissolved.

## WOB-Willys Overland do Brasil Background

Willys Overland do Brasil was acquired by Kaiser-Frazer Corp. of Willow Run when it merged with Willys Jeep of Toledo. The Brazilian operations consisted of a small automobile assembly plant, assembling only 50 Jeeps per day. In late 1957, WOB was encouraged by the Brazilian government to expand its capacity, and WOB sought to enter a joint venture with Chrysler Corporation to manufacture 25,000 Jeeps and station wagons, and 22,000 Plymouth Savoys of 1956 vintage.

KE was retained in December, 1957, to advise WOB whether to expand the existing plant located at Sao Bernardo, a suburb of Sao Paolo or whether to start a green field site at Taubate located some 130 miles northeast of Sao Paolo. A study made by Sam Ruvkun, while in Brazil, concluded that remaining at Sao Bernardo was the best solution. He was asked to present these findings to a joint meeting with Chrysler executives and WOB executives who were discussing how to work together and to determine what equipment, tools, and designs each could contribute. The basic idea was to invest equipment, tools, and dies already owned, along with designs of successful automobiles that were no longer popular in the United States but were perfectly suited to the Brazilian market.

After several hours of discussion, it became apparent that both sides did not have enough data available to make an intelligent decision, and they asked for his comments. He suggested that we prepare for them a scoping report, which would inventory in detail what each party had available in equipment, tools, dies, and designs, and we would estimate the value of these items as well as the cost of installation.

The scoping study completed in just two months was a compendium of available facts brought together in one spot. The costs involved were more than originally contemplated by the planning group, and the split of responsibilities did not satisfy either side. It was decided to drop the venture.

Soon thereafter, WOB requested that KE prepare a different scoping report to cover a venture for WOB alone, consisting of 60,000 Jeeps, station wagons, and Willys passenger cars. This report was completed in April, 1958, and served as the basis for the project that was built.

At the same time, KE submitted a proposal for an integrated program to handle procurement, detail design, and construction coordination. This proposal was not being acted upon by the operating staff as they felt, erroneously, that they could handle the expansion program along with operating the facilities. By this time the operating staff included a number of Kaiser personnel headed by Max Pearce.

One of the key issues at the time was the obtaining of sufficient foreign exchange financing to allow the project to proceed. Hickman Price, who was the president of WOB, traveled to Washington to try to obtain dollar financing from the IFC (International Finance Corporation, an affiliate of the World Bank). They offered the requested financing provided WOB retained an independent engineering organization to oversee the project. It was their policy to not have an operating company try to oversee a complex expansion program with the same personnel. That day, Price called Ruvkun, reminded him of the proposal we had submitted and said, "You're hired, come to Washington tomorrow."

## Summary

KE's contract for services was authorized in May, 1958, and facilities were completed by December, 1959, with automobile production on individual production units preceding the final date. The first passenger cars were produced in September, 1959. Some facilities were completed in 11 months, and some took 17 months, all on an expedited basis.

Funds were invested for tools, equipment, and buildings totaling the equivalent of $40 million in 1958 dollars (about $220-million value in the year 2000 cost basis).

KE's service revenue was about $750,000 of which the fee was $350,000.

KE staff consisted of nine North American personnel who initiated the project in Toledo, Ohio, where Willys was based. This original assignment was to select equipment, prepare processing sheets for later detailing in Brazil, and specify other equipment requirements. This same group then moved to Brazil to supervise the work of local contractors and suppliers.

WOB's industrial manager was Max Pearce.

KE's project manager was Al Hilleland. His staff included Harvey Hautala, Bob Hammersmith, Karl Jansen, Joe Clark, Nick Petroff, Horace Hibbard, and Don Hoppe.

## Project Description

The facilities completed were:

- a press plant for stamping auto body parts
- passenger car assembly plant
- axle and transmission plant
- import and storage building
- administration building
- general facilities building
- cafeteria
- foundry

At the peak, some 1,400 construction workers were employed under Brazilian construction contractors. In Toledo a maximum of 100 automotive people contributed part time to design, procurement, and specification work.

## KE's Role

This project required the efforts of a small staff that exercised mature judgment and could manage large numbers of local engineers, contractors, and suppliers. The extra challenge came in maximizing the use of local resources to minimize use of foreign exchange. WOB earned all its income in local exchange, and few dollars were available for outside purchase of goods and services.

The project results proved that many good engineers, contractors, and suppliers were available if they were properly supervised and compensated.

KE's major contribution was in managing the program, outlining the project requirements, and setting up controls for proper execution by local people.

## Successful Automobile Venture

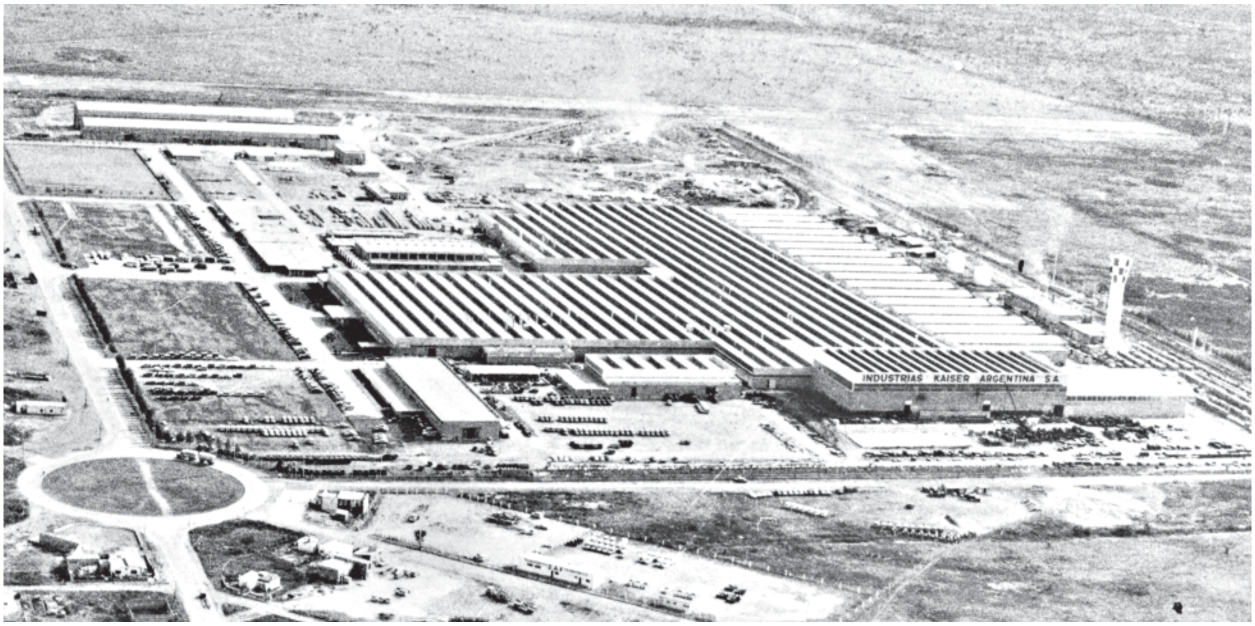
From WOB's standpoint, their dollar investment came mostly from investing tools, dies, and equipment which were no longer used in the U.S. and by obtaining small dollar loans. Probably less than 10 percent of the cost was in new U.S. dollars.

The automobile venture was eminently successful as WOB went on to produce many different models of automobiles for a number of years. With the early production of Jeeps, WOB became known as the provider of cars which fit the Brazilian need for utility and ruggedness in their rough roads and streets.

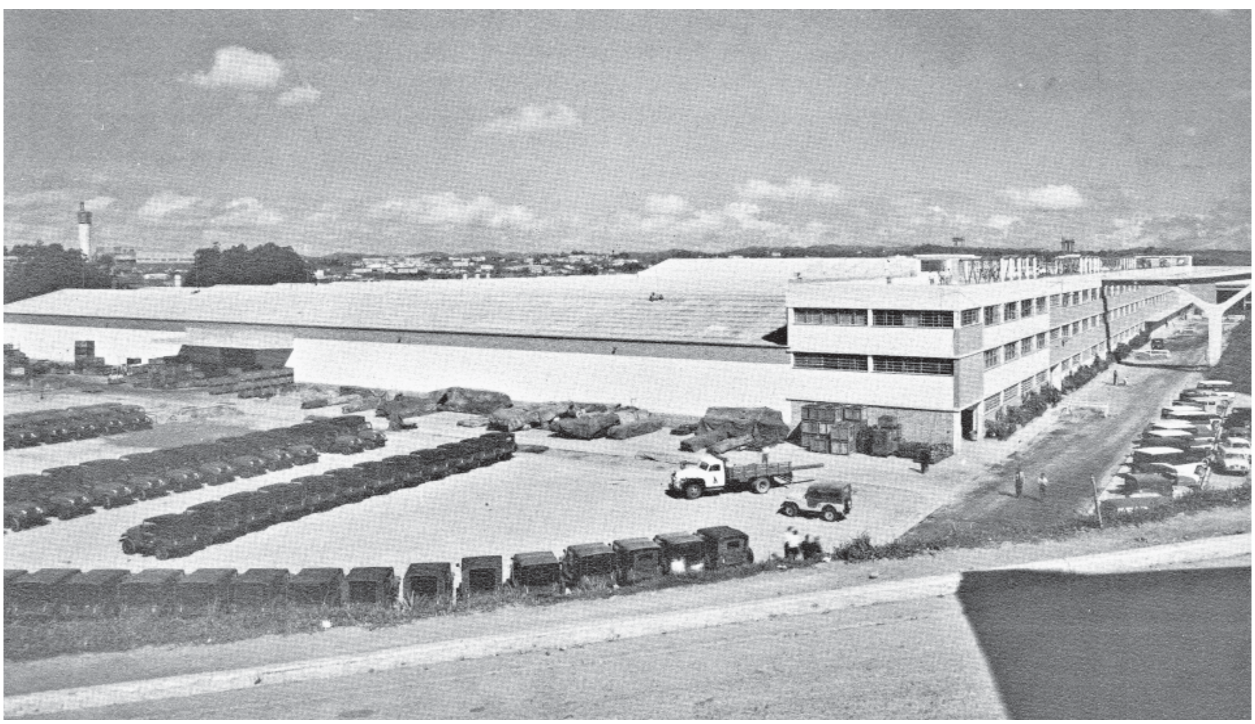
Because they hit the market before others, the Jeep gained wide acceptance. It was known in Brazil as a locally produced, national car. Later, as roadways improved, the market changed, and WOB produced passenger cars.

The success of WOB was laid to a number of factors:

- Its early completion of the facilities capitalized on the starved market for cars;.
- It produced a car, the Jeep, that was ideally suited for the country at that time.
- It trained production workers who became as proficient as US workers;
- Itdeveloped local vendors to supply automobile parts with quality that satisfied international standards (it set up a local automotive industry).
- It developed a knowledgeable dealer organization.




When Kaiser-Frazer ceased automobile operations in the United States, the facilities were transferred to Latin America where two successful integrated automobile plants were built. The IKA (Industrias Kaiser Argentina) plant was built by KE in Cordoba, Argentina, in 1954. This was the first integrated automobile plant in Latin America. KE provided engineering and construction management personnel to perform the entire project in Argentina. The plant produced passenger automobiles. Overview of the IKA plant.



Willys Overland do Brasil automobile plant was built in a suburb of Sao Paolo in 1958. KE personnel supervised local engineers and contractors in building  the plant to produce some parts in 11 months and completed the project in 17 months. Overview of the plant. Note the Jeeps parked in the lot. Originally, the plant produced Jeeps exclusively. It became the Brazilian national car because of the poor roads at the time. The versatility of the Jeep lasted until roads improved. Then the plant was converted to produce passenger cars.

Chapter 17

# Oral Histories

Table of Contents



## About the Oral Histories

Over the several years that this book was in preparation, a number of authors submitted first-person accounts of their personal experiences. Several years ago, the editors invited a number of senior KE alumni to likewise record their "reflections, remembrances, and bon mot" that they may have collected. This chapter records those literary contributions from 23 different authors, covering 35 oral histories.

The Oral Histories are different from the project histories in that they record the authors' observations about the environment under which they worked along with some whimsical observations about the task at hand. They tried not to get too deep into the technical aspects of projects.

For the most part, the authors' texts have been unedited except for judicious placing of subheads when such subheads could clarify the text. Only in one place was an author's words edited out. When this author referred to a co-worker as a "pain in the ass," we edited it out. These persons are left nameless.

The most prolific writer is Jim Miller who managed a number of construction projects. He tells some interesting tales about eight of his projects.

### Oral Histories Included (chronologically)

| Years | Author | Subject or Project Covered |
|---|---|---|
| 1931-1933 | Chad Calhoun | Boulder Dam: How Kaiser Became Involved |
| 1937 | Bill Ball | Coulee Dam: Kaiser Engineers' Genesis |
| 1942-1960 | Phil Bush | Remembrances: Fontana to 1960 |
| 1934-1955 | Bob Rice | Reminiscences of Old Time Kaiser Employees, Coulee to KE |
| 1940-1970 | Burr Tupper | Kaiser Work Experience |
| 1954 | Vince Palmer | Snowy Mountains Project |
| 1941-1983 | Jim McCloud | Looking Back |
| 1941-1981 | Vic Cole | Looking Back, Looking Forward |
| 1941-1980 | Sam Ruvkun | Reflections, Remembrances, Vignettes |
| 1950-1963 | Harry Thayer | HJK Tales and Permanente's 5th Kiln |
| 1950-1973 | Frank Kast | Oakland, Middletown, Didier |
| 1953 | Jim Miller | Garrison Dam |
| 1957 | Al Wallach | Remembrances, Quebec Cartier Pilot Plant |
| 1959 | Sherrill McDonald | It Couldn't Be Done |
| 1960 | Al Wallach | Remembrances, Quebec Cartier, Startup |
| 1960 | Jim Miller | ICBM Missile Base Notes |
| 1960-1982 | Regina Solomon | An Architect's Story |
| 1962 | Harvey Ceaser | Trimmu Sidhai Link Canal |
| 1961 | Omar Finsand | Linde Hydrogen Plant |
| 1963 | Jim Miller | Wabush Notes |
| 1964 | Jim Miller | Guri Dam |
| 1969 | Jim Miller | SouthwireNotes |
| 1970 | Jim Miller | New Madrid Notes |
| 1971-1974 | Jim Miller | Ishpheming Notes, Tilden Project |
| 1978 | Sam Ruvkun | Escape from Iran |
| 1975-1978 | Jim Miller | Ahwaz Notes |
| 1975 | Sam Ruvkun | How We Got the Krakatau Job & the Didier Coke Job |
| 1975 | Bill Smith | Krakatau Project |
| 1977 | Bill Sproule | Stanford Linear Accelerator |
| 1981 | Al Wallach | Remembrances, LNG Australia |
| 1986 | Alex Lindsay | Concerns Over Chernobyl Accident |
| 1982 | Dick Hulseman | Space Shuttle Assembly Building |
| 1984 | Omar Finsand | Montana Talc Plant |
| 1995 | Jim Thompson | Some Pithy Remarks |
| 1995 | Lou Oppenheim | Short Interview |

## *Boulder Dam, How Kaiser Got Involved by Chad Calhoun*

*(Editors' Note:* Calhoun was Kaiser Industries' Washington representative for the period of the Kaiser industrial growth. He was one of Mr. Kaiser's inner circle and a key man in his empire's growth. This oral history comes from his unpublished "Recollections of Henry Kaiser: 1931 to 1950.")

### There Was No Warning

There was nothing to indicate an impending maelstrom of demanding fate, fortunate destiny, the ultimate of personal achievement, years of compounded confusion, Herculean tasks, impossible goals attained, and inexpressible satisfaction.

San Francisco was clear, cool, and invigorating when I first met Henry Kaiser that February day in 1931.

He was 48 then and I, 33.

Destiny, beneficent destiny, descended on me that day. It also touched him. It was my good fortune to function, at least at times, as a beneficial catalyst during many extremely interesting and eventful years of prodigious achievements.

### First Meeting of Six Companies (I Meet Henry Kaiser)

W. A. (Dad) Bechtel was chairman of the first meeting in early February, 1931, at the San Francisco Engineers' Club, of what soon became known as the Six Companies, Inc., builder of Hoover (Boulder) Dam. (Dad Bechtel was father of Warren, Jr., Steve, and Kenneth Bechtel). It was at this meeting arranged by the banks and bonding companies that I first met Henry Kaiser. I had never heard of him, although his paving company had been working in California several years. My experience had been as an engineer on heavy construction projects.

Bids for the construction of Boulder Dam (renamed later as Hoover Dam) were to be opened March 4, 1931, in Denver, Colorado, by the United States Bureau of Reclamation. The magnitude of the project and the generally believed physical hazards involved precluded any one contracting firm from financing and obtaining the required large performance bond. Several western contractors had manifested much interest but none could swing it alone.

Someone had suggested forming a combination of these western contractors, a pooling of their experience, and financial resources.

At the time, I was manager of the Los Angeles office and operations of MacDonald & Kahn, a San Francisco contracting firm. They had manifested an interest in the project. I had prepared a plan of construction and estimate of cost. Since the question of financing and bonding requirement was a most important factor, I had also prepared a financial forecast by months covering a 60-month construction period.

The meeting began by the bankers' representative presenting their resume of the hazards involved and a minimum paid-in capital requirement of $10,000,000— an amount that was prohibitive to the assembled contractors and beyond their collective resources.

Then the bonding company engineer, Mason Pratt, added what seemed to be the coup de grace by further elaborating on the difficulties, magnitude, and risks.

Seated at the long table in a special room at the Engineers' Club were twenty some men; the principals of the separate contracting companies and subordinates like myself. Many had seen and met the others for the first time at this meeting. There were no special marks to distinguish a principal from an employee. There was no "player identification."

When Pratt finished his negative analysis and conclusion a heavy pall of gloom and despair filled the room.

At the head of the table, alongside Chairman W. A. Bechtel, sat a bald, portly, round-faced man with dark, electric, penetrating eyes. The chairman, discouraged, dismayed, sat silent. This other man ventured a few words and asked if anyone had anything to say in rebuttal. He singled out J. Q. Barlow, chief engineer of the world-renowned Utah Construction Company. Barlow had nothing to offer. Next he asked Harry Morrison who allowed that Pratt made it seem more of a risk than he thought, but his experienced dam builder, Frank Crowe, should reply further. Crowe spoke but did not succeed in refuting the bankers' requirement of $10,000,000 paid-in capital, or the bonding companies' exorbitant demands.

Except for my two employers—Alan MacDonald and Felix Kahn—I had never before met anyone in the room. I was a young newcomer and feeling quite inferior in the presence of so many experienced elders.

My financial forecast showed that a maximum of $3,400,000 would be required for this $50,000,000 project. No one else, not even the bonding company engineer or the bankers, had made such a forecast. Their figures had come off the top of their heads. Surprisingly to me, neither the experienced dam builders, Crowe or Barlow, had a financial forecast to present.

There I sat with my $3,400,000 figure backed with pages of figures, bidding schedule, progress schedule, equipment purchases, payrolls, and other expense, etc., and income for contract work done based on a reasonable rate of construction progress. Physical hazards and risks had been properly noted and thoroughly analyzed revealing they were not as great as generally believed. The financial curves of expenditures and income were plotted on graph paper month by month and showed that after the 15th month the $3,400,000 capital expenditure would be returned in full. From that time on the operation would be on "house money."

I was appalled at the predominance of the prevailing negative thinking and the helplessness of the principals and their successful and experienced dam builders to offer anything in rebuttal.

My principals, Alan MacDonald and Felix Kahn, were not aware of my estimate details and financial forecast. They had tolerated my preparation of an estimate but presumably because of indifference or lack of confidence in me, had refused, the day before, to review it with me. As the gloom spread throughout the room, they, of course, remained silent, not being aware of my forecasts.

Alongside, to my right, was a youngish looking man in a blue serge suit, perhaps a few years older than I. I had missed his name and assumed he was a "deck hand" like me.

While the gloom and pessimism were running rampant, I timidly showed him my figures and charts. He quickly looked over them while others were talking and was impressed.

He called out to the portly man alongside "Dad" Bechtel, "Mr. Kaiser, I think we have something of interest." It was my first meeting with Henry Kaiser.

It was also my first meeting with Marriner Eccles, a director and large stockholder of Utah Construction Company, who was later appointed by President Roosevelt to the Federal Reserve Board and its Chairman for many years—the man alongside me in the blue serge suit.

Kaiser seized on my figures and charts. Something akin to pandemonium broke out—lots of talk. Mostly Kaiser's interrogation of the negative Pratt. Pratt was helpless; it was apparent he had no figures or real analyses to back up his restrictive requirements. The project had been resuscitated for this group. Thus, when it then appeared there was a possibility that the contractors could finance the construction cost and obtain a bond, a bidding price had to be established.

### Comparing Estimates/ The Agreed Estimate

Four estimates of cost had been prepared; one by Bechtel's consultant. one by Frank Crowe, one by J. Q. Barlow, and one by me. The principals instructed the four of us to retire to another room, compare our estimates of cost, and to make a recommendation to them.

I was in considerable awe of these other three men my seniors by many years—each with a long record of successful engineering and construction achievements on projects of magnitude, including many western dams.

I gathered up my two large expandable brief cases filled with several loose-leaf binders, figures and charts, and rolls of drawings. They made quite a stack on the conference table.

The Bechtel man had a roll of drawings and two loose-leaf binders; Crowe, one thin binder; J. Q. Barlow, the dean of the group, a used, large manila envelope containing a few loose sheets of ruled yellow paper.

J. Q., sitting opposite me, slowly filled his corn cob pipe, tamped it—struck a long match on his pants, drew heavily, glanced at me, and said, "Son, looks like you got plenty of figures there." Crowe let out a laugh, which seemed to me like a deriding or a patronizing sound. I wished I were somewhere else.

Crowe and Barlow decided we should compare total costs first. (There were 118 separate bid items.) Crowe said, "Write your total cost figure on a piece of paper with your name and put it face down in the center of the table."

My fingers trembled as I wrote out $40,300,000 —Chad F.C., and attempting an air of composure and confidence but failing miserably, I am sure, I hesitatingly shoved the paper face down to the table center.

"You turn them over, J. Q," said Crowe. The first one turned up was the Bechtel man's:

"$30,200,000,"read Barlow loudly.

"Oh, no, " I thought. "I'm way high." Then he read Crowe's:

"$40,200,000." And then his own.

"$40,700,000" floated away on a cloud—beaming—right in the middle.

The first figure was discarded. The Barlow, Crowe, Calhoun cost figures were averaged, and an agreed upon cost figure of $40,400,000 was presented to the Six Company principals.

My ego was suddenly inflated. I detected a warmer, more friendly, and somewhat respectful attitude on the part of Barlow and Crowe towards me. I felt a comforting surge of confidence.

### Successful Bid Price at $50,000,000

We made our recommendation to the waiting principals. They added profit and agreed on a bid price of just under $50,000,000.

But the top officials of the Eastern bonding companies still had to be satisfied. Leland Cutler of San Francisco, and Mr. Joyce representing the major bonding companies and their gloomy, ill-prepared engineer, Pratt, did not have authority to grant formal approval. Appeal to top bonding company management was necessary.

As a result, it was agreed that Mr. Kaiser, representing the group, with a photostat copy of my estimate, analysis, financial forecast, and charts, would go East for further discussions at a higher level with the bonding companies. The result was that the bonding companies' requirements were reduced; Six Companies was formed, met the financial commitments, and was the successful bidder at slightly under $50,000,000 for the construction of Boulder Dam.

### Henry Kaiser, Executive Committee Chairman

Boulder Dam was completed in record time with Henry Kaiser serving as an effective, dynamic, restless, and, at times, annoying, and irritating chairman of the Six Companies Executive Committee.

The maximum cash outlay by the Six Companies was slightly less than the $ 3,400,000 of my forecast, and occurred a little earlier than the 15 months I had calculated.

Chad Calhoun speaks about his Boulder Dam days. Here's a shot of Henry Kaiser (second from left) with fellow contractors in front of what is now called Hoover Dam (about 1934). Calhoun describes the first meeting of the Six Companies joint venture and how their winning bid for the project was developed.

Stories by Bill Ball and Bob Rice in this chapter of Oral Histories reminisce about construction of Grand Coulee Dam (below). Personnel and equipment such as the Whirley Cranes used for construction of the dam were moved to the Richmond Shipyards in 1941. Grand Coulee Dam is on the Columbia River in Washington. Kaiser was the joint venture sponsor.

### My Life with Kaiser

From then on, in varying degrees, my life was to be either on the outer periphery of Henry Kaiser's activities or closely woven within the full range of his personal life and his dynamic building and production miracles.

## *Genesis of Kaiser Engineers by Bill Ball*

At the beginning there was Henry Kaiser, photographer, road builder, dam builder, Pat Donaldson, and many, many others. Engineering was done on a project-to-project basis during those industrialist and builder of men. As he blazed his way through this diversity of jobs, he accumulated a core of brilliant and, like himself, hard-working employees, such people as A. B. Ordway, Henry's son Edgar, Gene Trefethen, Joe Reis, Ralph Knight, Mike Miller, George Havas, Tom Price, Jim Foster, Pat Donaldson, and many, many others. Engineering was done on a project-to-project basis during those early years and it would be difficult to say just when we became Kaiser Engineers, rather than "Henry's engineers." It then rests upon the date of incorporation of the company, August, 1941, to establish the starting point for this story.

### Grand Coulee Dam

Construction of the Grand Coulee Dam on the Columbia River in Washington State marks the point where five of us began our careers with Kaiser in the late Thirties and continued all the way into the late '70s when we retired. We think of Coulee as a great place to have started our Kaiser association. It was a magnificent undertaking, creating thousands of jobs during the Great Depression, preparing for irrigation to reclaim thousands of acres of otherwise unproductive land and developing a power-generation facility that required the world's largest turbines and generators at that time.

Everything about Coulee was big, from its length of 4,300 feet to the 11,250,000 cubic yards of concrete in the structure and the 18 150,000-hp turbines driving the 105,000-kw generators. To prepare the foundations of that massive structure 19,000,000 cubic yards of excavation were carved out of the ancient Coulee through which the mighty Columbia River had been flowing for thousands of years.

### Innovation

Innovation was the word for the program, from the vision of local people who could see the benefits, to the Bureau of Reclamation which broke new grounds in engineering and design and finally, on the part of the construction contractor whose efficiency and ingenuity led to completion of the project a year-and-a-half ahead of schedule, and at a substantial profit. An example of this ingenuity and creative thinking is forever engraved in history by the application of freezing a huge section of unstable earth so that slides could be halted until construction of retaining structures could be completed to block the slide area.

### Living Experience

We will never forget that experience. At first, we lived in the sprawling, boomtown above the dam site; then it was the contractor's bachelors' quarters. Finally, most of us wound up living with families in Mason City, the neat, well-planned community on the high east bank of the river below the dam. It was there, incidentally, that Dr. Sidney Garfield set up the medical plan to serve the construction workers and their families that led, ultimately, to what is now one of the largest health care programs in the world, Kaiser Permanente. Also engraved on memory is the 24-hour, 7-days-a-week sound of construction. The ever-present grinding of the mix plant providing concrete to the trains that delivered concrete in 4 CY buckets to the big hammerhead cranes, the crump of blasting as rock was being excavated for the pump station, the air motors of the vibrators settling the concrete, the traffic noise of supply trucks, and the cement trains; all of this cacophony became a symphony to our ears because we were a part of it, and it was the sound of progress.

### Record Concrete Pour

There was the day when "we" poured 21,000 yards of concrete! The mad, wild scramble had everyone keyed to a fever pitch as the day wound down to the 24th hour, and when it ticked off the last minute, shift whistles all over the job blared the fact that we had set a record for the world to shoot at. Next day, everything returned to normal, the record was forgotten, and there were new goals to meet and a job to get on with.

### Grand Coulee Today

More than 60 years later, the beautiful creation has an added dam and powerhouse. The turbines at 960,000 hp and the generators at 700,000-kw, dwarf the original units and raise the total generating capacity of the power plant to 6,494,000 kw. The dam now is nearly 5,223 feet long, nearly a mile. Total concrete in its structures has increased to 13,000,000 cubic yards and excavation has nearly doubled. As we visit the site today, there is no sound from that magnificent monolith. It sits silently pouring out power for industry and cities and irrigation water for agriculture. Those of us who were immersed in the great job those many years ago now see the dam in a different perspective, and we are awed at what man has accomplished. Great good fortune had brought us to that place at that time, and it forever shaped our lives and has been reflected in the history of Kaiser Engineers.

### 1937 Prices

How would a contractor today like to get $3.53 a cubic yard for mining the aggregate and mixing and placing concrete in the main dam structure? How would you as a junior engineer today like to earn 87.5 cents per hour (a salary of $35 per week, $1820 per year)? The hourly rate was listed in the book of specifications for the project issued by the Bureau of Reclamation in 1937. It is interesting to note that today's salaries are more than twenty-five times the one quoted.

### He Better Get It Done Fast

It bears repeating that those of us from the Coulee and the other early jobs who became long-term members of Kaiser Engineers, brought with us memories of the zenith of Henry Kaiser's construction achievements—the discipline of Clay Bedford's management, and the realization that a team is better than a collection of individual stars. Through the years building ships, helicopters, automobile plants, and a host of other wild and wooly projects, we learned that Henry Kaiser was right when he said, "If you give a man a job, no matter how difficult, and leave him alone, he will get it done." He added one caveat, "But he better get it done fast."

### KE's First Chief Engineer

This genesis would not be complete without mention of Kaiser Engineers' first chief engineer. He joined the Kaiser circus in Cuba in 1922 during the road building job and soon became the man to whom Henry turned for answers on any engineering question. He held the title of chief engineer for all the industries founded by Henry while he was organizing and shaping Kaiser Engineers. He was brilliant, hard-working (what else with Henry?), and respected for his breadth of knowledge and warmth with all who worked for him. That man was George Havas.

## *Remembrances: Fontana to 1960*
## *by Phil Bush*

### Fontana, Kaiser Steel Plant, December 1942

Having started to build an integrated steel mill in April, 1942, it was imperative in Henry Kaiser's mind that operations must begin before the end of the year. The significant event was to be the "blowing-in" of the West Coast's first-ever blast furnace on December 31. But, in real life, there is nothing "spectacular" about blowing-in a blast furnace.

Bill Vogt, chief plant engineer for the Fontana plant, was assigned the task of making the event spectacular. The great day arrived; multitudes from the government, press, political life, Kaiser personnel, etc. were assembled in the blast furnace area. At the appointed time, Mr. Kaiser closed the switch to start the turbo-blower supplying air to the furnace's tuyeres (air ports) to begin the process of making pig iron—normally a relatively quiet event. However, this day, Bill Vogt had circled the exterior of the furnace hearth with a solid ring of magnesium flares, so that as Mr. Kaiser closed the switch, the flares ignited, and everyone could witness a "spectacular" event.

Undoubtedly, not one witness in ten realized that a 25-foot diameter ring of magnesium flares had nothing to do with starting-up or operating a blast furnace.

### Harold Andresen Falling All Over Himself to Make a Point

It's 1942, and Messrs. Phil Bush and Bruno Franceschi helped Hal Andresen celebrate his engagement to marry Laverne. Dinner with an immoderate number of "toasts" was completed, and all returned to Hal's office. Hal, with a satisfied grin leaned back in his chair, and just kept on leaning until the inevitable backward somersault and possible cracked skull occurred.

After more than 50 years, there is still swirling controversy as to whether Andresen's ensuing career was enhanced or negatively impacted by this shocking event.

### 1940s Xmas Parties by Kaiser Companies

These dinner-dances were usually held at the Diablo Country Club. The genuine warmth of Henry J. and wife Bess would always make all of us feel great, and that feeling was enhanced significantly with the Christmas bonus check of a half-month's salary. Of course, those were the days when the club still had slot machines, and the sheriff "looked the other way."

It always seemed to rain for days. One year many of the cars got stuck in the muddy parking lot, and the unlucky drivers had to scrounge rides home with the luckier, unstuck ones and return the next day with a tow truck.

### Return from European Vacation

In 1958, Margie and I were flying home from a European vacation. After an overnight flight from London on British Airways, our plane landed in New York, where we were routed through Customs, followed by breakfast in the terminal, before re-boarding the same plane to continue on to San Francisco. As we de-planed in New York, Kaiser Engineers' New York office manager, Maurey Nicholls, walked up to us and said my schedule was changed. I was required the next day to lead an interview of KE personnel by the Atomic Energy Commission in Washington, D.C. for a big nuclear project for which we had been competing.

I kissed Margie and waved good-bye to her as her continuing flight left for San Francisco. Nicholls had already arranged for British Airways to somehow sort out my luggage from the plane. I then went with Nicholls to Eastern Airlines to change my ticket. To my horror, I reached for and felt an empty back pocket—no wallet! I guessed that in slumping while sleeping in my plane seat overnight, my wallet had probably slipped out of my rear pocket and might still be on the seat next to Margie! So Nicholls and I ran to the British Airways ticket counter, asked if Margie's flight was still within telephone range. The ticket agent said, "I'll try, sir." There followed the ensuing call, the phone question, the hold, the relieved facial expression, and then, a typical British protocol and question to me: "Sir, they found your wallet on the seat next to your wife, and we need your approval for the flight attendant to give it to Mrs. Bush!" Whew!

That was 1958. Can anyone imagine the wallet being still on the seat if this had happened in the year 2000? Epilogue: Nicholls paid for my ticket to Washington and loaned me some money for a stay of unknown duration. We had a good interview and, the next day we were awarded the multi-million dollar Experimental Gas-Cooled Nuclear Reactor job.

### Equal Employment Opportunity Circa 1960

Barbara, a young lady with an engineering degree, was hired by Bruno Franceschi, manager of the Progress Reports Department in Oakland. This was a time when practically the only positions open to women were secretarial or clerical in nature; smoking by women was restricted to rest rooms or the cafeteria. When Barbara requested the privilege of smoking in the office area, as was the practice for engineers and other male staff, Franceschi grumbled quite audibly, "OK, but I suppose the next thing she'll want is to use the men's urinal."

## *Reminiscences of Old-time Kaiser Employees: Coulee to KE by Bob Rice*

The Kaiser people came up from Bonneville when CBI (Consolidated Builders, Inc.) won the third contract for building Coulee Dam. I worked on the first contract, which was to excavate the overburden on the damsite down to river level. That was called the Ryan contract in the year 1934.

After considerable argument and political maneuvering, Congress decided that a high dam would be built, with the construction to be done in two separate contracts. Mason, Walsh, Atkinson & Kier (MWAK) won the contract to build the base of the dam during 1935 to 1937.

### Surveying the River Bottom

Jack Walling was the man in charge of personnel, and he gave me the job of running a level with the survey crew that was mapping the river bottom. A crane hooked to a long piece of large-diameter pipe (12 or 16") was mounted on a barge with the barge being positioned on the river by cables, fore and aft, reaching to each bank. Donkey engines controlled the cables. The survey crew consisted of two instrument men and one level man. The boss was positioned on the barge, and he directed the barge movement and the dropping of the "rod," which, of course, had foot and tenth markings similar to a regular surveying rod. Our instruments were tied into the dam site survey grid. If I remember right, Charlie LaPlante was one of the instrument men.

Later, 12 by 12 beams were assembled into a crib, the bottom of which conformed to the river bottom, as determined by our crew. These cribs were sunk by filling them with large cobbles, boulders and earth with sheet piling being driven along their outer edge, forming the east and west cofferdams so that excavation to the bedrock below the river could be accomplished.

### People Working on the Dam

MWAK built the base of the dam, up to elevation 945 except for Block 40, which handled the diversion of the flow of the river. John Hallett worked in the reinforcing steel department. Steve Girard was an OK man working for the Concrete superintendent. Bill Ball and Vince Palmer were, I believe, in engineering. Sam Banks worked for Pop Baker, building the powerhouses. I was assigned to the Embedded Pipe Department that installed the copper grout stop, the grout pipe, the cooling pipe, and the block drains, first as office engineer and later as graveyard shift grout stop welding foreman. The Department boss was Harvey Hurlburt and later, Roger Greensburg.

### CBI Contract, 1938

CBI (Consolidated Builders Inc.) won the contract to complete the construction of Coulee Dam and started operations in 1938. Clay Bedford was in charge of the entire operation. Tim Bedford had charge of the gravel plant. Again, Jack Walling was Personnel Manager. Returning from a quarter at the University of Washington, I was given work checking delivery of asphalt-laden trucks for building new streets in the company townsite at Mason City.

CBI had a department that MWAK did not, and this department was called the Junior Engineers Department. It was headed by Jack Mims. Among the junior engineers were Jim Beatty, Jim Ayres, Earl Peacock, Joe McNealy, and myself. Our principal task was to report the quantities of pipe and miscellaneous material embedded in the dam.

Later, I was assigned as an OK man for the west powerhouse. An OK man's task was to be sure that everything was accomplished that needed to be done before calling for the official government inspection before concreting operations could begin.

CBI brought many of the Bonneville crew up to Coulee. Among these was the superintendent of the embedded pipe department. He didn't do so well, so he was replaced by Roger Greensburg who immediately reassembled the old MWAK outfit. Steve Girard was field engineer of the day shift, Dutch Hendricks had swing shift, and I had graveyard. Later, I was promoted to relief walking boss, substituting for the three walking bosses on their days off. I know that we three had the same position at one time, as Dutch Hendricks and I split the day when Steve had a foot in a cast and was hobbling around on crutches. Dutch worked a day and half of swing, and I worked half of swing and graveyard.

Steve ended up as the head of the department when Roger Greensburg was promoted.

As the dam got higher, the distance from the upstream face and the downstream face got shorter and shorter. Soon there was less and less embedded pipe to place. I was offered a different job but instead decided to see if there was work to be had at Shasta Dam, so I refused the offer.

### Richmond Shipyard No. 2

After several years, I rejoined Kaiser in 1942 at Richmond Shipyard No. 2, where the Liberty ship was the product. Later, we built Victory ships of the troop transport design. Tim Bedford was the boss, with J. C. McFarland, who had been rigger boss at Coulee as yard superintendent.

Many faces were old to me but even more were new. Carl Olson was chief naval architect at Yard 2. Sam Ruvkun, Jim McCloud, and Vic Cole worked at Yard 3.

### Building an Automobile

As the war was coming to an end, Henry J. got interested in the production of automobiles. One day McFarland collared me in the office and told me to rush home, change my clothes, and be back pronto to meet Clay Bedford. I was to accompany

Clay to a meeting with Henry J. I was to be given some blueprints, and I was to bring them back to the yard.

It seems that Mr. Kaiser had visited an automobile show and had become interested in the Renault front-wheel drive, torsion-bar suspension car. The engine was in back of the front wheels. The blueprints turned out to be photographs. McFarland had the task of organizing the building of a mock-up, but with the engine in front of the front wheels. The man he had in mind to do this was off shopping with his wife in San Francisco. So I was handed the job.

I went to the various department heads and got them to release to me some good sheet metal workers, some good machinists, and mechanics. We set up operations in a building near the sheet metal shop that wasn't being used. Howard Lindberg was Henry J.'s official head of the operation. He got somebody to lend us a Renault, which we dismantled. Carl Olson had assigned some draftsmen to me, so they drew up plans for a new chassis.

My mechanics discovered that the Renault engine, which was of 4 cylinders, could be converted to being in front of the front wheels by the removal of the drive gear from one side of the pinion to a new position on the other. Luckily, the transmission case accommodated this move. One afternoon, when the chassis, with the engine, torsion-bar suspension, and the wheels were in place, along with a dashboard and a steering wheel, Mr. Kaiser paid us a visit. He was pleased with the work so far but wanted to visualize where the cowl would be.

I recalled where some lengths of strip iron about 1/8 by 3/4 inch were located, so I dragged in a strip, had it cut to about 10 feet in length, positioned it about where a cowl would be and had it fastened in place by sheet metal screws. We then draped it into a cowl height that pleased Mr. Kaiser, cut off the excess length and fastened that side to the frame. That started it. We soon had fenders, the start of a body, and were working toward the rear, where the rear wheels trailed behind the frame. We were all stumped on how to support the rear of the body where it had to go up and over the rear wheels.

Mr. Kaiser was literally jumping up and down with excitement, and I will always remember what he said. What he said was, "I don't know how to do it FAST."

Mr. Kaiser had to leave to go to Yard 3 where he gave a speech, but when he got back about 11 p.m., the un-driveable vehicle was waiting for him, except that you would have to have crawled through a window opening to get inside the car.

### Research Moved to Emeryville

We later moved operations to 59th Street in Emeryville where we played with plastics and built a plaster mock-up of a sedan and where Dean Hammond built a flyable 4-passenger tricycle gear, pusher aircraft which was years ahead of that day's styling. It was successfully test flown at Oakland Airport.

### Willow Run

In June of 1946, I was called back to Willow Run. J. C. McFarland was in charge of the body shop. I don't remember many future Kaiser Engineers being at Willow Run. Jim McCloud was there for a while, as was also Vic Cole, but they had the good sense to go back to California. I don't know when Carl Olson went to work at the Engine Division, but it was probably in '47 when Continental failed to supply enough engines, and Kaiser took over the Engine Division in East Detroit. Jim McCloud probably went there, too, at that time.

Jim and Carl went to Argentina with IKA. I had charge of the dismantling of the Engine Division and shipment of tools and equipment to Argentina.

Tim Bedford rescued me from Detroit in July, 1955, where I joined Kaiser Engineers.

## *Kaiser Work Experience by Burr Tupper*

### Magnesium Plant

My career with Kaiser started in 1940 at the Permanente Cement Plant in Cupertino, California. Kaiser was starting the design and construction for building a magnesium plant, based on the process developed by an Austrian engineer. During the preliminary start-up of construction, we were known as the Todd-California Shipbuilding Corp., Chemical Engineering Division. Soon after, it was changed to Kaiser Magnesium.

The project was headed by Harry Davis, VP and general manager; Ralph Knight, chief engineer, and Bill Pollin, construction superintendent. Engineering was performed by Donald R. Warren Company of Los Angeles. Warren's supervising engineer at the job site was Carl Nelson. Charlie Johnston was Kaiser's electrical engineer. Jim Beatty was the day shift concrete foreman, and I worked the night shift. Bert Morgan was the carpenter superintendent.

Harry Davis, Professor Tolan of Stanford, Bill Pollin, and I were driving to visit Basic-Wits Magnesium in Las Vegas. After a night's stop off in Reno, we left on December 7th on our way to Reno. Near Fallon, Nevada, we heard on the radio of the bombing of Pearl Harbor. We immediately returned to Reno, and the others returned by air to Permanente. I was given the task of driving the large Cadillac car back to the Bay Area. I had never driven over the Sierra Nevada mountains before, and it was a particularly scary experience.

Halfway through the job the Austrian engineer left, as he had been using the diplomatic pouch for transmittal of letters to Austria.

Towards the end of the magnesium plant construction, I worked on material take-offs for the dolomite quarry and conveyor belt construction at Natividad, California and for the magnesium sea water processing facility at Moss Landing, California.

## Henry J. Kaiser Engineering

After start up of the magnesium plant, several of us moved to Oakland for the start of a new company called Henry J. Kaiser Development and Engineering. It was headed by Ralph Knight. Others that I remember were Jim Toomey, patents; Ed Lowell, estimator; and myself, architectural designer. After several months, I was transferred to Kaiser Engineers at Fontana, California, to work on the construction of an integrated steel mill facility.

## Fontana Steel Mill

Tom Price was the general manager. Frank Backman was general construction manager. Others that I remember were Joe Kroll, assistant superintendent; Frank Bort, blast furnace construction; Red Wilson, piping superintendent; Art Fisher, field engineering; Chet Purdy, inspection; Arky Price, materials superintendent; Sonny Farrell and Jack Walling, industrial relations; Bob Burns, personnel manager; Phil Bush, assistant to Tom Price, and myself, administrative assistant for quantity surveying; preparation of Daily Progress Reports; recording as-built drawings, and construction administration of subcontractors, including contractors and engineers for service buildings; i.e., administration, cafeteria, laboratory, area office buildings, water and sewage treatment facilities, etc.

One of the contractors, McIsaac and Menenk, who had contracts on several of the service buildings, took us to Arbitration Court, contending that they suffered financial losses because of our diverting reinforcing steel from their jobs to the major projects being constructed by Kaiser Engineers, i.e., blast furnace, open hearth, rolling mills, etc. As manager of contracts, I and Sonny Farrell from Fontana and Bill Marks and Todd Inch from Oakland spent considerable weeks in court defending Kaiser's position. We lost the case and were ordered to pay over $300,000 in damages. Thereafter, arbitration was eliminated from future contracts.

All large construction projects always have one character who is the brunt of a lot of kidding. At Fontana it was Chief Weaver of security. When we started up the sewage treatment plant, they called Weaver to tell him there was an abortion floating around on the settling pond. Weaver with his boots on arrived to check it out. After wading out in the pond, he discovered it was a rubber doll that the men had put there.

Frank Backman, Red Wilson, Sonny Farrell, Jack Walling, and Chief Weaver would get a poker game going occasionally. At one of these sessions the Chief announced that he had a full house. Backmam said, “That's good, but I've got a Mexican full house.” The Chief said, “That beats me. Pick them up.” Of course, Backman had nothing.

At another time, the chief took a large rural mailbox to the paint shop and asked Ron Twombley to have his name painted on it. As he bent over to lay the box on the floor, one of the painters who was using a vibrator gun to identify metal tools and knowing the chief was real goosey, let him have it. The chief jumped over the box and through a screen door.

## Denver Shell Plant

Upon completion of most of the work, I was transferred to the Denver, Colorado, Shell Manufacturing Plant. Henry Kaiser, Jr. was the general manager with Lyman Henshaw as plant manager. Henry's MS was beginning to take over control of his body, so he spent most of his time at home. Lyman also was having problems. He was replaced by Jim Foster as plant manager and myself as his assistant. Bob Hammersmith was field engineer, and Newk Warburton was the manager of administration and accounting.

As housing was impossible to obtain, a few of us lived at the Brown Palace Hotel. We lived there for six months until I located a contractor who had stopped work on two practically completed houses except for some plumbing, pipe, and fixtures. I managed to locate some of the materials for him to finish the houses—one for me and one for Newk Warburton.

We received steel billets from Bert Inch's plant in Fontana, and we cut them to shell sizes, heat treated them, and then placed them in a large forging press to forge into a rough shell. Then they were machined into finished 90-mm, 6-inch and 8-inch shells. The rotating bands plus fuse and boosters we manufactured were assembled to complete the shell, which were then placed on pallets ready for shipment to a shell munitions plant for loading.

## Fontana Open Hearth and Soaking Pits

When the war ended, we placed the plant equipment on standby, and some of us returned to jobs at Kaiser in Oakland.

I shared an office with Ed Clovis, and the two of us worked with George Vreeland, project manager of the design for additions to the open hearth and soaking pits at Fontana. As things were pretty slow at Kaiser, I left for two years on another project.

## Bristol Manufacturing Plant

I returned to Kaiser and was sent to Bristol, Pennsylvania, to the Kaiser Fleetwings Plant to take over from Art Fisher who was being sent to a new project in India. Bristol was converted from making aircraft parts manufacturing to a heavy press, welding, and assembly operation to manufacture the rear deck and doors for the Kaiser-Frazer Automobile Plant in Willow Run, Michigan.

Kaiser Fleetwings, under Shirk Hackley, had obtained a contract from Sears-Roebuck to manufacture metal bathtubs and sinks. Harry Bernat was the project engineer in Oakland, and I supervised the construction in Bristol. We installed three large heavy-duty presses plus other presses, brakes, slitting lines, automatic welding equipment, and assembly lines. We also built a new enameling plant, including pickling facility and a hump-type enameling furnace. Later on, we installed facilities to form and assemble metal kitchen cabinets plus a conveyor and electrostatic paint spraying booths.

Upon completion of work in Bristol, I was sent to Seattle to build a slip-formed cement silo for Glacier Sand and Gravel. Upon completion of the pile-driving operation, Don Barrie took over from me, and I went to Jamaica to build a bauxite mining facility.

## Jamaica Bauxite Mining Facilities

The Jamaican project consisted of 15 miles of railroad track, an 1,100-foot long deep-water pier, rotary car dumper, raw bauxite storage and rotary kiln, a large dry storage building with draw down pits and covered conveyor system to ship loading facilities on the pier. Harry Bernat was the project engineer in Oakland, and I handled the construction management in Jamaica. The pier was constructed by Horace E. Williams Company from New Orleans. Chicago Bridge and Iron from Chicago constructed the water towers. Karl Hicks of Williams was the pier construction superintendent. The pier was built from a large LST that was moved about by a sea-going tug. Native Jamaican women set up food preparation along the beach to serve the Jamaican workmen. Two fresh water wells were drilled, and they had to be drilled to sea level. Before the wells were drilled and water was delivered to our homes in Mandeville, we had to be satisfied with water from the cistern, which contained run-off rainwater from gutters from the roof.

In addition to the railroad, mining sites, and the plant and pier at Little Pedro Point (later changed to Port Kaiser), we constructed a cookhouse and housing at a place called Duff House. At Spur Tree outside of Mandeville on the way to Alligator Pond and Port Kaiser, we built housing, administrative office, laboratory, and garage repair facilities. It has been too long ago to remember all of the names of the American personnel we had, but they were a hard-working and dedicated crew, working in tough conditions.

Towards the end of the job, Harry Bernat took over from me, and I went to Vicksburg, Mississippi, to build a plant for Westinghouse Electric Corporation.

## Vicksburg Lighting Plant

The plant was over 300,000 square feet and was the first building east of the Mississippi River utilizing the concrete tilt-up panels. It was built for $250,000 under budget. This was achieved by taking advantage of the local soil conditions, which enabled us to excavate for neat foundations in lieu of one-to-one slope and wood forms. We dug the footings, set grade and level stakes, and poured the foundations with a unique high-discharge mixer truck developed by the nearby LeTourneau plant. We also rented other equipment including dozers, graders, bomber cranes (that had been used on aircraft carriers) to lift and set pre-cast concrete wall panels. The rest of the plant was built using standard materials and construction practices. Don Daly in Oakland was the project design engineer.

We installed steel slitting lines, press brakes and forming presses, plus enameling, pickling and electric hump-type furnaces. The balance of the facility was assembly line, warehouse, shipping ,and offices.

Westinghouse requested permission to talk to me about joining them. It was a very attractive manager position, which I accepted. After 11 years with Westinghouse, as director of corporate design and construction, I returned to Kaiser.

### H.J. Kaiser Canada, Montreal

I moved from Pittsburgh, Pennsylvania to Montreal, Quebec, to work for Tim Bedford, President of Henry J. Kaiser, Canada, Ltd. as assistant manager. Kaiser Canada was finishing up on three sections of the Montreal Subway, including a tunnel under the St. Lawrence River. They were working on other projects, including ore processing facilities and an asbestos stripping operation.

Kaiser Canada together with two French Canadian firms and a French steel engineering company formed a consortium to obtain a contract for the design of an integrated steel mill for the Quebec government.

With help from Bob Wolf, Mike Janner, Gordon Zwissler, Guy DeSpeville, and other Kaiser personnel, a plan was developed with the Canadian and French engineers. Many meetings between the partners lasted until 2 o'clock in the morning to finalize contract language, French to English, English to French. Finally, an acceptable working agreement and division of responsibility were established.

A contract was received, and organization comprised of specialists from the four firms established an office to perform the work. I worked at the start as Kaiser Canada lead contact, but as French was difficult for me to learn and communicate, Tim Bedford, who was fluent in French, and I switched jobs. He moved to the consortium, and I returned to look after and to go after new work for Kaiser Canada.

There had been a fire at the Wabush Pelletizing plant, and Pat Bedford was dispatched to reconstruct and return the plant to operation. We also put together several proposals for other projects that we had the expertise for. Les Trew and Al Wallach were the engineers.

One Sunday afternoon, we received a call from a cement company that we had previously bid for the design of a cement silo, but we did not get the job as they thought we were too high and decided to design it themselves. I drove up to Quebec to see what the problem was. The problem was that when they filled the silo for the first time, it split open like a watermelon, spilling cement all over the ground.

Upon close examination of the silo, it was noted that they had not put any reinforcing steel where the hoist, used for the slip forming, was attached. We were awarded a contract for re-design.

### Back to Oakland

I was transferred to Oakland to manage the architectural project design group, one of Vic Cole's divisions. During my participation, we did seven hospitals for Kaiser Permanente in Oakland, Sacramento, Santa Clara, Redwood City, Bellflower, San Diego, and West Los Angeles.

### Sheraton Hotels

The Kaiser Foundation inspector on the Santa Clara job formerly worked for the Sheraton Hotel Corp. He told me that Sheraton was planning to start a $329-million international expansion program. I contacted the person he suggested I talk to and was invited to come to Boston to learn of their expansion program and to state our interest and our international experience.

Bechtel, Kaiser, and three other firms were invited to make presentations of their work experience and countries they had work in. Bruno Francheschi and his staff, Sam Ruvkun, and Earl Peacock were contacted to help to provide background and experience of our international projects. Earl Peacock was most helpful and accompanied me to Boston to make our presentation to Bob Brown, executive vice president of Sheraton, plus Fred Mills, vice president and principal of facilities design and construction.

Each firm made private presentations and was told that they would be advised when a selection had been made. Earl left Boston, and I went back to the hotel to wait it out. I received a call advising me we had been selected and to come back in the morning to discuss the program. I called Lou and Vic to advise them that Kaiser had been selected. Next morning, Sheraton advised me they wanted me to meet their construction manager in Santiago, Chile, to visit a new hotel under construction; then on to Rio de Janeiro and then to Buenos Aires to meet local architects they were considering for new hotels. I was home for two days then on to Stockholm and Oslo to meet with the vice president of Sheraton design to participate in discussions on new hotels there.

We set up a small group of Kaiser engineers in Sheraton facilities in Boston, headed by Bob Matteson, architect, and a larger group in Oakland headed-up by Stan Kulp. In Boston the group worked with the Sheraton design group on the design and full-size mock-up of a standardized hotel room that was to be incorporated in the proposed new hotels to be built. In Oakland we worked on preliminary design and engineering for start-up of the first group of hotels. I divided my time between Oakland and Boston to keep the work on schedule.

During my work with Sheraton, we were involved either in providing design or construction management in hotels in Rio de Janeiro, Buenos Aires, Stockholm, Oslo, Lisbon, Toronto, and the 1,500-room Royal Hawaiian in Honolulu. There was a change in the Sheraton organization, and the people we had been working with were replaced with others. The new vice president of design was a man who formerly was with IBM. I had previously worked with him when I was at Westinghouse. After awhile, changes were made, and Kaiser dropped out of the project.

### Return to Oakland

In the meantime, we continued doing work for Kaiser hospitals. Kaiser Gypsum requested my help in providing new uses for gypsum in buildings, and I was transferred to work for Gypsum. I spent considerable time back and forth between Oakland and Mexico City. With a change in the Gypsum management, many functions were dropped. I took early retirement and spent four years with Bechtel's urban and industrial projects as manager of building systems.

## *Snowy Mountains Project by Vince Palmer*

The Snowy Mountains Hydroelectric Authority, a government agency of the Australian government, was established to take advantage of the high annual snowfall and rainfall of the Snowy Mountains, together with a rapid drop to low altitudes. Rivers were diverted to provide irrigation water for arid areas west of the mountains and provide power for urban areas.

The Commonwealth Parliament passed the Snowy Mountains Hydroelectric Power Act in July, 1949. Survey and diamond drilling camps were established, and road construction was started in 1950. A Norwegian contractor started construction of the Guthega Project in 1952. The Snowy Mountains Project was the largest civil construction project ever constructed by the Australian government. The entire scheme was completed in 1974.

Kaiser Engineers completed this vast undertaking. There follows some of my observations along the way.

### Eucumbene: Tumut Tunnel, Tumut Pond Dam

The first Kaiser Engineers-managed project was bid as a Joint Venture and included Kaiser Engineers, Walsh Construction Company, Perini & Sons, Inc., Raymond Concrete Pile Construction Company, Ltd., and the Arthur A. Johnson Corp. known as Kaiser-Walsh-Perini-Raymond. Work started in 1954. The value of the contract was $54,400,000.

### Completion of Eucumbene Dam.

Prior to 1956, the Eucumbene Dam (then called Adaminaby Dam) was being undertaken by the Public Works Department of New South Wales. They were way behind schedule and did not have the proper skills. The authority cancelled the contract with the Public Works Department and let the completion out for bids. Kaiser-Walsh-Perini-Raymond was the low bidder and completed the work ahead of schedule. KWPR started the completion work in May of 1956. The value of this work was $13,900,000.

### T-2 Dam, Powerhouse, and Tunnels

Construction of a diversion dam, tunnel, and underground powerhouse. The T-2 diversion dam, tunnel and underground powerhouse comprised the third phase of the Snowy Mountains Hydroelectric Scheme. This project was a joint venture sponsored by Kaiser Engineers. The underground powerhouse is located in the heart of a mountain 800 feet below ground level at an elevation of 1600 feet. Four 70,000-kw generators, each driven by a 96,000-hp turbine, supply a total of 280,000 kw of power. Power from the transformer hall is brought to the switchyard at the surface through an inclined cable tunnel 9' 6" square, 500 feet long and sloping at 34 degrees. The value of this work was $45,000,000.

### Khancoban Dam

Construction of this dam and spillway by Kaiser Engineers was part of a contract which also included excavation for the Murray No. 2 Power Station and Tailwater Channel on the western slope of the Snowy Mountains. The 194-foot long, 163-foot wide spillway is equipped with two radial gates, which regulate the flow of the Swampy Plains River. The value of this work was $4,500,000.

### Starting Work

John Tacke was project manager. He and Ken Neilson started an office in Sydney after the awarding of the contract. The first person hired in Australia was a secretary by the name of Betty Thompson who stayed in the Sydney office throughout the Snowy work. She was also in the Sydney office on many other Kaiser Engineers' Australian jobs.

After being awarded the contract, the first four Kaiser people to arrive in Cooma were Russ Hoffman, Vince Palmer, Ossie Mickelson and Joe McNealy. We arrived in Sydney, and the next day obtained our driver's licenses. On the third day we each drove a pickup from Sydney to Cooma. Australians drove on the left side of the road, and we had our experiences driving the 270 miles from Sydney to Cooma. We checked into the Alpine Hotel, and the next morning met with Sir William Hudson, the commissioner of the Snowy Mountains Authority. He assigned us some temporary buildings at Polo Flat, just out of Cooma. We proceeded to set up business.

Cooma was a very crowded town, and rooms were very scarce. U.S. personnel who brought their families with them to Australia had to keep them in a hotel in Canberra until houses were built or purchased by Kaiser-Walsh-Perini-Raymond.

We started hiring Australian people. We built an office building, a warehouse, and a machine shop. We took over a Snowy factory to build pre-fab houses. We hired a U.S. citizen who was working for the Snowy Authority by the name of Linc Grayson on our Australian pay scale. He stayed with us for many years. He was transferred to the Oakland office and went on a few field jobs.

In the early days of the Snowy, the stores in Cooma were open from 9 a.m. to 12 noon and then from 1 p.m. until 6 pm; on Saturday from 9 a.m. until noon, and closed all day Sunday. The job was on a six-day week, and our only day off was Sunday, so shopping was a problem. On the first Sunday in Cooma, Joe McNealy and Vince Palmer decided to go to the ocean to see the beach. Once there, we needed gas to return to Cooma and found all service stations were closed. They finally found a man selling black market gas in an alley, filled up, and returned to Cooma okay.

Joe McNealy and Vince Palmer roomed together in the Alpine Hotel in Cooma. Every morning at 6:30 a.m. the maid would come in with coffee and a biscuit. Vince loved it, but Joe would tell the girl he didn't want it. She would leave it anyway. Joe wouldn't touch it and continued to tell her he didn't want it. She left it every morning for three months until such time as temporary housing became available.

The workforce mostly consisted of displaced persons from Europe. After the war, Australia recruited people from Europe. An estimate was that there were seventy nationalities on the project. About one-third of the workforce was Australian in line with a condition laid down by the government.

### Union Problems

After the tunnel work started, the unions were establishing their muscle and wanted to obtain changes to the work rules. Greg Oakes, an Australian, was made head of Labour Relations for the joint venture. Project manager, John Tacke, wanted an American to sit in on many of the labour meetings. Vince Palmer was assigned to attend the early meetings. Greg Oakes and Vince Palmer had a meeting with Charlie Oliver, the powerful Secretary of the Australian Workers' Union, in which we told Oliver that we would by contract get extra money if a NSW judge determined that working conditions (including wages) were necessary. Instead of striking, the unions brought all disputes to Judge Stanley Taylor. When Vince Palmer left the Snowy for an assignment in the States, Judge Taylor, Charlie Oliver, Greg Oakes, and Vince Palmer had lunch in Sydney—and Oliver paid for the lunch!

### Bonus System

To improve progress in the tunnel work, John Tacke had us sound-out Charlie Oliver on a bonus system. Oliver was for it. Tom Price came out from Oakland, and Price, Oakes, Palmer, and Charlie Oliver had several meetings, which established a bonus system, which was approved by management and the union. The bonus system added several Australian pounds to a weekly kitty for all footage over 150 feet of tunnel per heading. The men at the face received a full share almost right away. The last record by KWPR was 484 feet in 6 days, set in July, 1956. The tunnel men were averaging more than double the award wages for tunnel work. One day John Hester got into an argument with Clyde Turner and hit him. John Tacke fired Hester. Lou Perini was in Vince Palmer's office when the word came into the office. Lou said, "If I had a tunnel man that got the footage John Hester is making, I would let him hit me every morning!"

### People of Eucumbene Dam

KWPR started Eucumbene Dam in May of 1956. Harold "Curly" Christman was made general superintendent reporting to John Tacke, general manager of KWPR in Australia. Curly had two of his brothers with him as superintendents. After Curly arrived he went out on the job and discovered a group of workmen were boiling the billy at 10 o'clock for morning tea. All the trucks had stopped, as they had always done, and the drivers were all gathered around the fire, making tea. Curly arrived yelling "What's going on here?" With one swift kick, he sent that billy flying through the air. He finally agreed to issue thermoses. "But don't get off the trucks!"

The engineering and accounting at Eucumbene Dam were all Australian people. They were all transferred from the first PWD job. John Robertson was construction engineer. He started a very successful business after he completed his Snowy work. Other KWPR Australian engineers did a good job and were future Australian leaders in the construction industry.

### People of T-2 Dam, Powerhouse

"Red" Fulton, a Kaiser Engineers superintendent who had worked on several dams in the States for Kaiser Engineers, was made project manager. Bob Miller was made project engineer. A complete town was constructed in the mountains near the job site. It was named Sue City after Edgar Kaiser's wife, Sue Kaiser.

Australians held the accounting and other management positions. One Australian, Geoff Moran, was office engineer. He was also the first Australian contract hire. He later became chief engineer for Laytons Engineers who are one of the largest construction companies in Australia.

### People of Khancoban Dam

Harold "Curly" Christman was the general superintendent. Most of the other people were either from the T-2 Group, or U.S. personnel, or Australians. He had a very capable group of Australians who handled most of the other positions.

## *Looking Back*
## *by Jim McCloud*

### Shipyards

A month or so prior to graduation in 1941, Dean Samuel Morris of the Stanford School of Engineering, suggested I talk to Henry J. Kaiser, Jr. at the Richmond Shipyards since Henry Jr. had indicated that there were openings for junior engineers. Henry Jr. whom everyone called "JR," was student manager of the freshman football team that I played on, and I knew him pretty well. After an exchange of correspondence, submittal of transcripts, and resumes of work experience, JR arranged an interview for me with Clay P. Bedford, general manager of the Richmond Yards. Mr. Bedford's office was then at Richmond Shipyard #1, the construction of which had begun in November, 1940. I spent a lot of time rehearsing answers to the many questions, technical and otherwise, that I expected would be asked by Mr. Bedford. I visually pictured Mr. Bedford sitting across a desk from me, probing my past, sizing up my character and, more than likely, sending me to others for a further check. Hopefully then getting hired.

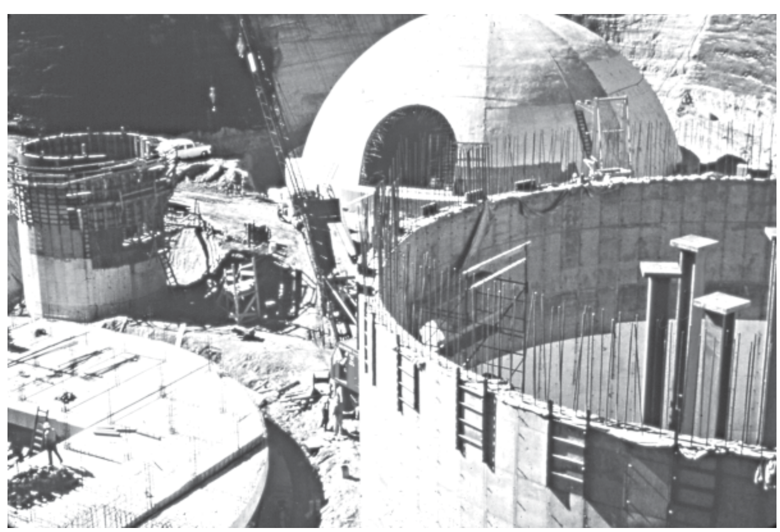
I arrived at the appointed time with a file folder complete with transcripts, work history, and the like. Howard Welch, principal secretary to Mr. Bedford, met me and showed me a bench in the corridor that led to the Bedford outer office and told me to wait. In a little while, Mr. Bedford appeared in the corridor, and I stood up and introduced myself. I don't recall any handshake. He remained standing and looked me over a bit while he was reviewing my letter of application and asked, "Can you type?"

Jim McCloud and Vic Cole recall their shipyard years. Many of KE's executives began their careers at the Richmond Shipyards and others sojourned there as they moved from project to project and finally ended up at KE.

Yard #3 in Richmond (above) was the 'permanent' shipyard. Ships were built in graving docks and launched by flooding the basins rather than sliding down a shipway.

Jim Miller describes his trials and tribulations of construction on a number of projects. The Titan Missile Base in Mountain Home, Idaho, was built in 1960 at the height of the Cold War. On this project, the Air Force kept making changes often, making construction quite difficult. Despite these difficulties, KE completed the work on schedule. The missiles were never fired.

Note the two workmen standing next to the crane (center) and another workman standing on the concrete (lower left).



I answered affirmatively because I had taken touch typing in high school and was, in fact, pretty good at it. With that, Mr. Bedford said, “You’re hired.” And that was the end of an interview that took less than five minutes. Over the years I have often wondered what would have been the outcome of the interview if I wasn’t able to type!

I reported for work the day after graduation and was put on the payroll at $40 per week and assigned a desk in the outer office where Howard Welch and a secretary who assisted him sat. My principal job was reviewing all incoming correspondence from the U.S. Maritime Commission, the British Purchasing Commission, Lloyd’s Register, the American Bureau of Shipping, etc. Then I would prepare a daily briefing memo for Mr. Bedford that summarized the principal questions, so he could take the action necessary without wading through a pile of correspondence. And it did come in piles! Gradually as I found my way around and met the various department heads, I was able to get the answers needed for Bedford’s approval and save him a little more time.

The first shipyard in Richmond was a joint venture between a group of contractors (ex-Six Companies) led by Kaiser and the Todd Shipbuilding Corp., headed by John O. Reilly and R. J. Lament. Each group held a financial interest in the other’s yard. The first contract was For 30 British coal burners to be built in the new yard at Richmond and 30 in Todd’s Bath Iron yard in the East. As an aside, the later Liberty ships were practically duplicates of the British ships but were oil burners.

Todd assigned some supervisory personnel led by E. J. Hannay to teach Kaiser how to build ships. In my errand running forays in the Yard, I would usually find Hannay on one of the shipways watching ship erection progress. But his methods and those of the Kaiser group didn’t mesh too well. The construction stiffs considered a ship as just another steel structure, and building it plate by plate wasn’t the way one built a bridge. Hence prefabrication of major elements came about allowing the work to get spread out, enabling as much down hand welding as possible and the employment of many more craftsmen at any given time on a given ship.

The Todd-Kaiser Group joint venture was short-lived. The break-up came upon the completion of the British contract in 1942.

C. P. Bedford had two buttons below the top of his desk. One was for Joe Friedman, the other for Dave Oppenheim, both of whom had offices down the hall. Joe handled estimates and forecasts, and Dave produced various reports—progress, proposals, etc. Always beautifully done. When I heard one of those buttons sound off, either Joe or Dave would appear in about one minute. Dave, in particular, always made a dramatic entrance; his hair would be streaming out in back and with a bundle of reports in his arms. Joe, not as colorful, but he wasn’t walking either. When you worked for Clay, you moved!

### I Was Moved to Construction

After a few months at Yard 1, I was assigned to O. H. McCoon, superintendent of construction at Yard 2, as his office engineer. Construction was more to my liking, having worked for about a year in the Civilian Conservation Corps during the Depression days in the early ‘30s and later on construction at Standard Oil’s Richmond Refinery for about a year prior to college, and then every intervening summer vacation.

In McCoon’s office I was responsible for maintaining the print file and making sure that the latest revision was being used by the field. Dave Anderson ran the carpenters with John Salo as his quarterman, “Chippy” Jack Taylor was the ironworker boss; Dave Carlson, the pile bucks and framers; Kenny Flood, the electricians; and “Butch” Siebert, the laborers. Hugh Williams was McCoon’s assistant.

One day, Ken Flood came to the office and said he had to get a transformer pad poured in a hurry. Since I was the only one in the office, I went out in the field and diverted some laborers and concrete trucks and got the job done for him. McCoon heard about this and started giving me more field assignments and in a couple of months the title of Field Construction Superintendent. I was even assigned my own pickup truck. One job I vividly remember running was the construction of the Prefabrication Plant which was situated between Yards I and 2 and produced deck house sections for both yards. This was a hi-ball job, seven days per week, three shifts per day.

Toward the end of 1941, H. McCoon was transferred to Yard 3 to run the construction of that yard. Tim Bedford came down from the Mare Island job that he had just finished and replaced McCoon. Stan Kimball was with Bedford also.

### December 7, 1941

December 7, 1941, fell on a Sunday, and I had just received news of the Japanese attack on Pearl

Harbor as I was standing on the Yard 2 outfitting dock that we had just completed. This was a long finger pier that jutted out into the Bay and carried Whirley cranes and was long enough to berth about three Liberty ships on each side. We had been dredging the in-board side with a barge-loaded clamshell that deposited the spoils into a big muck barge that was moored alongside the finger pier. The previous evening, the dredge had mis-loaded the muck barge, causing it to flip over and ram the finger pier, causing a shift in the center of about 10 feet. We were able to get the pier back into somewhat of alignment, but you could always see a curve in the Whirley crane rails. A great way to start a war!

As Yard 2 construction drew to a close in 1942, Ken Flood was named Outfitting Superintendent of Yard 2, and he asked for me to join him as Graveyard Superintendent. Bob Kitchen was Swingshift Superintendent. I remember going on shift early one night and checking into the Outfitting office to see if Flood or Kitchen had left me any special work orders. Kitchen's secretary whom I had never seen before, was the only one in the office, and when she saw me in Flood's office pawing over his papers, she came in and asked what in hell I thought I was doing. I explained who I was, and she left. But I sure didn't forget her because this black-haired beauty, Geneva "Gus" Edgar, an Okie from Cleveland, Oklahoma, two years later became Mrs. James McCloud.

## World-Record Liberty Ship

Another memorable event was the construction of the world-record Liberty for speed of construction, the *Robert E. Peary.* Seven and a half days after keel laying she was sailing through the Golden Gate with a load of cargo. We had so many welders working on the hull while she was on the way that if you dropped a coin on the deck, it would be welded before you could pick it up.

## Yard 3

In 1943, Kaiser Yard 3 had started building ships, the C4 troop transports, the biggest we built during the war and which had the capacity for transporting 4,000 troops for voyages of long duration. They were already being floated in the basins and about four of them were already tied up at the Yard 3 outfitting dock. The outfitting of a C4 was many times the complexity of a Liberty. Living and dining quarters for 4,000 men plus crew, refrigeration, water evaporators, generating capacity, steam turbines with many times the horsepower of the Liberty's reciprocating engines, toilets, infirmary, laundry etc. The outfitting dock was having problems and Flood was made Yard 3 outfitting superintendent, and he took me with him to run the day shift. Lloyd Sherman, a carpenter boss I had worked with, became swing shift superintendent, and Dave Pike, an ironworker took over graveyard. When Flood became general yard superintendent, replacing J.C. McFarland, I took over his job, and L. B. Harbour, a Stanford engineering classmate, became day shift superintendent.

There were only a couple of us from Stanford in the Yards. It seemed that the Class of '41 graduates from UC Berkeley were everywhere. To name a few: Carl Olson, Bob Jesperson, Jack Hughes, Sam Ruvkun, Hal Andresen, Vic Cole, Bart Shackelford, and probably a lot more. We were really outnumbered, but we did talk to each other. Speaking of Vic, reminds that he and Phil Soukup, who was a Morrison-Knudsen hand at Coulee, ran the basins where the C4 hulls were erected. They got rid of them as soon as they floated and were complete structurally and sent them to the outfitting dock. They were bare-bones and, luckily, they didn't forget to stow the boilers in the engine room flat before they welded up the hatches. *(Editor's Note:* This last sentence is a typical McCloud humorous needle to his counterparts running the basin work. It was a matter of judgment of how much gear to stow before launching. McCloud chided them about not doing enough work before launching.)

Another speed demon was Ozzie Babich, the paint boss. Ozzie's motto was, "Put on a heavy first coat, and maybe we won't have to paint on a second."

The outfitting dock had all the electrical, piping, mechanical installations, joiner work, (ship's carpentry), rigging, ship's armaments, you name it. All the engine room equipment, such as boilers, propulsion turbines, pumps, and generators had to be aligned on their respective foundations, steam piping insulated, and tested. Everything was subjected to testing by the Maritime Commission and American Bureau of Shipping Inspectors, and the completed ship and gear were subjected to dock and sea trials.

But we got the job done through work scheduling and sequencing of the various crafts, which together had some 8,000 men working on the outfitting dock, and soon were delivering ships to the U.S. Navy.

## Kaiser's Shipbuilding Record

During the war effort, Kaiser built and operated seven yards, four in Richmond, California, one in Portland, Oregon, one each in Vancouver and Astoria, Washington. The seven Kaiser yards built approximately one-third of the total Merchant Marine tonnage that was built in the U.S. during the war and first had to build the shipyards to do it in. Harry Truman, then a Senator, was the chairman of a special committee investigating the National Defense Program, and in its report of June 23, 1944, concluded:

- Kaiser Yards ranked first, second and third in the Nation, in speed of construction of all U.S. Liberty Shipyards.
- Kaiser-built Liberty ships required less manhours than vessels constructed at any other U.S. shipyard.
- Kaiser yards ranked second, third and fifth in economy of construction despite the higher basic wage rate scales present on the West Coast.
- All Kaiser shipyards were commended by the Truman Committee and the Maritime Commission for efficiency, performance and for the rapid increase in efficiency when any new project was undertaken.

## Rosie the Riveter Memorial

The City of Richmond has established a Rosie the Riveter Memorial at the site of the Kaiser yards to memorialize the war-time accomplishments of the Kaiser Yards and American women's labor during World War II. It has also acquired the Red Oak Victory, launched in 1944 from Yard 1 and probably the last ship still floating that was built in Richmond. It is on exhibit and currently undergoing restoration by volunteers.

## Willow Run

After the war ended, we finished some conversion and ship repair work and turned the yard over to the Maritime Commission. I was one of the last Kaiser hands to leave the yard and was transferred to the Willow Run plant of the Kaiser-Frazer Corporation located in Ypsilanti, Michigan. The old automobile supervision at the plant called all of us from the West Coast—"orange juicers."

My wife Gus, and I lived in an apartment joining that of Carl and Monna Olson. The only trouble was that it was located on a floor above the Ypsilanti Bottling Works and about 4 a.m. every morning loading of trucks began and bottles clanged. We sure didn't need alarm clocks.

Willow Run was a short assignment because of my own choosing. I was given the title, "Superintendent of By Products," which sounds pretty important, but I actually was a glorified junk man. All the droppings in the plant—bolts, nuts, parts- you name it, were brought to my section by the clean-up crews, and I had about ten or fifteen old UAW workers who couldn't cut it on the assembly lines, assigned to the by-products section. I even had a foreman, also a union member, since salaried personnel were not allowed to give direct orders to hourly people.

Our job was to sort out and clean all the parts and return them to their proper places on the assembly lines. About the only thing I had to do was paper work on personnel, time and evaluations, which no one read, and material transfer forms. After about six months of this, I told Steve Girard, my direct boss, that I needed a more challenging job. I guess he didn't take me too seriously, and after two or three successive meetings in as many months, I gave him my resignation.

I put Gus, who was pregnant, in the old Chevy, said goodbye to the Olsons at the bottling works, and headed for the West Coast.

## Pacific Bridge Company

In about a month I landed a job at the Pacific Bridge Company—one of the Six Companies—with home offices in San Francisco. Pacific Bridge had taken a license from the Preload Corporation, which allowed it to design and build prestressed concrete tanks using Preload patented design and equipment. The biggest job we got while I worked there was for the construction of 18 large—about 125 feet in diameter—prestressed concrete and domed tanks for the Hyperion Sewage Treatment plant in Los Angeles. I was with Pacific Bridge about two years when Ken Flood and Tim Bedford contacted me. Kaiser-Frazer had bought the Detroit engine plant from Continental Motors, and Tim was appointed general manager and Flood, works manager.

I was offered the position of chief industrial engineer at about twice what I was making, so it didn't take Gus and me long to decide. Besides, the job sounded like it would be challenging. The Hyperion job was about buttoned up, and Clay Bedford had talked to Gorrill Swigert, president and principal owner of Pacific Bridge, who was a good friend of Clay's and paved the way for an amicable departure.

## Detroit Engine Division

The industrial engineering department was responsible for all plant layouts, methods and time study and manpower allocations. This latter job would always cause me to get into the middle of a union grievance and in a short period of time, labor relations was added to my responsibilities. Negotiating with Local 280 of the UAW-CIO was no fun, but it was educational. The union leaders' main objective was to divide direct labor into as many different classifications as possible and get more people on the job. They didn't care about the company's bottom line that was for management to worry about. For example, a machine operator only could load the part, push a button for the particular machining operation, and move the part to the next station. If a tool got dull, a tool changer had to change it. An inspector had to check the dimensional quality of the particular operation. A "chipper" had to clean up the work place, an oiler had to grease the machine. I sure remembered this when I got to Argentina and negotiated our contracts there. We eliminated about 2/3 of the number of different classifications we had at Detroit.

The engine division was like coming home. Old friends—Bill Cannon and Pete Mapes in purchasing; Gordon Woods, tool engineering,; Carl Olson, chief product engineer; Bob Scheuerle ran the final assembly line; Noel Kitchen in planning; Dave Page ran our foundry at Dowagiac, Michigan, and, of course, Ken Flood and Tim Bedford.

With the outbreak of the Korean War, the engine division landed a contract to build the R1300 radial engine under license to the Curtis-Wright Corporation. These engines were used in the T28 trainer and the Sikorsky helicopter. Squeezing in the equipment to make the aero engines and continue the manufacturing of the auto engines was a tough layout problem at both the Detroit plant and its subsidiary, the Dowagiac foundry. But we did it and also made money. By this time, I was general manager of the division. But with Kaiser's acquisition of Willys-Overland in Toledo—renamed Kaiser Jeep Corporation—and its decision to discontinue passenger car manufacturing, the engine division and other ex-Kaiser-Frazer facilities became redundant.

## Argentina

At the suggestion of De Lesseps "Chep" Morrison, then Mayor of New Orleans and later Ambassador to the Organization of American States, Henry Kaiser decided to take a swing through South America to see if there was a way to employ our surplus automotive manufacturing equipment there. On his first trip in August, 1954, he visited several countries, and in Argentina he was accorded a tremendous welcome by President Peron. I was originally slated to go on the first trip since my crew in Detroit had prepared the technical aspects of the proposals to the various countries that Kaiser would visit. At the last minute, however, Mr. Kaiser decided he didn't want any engineers along at this point. Gene Trefethen told me at the time, "Don't worry, the boss will come back with something." Mr. Kaiser's meetings with the Argentines in August, '54, culminated with his promise to return in October with a definitive proposal.

## Proposal Accepted

I was called to Oakland to help prepare it. Our team was led by George Havas, ably assisted by Lloyd Cutler, our Washington counsel, Tim Bedford, Bruno Franceschi, Paul Havas, John Banks, and others from time to time. It became evident we were lacking a lot of basic information on Argentina's infrastructure that would be needed to support an automotive manufacturing operation and John Banks and I were sent down to gather up what we could in the short space of two weeks. The definitive proposal was presented to the Peron government in October, agreed to in principal, and Industrias Kaiser Argentina was incorporated in January, 1955. Kaiser would have about a 35-percent interest in the new company's equity, the Argentine Air Force about 15 percent, and the public about 50 percent.

## Constructing the Plant

Jack Hughes brought a team of Kaiser engineers down, among them Bill Ball, Bob Hammersmith, George Schumann and supplemented them with a lot of Argentine engineers. The KE team designed the plant buildings, conveyors, paint systems, and the like, following the plant layouts, process flow, and plant engineering specs called out by the

Detroit Engine Division crew under the supervision of Ken Flood. Wright Price moved to Cordoba where the plant was to be located and started construction in March, 1955. Thirteen months later, the first vehicle came off the line, a 4-wheel drive Jeep, most of which had been manufactured in the plant. In a short period of time, over 90 percent of our vehicles, by value, were manufactured there, the first integrally manufactured vehicles in Latin America. That was the objective since Argentina did not have the foreign exchange necessary to allow it to import vehicles to satisfy the public demand for transportation.

### Surviving Two Revolutions

I should also relate that during this first 13-month period, our management suffered with the problems brought about by two revolutions. In June, 1955, the Argentine Navy rebelled against the Peron government. While the revolution was aborted in a week or ten days, during this period, Argentine Naval Air pilots attempted to bomb the Casa Rosada (Government House), and Graham Tune, an expatriate Industrial Engineer from the Detroit Engine Division, was killed. It was during the aerial bombardment, as he was returning from lunch to our Buenos Aires office. Graham was a very respected fellow and a good friend. You can well imagine the effect this had on all of us.

Again, in September, 1955, another revolution took place, and this time the Army and the Navy joined together. This resulted in the ouster of President Peron, and the military installed General Lonardi to replace him. Martial law was in effect and in December, 1955, IKA was placed on the Interdiction List of entities as the new government swung into action. Having been organized during the Peron regime, IKA, as well as many other prominent companies, Fiat Motors for example, were suspect, and the new government tried to ferret out proof of any acts of collusion, bribery, or misrepresentation in the organizing of the company. An interventor was appointed to control and audit IKA's on-going operations. Finally, six months or so later, after many meetings with authorities, government audits, document submittals, you name it, the interdiction was lifted on June 21, 1956, which demonstrated that we had been organized legally and correctly. We were the first company to be removed from the list.

### Progress Report to Mr. Kaiser

Henry Kaiser was then living in Honolulu but was keenly interested in IKA's progress. I went there two or three times during the IKA years. Once Gus was with me, and we were invited to the home for dinner. The only other guest was the movie and TV star, Eddie Albert. Mr. Kaiser was an avid TV watcher. He showed me his bedroom where he had three TV sets side by side. He would have all three on visual and one on sound. If he saw something that attracted his attention on one of the other sets, he would switch the sound to it. This way, he told me he had much greater variety.

Mr. Kaiser's office was, in reality a construction shack, located on the edge of a lagoon. These were the days of the Hawaii Kai hotel venture and the Hawaiian village housing project. In reality H. J. was the construction superintendent, and Dave Oppenheim was his leg man. Edgar Kaiser called me once in Argentina and told me that his father would like to get updated on IKA. In the propeller days it took about 36 hours to fly from Buenos Aires to San Francisco. Edgar Kaiser and Steve Girard were waiting for me at the airport, and we got on another plane to Honolulu where we landed in the morning and went straight to Mr. Kaiser's office. We reviewed IKA's progress and problems for a few hours, interspersed with hot dogs that H.J. cooked for us in a microwave oven (one of the first) that was in his office. We finished up about 3 p.m. and Henry said, "I know you all want to get back to work," and we left and got on a plane back to San Francisco. Added up, I went about 60 hours without sleep.

### IKA's Story

IKA and its subsidiaries became the largest manufacturing entity in Argentina. Its story is too long to tell here. *(Editor's Note:* McCloud has written an entire book on the subject entitled, *The IKA Story,* dated 1995.) Suffice it to say that the years I spent in Argentina were the most fruitful and enjoyable of any I have experienced in my professional life. IKA was a continuous expansion program and one that never lacked for surprises that would blow in from the least suspected quarter. As Henry Kaiser often said, "Problems are opportunities in work clothes." Using this criterion, I can assure you we had our share of challenges.

## Back to the USA

In 1967, the year that Henry Kaiser passed away, Kaiser Industries took the final decision to remove itself from the automotive world. I am pretty sure that this decision was approved by Mr. Kaiser before his passing because Edgar had told me in late 1966 that it would probably be approved. This entailed the divestment of all of its automotive holdings, which included the equities in IKA and Willys Overland do Brazil and the wholly owned Kaiser Jeep Corporation. And all of them were profitable at the time. While I didn't particularly like the decision, I had to agree that it was correct. Kaiser's world was raw materials, engineering, and construction—not the retail world.

I remained in Argentina after the divestment for about four years looking after the Kaiser Aluminum operations which included a rolling mill and some mining properties there and in Peru—mainly fluorite deposits. I was also involved with Bob Conner at Guri Dam in Venezuela, attempting to get a fair settlement of our claims on that job. We didn't come close to what we and our partners, Christiani and Nielsen and Merritt, Chapman, Scott left on the table, but that's another story.

## Group President of Kaiser Industries

In January, 1972, I reported for duty in Oakland. I was appointed group president of Kaiser Industries Corporation with direct responsibilities for the operations of Kaiser Aerospace and Electronics, Kaiser Sand and Gravel and a new venture that had just been started—Kaiser Glass Fibers. I was also named a director of Kaiser Industries Corporation.

Gene Trefethen had been the prime mover in starting up the glass fiber operation. He saw another major raw material opportunity as he had foreseen in the case of aluminum. But there was a big difference between the two. The takeover by Kaiser of the war production plants in the cheap energy area of the Northwest, along with a cadre of technologically-competent people was a lot different than the way the entry into glass fibers was being approached. Kaiser Glass Fibers had one man and only one man—Al Lewis—who knew the technology and, to a degree, the industry's market. The plant itself that was located in the Ontario area was nothing more than a pilot plant producing small quantities of reinforced fiber glass mats. To get into a competitive position with the majors in the U.S. —Pittsburgh Plate Glass was the biggest—would take hundreds of millions of dollars in capital outlays and pre-production costs, but of equal importance was technology. Another big difference compared to aluminum was the fact that the U.S. needed the output from the plants we took over, and policy-wise the U.S. wanted to break the Alcoa monopoly. Gene was a bit disappointed, but he and Bill Roesch, who was then in the picture, went along with my recommendation, and we put Kaiser Glass Fibers to bed.

## New KI President

According to memory, sometime in late 1973, Edgar called a top-level meeting at the Bohemian Grove in Edgar's camp at Sleepy Hollow. I had no inkling of what the agenda was going to be, but when I got there and looked around and saw Gene Trefethen, Edgar Kaiser, Jr., Henry Meade Kaiser, Jack Carlson of Steel, Pete Hass of Cement, Cornell Maier of Aluminum, Steve Girard, Chad Calhoun, Jim Parker, and a few others of like stature, I knew something pretty important was coming down. It was a beautiful day, and we sat in a circle of chairs out in the open. With little preamble to his announcement, Edgar stated that Gene would be moving to the vice- chairmanship of Industries, and William A. Roesch, of Jones and Laughlin Steel, would be the new president of Kaiser Industries. This was a bombshell. Gene was a couple of years away from the magic 65 but, as Edgar explained, he wanted a transition period. He also related that he had met Roesch at several steel industry meetings and conventions, was impressed with his managerial abilities, and asked if there were questions. Not many were asked. This was the first time, to my knowledge, that a major executive had been brought in from the "outside" to fill the top executive position of any of the Kaiser companies.

## President of Kaiser Engineers

In the latter half of 1974, Roesch appointed me President of Kaiser Engineers. Lou Oppenheim was then in Kaiser Steel, and I consulted with him. His advice was extremely helpful. KE had a loss for the calendar year 1974, the first year I signed off on. It was caused by the aluminum LNG tank job in Mobile, Alabama. KE was prime contractor to Kaiser Aluminum. The usage of aluminum as a substitute for steel because of the shipping weight advantage in LNG tankage should have had a more intensive experimental stage, but went instead from design to full-scale production. There was nothing wrong with the concept and tank design, but during the tank construction phase, the Coast Guard and

American Bureau of Shipping inspectors, concerned with aluminum's unknowns, nit-picked every weld and connection, causing a tremendous amount of rework. I met several times with Cornell Maier, president of Kaiser Aluminum, in an attempt to get cost relief, but to no avail. Edgar apparently wasn't aware of this because he called me to his office one day—Jim Parker was present also—and bawled me out in no uncertain terms for not working out the problem with Cornell. He later apologized when Jim told him that I had been trying to work out the problem with Cornell. Anyway, this job caused our 1974 calendar loss. And, while I am not sure of the financials, I am pretty sure that Kaiser Engineers reported a profit for every year that followed during my years as president, which culminated with calendar 1982.

## KI Dissolution

In a 1977 Board Meeting of Kaiser Industries Corporation, we voted to dissolve the company. I sat across the table from Edgar Kaiser, and I could sense that this was one of the toughest decisions that he ever had to make. I was thinking to myself also that Henry Kaiser was probably rolling over in his grave. However, aside from the emotional problems, there were good reasons in the interests of the shareholders which I have to admit. On the day we voted to dissolve the company, Kaiser Industries was quoted on the American exchange at about \$4.50 per share. After the dissolution and the distribution of all Kaiser Industries' assets, each shareholder received the equivalent of more than \$25 per share in cash and share values in the Aluminum, Cement, and Steel companies. The IRS had ruled that the share holdings that Industries had in the three affiliates could be distributed directly to the Industries shareholder in prorata amounts. These wholly-owned subsidiaries were primarily Kaiser Engineers, Kaiser Aerospace, and Kaiser Sand and Gravel. But in order to allow a tax-free distribution of assets, they had to be sold and the cash proceeds then distributed. This prevented us from incorporating Kaiser Engineers and the others into one or all of the affiliates prior to the distribution. Another thing one must remember is the fact that the Kaiser Family Foundation, not to be confused with the Kaiser Permanente Hospital Foundation, was the largest single owner of Kaiser Industries shares. The sale provided it liquid assets with a substantial increase, enabling it to carry out the charitable precepts of its founder, Henry J. Kaiser.

My final years with Kaiser Engineers under Raymond ownership were profitable ones, but I must say that it was a different atmosphere from that we enjoyed with the Kaiser Family. While KE did very well, Raymond had some problems that reverberated on us. In one sense, KE was Raymond's cash cow. Raymond borrowed a lot of money to go into offshore drilling in the Gulf of Mexico during a downturn trend in oil prices and later, after I retired, borrowed more to finance the Employee Stock Ownership Program. The debt burden of Raymond reverberated on KE, and Raymond left the picture when the lending agencies caused Kaiser Engineers to be sold. The Washington, D.C. company that took over Kaiser Engineers made many management errors and currently is in bankruptcy. A sad ending.

## Retirement Years

I have managed to keep fairly busy with some community projects. One of them has been the restoration of the *USS Potomac*, President Roosevelt's presidential yacht. Wally Abernathy, then executive director of the Port of Oakland bought the ship when it was being auctioned for its scrap value and asked me to head up the Association for the Preservation of the Presidential Yacht Potomac. James Roosevelt, the President's oldest son, was the Chairman of the Board, and I was the first president. Various union heads and local business executives are members. James Roosevelt was able to obtain a matching grant from Congress in the amount of \$2,500,000 through his personal friend, President Ronald Reagan. We, in turn, more than matched with various corporate contributions, volunteer crafts labor, and in-kind contributions of machinery, materials, and furniture. It took us a few years and after valuing the labor and material donations, contributions, and the congressional grant, the project was valued at over \$6,000,000 total. The *Potomac* was finally opened to the public on Memorial Day, May 20, 1995—about ten years from start to finish. The restored vessel is berthed in the Oakland Estuary at the foot of Clay Street and is open to the public. It goes out on cruises around the Bay, and we concentrate on bringing classes from the Oakland schools to the ship, educating them on the accomplishments of the President, and taking them for a cruise. Michael Roosevelt, son of James, is current board president. His father passed on recently but lived to see the job done.

Another project was the construction of a Skilled Nursing Facility for the Sisters of Mercy Retirement and Care Center in East Oakland. I assisted an old friend, Sister Mary Jean Maier, in this, and we raised the money through contact with various foundations, and I also helped with architect and contractor selection and subsequent supervision. We got the job done, and today the facility is noted for its care of older people who are practically helpless. It has 59 beds, nursing centers, and the special facilities necessary.

Another committee we formed just recently which consists of Cornell Maier, Aluminum; Lee Emerson, Steel; Walt Ousterman, Cement; Jim Vohs, Kaiser Permanete Hospitals; and myself, has as its objective the setting up in the Kaiser Convention Center a permanent museum in honor of H. J. Kaiser. It will contain a tremendous amount of memorabilia, most of which was collected by Gene Trefethen, and is located in his winery in Napa. John Trefethen, Gene's son, is ready to donate it to the memorial. Wish us luck!

## *Looking Backward, Looking Forward by Vic Cole*

*(Editors' Note:* The following interview was published in the May 26, 1981, issue of the *KE News.* It captured the essence of Cole's perceptive mind about capturing new markets for KE. He relates his philosophy of marketing and how it resulted in successful projects in minerals, transportation, synfuels, and coal. His optimisim and drive come through clearly.)

He had scarcely heard of the Kaiser organization and was studying civil engineering at the University of California because he liked to be part of building things and had worked for his dad in the contracting business. In fact, he was pretty certain that after graduation he would sign up to work with an oil company in Southern California, since he had spent two summers with them, and it looked like a good career.

But the year was 1941, with much of the world already at war, and everywhere changes were swiftly underway. The oil company, their situation altered, suggested that Vic Cole look for a job more in tune with the wartime activities. It was his professor at Cal, R. E. Davis, who advised Cole to consider the Kaiser organization and who arranged the initial interview, thus paving the way for what turned out to be a 40-year Kaiser career. Cole retired as KE's executive vice president at the end of May.

"I was instantly taken with the Kaiser people," Cole remembers. "I was impressed with the enthusiasm, the drive, the energy that everyone displayed."

### Shipyard Years

He was offered a job as a junior engineer, to work on the shipyard that Kaiser was building at Richmond, California. "They wanted me to quit school and come right then, in March, 1941," he recalls, "but I waited until I finished school in June. I turned down several other offers that were financially better because I liked the enthusiasm I saw."

In the meantime, he reported back to his classmates at Cal, suggesting that they, too, look into this "dynamic outfit." Many took his suggestion, and about 18 eventually came to work for Kaiser, among them Carl Olson, Hal Andresen, Sam Ruvkun, and Jack Hughes.

Also among his shipyard colleagues was Jim McCloud, a 1941 engineering graduate from Stanford.

"At one time, between us," Cole says, "we were responsible for an entire shipyard that employed 32,000 men and women—I had charge of everything before a ship launched, and Jim had charge of everything after it was in the water."

"During the war," he recalls, "things happened so fast that I never stayed in one assignment more than nine months—from shipyard construction, to shipbuilding itself, to chief engineer, to assistant yard superintendent. It was a fantastic opportunity to learn how to manage people and materials."

The Kaiser Shipyards, he points out, had an outstanding reputation, turning out ships faster and at a lower cost than any other shipyard. During the war, one-third of the U.S. Merchant Marine vessels were built by Kaiser.

### Automobile, Cement, Gypsum

When the war ended and shipbuilding ceased, Cole took other assignments with the Kaiser companies—auto making, cement—and by 1957 he was vice president and assistant general manager of Kaiser Gypsum Corporation.

### Joining Kaiser Engineers

At that point, Kaiser Engineers, still a part of the Kaiser cluster of companies, was designing a huge expansion for Kaiser Steel's plant at Fontana, California. It was a mammoth, complex job, with a lot of money at stake. Midway in the project, the top man took ill, and Cole was transferred to KE and given the job of heading up the project.

"I was unhappy about it at the time," he remembers, "I was upset at interrupting what I thought was a good career, at having to switch into a new line of work."

The Fontana assignment proved to be another important learning experience. The job involved doubling the plant's steelmaking capacity to 3 million tons per year.

Through the 1950s, KE had primarily done engineering and construction work for the other Kaiser companies—in steel, aluminum, cement—but by the end of that decade, KE began to branch out. Cole was involved in the initial marketing of KE's services to the steel industry. Then came minerals work, and the company seized other opportunities that arose.

When someone mentioned that Los Angeles was looking for an engineering and construction firm to handle a transit study, Cole followed up the tip, and KE landed the job.

"We've been working on transit assignments for Los Angeles off and on ever since," Cole says. "Next we got the Washington transit job, and we started to realize that transportation would be a growing field because of urban congestion, for one thing, and the need for public mass transportation in a high-rise environment."

Today, Cole says, KE can no longer rely on opportunities to appear at the door, but has learned to study the market more closely and has come to understand the importance of selling the company's services and skills.

"One of my favorite themes," he says, "is the need to diversify ourselves so that we can achieve the balance to overcome the ups and downs as particular markets fluctuate with economic circumstances. For instance, minerals and metals jobs tend to rise and fall together, and we need to offset that with expertise in other areas, such as power or transportation."

The company's reputation has always been excellent, he says, which allows KE to take on work in other fields that are new but related to previous work. He cites synfuels as an example.

"This was a different area," he points out, "but it uses a lot of our basic skills, and if we're alert, we'll be a major participant in the synfuels area. And the same thing is true with coal."

The company began to do coal work because of the earlier Kaiser affiliation at the Sunnyside mine in Utah and Sparwood in British Columbia.

"Now, we keep doing coal handling facilities and coal preparation plants," he says, "and we're making good strides. Although the U.S. coal business has developed a bit slower than we originally expected, coal will provide major work for for a long time to come. We know the coal reserves are there."

"One thing I've learned," he stresses, "is that you have to have a great deal of patience and tenacity. You have to make a determined effort and stay right there. You may live through some lean times, but you will make it."

Again, synfuels is an example. Cole was a part of the team that in 1973 forged an association with C-E Lummus, a relationship that led to the initial work on the Great Plains Coal Gasification Project.

"It's been a long period from then to now—but we're there, " he says. "I have no doubt that synfuels will be a big field and that any slowdowns will prove to be only a flat spot on the overall rising curve. The need is obvious. The United States has to turn its fuel resources into usable form, part of which is liquid or gas."

And does he have any particular advice for the young engineer, the graduate of 1981?

"I think that once you have landed a job with KE," he muses, "you need to specialize in one or more industry areas. Most of our clients are looking to hire a firm that offers specialized knowledge—in cement plant technology, for example. It's no longer enough to be a darned good civil engineer."

"If I had to sum up KE's strengths," he says, "it would be our specialized skills and knowledge of the industries we serve, combined with our ability to handle complex management assignments—all through our people. We have developed project management systems, excellent project control methods, economical approaches to our work, and, most important, project managers. I think that has everything to do with the company's success."

Others would quickly add that Vic Cole himself has figured considerably in that success.

Two photographs accompanied the *KE News* article. One shows Vic and his wife Marj at the launching of the Kaiser-built ship *USS Oneida* on October 31, 1944, at Richmond. The photo shows Marj with a bottle of champagne about to christen the ship—an honor bestowed on them for the great works accomplished in producing the vessel.

The second photograph shows Vic and Jim McCloud together at his retirement celebration. The caption states that they shared a working relationship that goes back 40 years. In fact, they worked together at the shipyards, then at Willow Run, and finally at Kaiser Engineers.

## *Reflections, Remembrances, Vignettes by Sam Ruvkun*

I spent over four decades with the Kaiser organizations, mostly with Kaiser Engineers. The last 25 years were predominantly in the role of marketing and managing large industrial projects overseas. I am a saver of the bon mot (literally meaning a good word or clever remark or a witticism). That and the little vignettes of everyday life that occurred during my working career are recorded here. They are reflections, remembrances, vignettes, bon mot, oral histories, and anecdotal recollections.

I've enjoyed telling these over the years to anyone who would listen. Now I've correlated them and have recorded them in some kind of an order.

### International Jokes

Everyone likes a joke. Jokes are the same the world over:

During the first detente with the USSR, we were actively pursuing work in Bulgaria. It was during a visit to Oakland of the Minister of Economy that we met a suave, well-dressed young bureaucrat who spoke English in the vernacular. During dinner, he told us how things were in his household. "My wife and I have a 50-50 arrangement. I earn it. And she spends it." Not new but interesting for a Communist to say.

While preparing for my first visit to Russia, I attended a seminar for business men, sponsored by the Department of Commerce in Washington. Addressing this particular dinner was a commercial attache who opened with a joke. He said, "There is a big difference between the moral attitudes in Russia and in the United States. In the U.S., you are fighting against man's inhumanity to man. Whereas in Russia, it's just the opposite."

A Brazilian astronaut goes for a space walk. He returns to the capsule and knocks. A voice from within shouts, "Who's there?"

A Brazilian bumper sticker reads, "Don't bother me. I'm looking at the girls."

George Havas was a great engineer and leader of KE. He also was a master estimator. One day I was recording entries as he spread overhead in an estimate with his slide rule moving a mile a minute. Suddenly, we came to one entry I couldn't take. He called out 2,000 units at $2, about $3,990. His slide rule needed adjustment.

And George Havas the younger, who was my assistant, reminds me of the time we were working away and he started to clean up his papers. I asked where he was going. He said it was 5 p.m., quitting time. I replied, "It can't be. I'm not tired yet."

I was a captive of Henry Kaiser for several days in a hotel room in Bogota, Colombia, where he was trying to develop some coking quality coal fields in Cali, Colombia. He had me making estimates of cost of transporting the coal by pipeline without any technical details having been worked out. He came to my room by the hour checking on my progress, while I kept insisting that we needed professionals to make a feasibility study. Harry Bernat was assigned along with Archie McArthur to do the study. They came back in just a few days. I asked Harry what happened to abort the study so early. Well, he said we looked at the coal seams and decided that it would take very short miners to mine the coal. They would be 6-inches tall. Taking out the coal was not feasible.

We were consultants to Braden Copper Company in Chile. One assignment requested by the mining crew was for us to study the hoist drum for the main mine hoist that had been in use for 50 years. The conjecture was that since this was the lifeline of the mine, there might be metal fatigue. Ernest Putman, our mechanical engineering expert, was assigned to investigate. Upon his return, I asked Ernie if he had an answer. His response was, "It ain't tired yet."

Luis Allende was for years our representative in Buenos Aires. Before that, he assisted me in Oakland. After he had gone on his own for a few years, I ran into him at the American Club in Buenos Aires and was greeted with much gusto. He said what a coincidence it was. He was so happy that he had just won a competition for an engineering project. And he said, I owe it all to you. Because I made "a Sam Ruvkun-type proposal." Well, I was glad for the credit. I'm still not sure what "a Sam Ruvkun-type proposal" really is.

Back to the Tata project. We often arranged for the visiting engineers from India to come to homes for cocktails and dinner. This one evening we had invited several of them to our home and in preparation had notified our children they were coming. When we greeted the guests at the door, my 5-year-old son Gary sounded off with, “But where are their feathers.” We had called them Indian engineers, and he took it literally. Our guests took it with good humor.

One of the client’s representatives during master planning in Oakland for the COSIPA project in Brazil was Luis Araujo. He was a young man who had left his girl friend and was lonesome for her. Arrangements were made for a long-distance marriage, by phone. George and Judith Havas made the wedding ceremony at their home, and Luis made the connection by an 8,000-mile phone hook-up.

I’ll never forget Frank Bilotti’s attempt to order martinis for us in Sao Paolo, Brazil. We were just starting the Willys do Brazil automobile plant and the COSIPA project, and our people did not know the language. Frank was there to set up the books. He volunteered to use his knowlege of Italian to order the drinks. With great gestures, he explained how to mix vermouth and gin with ice in a container and to shake it well. But the waiter didn’t seem to get it. After a while, he nudged Frank and said in perfect English, “Hey, tell me what you want, and I’ll get it for you.”

## Travelling, Driving Overseas

Traffic is terrific overseas. Drivers love to speed, and rules are made for the other guy. My wife used to worry about my frequent air travel, until her first visit to Brazil. Then she realized how dangerous it was to drive in a cab. She no longer worried about the air flights.

Taxi drivers in Iran are no better. On one drive into downtown Teheran, we ran into a one-way street. The driver made the turn and proceeded to back up for two blocks at very high speed.

Old pros at international travel soon learn that it’s dangerous to cross the street at the corner. Drivers have several avenues of attack. Some even aim for the pedestrian to drive them back to the sidewalk. It’s easier and safer to cross in the middle of the block. That way you only have to look two ways to identify where the traffic is coming from.

I flew into the Dominican Republic one day for a return visit. I hailed a cab and asked about the fare. $8, he said. I knew the trip out was $2 the prior visit. So I got out and hailed another cab. Fare...$8. The third cab...$8. Then I noticed the smiles. They had a cartel. I paid the $8.

‘One of the incidents related by Sam Ruvkun (above) in his ‘Reflectionss, Remembrances, and Vignettes’ occurred on the CVG (Guayanas) project, alongside the Orinoco River, where he was inspecting the work of the KE assigned crew. An automobile sedan had been assigned to him for traveling between job sites. Then, one night he parked it in the well-lit parking lot of the Holiday Inn in Puerto Ordaz. The next morning as he started the car, he gave it a double take, and found the engine hood missing. Someone needed it badly. He inspected the CVG work using this hoodless car for the next two days until a replacement was made available.

I arrived at the Sao Paolo airport one day and was met by Bill Simonsen, our local representative, in a rather new small Ford. Enroute into the city a truck in front of us threw a small rock that hit our windshield just right so that it shattered in place, making it impossible to see. I navigated Bill over to the shoulder, and we then removed all the broken glass. How do you drive without a windshield? At first, we rolled the windows down, and the wind blew mightily. Then we closed the windows. Guess what? It was like driving in an enclosed automobile.

Traveling overseas is always an experience. When travelling with my co-workers, I like to start out quoting my two rules of travel. The first: if anything can go wrong on a trip, it will. The second rule: and if it does, I don't want to hear about it.

When I stopped traveling, I had logged over 2,000,000 miles.

## The Bon Mot

When we were doing the Tata project in Oakland, I would visit the draft...(whoops, George Schuman prohibited calling it a drafting room) ...the design office. One day I passed the board of Tony Witkowski and greeted him with, "Tony, how are you?" His answer was, "Better." "How better?" "Better not to talk about it!"

Mike Janner is remembered for his one-liners. One day one of our cohorts was down at the mouth. Mike looked at him in all seriousness and said, "Cheer up. It's not as bad as you think. It's worse."

Here's Mike again relating his experience with British forces during the war. They posted a sign reading, "We did it!" Followed by another sign that read, "What is it?"

When studying for my registration examination, I was told about the answer to a New York exam when an "Amusement Engineer" was asked what safety factor he used in designing loop-de-loops and scenic railways. His answer was nine tenths. "You mean less than one?" "Why?" The answer he gave was...to give the customer a better thrill.

The final exam at West Point is how do you put up a flagpole. The number one student in the class describes the stresses on the ropes, the angles to be used in lifting and a lot of technical jargon. Wrong. The number two student describes the lifting gear needed, the size of the hole and where the lifting points will be. Wrong again. Then the student who entered from serving in the ranks comes to bat. He thinks a while and answers, "I would say 'Sergeant, put up the flag pole.'" That was the right answer.

Frank Kast and I were working on a proposal. The question became how to convince the client that he needed a planning document. Frank's comment was, "You can't get there without a road map." Then, when we spoke of establishing a baseline, he said, "You don't know where you're going if you don't know where you're at."

Bruno Franceschi liked to be precise. He didn't want his staff to assume anything. He said "When you ASSUME, you make an ASS out of U and ME."

We were in an intense planning session with an important client from Chile when it was decided to consider a special copper by-product precipitator. We didn't know what it would look like, but the mining engineers present gave a general idea of it. Then it was decided to have a cost guestimate made. We called Ed Lowell into the conference room and with waving of hands and approximation of sizes, asked him to run the numbers. He asked how much time he had and was told...one hour.

Ed returned in the hour with one of his famous green estimating sheets and set his estimate down in front of us. The title read, "WAG Estimate." He defined this as...a Wild-Assed Guess. Good enough. Now we wanted more refinement and gave him another hour. At the assigned time, he returned with the second try. This time it read, "SWAG Estimate." What was that? "Well, since I had the luxury of this second hour, it is now "a Scientific Wild-Assed Guess."

We sometimes faced problems in communications. I was presented with this brass plaque to commemorate a favorite saying, "I know you believe you understand what you think I said, but I am not sure you realize that what you heard is not what I meant."

And lest we get too smug about our profession, I like this bromide: "An engineer is one who passes as an expert On the strength of being able to turn out with prolific fortitude, Strings of in-comprehensible formulae Calculated with micrometric precision From extremely vague assumptions, acquired from inconclusive tests carried out with instruments of problematical accuracy By persons of doubtful reliability And of rather dubious mentality.

Earl Peacock respects authority, having been a military man for many years. Once in a while he disagrees with his boss. Once he was heard to start his objection by saying, “You son-of-a- bitch…SIR!”

Claude Harper was the vice president and general manager of Kaiser Gypsum who would come to lunch and tell hilarious stories about his business experiences. This one day he was especially frustrated by a review of a complex legal document. After describing what it was about, he said he got so confused that, “I could not tell who was the f—ee and who was the f—er!”

## Not Too Good Construction

Working overseas or working in the U.S., not all construction comes out well.

We are now at Richmond Shipyard #3 during construction of the graving docks. Our engineering department showed how to build a cofferdam to allow dewatering of the docks. So high, so wide with clay core, using small rocks for face protection. Comes construction time, at night, and Pop Baker, the construction superintendent, ignores the design and brings in the largest boulders he can find so that he can make production volume. Here is Harry Bernat, the designer, on the shore hollering and waving his arms for them to stop. To no avail. Finally, after much effort the cofferdam is made waterproof.

After the graving docks are completed, it’s time to remove the cofferdam. No dragline was big enough to take out the rocks...divers placing blasting powder finally saved the day.

We’re still at Richmond. To carry some of the workers from San Francisco it is decided to install a ferry system, requiring a new ferry slip at the yard. There being a war on, no treated piles were available. Someone remembered a Navy research project that said copperized piles would do the trick. Piles were ordered and driven. The slip worked fine until the first foggy day.

Then the ferry captain could not find the center of the slip, landed off-center, hitting the structure rather hard. The piles snapped and the slip was inoperative.

In an investigation the next day here is Bill Ball with his trusted camera, a ruler marking the piles and there in the middle were many marine borers (teredos) measuring over 8 inches in length. They had eaten through the piles. Rather than being a deterrent, the copperized piles fed the teredos.

We were designing a new steel mill near Sao Paolo, Brazil, on an old banana orchard. Next to the orchard was a hill, which served as a source of rock for filling in the marsh area. Our design called for the plant water system to have its main tank mounted on the hill which would provide a natural head and an ideal location. Enter the local civil engineer who had been the mayor of the town and was noted for his civil engineering ability.

At a Board of Director’s meeting, he shot down the KE design on the trumped-up theory that the hill was unstable. Instead, he wanted to design a very large elevated concrete tank to be sited at the foot of the hill. It was obvious that he wanted to build a monument. The Board approved his going ahead, and designs were completed.

Fortunately, before the monument could be built, a new professional group took over running the steel mill construction, and our hillside tank was eventually built.

One of our consulting projects was in the Guayanas area of Venezuela on the Orinoco River. We came in after engineering had been underway and had a field staff monitoring the construction. One day Frank Walker came in to say something was wrong with the layout of a main water line.

The stakes showed it running up over a knoll and then down again, whereas a slight arc would avoid the hill entirely. When we questioned the designer in Caracas, he disclaimed any responsibility. He explained how he had bid lump sum on the design. The client refused to allow time for his engineers to visit the site. All field data was supplied by the client. Obviously, the survey was wrong and by eye-balling one could detect it. But the client got low-cost engineering and very costly construction.

KE had an iron ore project in Canada for which a tailings pipeline was required. Harry Bernat was the designer and planned to put it underground. The client insisted that putting it above ground would save a great deal of money. Harry persisted in explaining the hazards. But the client kept insisting . Finally, Harry spent a lot of time making calculations and concluded that the line would freeze in the winter. The client still decided to build it above ground.

To try to get his point across Harry said, "If you do, you're going to have the largest icicle in North America." He was right. The next year the line froze up and burst.

My friend Poncho Soza in Chile built a great many apartment projects. One day he was showing me around one that he was particularly proud of. But when we came upon one of the rooms not yet finished, here was an obrero with hammer and chisel, chipping out the newly poured concrete to allow for installation of electrical conduits and outlets. I commented to Poncho that I knew he knew about modern construction practices, but I didn't understand why they were doing it this way. Certainly, he could put an engineer on the job to layout the conduit before concrete was poured. He answered that you know it and I know it. But, if I had that talented engineer who could preorder the electrical gear and lay it out on a drawing and supervise the installation....I would not use him for that purpose. I would put him on getting more business. After all, it doesn't cost very much for this obrero to chip it out.

### My Most Unforgettable Characters

Ed Husted (1942)...was not exactly a Kaiser employee. He was the materials controller for the United States Maritime Commission, an agency that approved all materials purchases at Yard #3 in Richmond. People who normally brought requisitions to him for approval were warehousemen and expediters. I later found them to be at odds with him after a short time that he had the position. What I found out later was that some of these fellows, drew an instant impression that he was an old maid, and that they could hoodwink him with reasons for materials needs rather than giving solid facts. This proved to be a mistake.

One day my boss, Einar Larsen, general manager of Yard #3, was sent off on a secret mission with Mr. Kaiser (later I discovered it was to negotiate the Kaiser-Hughes plywood aircraft deal). Pinch-hitting for him was a VIP from the Oakland office, one A. B. Ordway.

The first thing Ord did was sit down at my desk and ask *me* what he should do next! Me?

A 23-year-old kid?

I suggested that one of the projects left pending was the need to justify to Mr. Husted the purchase of 19 forklift trucks for warehousing. These were controlled tightly by the War Production Board, requiring priority justification. Ord, said, "Fine, Sam, you prepare the justification."

Then after two weeks of analysis and drafting and redrafting a justification, Ord signed the letter and said, "Now, Sam, go down the hall and submit it to Mr. Husted." Who? Me? I knew of the problems the field staff had had with this guy. Why was Ord throwing me to the wolf?

Husted was pleasant enough. He read the letter carefully and then looked up and asked, "Did you write this letter?" In the littlest voice I could muster, I replied in the affirmative.

Pause. "Good letter."

Then he asked why was one needed in the sorting yard. My answer was, "I don't know, but I'll go find out." As I started out the door, he said, "No. Wait. I'll sign this, and when you find out, let me know." Whew!

When I returned to my desk, it was as if I were a hero. Ord wanted to know what I told him. My reply was that I didn't know the answer to his question. This was the correct answer. The man did not want false answers. I told the simple truth. And for my remaining time at Yard #3, Ed Husted and I became great friends, and I became the designated approval-getter.

Who was this guy? As I got to know him better, I visited in his office often. One day I looked over a picture of a horse. He said it was his. It's name...War Admiral, winner of the Preakness. Another day I looked at a picture of Husted with a familiar pilot in front of a WW I Spad airplane. He said, "That is Eddie Rickenbacker. He and I flew with the Lafayette Escadrille and, incidentally, I was also an ace, too."

And then I found out he was a successful home builder in the Tucson, Arizona, area. When I decided I could no longer stay out of the military, I was assigned to Tucson for indoctrination into the Navy. Ed Husted volunteered his little mansion in the Catalina Foothill Estates for my wife to stay while I was on the base being indoctrinated.

Far from being a weakling, this *was* a man!

I should call this piece, "The Romance of Engineering" in honor of my first engineering boss. It was Art Shaw, who, during my last summer at college, supervised my surveying crew. As we traipsed through the 4-foot high weeds, in 105-degree heat in the shade (but there was no shade) and, as the mosquitoes bit at our necks, or we still couldn't find that corner stake we were looking for... he would remark..."Ah, the Romance of

Engineering." And whenever something else went awry, it was again, "Ah, the Romance of Engineering."

Art Shaw (vintage 1939)... was a character out of World War I. He was the party chief of a surveying party...a typical SI (so named after the illiterate sivil ingineer). He wore a WW I wide-brimmed sombrero, leather leggings, and baggy breeches. It was he who coined the phrase "Ah, the Romance of Engineering." We once were instructed to look for ancient mile monuments somewhere in cracked adobe, with 1-inch wide cracks. After digging with pick and shovel and still failing to find the monument...he regaled us with this tale. The old-time surveyor measured the mile posts by tying a rag to the wheel of his buggy and then counted the number of rotations of the wheel. That was why we couldn't find the monument. Again, "Ah, the Romance of Engineering."

## Language Problems

We were working on hydroelectric projects on the Iguaçu River of Brazil. On one of my visits to Curitiba, the president of the power company introduced me to Leonaldo de Lima and announced that Leonaldo would be visiting us in connection with a report we were preparing. At that time his English was poor. By the time he came to Oakland his English had improved, and he was able to navigate pretty well. On completion of his assignment, we had a despidida for him, and I asked him how he found things as compared to what he expected when he left Brazil. He got quite excited when he said, "I want to face my English teacher right away. When I go to a store and buy something, I say, 'Thank You' as I was taught. The teacher said the response would be, 'You're welcome.' Not so! Where is it written in the book that the response is 'You Betcha?'"

On my first visit to Russia, I was to be accompanied by a member of Kaiser Trading's staff from London because he had been to Russia several times and knew his way around. At the last minute his visa did not arrive, so I went alone. It was as if a blind man had arrived in Moscow. I didn't know Russian and had no clue as to the Cyrillic alphabet. Somehow, I made my way to the Rossiya hotel, the largest hotel in the world with 6,000 rooms. After registering, I decided to go for a walk, looking for Red Square. There were no signs (if there were, I couldn't read them) so that I couldn't find it. The next day I found out...I was standing in it.

When I returned to the hotel, I got lost and could not find my way to my room. Each floor had an attendant. I was beyond the curtained-off area, so the attendant opened up and let me in. Then an hour later I decided to try again. Again I got lost. Again the attendant let me in. I heard her say something like, "Idiot, Americanski"…which I thought was rather crude. It was much later, when studying the language, that I learned that she was not insulting me. She was making a statement that translates to "Here comes the American again."

Later in the same trip to Russia, I decided after my translator left for home, to solo on the Metro to go to the famous Russian Cirque (circus). I was chaperoned to the starting station, and two travelers were asked to alert me for the proper station stop, which they agreed to do. But before I knew it, they got off without a word to me. By luck, I got off at the right stop.

Then came the fun. I could not see the dome that was described to me and had no idea which way to go. I saw a man reading a newspaper at the Metro exit, and holding my red ticket up to him, I asked "Cirque? Cirque?" He looked up, put down his paper, pointed and said in perfect English "It's over there."

Now I'm in Paris, just returning from a two-month assignment in Finland. Again I'm out for a walk in downtown Paris, having been put up in the Continental Hotel. On the way back I got lost. The first gendarme I saw I approached with all innocence and asked, "Continental Hotel?" No response. Que? Que? Try again. "CONT-in-ental" or "Cont-in-ENT-al." No response. So I took out a piece of paper and wrote it. He said, "Oui. Continent-ALL!"

Now I'm in Genoa, having gone out for my early morning walk. This day I took a wrong turn in the cow trails that serve as streets of Genoa. It was getting late for my 8:30 meeting. Finally, I saw a line up of taxi's and got into the first one, announcing that I wanted to go to the Metropole Hotel. A quizzical look. An OK. Then the driver flipped the meter flag; turned the corner into the entry of the Metropole. Full fare charged.

Traveling between countries of Latin America, one needs to keep straight the different dialects and languages. Spanish is different from Portuguese. "Habla" and "Fala" for speaking. An office can be an oficina or an escritorio. Butter can be manteca or mantequilla.

As in most languages, phonetics play a part in understanding them. On a visit to Santiago, Chile, I noticed an ice cream push cart in the suburbs. The lettering on the side looked strange until I pronounced it phonetically as a Spanish-speaking person would. The lettering on the side read, "Hay Scrim…Helado." The first word is pronounced "eye." The second one "screem." Oh. It's "ice cream." Helado is ice cream in Spanish. In other words it's "ice cream, ice cream."

In Chile, KE had a fine relationship with a local construction firm, the head of which was Poncho Soza. Poncho and I hit off a mutual appreciation for each other, and on each visit we would discuss general philosophy and construction practices. The trouble was that Poncho was not comfortable speaking English, but read and understood it well. I was the opposite. I was not comfortable speaking Spanish, but read it and understood it.

Our conversations were a kick for anyone else to behold…Poncho speaking in Spanish and in a very animated way and me speaking English with gestures and all. We understood each other in more ways than just language. I learned his philosophy of life, business, and ethics.

## Foreign Entanglements

Inevitably, when marketing one's wares internationally, one gets involved in learning about local politics. As goes the politics of a country, so goes its economic health and ,ultimately, if both things are favorable, markets open up for our services. A few things of note occurred during my regime as a KE marketer.

Kaiser Industries explored iron ore mining in Brazil and employed a prominent local mining engineer to give expert advice. I used his services also. On each of my quarterly trips to Brazil, I would call on Glaicon de Paiva and discuss the state of affairs. As we usually did, on this one occasion we started discussing local politics of early 1970, which had reached an impasse with rumors of malfeasance in the presidency, ineptitude, and a general distrust of him. Glaicon gave a lucid description of what he thought the business community should do, including enlisting the aid of the respected military. Soon thereafter, there was a successful military coup, which installed a new president. A month later, when reading my *Reader's Digest*, I came across a first person article about the Brazilian coup. I was surprised to read that the ringleader of the coup was Glaicon de Paiva. Here I heard it from the oracle, telling me beforehand what was about to happen. It was not hypothetical at all. He was telling me what was going to happen in a couple of weeks.

KE had a construction management project in Ascunsion, Paraguay, to build water-treating facilities. When it came time to inaugurate the facilities, I was asked to say a few words. It came my turn to go to the podium, and I realized that the U.S. ambassador was not there. I identified him in the audience and addressed him along with President Stroesner. (There was great rustling as they now found space for him on the podium). I then learned that my talk was being aired all over the country by radio in Spanish. At the conclusion, President Stroesner sought me out and said, "Thank you for your kind words."

In 1972, Kaiser companies were invited to go to Managua, Nicaragua, to see if we could help after their severe earthquake of that year. Henry Mead Kaiser and I were the team invited. Eventually, arrangements were made for us to have dinner with President Somoza. Here was an engineer-type educated at the U.S. military academy. We had a captive audience, but we couldn't get him to talk about our proposal. All evening was spent in his questioning Henry about his grandfather, the empire, and how Henry was involved in the business. Needless to say, we didn't get any business.

We made a successful proposal to Indonesia to rescue its Krakatau steel mill. When it came time to execute our contract, I was ushered in to see the Minister of Administrative Reform. Dr. Sumarlin, got his Ph.D. in economics from Berkeley. Most of the meeting was spent updating him on Berkeley. Later, I discovered that four of the ministers running the government got Ph.D.s from Berkeley. They were affectionately called, "the Berkeley Mafia," a name which I later saw in popular print even in the U.S.

Now I'm in Russia pursuing a new container port project for the Black Sea Shipping Lines out of Odessa. There was no official way to get from Moscow to Odessa, so I merely ordered an air flight and went. When I showed up, there was some consternation about how I got there and whether or not I was an official visitor. Anyway, they agreed to show me around with the chief engineer and his driver showing me the facilities.

This day happened to be a rainy day. And Russian drivers drive fast. As we approached a truck, our car went into a skid, and we rammed the truck. My only pain was in my shins as my legs got forced against the front seat.

The chief engineer was quite anxious about what my reaction would be. He gave great kudos about what a good driver the man was. He wanted to be sure that I did not file a complaint. I did not. When I got back to Moscow, all officialdom knew of my escapade. It did help me get some attention for getting appointments (a difficult task in Moscow usually).

General Macedo Soares was the president of COSIPA and previously built and operated an integrated steel mill at Volta Redondo, Brazil. When he came to Oakland to review our planning effort, he related a story that just occurred. On the way to Oakland, he stopped off in Caracas, Venezuela, to consult on their new steel mill. He noticed, he said, an inordinate number of military personnel and asked his hosts why they needed so many. The answer was “for defense.”

He asked, “Who do you think your enemy might be? Certainly, you could not be successful in a war with the United States. Or maybe you might go to war with your neighbor, Brazil. And if you did, you might win! Then what would you do?”

At the early stages of our work for the Tata project in India, we prepared a number of engineering documents including general specs, budget estimate, program, and procedure manuals. We spent a great deal of time making them presentable for the impending visit of the Chairman of Tata Iron and Steel, Mr. J.R.D. Tata. George Havas and I traveled to New York to make the presentation at Mr. Tata’s suite in the Waldorf Astoria.

We set the documents down on his coffee table, and he opened up the first document to read the frontispiece, which was a map of India we had copied from a handy atlas. All hell broke loose. He was angry, complaining about our insensitivity to India’s concerns. Inadvertently, we had shown Kashmir as not being part of India. Our map was obsolete. But our knowledge of recent skirmishes with Pakistan was nil. It took the entire session to assure him that all maps would be changed and that it was an innocent mistake. My recollection is that little other time was spent on the real purpose of the meeting. Epilogue: as of early 2000*s*, the Kashmir dispute between India and Pakistan is still going on.

My nephew, Steve, knew of my frequent travels overseas. He tells me he noticed that wherever I would go there would be some sort of uproar or insurrection. He was convinced that I was a secret member of the CIA! No, Steve, just KE at work.

## *HJK Tales & The Fifth Kiln by Harry Thayer*

### The Stealth Performance Bond
(Source: Alden McElrath)

Mac was working on a bid for some hydro project in the Pacific Northwest, along with Henry Kaiser and some other helpers. The schedule was pretty tight so they had to finish the bid on the SP on the way up to Portland.

When they got to Portland, where they were to transfer to the SP&S for points east, Henry left them all in the Union Station, saying, “Now you fellows wait for me here. I have to go and get the performance bond. So off he goes to some bondsman in downtown Portland.

He comes back with a grin on his face and tells the fellows how these things are done. “I got the bond,” he said, “for 30 percent higher than our bid. That’s so those sneaky guys who go around bribing bondsmen won’t be able to find out what our bid was!”

Mac then said to me, “Now that would never have occurred to me without someone telling me about it.” I said, “I wonder if things like that are why Henry Kaiser was Henry Kaiser and we were just us.”

### Instant Paradise
(Source: *Time* Magazine)

The physical facts herein were recently confirmed by a Deadwood Associates member who actually worked on the project. *(Editor’s Note:* Deadwood Associates is the name used by Kaiser retirees who meet for lunch monthly at the Hungry Hunter Restaurant in Lafayette.)

When Henry Kaiser first “retired” to Hawaii, he started retirement hobbies that were quite annoying to the Six Companies who thought they had things under control. His first hobby was his new hotel.

The Six Companies could have cared less about Henry’s finding a nice lagoon or ocean-side property; all that he found available was an old, shallow, muddy, backwater slough with a garbage dump on each bank. This didn’t bother Henry in the least. He brought in trucks and shovels and hauled all the garbage away. Then he brought in a dredge and deepened the slough and widened it until it began to look better. Then he hauled in

300,000 yards of nice white sand and built a couple of pretty beaches on the banks of what was now becoming a tropical lagoon. Next came another umpteen thousand yards of sand to build a nice island in the middle of the lagoon.

Then came giant trucks and cranes to bring in full-grown palm trees to plant on the island and behind the new beaches. Finally tropical plants in bloom, flowering shrubs, and winding, crushed-seashell pathways in amongst the beautiful flowers and under the shady palms.

Presto! Instant tropical paradise, lacking only Esther Williams!

The first act in the lounge was Red Skelton, but first the management gave him the grand tour of all this synthetic splendor. Red looked on in awe, and didn't say anything until the tour's end. Then, with his wicked grin, "My, what God could have done if he'd only had money!"

### Sabotaged Mail Box

*(Source:* Bob Condit, a KE piping engineer who came down to Baton Rouge to take field measurements of all of the piping to which the new expansion was to connect. Nan reminded me not to forget the mailbox, a tale we heard shortly after it occurred, while we were in Baton Rouge.)

Alcoa, or so the story went, really wasn't interested in saving their successors any expense at all, such as Bob's surveying. You see, they had built and operated this plant for the government as an emergency, wartime measure. When the war ended and it came time for the government to dispose of these excess plants, Alcoa cleared out all the files, including every plant drawing; hence Bob. They even removed every drop of caustic soda from the process system

Well, anyway the mailbox. Bob had been assigned, before he came down to Baton Rouge, to Henry's new estate in Lafayette. The project was swarming with Kaiser Engineers, both in Lafayette and at the Oakland office.

The project manager and a project engineer teamed up with a KE architect to dream up a suitable mailbox. The theme of the whole estate was Hawaiian, so this little team settled on a perfect scale replica of a Hawaiian hut as the ideal mailbox.

So the architect does the rendering, and gets it approved, and then the detail drawings and then specs, and they're all set. Then the project engineer and the architect visit a first-class model builder, and then *he* goes to work. And a few weeks later it's all done, and they have the grand installation on a nice white post at the estate's driveway entrance.

Bob said at this point, with the project engineer, and the project manager, and the architect, and the model builder, and the installation workers, that this mailbox probably didn't cost more than five thousand dollars, 1951 money.

So now comes the little *Tribune* carrier, 11 years old, on his bicycle, and nails up his orange Tribune can on the side of the mailbox, just as he does for the rest of his customers. He probably thought he was doing Mr. Kaiser a favor, but that was probably not the effect that the KE project team had in mind.

### Midnight Lawnseed
### (Source: H. V. Lindbergh)

Lindy was one of Henry Kaiser's principal troubleshooters. Dick Socolich and I were talking to him one day about a Kaiser Industries real-estate project, and Lindy took the opportunity to tell a couple of Henry Kaiser stories.

One night shortly after midnight the phone rang and Lindy got out of bed to answer it. It was Henry from Honolulu. Henry didn't pay much attention to time zones nor to his helpers' sleeping status.

He figured first, that all his principal assistants were as interested in work as he was—I mean it's such fun, what else is there?—and second, why were they getting so much money if not to suffer a little inconvenience from time to time. Probably 95 percent of said assistants agreed with both propositions.

Anyway, Henry said, "Lindy, we're about to get into final landscaping on this housing development of ours, and I need to know what kind of lawnseed does best over here in this tropical climate. Can you give me a hand on that?"

"Certainly, Mr. Kaiser," said Lindy as he climbed into his bathrobe. Now Lindy knew from long experience that Henry didn't mean tomorrow morning when the normal workday started, and Henry knew that Lindy understood "right now." So Lindy wrote down the phone numbers of the CEOs of the five top lawnseed companies in the U.S. I don't know if he had a *Thomas Register* at home with him, or if he had to get Joe Rowan, KE's procurement manager out of bed to read him these names. Anyway, Lindy proceeded to rout all these CEOs out of bed, one by one, to ask his question. They may have known the answer themselves; probably they, in turn, had to get some helper out of bed to dig up the answer. None of them minded in the least—the vision of Kaiser millions flowing into their bank accounts soothed all irritations about being summoned in the wee small hours. So pretty soon Lindy had his answers and phoned Henry back, just as Mr. Kaiser assumed he would.

### Quicky Survey
### (Source: Doug Boswell)

Doug was my insurance agent 35 years ago, and he said that he was on the survey team that did Hoffman Boulevard Extension, the cut-off from Albany along the mud flats to the Richmond shipyards.

The shipyard management had to somehow relieve the tremendous traffic jams on San Pablo Avenue as 90,000 workers tried to get to and from the shipyards. They needed to relieve Hoffman Boulevard, which also was to have an interurban railway alongside to haul shipyard workers from the Berkeley ferry.

Doug said that management had given the survey party eight whole hours to do the final layout for four and one quarter miles of route. Doug said he was on the dead run for most of the day, dragging the chain from station to station. With that short a schedule, they couldn't have done much more than place centerline stakes, with cut and fill elevations written on them, leaving development of the cross section to the skill of the scraper operators. *(Editor's Note:* Einar Larsen who was manager of Yard #3 in Richmond had been for years a design engineer for the California Highway Department. *He* was the designer and ramrod for construction of the cut-off roadway.)

### 'Look Ma, No Footings'
### (Source: Arnold Kackman)

Arnold got this from John Garoutte, the Permanente plant manager, at least in 1950 when I was at the Fifth Kiln job. Garoutte liked to needle Arnold about how cement plant construction in the '80s took thirty months, at least. "What's the matter with you guys?" said Garoutte. "Back then we did them in nine months!" So then Garoutte told him about the construction of the original two-kiln plant in 1939. Like everything else Henry Kaiser did, it was in a hurry. At that time, Garoutte was in charge of steel erection, and it had come time for him to do the main mill building. Just one little problem, according to Garoutte: the foundation contractor hadn't shown up on schedule, so Garoutte was faced with a bare plot of dirt. So Garoutte, having to meet his own schedule, "floated" all the columns. As you know, this meant straddling the future space for each footing with a pair of beams supported on temporary cribbing at each end, with the column fastened to the beams. I hope Garoutte was kind enough to leave space for some minimum backslope for the future excavation, but I'm not sure about that.

When the footing contractor showed up, he started crying the blues, and Garoutte said, "That's not my problem," and walked away. He'd met his schedule, which, you might say, had "float" in it.

### Christmas Present for Mr. Kaiser
### (Source: The Old-timers at Permanente When I Worked There in 1950)

We all read in the December, 1939, newspapers about Mr. Kaiser's "boys" at Permanente starting up the new cement plant six months after their June, 1939, start. They thought it would be nice to send him the first sack of cement made in his brand new plant. He was on Christmas vacation at the time, at his vacation place on Orcas Island in Puget Sound. Well, the old-timers told me how that came about.

The plant was pretty well along in December, but still some months from start-up. One of the kilns and the clinker cooler at the end of it were done, and so was one finish mill, and they had power to all those. No clinker conveyors, though, nor any clinker bins. So, wanting to make points with the boss, and very proud of their progress to date, they lined up a gang of laborers with wheelbarrows at the downstream end of the completed clinker cooler—then started the kiln and pumped in the slurry. When the still-warn and smoking clinker began coming out the end of the cooler, the laborers caught it in their wheelbarrows and wheeled it over to the finish mill, and they ground up a sack of cement. They must have had a chute down that tall retaining wall at Permanente between the kiln level and the mill level, with more wheelbarrows at the bottom.

After all that, of course, they got back to work for another three months to really finish the plant.

### That Was One Filthy Cement Plant
### (Source: I Was There)

We had been working pretty hard for six months on the Fifth Kiln at Permanente and, concentrating on the work, apparently we had let housekeeping slide. So, in January of 1951, the place really might not have looked all that great. Scrap lumber and stripped forms were lying around helter-skelter in various places. The dirt roads were rutted and muddy with inconvenient puddles. Compressor hoses and temporary cables were draped at random over the work, and trash accumulations were pretty frequent. The cement folks one night had let a slurry tank overflow, and the dried slurry on the side of the concrete tank didn't help any. But we were concentrating on the work so we didn't even notice.

Henry came to visit John Garoutte in the front office, and then they toured the job. The story I heard was that Henry turned to Garoutte and said something to the effect that this is the crummiest plant I've ever seen, and I'm coming back in two weeks, and if everything isn't spic and span, I'll get a plant manager who knows what he's doing.

Having it called to our attention that way, we noticed the problem—then not a lick of construction got done for three days, as everyone turned to and had a clean sweepdown, fore and aft. Every available cement person went to work, too, and the place looked much better.

So then comes the day for the two-week inspection, and, I was told, Henry stopped off to pick up Garoutte, then drove up the road to the quarry, completely by-passing the plant. He didn't feel he had to waste his time; he knew the plant would be clean!

## Brave Bulldozer Operator

I'll not soon forget a bulldozer operator at the Fifth Kiln job—I never knew his name—who made the new cut north of the Cottrel precipitator extension; the road around the building had to be widened to provide space for the expansion. The problem was that the north side of the road was a cut about 100 feet high, standing at about a 1:20 slope, a cliff in other words.

So this operator puts his D-7 in low and works his way up the hillside to the top of the cut—then stops and angles his blade so that the forward corner points in towards the hill. Then, with his outside tread no more than 18 inches from the edge of the 100-foot cliff, he takes his first cut, flattening off the top of the hillside a little bit. Then he backs up and takes off a little more, and so forth until he has a flat bench, and then it's just a matter of working the bench down to road level. The tractor was never more than 18 inches from the drop-off. I would have been leery of just standing at cliff's edge, but he drove a bulldozer there. Actually, the Franciscan was pretty solid—cherts and slates and shales and limestone lenses, but one can always run into an unknown, weak seam which would have sent the tractor crashing to the road below. It was a very nervy exhibition, and the vicarious experience was very useful to me at an Oak Ridge job nine years later, which I'll write about after a while.

## Kiln Drive Motor

Corporate life, I was pleased to discover, was rife with drollery, and life in the field perhaps even more so. The Fifth Kiln was no exception. The kiln's drive motor, for example, provided its share of laughs.

This motor was delivered very early in the job and was stored in our office building, an old warehouse. We walked through the warehouse area to and from our office in a corner room. The last thing we walked past before entering the office was that motor. It was a pale green with a clockwise rotation arrow cast into the housing. The arrow was painted a bright red so no one could miss it. Well, that motor sat there for perhaps seven months until it was time to install it in the drive house.

It was just then that the light dawned on some one. The first four drive houses were on the west sides of the kilns; the fifth drive house was on the east side, but someone had specified a duplicate motor. It wasn't too bad a fix. Factory people came in and reversed the interior wiring. They couldn't un-cast the arrow however; I guess they just painted it over.

But the drollest part was that no one could say much about it. The only people who had been walking past this bright red arrow at least four times a day for seven months were the junior engineer, the field engineer, the construction superintendent, the millwright foreman, the electrical superintendent, plus frequent trips from Oakland by the division manager and the project manager. Everyone just did a slow burn.

## Disconnecting Interlocks

The kiln drive house was the locale for another funny bit. The auxiliary drive motor there was a small diesel engine with a spur gear arranged to engage the main bull gear when a clutch was thrown. This engine turned over about 3000 rpm max, and its sole purpose was to keep the kiln rotating very slowly when electric power failed so that the red-hot kiln wouldn't take a permanent and ruinous warp. We installed an automatic lockout so that the main drive motor couldn't start if the auxiliary spur-gear clutch were engaged.

Well, one morning I noticed a sizeable gang milling around the drive house, so I went inside to see what was going on. The floor was covered with oil, the crankcase pan was lying in shattered pieces, bits of bearing caps were lying around, and the crank shaft, also on the floor had been bent into a Z shape by the explosion on the graveyard shift. The main motor had been started while the auxiliary clutch was engaged; they figured that the diesel had got up to 11,000 rpm before it exploded.

Jim Lake, our electrical superintendent, told me what brought all that about. Oakland Design had come in with a complete, plant-wide set of interlocks to keep accidents like this from happening, and Jim had seen to their installation. Now Permanente, said Jim, had this philosophy about interlocks—they interfered with production, they thought. So before they started the new plant, they went around and disconnected most of the interlocks. They apparently disconnected one too many for the well being of the auxiliary diesel.

## Blow Torch in the Toolbox

Jim was a very competent electrical superintendent, a veteran of Fontana like a lot of others on that job, and one of the smoothest talkers you'd ever meet. He was never at a loss for the killer comeback if you tried to back him into a corner. All this was done in a very agreeable way, however; Jim was an exceedingly likeable fellow.

Once there was an electrician's dispute in which the steward claimed Jim was not in accord with the rules. "Alright,"said Jim, "Let's go by the rules. Now if you read the book carefully, you'll notice that it describes the electrician's required tool kit, and one of the items he's got to have is a blow torch." Now blow torches were at least 15 years out of date then, but no one had thought to update the rule book. "Now," said Jim, "Monday morning I'll have a toolbox inspection, and anyone who doesn't have a blow torch gets his time." The dispute was then settled amicably, i.e., Jim's way.

## Good Ironworker

Another likeable superintendent was the ironworkers' Hippo Miller, nicknamed for his large size—about 6, 2 and 230 pounds. A large ironworker is usually a contradiction in terms—they're mostly medium-sized and wiry for scrambling around the "red iron." Hippo had worked on the Bay Bridge and told me something I didn't know: "A lot of professional ironworkers quit on that job," he said. "It was just too much bridge for them." It was a very dangerous job, with the daily fog keeping the iron wet most of the time. I remember reading at the time that 47 men lost their lives during the job.

Well, Hippo had an even larger man working for him, Ole Olsen. Ole was only a couple of inches taller than Hippo but was about the most massive man you'd ever find. His head was so large that the standard hard hat was too small; he had to wear it sort of perched on the front of his head. So Hippo had this story about the time he and Ole were out on the town one night after a job in Seattle.

About midnight Hippo got tired and went back to the hotel. Ole, however, was just getting started. "About 4 a.m.," Hippo said, "this horrible screaming woke me up, so I got up and went to the window. Down on the street were two policemen trying to arrest Ole for being drunk, which he was. Ole had both police in a bear hug and was squeezing. Finally, Seattle assembled enough police to subdue Ole and took him off to jail. So next morning I had to go down to court to try to get Ole bailed out."

"But Mr. Miller," said the judge, "your friend, Mr. Olsen, was drunk and disorderly." "I know he was, your honor," said Hippo, "but you show me an ironworker that won't get drunk, and I'll show you an ironworker who's no good!"

## Cooking the Books

Another good man was the heavy equipment foreman, George, I think his name was—anyway that'll do for the story about the Christmas party. George, you see, filled out the equipment usage tickets and handed them to me every day for cost coding. Well, on December 24 in the middle of the afternoon, Earl Heple, from whom we rented most of our equipment, drives up with his station wagon loaded with whiskey, and starts passing it around, a bottle for everyone in the office and for all the superintendents and foremen. Well, at a half hour before quitting time it was generally understood that work was through for the day, and there's a party going on up in the surveyors' shack farther up the hill. This was my first postwar job (I had been going to college) and pre-Christmas time off was a new one for me. "An entire half-hour off with pay," I thought, "how utterly generous of the company."

So we all take our bottles up to the party and are having quite a time. So after a few drinks, George comes up to me and says, "About those equipment tickets. I wasn't too conscientious about accuracy. All I would do was write down a couple of things because I knew that you knew where you wanted to put the money." Well, at that time—four months into my working career—I didn't know any such thing. It was a very early introduction into the common understanding that the field was expected —by some—to cook the books so that the final recorded costs came out looking like the original Oakland estimate!

## *Oakland, Middletown & Didier by Frank Kast*

### In His Own Words

I spent a few hours flipping through my notebooks but found only a wealth of technical data, design estimates, drawings, titles, structural calculations, meeting notes, and other very important uninspiring data. It is obviously too important to let anyone see. Calculations for bridge arches, crane girders, heavy foundations don't exist anymore because computers do all the work now. If you printed some of those, no one would know what they were. We did some of our best engineering in motel rooms with some real experts in every field. Bill Stolmack, John Hart, Ray Wilson, Morry Wortman, John Ernst, Bob Auld, Bill Bertwell, and on and on.

Try these items on for size.

### Middletown–November '65

Oakland management visited Middletown regularly during the 8 years we were actively working. Bob Wolf visited at least monthly, but Lou Oppenheim and Jack Hughes about once a year to meet with the Armco management. On each occasion, the visit would, of course, include a dinner at the local country club.

This particular November, a very early and unexpected snow fell while we were having dinner. When we were leaving, I walked to the parking lot and drove up to the club under the entrance canopy to pick up my wife. And you may have guessed, I got stuck in the snow with rear wheels spinning on the slight incline.

I got out of the car, my wife took the wheel, and Bob Wolf, Lou Oppenheim, Jack Hughes, and I pushed.

All of a sudden, the traction grabbed, the car lurched forward, and Lou fell flat on his face prostrate in the muddy snow, covering his coat, hat, and face in toto. It was a sight to behold. Of course, no one dared to laugh.

Welcome to Middletown!

### Oakland about 1948–1950

During the early years of my career, when the design office was in the original Kaiser Building at 1924 Broadway, I was a young structural engineer, working on the board with Tobey Tobias, Morry Wortman, Lee Misner, Ray Wilson, and others.

Henry Kaiser was building his house in Lafayette at the time, and the driveway entrance went over a ditch (maybe they called it a creek) on the way up to the house. The assignment was:

- build a wood plank bridge
- architecture to be rustic
- planks were to be loose so they went "klickety-klak" as a Kaiser or Frazer car drove over the bridge.

We were convinced that just leaving the planks loose wouldn't do it because the wheelbase, speed and weight had to match a period of vibration to give out the right "klickety-klak" sound. All of that technical jargon was ridiculous, of course, as we were being entirely theoretical. My solution was to provide a simple retainer at the ends of each plank and just lay them in and listen.

Every car makes a different sound, verifying the period of vibration theory, but all cars made good noises. As far as I know, "klickety-klak" still goes on.

### Joint Venture with Didier–1970s

During the late 1970s, we had a joint-venture agreement with Didier Engineering to promote their unique Coke Oven Technology. Their headquarters were in Essen, Germany.

Our first opportunity was a proposal to DOFASCO in Hamilton, Ontario. The DOFASCO people were partial to the Didier Technology but were cautious to assure themselves that this was the right solution for them.

Months of meetings, estimates, design details, organization charts, planning, and scheduling reviews finally led to our being awarded the project. Work was to be handled from our steel division offices in Chicago.

On the day of the award, Bob Wolf called me from Oakland to tell me we had won the award and called back a few hours later to express surprise that I was still there. He suggested I take the key members of the staff who worked so hard downstairs and buy them a drink. We had a mini-celebration at about 4 p.m.

I had a martini—maybe two or so and left for home. The drive was 45 minutes, and I was getting sleepy. I had to fight to stay awake, but I made it just fine.

I drove into the garage and through the garage *into* the living room.

## *Garrison Dam Powerhouse by Jim Miller*

### Scope of Our Work

Garrison Dam is located on the upper Missouri River in west central North Dakota about 75 miles northwest of Bismark. It is part of the U.S. Army Corps of Engineers Missouri River, Pick-Sloan Plan. This was a decades-long effort to control floods and generate power in the Missouri River basin. One of the largest man-made lakes in the U.S.was formed by the earth-fill Garrison Dam that was built many years ago. Henry J. Kaiser Company (Kaiser Engineers) was the manager of the joint venture to construct a powerhouse, surge tank bases, and switchyard. Other joint-venture participants were B. Perini & Sons, Inc. and Walsh Construction Company.

Scope of work was the powerhouse concrete superstructure comprising five generator bays, an erection bay, and control bay plus a separate base for surge tanks for a total of 81,000 yards of concrete. Our contract included installation of three COE-furnished turbines and generators of 80,000 mw each, together with electrical installations, and the switchyard. Final contract volume was $11,146,567. Notice to proceed was issued on June 15, 1953, and the completion date was October 31, 1956. There were heavy liquidated damages of $1,000 per day for testing the generators.

### Some of the World's Worst Weather

This project is located in a very sparsely populated part of a very sparsely populated state (for good reasons: poor farming, poor everything). The weather in this part of the country features great extremes of temperature ranging from +100 F° in summer to -40° F in winter.

Weather conditions ultimately had a significant influence on the project with respect to added costs and additional time to complete the work. The first phase of the project was placement of the major structural concrete followed by mechanical and electrical work. Early concrete work fell behind schedule to the extent that the COE directed that work continue through the winter instead of the planned winter shutdown. This they deemed necessary to be ready for turbine and generator deliveries.

The winter of '53-'54 turned out to be one of the worst on record. According to Gene Hoggatt, the temperature did not rise above zero, day or night, from early January to mid-March. A temperature of 40 below was reached several times. Hoggatt recalls one day on the way to the jobsite several pheasants were seen standing in the snow like statues because they had frozen in place when they left cover in search of food. Even under these conditions, the COE refused to relax its requirement to water-cure the concrete. Immense icicles formed when the curing water froze, making the south wall of the powerhouse look like a winter wonderland. Contending with the ice and working in the cold weather even under partial shelter severely impacted the work efficiency, costs, and schedule (it was just too damn cold at the dam).

### We Lose Again

A claim was submitted for recovery of the added costs and an extension of time based on a dispute as to responsibility for the initial delays and whether the lost time could be recovered without working during the winter. Our claim was pursued aggressively to the COE Board of Contract Appeals where it was ultimately rejected contributing to a substantial project loss (bless the cold-hearted COE).

Local labor supply was almost non-existent because of the remote location of the project. Most skilled labor was recruited from the Minneapolis-St. Paul area. This, together with the severe weather and lack of local housing, contributed to high labor turnover and low efficiency.

Concrete encasement of the turbine scroll cases was made with a relatively new technique called "pre-pac." It called for placement of dry aggregate encasing the scroll case, followed by grouting of the mass through embedded pipes. This technique minimized shrinkage and reduced floatation forces on the scroll case.

### All Stuck Together Because of the Weather

The isolation of the site and the extreme weather conditions contributed to a closely-knit staff who relied upon themselves for recreation and entertainment. Recreation during the long winter was necessarily limited to indoor activities. There were abundant opportunities for excellent hunting and fishing during the short period of warm weather. One of the most popular groups was the Riverdale Sportsman's Club. Once a month during the summer, they held an outdoor meeting and cookout. The meat, usually venison, antelope, or mountain sheep, was supplied by the local game warden. It was a standing rule that no one asked him where he got it.

The project was initially managed by "Red" Wilson and completed by Art Fischer. Other key personnel included John Bargas, Ed Eagan, Curt Glass, Gene Hoggatt, Curt Jensen, Jack Lacey, Jack Lipner, Hal Meyer, Paul Pond, and Bert Provost. Foothill Electric performed the electrical work.

All in all, Garrison Powerhouse proved to be a tough experience for our staff. About the only positive results were: we didn't have to battle high heat and humidity or revolutionaries—just the Corps of Engineers!

## *Remembrances: Quebec Cartier Pilot Plant by Al Wallach*

### Proposed Plant

In late 1954, Quebec Cartier Mining Company, a subsidiary of United States Steel Corporation, awarded a contract to Kaiser Engineers to design an iron ore processing plant in Quebec, Canada. This plant was to be unique by including dry autogenous grinding mills and Humphrey spiral concentrators. It was to be built in Northern Quebec and designed for winter operation; all in all, an unusual processing plant concept.

The *dry* autogenous grinding mills being considered were massive 18-foot diameter cylinders, which would be rotated by 4000-horsepower motors. These would be fed with chunks of ore up to 10 inches in size, and discharged, by a stream of heated air, of minus one quarter of an inch particles. This air stream, with included solids, would go to air separators and large cyclone dust collectors. Plus 1/16th-inch material would return to the grinding mills, and 1/16-inch material would be mixed with water, the resultant pulp to be pumped to the Humphrey spirals. To provide the high-velocity, high-volume air streams would require high-horsepower fans and large, oil-fired heaters.

Spirals were steel semi-circular troughs wound around a central point forming a 30-inch diameter unit 5 feet high. When the ground pulp was fed to the top of the unit, it would run down by gravity with centrifugal force causing the lightest particles to ride to the outer edge and the heaviest particles to remain in the bottom of the trough. The heaviest material, concentrate, would be drawn off and fed to a similar spiral on a floor below. That concentrate would be fed to filters on a lower floor and finally to dryers before shipping. The plant was to produce 8 million tons per year of the dried concentrate.

### Reviewing Pilot Plant Results

At one of the early meetings with the client, Kaiser was asked to review the results of the operation the previous summer of a pilot plant built at Lac Jeannine, Quebec. A pilot plant is a relatively small-capacity plant with equipment similar to that in a production plant. The pilot plant at Lac Jeannine included a 6-foot diameter dry autogenous mill system and spiral separators. Kaiser recommended that the pilot plant be refurbished as necessary during the spring of 1958 and operated primarily to obtain design information in addition to what the metallurgists had assembled the previous summer.

The refurbishing was done under Kaiser's supervision who also supplied a young metallurgist as pilot plant superintendent. Al Wallach and Jim Thompson assisted in the preparation of the operations plan, reviewed plant results, and suggested changes and additional work. Everyone was satisfied with the results, and the pilot plant was shut down in the fall of 1958.

### Convincing Hardinge to Supply Information

At the Kaiser Montreal office conceptual design was completed and detail design started for the production plant. Some time later, I returned from a trip to the West Coast and was immediately accosted by San Terry, chief design engineer of KE, and Leif Jacobson and Virgil Huff, mechanical and electrical representatives of Quebec Cartier relative to the arrogance of the dry autogenous mill manufacturer's representatives and their refusal to supply basic design information. I thought this was amusing since I had been the one normally suffering this lack of cooperation but had not been able to convince others of the problem.

I suggested we contact the Hardinge Corporation to see if they would give us estimating prices and preliminary designs. In reply to their statements that Hardinge had previously refused. I stated that while in San Francisco at the mining conference, I had been approached by Charlie Nolan of Hardinge to talk to Mr. Hardinge who was also at the conference. We met, and Mr. Hardinge expressed his regret at the decision they had made regarding Quebec Cartier and felt they had made a major mistake.

We agreed that I would contact Mr. Hardinge and determine what they were willing to now do. I called York, Pennsylvania, and was assured they would contact Mr. Hardinge, and he would get back to me ASAP. Quite late that evening I received a call from him. He had been contacted by a messenger on horseback at a trout fishing camp in the Rocky Mountains. Mr. Hardinge had then ridden out on horseback for four and a half hours to get to a telephone. He promised to get back to me at our office by 9 a.m. the next morning, Friday, which he did.

He said that if we were willing, he would have a group in our office in Montreal by 8 a.m. on Monday morning and by 5 o'clock that day would tell us if they would respond to our request. If the answer was "yes," they would work in Montreal and by 5 p.m. on Friday would give us all the information we requested.

A sizeable team headed by the Hardinge general manager and their chief engineer arrived, answered "yes" on Monday and by 5 p.m. on Friday gave us essentially all the information required so that they could be included in the negotiations for the multi-million-dollar purchase for the grinding mill systems. Bob Russell, their general manager, reminded us that they were, of necessity, basing all their work on the pilot plant results and practically begged for a sample of the ore for testing at their plant to verify the results. Remains of a large sample prepared for another company were on a dock in Montreal and were immediately shipped to them.

### Observing Hardinge's Tests

Russell called and told me that they had run their 6-foot dry autogenous mill and verified the information we were using for the design criteria. He said they had not used up the sample and that Mr. Hardinge wanted to reconfigure their plant to a *wet* system and run the remainder of the sample. Hardinge was asking if I would come down on a weekend to observe the operation and that the Hardinge Company would reimburse Kaiser for my services and my expenses.

I contacted Kirby Coombs, development superintendent of Quebec Cartier, and we agreed on the advisability of going to York. I told Russell that Kirby and I would be flying down after work on Friday. However, we would pay our own way for flights and expenses, and the weekends were on our own time. Russell responded that everything would be ready for Saturday morning. We arrived in York and were taken to the club to stay overnight.

The grinding mill and screening system with required pumps and other auxiliary equipment were ready and started with the feed rate the same as for the dry system. For the wet grinding system, water was added directly to the grinding mill with the discharge of the mill going to a vibratory screen with 16th of an inch openings. The oversize went back to the mill, and the undersize flowed onto a flat trough for visual inspection and sampling.

Russell then asked us what we thought, and we said we would talk to him after an hour alone. When we met with him again, we asked that they operate the mill again on Sunday using up the remaining portion of the sample. We further requested that they prepare steam-cleaned 55-gallon drums and collect all the screen undersize in the drums and that they load the drums on one of their trucks and start it off for the Humphries Company in Denver, Colorado. We said that we would make arrangements for Humphries to set up their spiral test system in the same configuration that had been used the previous summer at the pilot plant in Lac Jeannine.

## Favorable Results for Wet Grinding

We returned to Montreal, and the next Thursday we received a call from Humphries who said the shipment was run through the plant, samples were taken, and analyzed. They said a written report would be sent the next day. Meanwhile, they said, "The percent recovery of concentrate was at least as good as that obtained at the Lac Jeannine pilot plant and that the concentrate grade was certainly as high as that obtained there."

The written reports were received from Humphries and Hardinge stating that the *wet autogenous test* showed that the capacity of a wet mill would be at least as high as a dry mill. Kirby Coombs, Mac Chineck, and I prepared a report including that information as well as preliminary calculations indicating that a sizeable reduction in operating and capital costs for the production plant could result from the switch from dry to wet grinding even at this late stage in the project. We further recommended that equipment be erected adjacent to the York, Pennsylvania, grinding mill to form a pilot plant and to be operated to verify our conclusions and recommendations.

## 'I Wouldn't Waste the Money!'

Mr. Severson, president of Quebec Cartier Mining Company convened a meeting with Mr. Russell and his chief engineer, Kirby, Jacobson, Huff of Q.C.M and Bernat,Terry, Chineck, and Wallach of Kaiser. Hours of discussion followed with all agreeing that the results were too good to ignore, but that it would be risky to change the design of the plant with what information now existed, and the ramifications of trying to build the plant on such a small amount of design information.

Mr. Severson finally said that the day was coming to an end and that he had to make the decision, but that before he did he had a question to ask of me. I asked what that was, and he said, "If it were your money, would you build the pilot plant?" I asked, "Do you mean my money or Kaiser's?" He replied, "Kaiser's, of course." I replied " Of course I would, you can't risk a $350-million investment without proof of our conclusions and recommendations to switch to a wet grinding system. What could the pilot plant cost to build and operate, a few hundred thousand dollars?" He then asked, " What if it were your own money?" I answered, "I'm so sure of our work I wouldn't waste the money, but that's my money not Kaiser's."

He decided to proceed with the pilot plant, and Kaiser was directed to prepare the design and start procurement of equipment. Hardinge was to make all arrangements to get the plant built and operating. Bernat and Terry agreed to slow down design on those portions of the plant that were most likely to be affected by the possible changes.

Mr. Severson then asked Russell how large a sample would be required. By some brief calculations Russell answered, "About 350 tons." Mr. Severson said, "Kirby you better call our Seven Islands office and tell them 400 tons." Kirby did so and told the office in Seven Islands to contact the mine site by radio and tell them this was first priority and to ship out 450 tons as soon as possible. The manager at the mine instructed his foremen to start refurbishing the winter road to Seven Islands and to clean all the trucks and load out at least 500 tons of already blasted ore in the pit. The front-end loader operator started to load the first truck, and when he hit the frozen ore with a cold bucket (it was 40 below zero) it shattered. A new bucket was flown in, assistance on the winter road was provided from the Seven Islands end, and the sample was loaded into railroad cars at Seven Islands. Incidentally after arrival at York, Pennsylvania, it took almost three days of steaming to thaw the ore just in time to start the operation of the pilot plant.

## Building the Pilot Plant

Kirby, Mac, and I prepared a flowsheet (a depiction of the flow of material through the pilot plant) and a list of equipment immediately. Bruno Boik, our structural supervisor, was instructed to design a timber tower to accommodate the spiral equipment layout as described to him by Mac Chineck, with adequate safety factors. This timber tower was to be an open-sided building with large timbers used instead of steel beams and columns.

As it was apparent that we could not prepare specifications, and purchase orders for the required equipment in the time available, various manufacturers and vendors were contacted by telephone for rental of the required equipment. The manufacturers and suppliers felt even that would be too time-consuming, and all agreed to provide the required equipment on a loan basis.

Allis-Chalmers had a suitable screen in Canada and shipped it to York. An ore feeder manufacturer in Pennsylvania said they would supply the feeders and a representative to calibrate and assist in the installation and adjustments. A pump manufacturer in Pennsylvania supplied a variety of pumps and motors and indicated that they had reels of various sizes of rubber hose that could be used in place of pipe. They would also send a crew to install and adjust the proper size pumps and motors as required. Humphries sent two truckloads of spirals and connections from their operation in Florida, as well as an engineer and several mechanics to do the installation and assist during the start-up and operation of the pilot plant.

Hardinge, which was a major equipment manufacturer, had ample supplies of steel and cable etc. at the site as well as welders, machinists, electricians, and laborers to complete the installation around the existing mill and on the timber tower. The tower was constructed by a local contractor.

The construction work and equipment installation was completed in 42 days and, as previously stated, the carloads of ore were thawed on that forty-second day.

### Operating the Pilot Plant

It had been agreed with Quebec Mining Company that we would operate and adjust the plant for thirty days and at that time a group from United States Steel Corporation and QCM would be given all the results and then visit York to observe the operation. After their visit, the decision would be made as to the change from the dry to the wet grinding system.

The pilot plant was started, and adjustments and modifications were made as required. Problems with the feed system to the plant were solved except for the operation of the controls of feed tonnage. During the afternoon of that day, we were notified that a plane load of U.S.Steel executives and technical people as well as the Quebec Cartier mining people, Severson, Huff, Jacobson, and their chief engineer, Jerry Peterson, would arrive early the next morning to observe the operation. We all worked through the night adjusting flows, stopping spills, and tearing out our hair. We could not get the weighing controls on the plant feed belt to function. However, the weight passing on the belt was accurately indicated on the control panel meter.

To solve the weighing problem, the accounting department made a tape showing what the total weight fed to the mill should be after ten minutes of operation and every ten minutes thereafter for ten hours. During the next day's operation, a man was stationed at the meter and rheostats that controlled the ore feeders out at the plant feed bin. He would adjust the feed rate every ten minutes as necessary to insure the pre-agreed tonnage.

### Wet Grinding Approved

The observers arrived, spent a number of hours at the plant observing operations, and asking innumerable questions. The entire group then left for a late lunch and caucus. Upon their return to the pilot plant, their spokesman announced that this was obviously the way to go and approved the change to a wet autogenous grinding system for the QCM production plant.

After the U.S. Steel representatives left, we shut down the plant for the day and proceeded to the club for a meeting and much needed liquid refreshments. It was agreed with Mr. Severson that the plant should be operated until the ore was depleted in approximately thirty days and that Chineck would remain to supervise the operation. He was to make sure design information as well as metallurgical results were recorded and sent to Kaiser in Montreal on a regular and timely basis. Design supervisors and process people reviewed results and requested additional information that they found would be helpful.

The results were extremely useful in plant design and, in addition, the concentrate, which was stockpiled, proved invaluable in providing samples for prospective sintering and pelleting vendors in sizing and estimating various size plants that might be required.

## *It Couldn't Be Done*
## *by Sherrill McDonald*

Recently, my wife was reading an anthology of poems, and I chanced to pick it up and page through a section entitled, "Inspiration." I came across the poem below by Edgar A. Guest which so struck me as applying to Henry J. and to the philosophy that he imbued in his various companies, including especially Kaiser Engineers, that I wanted to share it with others who read this book. The two "impossible" tasks that I recall were the bidding for supplying cement and aggregate for Shasta Dam when Kaiser had no supply source of cement at the time. The winning of those bids resulted in building the Permanente Cement Plant. I was not there for that event, but I was for the second one.

The second impossible task revolved around Mr. Kaiser's desire to build a cement plant in Hawaii when he found that he was unable to get land anywhere due primarily to the opposition of the Dillingham dynasty. As an alternative, he directed that one of the aircraft carriers built by the Kaiser yards during the war be found and used as an anchored cement plant just offshore. The design of this "impossible" venture was handed to KE. Many of those involved in this project, including Vic Cole and Ken Olsen, tried to talk Mr. Kaiser out of this idea without success. I recall talking to Ken about the difficulty of trying to put a long kiln on the deck of a carrier, and the kiln subject to large changes in length because of temperature variations—just one of the tough features to be overcome. Fortunately, land was found before a carrier was located, and this wild scheme never took place. But it did illustrate the principle found in this poem. For Mr. Kaiser there was no such thing as, "It Couldn't Be Done." *(Editor's Note:* Mr. Kaiser was often heard admonishing his subordinates thus: "Don't tell me how *not* to do it, tell me *how* to do it!")

## *It Couldn't Be Done*
## *by Edgar A. Guest*

SOMEBODY SAID that it couldn't be done,
But he with a chuckle replied
That "maybe it couldn't," but he would be one
Who wouldn't say so till he tried,
So he buckled right in with a trace of a grin
On his face. If he worried he hid it.
He started to sing as he tackled the thing
That couldn't be done, and he did it.

Somebody scoffed: "Oh, you'll never do that;
At least no one has ever done it;"
But he took off his coat and he took off his hat
And the first thing we knew he'd begun it.
With a lift of his chin and a bit of a grin,
Without any doubting or quiddit,
He started to sing as he tackled the thing
That couldn't be done, and he did it.

There are thousands to tell you it cannot be done,
There are thousands to prophesy failure.
There are thousands to point out to you, one by one,
The dangers that wait to assail you.
But just buckle in with a bit of a grin,
Just take off your coat and go to it:
Just start to sing as you tackle the thing
That "cannot be done," and you'll do it.

## *Remembrances: Quebec Cartier Startup*
## *by Al Wallach*

### Concentrator Process

The process to be used in the plant is briefly described next. An open-pit mine was started, blasting the rock benches with the broken rock loaded, by what were then the largest mechanical shovels, into trucks of 100-ton capacity. The trucks dumped into large hoppers with massive feeders, which fed two independent crushing systems. These consisted of the largest, to date, jaw crushers with an opening of 66 by 84 inches. The undersize of the feeder, minus 10" joined the crushed material and passed over screens with the oversize going to large gyratory crushers. The screen undersize and the crushed material joined on a large pan feeder, which fed a 54-inch wide conveyor belt one thousand feet long. This conveyor transported and elevated the "plant feed "to the top of a series of 12 large steel bins and distributed the feed to these bins as required. The plant, which was to handle approximately 20 million tons per year, was the first of its type and the first to be operated throughout the year in the hostile Northern Quebec winter climate.

Ore was withdrawn from the bottom of each of twelve bins to the grinding and concentration sections. Ore averaging approximately 32% iron would be upgraded to a concentrate of 65% iron, the concentrate partially dried, stockpiled, and then loaded out to 100-ton railroad cars, and shipped to the port on the St. Lawrence River.

### Review of Startup Procedures

In the early fall of 1960, I was requested by Quebec Cartier Mining Company to attend a meeting at Lac Jeannine, Quebec, to review the start-up procedures for their new concentrator. Les Trew, who had been my assistant during the detail design phase of the project, had continued working in the Montreal office on the completion of the engineering. He was primarily employed in preparing very detailed instructions on how to start each piece of equipment in the plant and, further, how to start each system. In addition, the instructions had warnings of possible problems and suggested cures.

Les and I were asked to come to Lac Jeannine to review the procedures with the newly assembled group of supervisors for the crushing plant and concentrator. This included a superintendent, assistant superintendent, three shift bosses, a repair superintendent, and a chief clerk.

### I'm Now Acting Superintendent

After the first morning of review, I was asked to see Virgil, the general manager for the operations, and was surprised to find Mr. Severson, the company president, with him. Virgil stated that Dave, the superintendent, was nervous about starting up the plant and so was the assistant superintendent. He further said that they would like me to stay, finish up the reviews, and then become their acting superintendent with Les acting as my assistant. I was shocked and replied that there was no way I could assume such a responsibility for Kaiser with the fiscal implications. At this point, Mr. Severson stated that they had received approval for my services from Oakland and had provided a document holding me and Kaiser blameless for any damages. I was flabbergasted, but after a few minutes agreed, not really understanding what I was getting into.

After a few days of classroom work, we welcomed the first group of employees, operators, helpers, laborers, and repairmen. We reviewed the procedures with them encouraging Dave and his crew to conduct the sessions and prepared to start the operations. The crushing plant was completed but the contractors were still working on the concentrator itself. After walking the group through the crushing plant many times and answering innumerable questions, we decided to start the crushing plant from receiving point to the discharge end of the 1,000-foot long conveyor. We did so with Les and me pushing the buttons, as the others were reluctant to do so. We ran into communication problems as the supervisors were all from the western portion of Canada and the workers from Quebec, in many cases with only a rudimentary grasp of English.

We had the mine dump a few truckloads into the receiving hopper for one crushing line, started the system in the reverse order: 1,000-foot conveyor first, then the lower feeder, gyratory crusher, screens, jaw crusher, and then the "wobbler" feeder. After a few moments the wobbler kicked off, and we assumed that a rock had jammed. After a miserable job of removing a couple of hundred tons from the hopper, we found no jam and when pushing the start button were amazed to see the feeder start.

### Start-up Problems

For the next ten days, we were plagued by the feeder problems until it was discovered a superfluous load control had in some way been installed and upon its removal, the feeder problem evaporated. During this time, problems of belt stoppages occurred as a result of operators and helpers checking to see if safety cords along the belts and feeders really worked. We reloaded the feed hopper and started our first smooth run. All seemed to be working fine when the main bearing on one side of the jaw crusher began smoking and after an emergency shutdown, we discovered the bearing exceedingly hot. Our repair crew had not been issued their tools yet, and we requested aid from the mechanical contractor still working in the concentrator. Upon removing the bearing cap, we discovered the bearing had actually melted a bit and later found that the water cooling system for the bearing had not functioned; the plug utilized during bearing pouring had inadvertently been left in place. After two hectic days of work, we repaired the damage and were ready to get back to operation.

About this time, we realized that one of our major problems was the lack of cooperation from the other operations at Lac Jeannine. Each group was more interested in getting its procedures written and approved by the home office of this major corporation than in our getting the plant running. The warehousing of parts, the issuance of vehicles and supplies, the supply of operators and other men, the provision of special meals for men working overtime all required my time which could not be spared. Dave proved useless and even though he was supposed to be with me all the time, he was always slipping off to go to a meeting or to supervise the setting up of his office and so on. I became very short tempered with the resultant delays but prepared for the next step in the start-up operations.

To continue on the description of the plant: the 1,000-foot conveyor discharged the minus ten-inch rock to a feeding system atop 12 very large steel silos. These were each the start of a grinding section with feeders below the silo discharged onto a belt that fed the 18-foot diameter autogenous grinding mill which discharged onto screens with approximately one-eighth inch openings. The undersize of the screens was pumped to the Humphries spiral concentrators and the oversize back to the mill. These 128 spirals were situated on a high floor adjacent to the mills and discharged to 64 cleaner spirals on the floor below which in turn discharged to filters on the bottom floor. The tailings went to a central receiving sump and were pumped to the tailings discharge area a mile or so away. We were to start one of three sections theoretically completed while the contractors continued work on the remaining nine sections.

### Starting Up the Spirals

Following the same procedure we utilized at the crusher, we strove to educate the operators and helpers to the location of start and stop buttons as well as emergency stops. We started the spiral feed pump with a water feed, tried to adjust the distribution system to the spirals, and worked back to the screens. While we were adjusting the sprays on the screens the contractor opened the main doors of the building to move in some large equipment. The sprays above the screens immediately froze, as did the surface of the screens. The outside temperature was in the minus thirties and it was necessary for me to give the contractor orders to reconnect his temporary heat for the building which had been disconnected when the boiler plant adjacent to the mill building had been accepted as complete by Cartier. This resulted in a lot of criticism as the temporary heat was very expensive, but after a meeting with Huff and his financial people, it was agreed that I could only operate if I was not constrained by any of the rules and regulations that were being developed. As you can imagine, I was getting more and more irritated with the Cartier personnel all the time.

After a few days of starts and stops, we finally got the first section of the plant running for a few hours and decided to institute the three shifts so that more people would become trained. Problems with the personnel department because of our assignments not exactly fitting their tables of organization were solved by Huff instructing them to leave me alone, and they could change things later after I left. To our chagrin, one of the main bearings on the autogenous grinding mill overheated, and we had to shut down. Once again, we required the services of the contractor, and it was found that careless welders, during mill installation, had not covered the oil sump for the bearing, and welding slag had damaged the bearing.

The manufacturer's representative verified the need to replace the bearing, which would be a major job. The warehouse refused to release a spare bearing since those parts had not yet been officially received and warehoused. Once again, after intervention by Huff and Severson, the warehouse was instructed to supply my needs and to worry about the paperwork later.

We proceeded to prepare the second section of the plant for operations, ran the crushing plant to fill that feed silo, and with the assistance of Humphries' representative set up the next series of spirals. Each spiral contained about twelve splitters to adjust the flow of pulp, and it was difficult to keep new operators from experimenting with the settings to see the effect. After a few days of operation, we switched over to the number three section and began to realize problems with the launders (semi-circular troughs) under the spirals which conveyed the concentrate or tailings to the collection points. If too little water was introduced at the top end of the launder, sanding and blockage of the launder could occur. The operators would, therefore, turn the water on full blast and not have spills in their area. The increased volume was too great at the collection points or main launders, and they would overflow. Quite a mess!

### Preparing for Visit by the Brass

About this time the Cartier management was getting nervous about a proposed visit by the top brass from Pittsburgh. Although it was some time in the future, it was hoped to have all three sections running when that visit occurred. We reached the goal of running the second and third sections together, but when we tried to start the first section, which had been repaired, we discovered that the ore in that silo had frozen during the interim with the temperature now down to the minus forties. The only way to get the ore moving was to use air jets passed up through the feeder openings until they reached about halfway up the center of the bin leaving an arch about twenty feet up. No help could be received from the miners. In order to teach our crew, it was necessary for me to creep along the feeder until I could see the arch above me, slide a 6-foot, 1-inch rod in until I could tape a second rod to the first. Then I repeated the operation with a third rod, attached a third of a stick of dynamite to the end, and raised it until the charge was against the center of the arch above me. The charge was detonated after I crawled out, and although the arch broke, it was not long until another formed calling for a repeat of the performance until we emptied that bin. lt wasn't until after I finally left that anyone else could do the blasting.

As you can imagine with all new men, it was necessary for Les or me to be at the plant all the time, and we were wearing out. We arranged for the shift bosses to work ten-hour shifts so that they could overlap at the beginning and end of each shift. We knew we would require additional water when nine or more of the mills were running and decided to start-up the water system from the main lake five miles away. A major argument had resulted from the steel companies' engineers rejecting the Kaiser plan to bury and insulate the pipeline. After the startup of the pumps and observing the start of freezing of the line, we shut it down. At the instruction of the general manager, we restarted the pumps with his assuming of responsibility. At the plant we had one old Jeep and had to use it to get to the outlying points such as the water pump house and the end of the tailings line to observe its operation. The reason for the lack of vehicles, although they were on hand, was that they had not been registered and could not be issued. As you can see, Les and I were getting more irritated by the constant lack of cooperation.

One night the shift boss returned from his inspection at the pump house and the end of the pipeline to report the pipelines closure at the discharge end. It was obvious that the pumps had to be shut down and the line drained to keep all five miles from splitting as the remainder of the water in the pipe froze. We took the men from the shift going off duty and attempted to drain the line, but all drain lines were frozen. We finally used sledges to knock the drains off the main pipe and by heating steel rods with welding torches were able to drive them through the ice into the center of this thirty-inch line and drain the remaining water. As we were finishing the job, Ken, the day shift boss came by, looked over what we had done, and said to the afternoon boss, "Well, Larry, you are now the proud possessor of the longest icicle in the world."

## Producing Finished Product

After a few weeks of ragged operations we finally were able to produce finished, filtered concentrate on the early morning of December 7, 1960. The visit from Pittsburgh was to start on the 8th.

We cleaned up the best we could and were determined to put on a good show. The trials and tribulations to that point had welded the crew into a group of "Us against the world." When the delegation of 20 or so VPs arrived, they were shown through the mine and then proceeded to the crushing plant and concentrator guided by Mr. Severson. In the concentrator the group was guided away from the area under the ore bins by rope lines marked with safety signs, "Do not proceed beyond this point." At Mr. Severson's whispered request to take a few of the men under the bins, I explained to him that the bins had frozen overnight. We had removed the siding from that portion of the building, and a large number of men were shoveling ore onto the feed belts. The weighing devices had been adjusted to show the correct amount of feed, but in actuality it was much less. We didn't think the executives from Pittsburgh would appreciate that sight. Mr. Severson made sure nobody crossed the safety lines.

While running only a few of the 12 grinding sections, Les and I anticipated major problems with the tailings system, The tailings disposal system was unique and consisted of the following: the tailings from each of the 12 sections flowed to a central collection point, a large pump sump feeding the two tailings lines. The pumps were at constant speed, and the level in the sump feeding the pumps was maintained by float valves to ensure a constant flow through the pipes. This was required to keep the largest particles from settling along the bottom of the pipe and eventually causing a plug. There were two pipelines and pump systems, one to be running and one a spare. A booster station was located about five thousand feet from the concentrator and initially there was 1,000 feet of pipe installed from that station to the discharge point.

The water fed to the autogenous mills and the screens was of necessity heated to keep from freezing when coming into contact with the incoming cold ore. This heated water was provided from a large heat exchanger on the basement floor. The heat exchangers were fed from a circulating hot water system from the main boiler plant a short distance from the concentrator, The flow of the pulp from the operating sections was about 40 degrees but the make-up water from the float valves was very close to freezing. To get the mixture in the tailings sump to the design temperature or above, Les and I had wired open the heat exchangers in the non-operating sections, with the water running onto the basement floor where it was collected as clean-up and pumped to the tailings sump. This allowed us a certain margin of safety against freezing and blocking of the tailings system. As you can imagine, even in the heated concentrator occasional clouds of vapor would appear and disappear from that hot water running along the concrete floor.

### Movie Incident

After the visit of the Pittsburgh executives, a Hollywood-based movie crew arrived to prepare a public relations film covering the great new project. They had already completed the portions on the mine, the railroad, the port, the town sites, and all the related facilities. When trying to film the operations inside the concentrator building, they were plagued by the vapor clouds and were insistent that we turn off the hot water for a day or so while they completed their work. We, of course, refused and after a meeting with Huff, Severson et al., we reluctantly agreed, after warning of the dire consequences and laying all blame for any catastrophe on their heads.

About 10 o'clock that night the instrumentation alarm indicated a leak in the operating tailings line, and we switched over to the second line. This took many minutes during which the leak continued. Les, the shift boss, and I rode the Jeep along the road paralleling the pipelines until we came to the break in the 12-inch pipeline. A rubber pipe section had ruptured at the end of an overpass of the railroad marshaling yard, which was almost completed. The entire area had been compacted and fine graded, and hundreds of ties had been unloaded that day and placed near their final location. The entire area was covered with tailings pulp which quickly froze. The railroad crews were after our necks, but there were no recriminations to our crew from above and from then on, our suggestions were normally accepted without argument.

### Finishing Up

With the approach of Christmas, we agreed that Les would go home to Montreal for the holidays and return before the end of the month. Upon his return, I would wind up my job and return to California. We were going along pretty good by Christmas Day and kept operating as planned. No one wanted any more freezing problems. With over half the sections operating, we were beginning to look like a respectable operation.

Kirby Coombs, QCM development super-intendent, invited me to join him for Christmas dinner at the new hotel, L'Auberge du Lac, and although I was in work clothes and rather dirty, I scrubbed my hands and face and settled down to have a good meal. The manager of personnel was slightly boozed up, stopped at our table, and in a loud voice said, "I just walked by the concentrator, and it reminded me of when I was a kid on the farm. It sounded like a herd of cattle all relieving themselves at the same time." He was referring to the wet concentrate falling off the end of the stacking conveyor and hitting the ground.

In just as loud a voice I replied, " It may sound like—to you, it may looks like—to you but when you and some of the other—'s here learn that it's your bread and butter, you will learn to love it." There was a sudden hush in the dining room, and I looked up to see all the wives and children looking at me with shocked faces. I was so embarrassed I could not finish what would have been a fine dinner.

On December 29 Les returned, and on the 31st I left Lac Jeannine for home. It was42 below zero with about a 20-mile-per-hour wind on the airport. I arrived home to start the New Year 28 pounds lighter and, hopefully, some wiser.

## *ICBM Missile Base Notes by Jim Miller*

### Project Description

The Titan Missile Base at Mt. Home Air Force Base near Mt. Home, Idaho, was one of a nationwide ICBM missile launch capability constructed during the early '60s, a period of very high tension in the Cold War between East and West. The missiles were first-generation, liquid-fueled ICBMs. Titan I missiles stood over 90 feet high and were stored in a vertical position in the underground silos. In firing, the missile, fueled, weighed 110 tons. It had an intercontinental range in excess of 5,000 miles and attained speeds up to 15,000 mph. Contracts for civil and related work were administered by the U.S. Army Corps of Engineers (COE) for the U.S. Air Force (USAF). The civil design for the Mt. Home installations was performed by Daniel, Mann, Johnson & Mendenhall (DMJM) for the COE.

Each Titan I base consisted of three missile launching complexes, and each launch complex was located within a radius of 25 to 30 miles from a Strategic Air Command (SAC) air base. Each launch complex consisted of three launchers, a control center, a powerhouse, portal silo, and two antenna silos, all with interconnecting tunnels, mechanical and electrical control and utility systems—all underground. Each launcher consisted of a missile silo 40 feet in diameter and 160 feet deep, flanked by a propellant terminal 37 feet in diameter, 41 feet deep; and an equipment terminal 48 feet in diameter, 34 feet high. Interconnecting steel tunnels ranged in diameter from 5 feet to 12 feet.

## Our Contract

Various sites around the country were bid in 1959, a period of low construction activity nationwide. Construction pricing was very competitive with low margins. While the majority of the work at a base was conventional civil concrete construction, the design to withstand a nuclear blast resulted in massive heavily reinforced structures, which were largely underground. The government specifications for such components as missile fuel systems were required to meet specifications for laboratory standards of cleanliness which far exceeded the experience and capabilities of the construction industry at that time. There was also an urgent need to complete the facilities as quickly as possible with contract provisions allowing no extensions of time for any reason and severe penalties for failure to meet completion dates. The missile systems, though, were still in a stage of continuing design when the civil works were started, thus setting the stage perfectly for major difficulties and high costs to carry out the construction program.

Our contract work required excavating and / or shafting for the various structures and connecting tunnels. The individual structures were all reinforced concrete, the tunnels were corrugated steel multiplate, and all included utilities, mechanical and electrical equipment, and support facilities. Long lead-time equipment, such as liquid oxygen (LOX) storage vessels, special valves, and other mechanical and electrical equipment were furnished by the government and installed under the contract. All structures were designed to withstand the shock of a nuclear blast at close range. Most of these structures were entirely underground. The missile silos extended to ground level where they were greatly enlarged and heavily reinforced. All utilities, equipment, and internal structures of the missile, propellant, equipment, and antenna silos as well as the powerhouse and control center structures themselves were mounted on shock absorbers to protect them from the enormous blast forces.

The construction joint venture was managed by Henry J. Kaiser Company (Kaiser Engineers). Financial participants were Raymond International, Inc., Macco Corporation, and Puget Sound Bridge and Drydock Company. The contract was bid in December, ‘59, awarded in February, ‘60; construction work started in March, ‘60 and completion was scheduled for April, ‘62. Our contract was fixed unit price for each structure with an initial contract amount of approximately $28,000,000.

## Complete the Design Later

The national emergency to construct the facilities as quickly as possible resulted in much of the detail design being performed during construction. Missile design itself was also undergoing changes arising from continuous testing and design improvements. Although the major components of the work were fixed at the start of construction, many details remained incomplete (a sure sign for all kinds of problems). These were issued during the construction phase. Ultimately, hundreds of changes and changes to the changes ad infinitum were issued. However, contract provisions stated that the completion date would *not* be extended for any reason, including changes to the work. Interesting! All work proceeded under the government concept of concurrent development, design, and construction. In this type of design-construct program, new design developments and modifications arrived at during the period of construction made necessary a substantial number of changes in the facilities at the time they were actually being built. As might be expected, these were major problems just waiting to arise, and rise they certainly did on a national scale with almost all contractors. The missile program became the subject of Congressional hearings in the fall of ‘60 and spring of ‘61.

The three launch complexes at Mt. Home were scattered across the Snake River plain near the air base, while the construction project office was located in Mt. Home itself. Road distances between the sites were long, and supervision visits to multiple sites daily via road were impractical; thus a small plane was used by the general superintendent and other supervisors who needed to visit each site regularly during the day.

## Instead of ABC It Was CBA

Work started first at Site C, followed by Site B, and then Site A. Our plan was to take advantage of the numerous identical structures and repeat similar operations in sequence in each complex and from one launch complex to the next. General excavation was carried to the elevation of the tunnel inverts, and shafts were sunk for the structures below that depth. The nine missile silo shafts were slip-formed to the elevation where they widened to large haunches extending to the surface to withstand the effect of a nuclear blast. The plan anticipated extensive reuse of the concrete formwork, much of which was specialized and complex because of the circular and domed structures as well as the massive designs to resist nuclear blasts. All structures were heavily reinforced with extensive use of #18 bars. The enlarged missile silo upper portion was the only major structure which extended to ground level.

During general excavation at Site A, which was located across the Snake River, animal bones were encountered. There was much speculation as to their age and what animal they may have come from. One of the staff spouses was an amateur anthropologist and identified them as from a mastodon. Others thought they were just cattle bones. Fortunately, the discovery didn't delay the work, and no one ever accurately identified them (one wag suggested they were bones from a previous contractor!).

Average manpower during the two-year construction period was 1,000 with the peak including subcontractors of 1,800. Pat Bedford was project manager. Other senior staff were John Aiello, Dan Blackwell, Charlie Brown, Tom Burns, Don Cardarelle, Rufus Chatham, Uwe Clausen, Oscar Hanson, Charlie Harman, Sherrill McDonald, Larry McNeil, Jim Miller, Vince Palmer, Bert Provost, Charlie Shaul, Lee Schilling, Tom Tarbill, Sabih Ustel, Carl Watt, and Al Zimmerman. Major subcontractors were A. Neri (electrical), Hanson-Kashner (slip-forming), Grafe Weeks (piping), and Wells Cargo (excavation). Bob McLeod of our legal firm, Thelen Marrin Johnson & Bridges, spent much of his time at the site later during the project to provide continuous legal input to the critical major claims. He promised to never again move to a construction site!

### Slip-Former Slipped

Our Mt. Home site was one of the very few which slip-formed the missile silo walls. This procedure worked well once the shafts were excavated. Unfortunately, the slip-form subcontractor encountered "financial difficulties" (went belly up) on another missile base, and his work at Mt. Home had to be completed by his bonding company. In order to prevent delay to this critical portion of the work, the joint venture took over and finished the work for the bonding company using the subcontractor's supervision, equipment, and labor force.

High-strength steel beams for the powerhouse shock mounts could not be delivered when needed and in order to maintain schedule, the powerhouse heavy base slab was constructed on timber cribbing. After delivery of the shock mounts they were installed under the slab which was then lowered by a complex of hydraulic jacks onto the shock mounts. This innovative change in sequence avoided a potentially serious delay of the first powerhouse and thus the following ones, too.

### Opening Doors Can Be Dangerous

The missile silo doors also presented a unique construction problem. These doors were designed to withstand a nuclear blast and were massive; each leaf weighed about 100 tons. Two leaves overlapped at their common closure and were hinged on the outer side. The concrete doors were cast in the horizontal closed position. The doors had to be opened to install the operating mechanism and to provide access for installation of other silo components. But the mechanism was not available at the time the doors were cast. Two other identical Titan sites preceded the Mt. Home project, and fatal accidents had occurred at each when the contractors used cranes to open the missile silo doors. Subsequently, it was determined that the contractors had failed to take into account the mechanics of the hinged leaf on the lifting load imposed on the crane, which was actually overloaded, and this caused the failures. Prior to that determination, it was necessary for us to open the doors at Mt. Home to allow for continuation of the work.

Having been advised of prior problems, the COE was ready and waiting with all kinds of cautionary advice—but no solutions, of course. Our site engineering staff identified the lifting problem and developed a solution using available cranes and other equipment to exert a horizontal force on the door leaf at the appropriate degree of opening. This was submitted to the COE, which naturally neither approved nor disapproved the plan and gave permission to proceed so long as the contractor accepted the entire responsibility (which we already had under the contract). A dry run was conducted on the first leaf, and the following day the door was opened exactly as planned. That left eight more doors to be opened, and these were completed without a hitch.

## Nothing Was Clean Enough

Missile fuel systems specifications required LOX cleanliness standards for pipe, valves, vessels, and equipment. These standards were much more stringent as to particulate contamination than construction piping subcontractors were used to meeting. Government-furnished vessels for our installation were not only delivered late but also did not meet the cleanliness specifications. The government furnished valves for our installation, which also failed to meet these requirements. Our piping subcontractor had set up a pipe cleaning shop near the job site in Boise. The cleaning procedure specified by pickling often failed to meet the cleanliness standards. In effect, performing the work as specified did not meet the cleanliness specified, which was substantially higher than construction and most manufacturing standards in practice at that time. Almost every component had to be repeatedly recleaned on site at enormous cost and time delays. This was probably the most vexing and the most complex technical problem encountered on the project.

## Redesigns of Redesigns of

As anticipated, there were continuous design changes during the course of the construction work. Blast doors and blast locks isolating parts of each complex were completely redesigned after components had been manufactured, delivered, *and* installed. Pipe and conduit were installed on shock mounts, which were redesigned and had to be changed. There were innumerable conflicts between various utility and process systems, which had not been resolved during design and had to be corrected when discovered in the field at considerable added cost and delay to the work. There were also substantial changes to many of the piping systems.

## Costs Accelerated at Missile Speed

Delays in the early work and the very tight schedule required that some concrete work be performed during the winter, which adversely impacted costs. Ultimately, the most significant factors were the many changes to the contract, which were so extensive that the entire project, including the original work was highly impacted. In effect, it became a completely different project from the bid project. We weren't alone. These same factors were affecting contractors on numerous similar missile bases around the country. All were encountering major financial problems due to the numerous changes and the inability of the COE and the contractors to agree on the costs of the changes. These were so numerous and frequent and impacted one another to the extent it was impossible to determine the added costs until the work was completed.

In the meantime, the contractors were not being paid for the changes. The COE eventually instituted two-part change orders to help relieve the financial problems of the changes and their impact. The COE would set apart one estimated price for the changed work and make progress payments based on part one of the change order. After the costs were finally known (usually after the work was completed), any additional costs were negotiated as part two of the change order. In most cases, this was deferred to the end of the project when the cumulative impact of all the changes on the original and changed work could be determined.

After the project was completed, Oakland management representatives headed by Lou Oppenheim together with Frank Bort, Paul Meyer, our attorney Bob McLeod, and key jobsite staff met in Los Angeles with a special officer of the COE. He was designated to resolve the negotiations of all the similar contractor claims for the missile bases nationwide. The Mt. Home negotiation was continuous for *two weeks,* and the final contract amount was settled at approximately $59,000,000. This was more than double the original contract amount, but the work was accomplished *within the original schedule* of 25 months with major increases of manpower, supervision, overtime, shifts, construction equipment, costs, and dedicated effort day and night of the project staff.

The civil work performed under the COE contract was only the structural and utilities part of the site work required to make the missile sites operational. There remained all of the equipment and systems connected directly with the missile and furnished by Martin Marietta, the missile designer and manufacturer for the USAF. This work was performed under separate contract directly with Martin Marietta. The same partners formed another joint venture to perform this work, which was called "activation management." The work was performed on a cost-plus-a-fixed fee contract with a final value of $7,400,000. The work was performed over an 18-month period ending in December, '62. Key personnel were Hal Andresen, project manager, Warren Evans, and Gene Hoggatt.

### Titans Didn't Last Long Anyway

As the national ICBM program with liquid-fueled missiles was being completed, new technology was used to develop solid-fueled missiles. This eliminated the complicated piping systems and related equipment required for the liquid-fueled missiles, greatly simplifying the missiles and the systems and also reducing their size. The new missiles were called Minuteman and were rapidly deployed by the USAF. The Minuteman quickly made the Titan and Atlas missiles obsolete, and the bases were deactivated within a short time as the Minuteman became operational. Rumor had it that the silos in Idaho were then used to store potatoes. (That's a lot of spuds!)

### Natural Beauty Made Mt. Home Barely Bearable

Although this project was a pressure pot for the entire staff from beginning to end, the region around Mt. Home offered numerous recreational and scenic attractions, which the families occasionally were able to enjoy. Idaho abounds with spectacular rivers and mountain scenery. Sun Valley was nearby for the skiers. Trout and salmon fishing was excellent in the Idaho rivers and streams. Bird and big game hunting was good, and mountain hiking and camping opportunities abounded. A great area for R & R for which we had little time.

At one time, much of the Snake River plain around Mt. Home had been irrigated but subsequently abandoned for some unknown reason. Most of the uncultivated areas were covered with sagebrush, which monotonously continued as far as the eye could see. One exception was the Bruneau River Canyon south and west of Mt. Home. This was a spectacular canyon eroded deeply into the Snake River plateau on a smaller scale similar to the Grand Canyon of the Colorado. You were completely unaware of the canyon until you almost fell into the Bruneau River hundreds of feet below. In recent years this has become a very popular place for rafters and white-water kayakers. There were no known access routes to the river in the immediate area at that time, so it wasn't possible for us to take advantage of this wonderful river and canyon. Along the Snake River proper, there were several scenic drives for our few spare hours. At numerous places springs flowed out of the volcanic rock bluffs along the river. These springs formed many small ponds or pools where watercress grew in abundance. Gathering there was a popular Sunday activity in season. Another popular product was the wild asparagus, which proliferated in the irrigation ditches throughout the area. If found at the right time, a delicious meal was forthcoming.

### Baah Baah

The Mt. Home area was Basque country. These ruggedly independent people were brought over from Spain to tend sheep, and some remained in the U.S. when their employment contracts were finished. Basque names were common in the Mt. Home phone directory, and there was even an abandoned jai alai court behind the old hotel in town. They lived on the range in distinctive wagons and led a solitary life with their herds. Basque sourdough recipes were found and used by many of our families for homemade bread.

This part of the country was unique in another aspect. Idaho probably had more sheep than people. When we traveled on the back roads, we were often delayed by sheep on the roads who were in no hurry to move out of the way. Nonetheless, it was impossible to buy lamb in the grocery stores! The California-based Kaiser engineers had to have their lamb chops imported. Either the locals didn't like to eat lamb, or they had a plentiful supply from their own herds.

In spite of the trials and tribulations of performing the work under the conditions imposed by the national emergency, the ICBM missile bases were a very critical component of our national defense at the time. It was a tribute to our management and a dedicated field staff that we were able to accomplish an imposing task under the most trying of circumstances.

## *Trimmu Sidhnai Link Canal by Harvey Ceaser*

### Background

The lndus Basin Development Plan was initiated in West Pakistan following the partition of British India into India and Pakistan (both East and West) as a result of Britain's decolonization of India in 1947. Following is an attempt to give the casual reader some minimal background of this event. In order to obtain a better understanding, the writer suggests that one might see the movie, "Ghandi" and read various historical books on the subject of India's partition.

Following World War II, the British gave up their colonial empire including what historically had been India. India was really a composite nation consisting of two predominant religious groups, Hindu and Muslim. The central portion of the sub-continent from north to south was mainly Hindu, while the two appendages, to the east and west, were predominantly Muslim. (These appendages became East and West Pakistan while the central portion became present-day India). Historically India was composed of states or principalities which British colonization had conquered and controlled. When the British attempted to partition the country prior to their withdrawal, they drew what they thought were reasonable lines of demarcation based upon various states' rulers' decisions. These decisions were often made based upon the religion the ruler supported and often without regard to the wishes of his populace or perhaps a significant portion of the population. Thus, a state with a predominantly Muslim population and a Muslim leader would generally become part of Pakistan, but a state with a predominantly Hindu population might also have opted for Pakistan (the Muslim country) if the ruler was Muslim (or vice versa for India if he was a Hindu). As the day of partition drew near, mass migrations took place as people tried to join their religious brethren in the new nations. Long-buried hatreds were unearthed which often resulted in carnage as mankind tried to right inequities with rifles.

Since the division of real estate was made on the basis of the ruler's wishes (as described above) it did not necessarily follow that the watersheds would be similarly apportioned. Pakistan and northwestern India are extremely dry desert-like areas. It turned out that several rivers that started in India and flowed into Pakistan were to be diverted at the Indian border so that their waters would remain in India, thus leaving significant parts of West Pakistan dry, especially in the Punjab region of the country. To overcome this, the World Bank, with financing from its various sources, decided to build a set of canals to divert water from rivers originating within West Pakistan in order to feed the watersheds deprived of waters of Indian origin. In modern-day medical terms, it is analogous to a huge bypass operation. The canals, though generally unlined, are somewhat similar to the California Aqueduct taking northern California water to the south.

A giant development plan was initiated by the World Bank to resolve the man-made problems. This watershed plan was called the lndus Basin Redevelopment Plan with the lndus River and its tributaries providing the major source of water to the dried-up rivers. The West Pakistan government established the West Pakistan Water and Power Development Authority (WAPDA) to administer the World Bank-financed project. The plan required the building of many miles of canals and several dams of great magnitude. In addition to the canals, several barrages (low dams or diversion dams stretching across a riverbed) were built. The first major international undertaking under the lndus Basin Plan was the Trimmu Sidhnai Link Canal that was to be built in the state of Punjab, southwest of Lahore.

## Contract Award

This project was competed on the world market, and Kaiser Engineers Pakistan, Inc. was selected from ten bidders as the successful tenderer with a bid of 164 million Rupees ($28,254,000), and a contract was let in 1962. The engineer was Tipton Kalmbach & Co. of the U.S. who had engineering responsibility for all the canals. Various other engineering firms had responsibility for the individual dams that were built later. The British engineering firm of Sir Alexander Gibb & Associates served as the World Bank's engineers on the project.

## The Project

Staff from Oakland and other Kaiser projects, both domestic and foreign (Australia, the Philippines, etc), were mobilized to the port of Karachi, the then capital city of Lahore and to a tent camp at Shorkot Road (about 140 miles southwest of Lahore) that was the designated location for a yet to be built construction camp which was to be occupied by the Kaiser expatriate staff, its Pakistani employees, plus representatives of Tipton Kalmbach, WAPDA, and their staffs. Brick bungalows were built by KE for WAPDA and Tipton Kalmbach staffs and prefabricated aluminum modular type housing was imported for the Kaiser personnel, both expatriate and indigenous. Prefabricated homes were equipped with an extra aluminum roof in an attempt to shield the houses from the intense summer sunshine.

The camp had a social hall appropriately named the Hawaiian Hut, a commissary which sold imported and some local food to the staff, hospital, swimming pool (which was off limits to females), tennis courts, an airstrip, two company Piper Cub airplanes, and a sand golf course. Kaiser had to install its own water treatment and generating plants and sewage system, as these utilities did not exist. The nearest and only phone was in the nearby town of Shorkot Road (a railroad town) at the local post office. The town was without electricity and other utilities, and most housing was constructed of mud bricks. Refrigeration was unknown, and the local meat market would slaughter animals upon demand. You would see fly-encrusted shanks of meat hanging on hooks outside of the butcher shops.

The region consisted of generally barren land where peasants could eke out a living growing irrigated cotton and food crops while living on the small plots of land that they worked. They lived in mud brick houses whose walls were plastered with animal dung, which was sun-dried and then used for cooking and heating purposes. Summer temperatures seemed to hover above the century mark and often exceeded 110 degrees Fahrenheit. The surrounding area was parched, and evaporation was significant enough to leave the soil encrusted with salts often rendering it useless for agriculture and often resulting in frequent dust storms. This extreme weather pattern continued until it was broken by huge black monsoon clouds that came from the southwest bringing heavy rainfall and often flooding.

The Trimmu Sidhnai Link Canal Project consisted of constructing forty-four miles of 300-foot wide canal from just below the confluence of the Chenab and Jhelum Rivers south to the Ravi River. Additionally, Kaiser relocated six miles of the adjacent Haveli Canal. There were 45 structures built on the canal starting with a headworks at a location called Trimmu on the Chenab River. The canal was mainly unlined throughout its entire length with various road crossings (bridges) and aqueducts or siphons allowing lateral streams to cross. Being a "link" canal it was used strictly to transfer water from one river to another without any water being diverted en route. At the lower end of the system, at Sidhnai, there was a tailworks that discharged the water into the next river, the Ravi Riser. Flow in the canal was 11,000 cusecs, and the adjacent Haveli carried 4,400 cusecs.

The canals ware constructed for the most part using standard earth-moving equipment such as scrapers, dozers, and elevating scrapers. Also a special Curly Christiansen belt-loading device was fabricated which would excavate soil and feed a series of parallel moving bottom dumps which hauled material to the embankments. In the wet sections draglines were required, oftentimes working from timber mats imported from the U.S. The draglines would stockpile excavated material and after allowing it to drain, the material would be loaded-out using conventional equipment. The excavated material was used to build the canal embankments, which were constructed with a clay liner to minimize seepage from the canal. In certain places where it was anticipated that the velocity of the water would be fast enough to undermine the banks the engineer designed brick and mortar linings to prevent erosion.

Construction included "normal" problems for a project of this nature in a foreign country. All major construction equipment and most fabricated materials were imported, as most local sources were too expensive, inadequate, or non-existent. Equipment maintenance became a major problem, and eventually a crew of Irish mechanics was brought in to buttress the few American expatriate mechanics that had the task of keeping the equipment going. The supply of brick became a difficult problem as the local brick kilns complained that they were unable to finance coke costs for the required bricks. Kaiser stepped in to finance these costs but soon learned that they had lost control of the amount of coke being used, and it was felt that unscrupulous kiln operators were pocketing the coke money.

As the job neared completion, it was discovered that a significant length of the canal had not been built to the contract tolerance of plus or minus 2 inches with some sections being at least a foot or more out of alignment. The management of Kaiser reportedly offered to pay WAPDA in lieu of realigning the canal. However WAPDA refused this offer and required Kaiser to relocate the canal to its designed location. WAPDA's rationale for refusal reportedly was that this was an early project in the overall development scheme, and acceptance of a variation would set a bad precedent for following contracts. It turned out that the final location wasn't critical, for when the canal was opened for service, the waters it transported often eroded the banks more than the canal was out of alignment. Kaiser attempted to realign the canal using its excavation equipment. Graders and bulldozers were outfitted with slope blades so that they could move on the top of the canal embankment and cut back the slopes; draglines were used where misalignment was found in inundated portions of the prism. Later other excavation equipment (draglines and scrapers) would come along and remove the shaved material from the inside of the prism. The excavated material or other material would then be compacted on the other side of the canal to attain the ideal prism alignment. After throwing all of its resources at this rework, Kaiser realized that it would not complete the project in time using the equipment on hand. At this time labor contractors were hired to assist in "righting" the canal prism. These contractors brought in hundreds of laborers and donkeys, which were outfitted with woven baskets, one on each side. The baskets were loaded with hand-shoveled material which was then carried by the donkeys out of the canal prism.

The ability of the labor contractors to mobilize men and donkeys probably saved the schedule on this project and allowed Kaiser to complete on time. The contractors were self-contained units, bringing their work forces in, setting up primitive camps along the canal section where they were working and completing their contracted sections of the canal. The labor contractors were reported to hold their workers in virtual servitude, keeping the laborers in constant debt through the use of usurious money lending practices, gambling, and prostitution in the camps. It was rumored that some of the labor barons kept armed patrols on duty around their camps and that the Government of Pakistan would not enter these camps.

Construction work was followed by legal action between Kaiser and WAPDA. A staff operating from the Lahore guest house dealt with the claims issues under the direction of Victor Tchelistcheff with assistance from lawyers from both the U.S. and England.

**Expatriate Personnel**

Sam Banks, Project Manager
William Gegg, MD
Curly Christiansen
Nick Petroff
John Christiansen
Johnny Stradz
Harvey Ceaser
Joe Vance
Gary Fenity
Red Fulton (Management Rep)
Victor Tchelsitcheff
John Brezina
Bob Berenz
Chuck Valerius
Onto Lindy
Charley Clifton
Norm Hemmond
John & Colleen Murray, Teachers

## *Linde Hydrogen Plant by Omar Finsand*

The Linde Company Liquid Hydrogen plant was located seven miles east of Ontario, California, and immediately south of the San Bernardino freeway. In 1961, Kaiser Engineers entered into a contract with Linde Company, a division of Union Carbide, to provide support, design, and construction of a 26-ton-per-day liquid hydrogen plant. Linde Company was committed to provide liquid hydrogen to the U.S. government for its space program.

The plant was built on a 30-acre site, which had been a grape vineyard. Considerable clearing and grading was required. Support services such as electric power, natural gas, water, and telephone lines were brought to the plant from nearby systems. Plant water was mainly obtained from a well drilled on the site.

Construction began in May, 1961, and was completed one year later. Kaiser Engineers' workforce peaked in December, 1961, with 434 craftsman. Pipefitters dominated the force with a peak of 186. Other major crafts included electricians and carpenters.

The plant included five main buildings. The largest was the compressor building, which was 254 feet by 52 feet and was partially enclosed. Two overhead cranes were mounted in the compressor building for servicing of equipment. Eleven compressors made up the compressor systems, the largest being the two 5,500-hp hydrogen recycle compressors. These units also required the largest crane picks during construction at 70 tons each. Other important equipment included the four expander turbines, two hydrogen and two nitrogen, each with its independent lube systems.

An extensive pneumatic instrumentation control system was installed to provide pressure and flow readings in the control room. A total of 315 copper and plastic pipelines were installed on pipe racks and supports between remote equipment and the control center.

Preparation of liquid hydrogen required first the removal of hydrogen as a gas from natural gas. This was accomplished by the action of superheated steam at the reformer. The hydrogen gas was then piped to the purifier for final purification before transfer to the liquifier where the gas was cooled in stages to -310° F by passing through heat exchangers. The super-cooled, high-pressure gas was then released through an expansion system causing a pressure and temperature drop where liquification occurs at -433° F. The product was then collected into insulated storage tanks and made ready for transport to users.

Linde Company provided the specialty design and technology, including product-handling equipment such as heat exchangers, vessels, separators, kettles, etc. Interconnecting pre-fabricated aluminum piping was provided by Blaw-Knox. Major plant systems furnished by others included the steam reformer by Chemico; the freon refrigeration system by York; cooling towers by Fluor; substations by Edison; and tanks by Chicago Bridge and Iron. Concrete foundations were by Kaiser Engineers.

This was a first commercially built liquid hydrogen plant by Linde Company. The hydrogen expansion turbines with operational speed reaching 84,000 rpm provided manufacturing problems. Turbine delivery scheduled for January, 1962, finally arrived in April, resulting in a compressed installation program. Scheduled production of liquid hydrogen was achieved in May, 1962.

Key personnel on the project for Kaiser Engineers were:

Peter Iovin
Ken Polly
H.V. (Red) Zilm
Gene Brown
Omar Finsand
Del Oliver
Frank Carr
Frank Dews
Bud Gordon

The project was completed in time to meet Linde Cornpany's delivery commitment to the government. This together with a cooperative relationship between Linde personnel and Kaiser Engineers resulted in a second project in the same area for Linde Company involving an expansion of their nearby nitrogen plant. Charles Shaul replaced Red Zilm as general superintendent for the nitrogen project, which was completed in October, 1962.

## *Wabush Notes by Jim Miller*

The scenario of my being assigned to Wabush project began while I was in Oakland following the close of the Mountain Home job. Vince Palmer mentioned on several occasions that Pat Bedford, who was already in Canada, had asked Frank Bort to have me come to Canada for the Wabush job.

We relocated to Canada as landed immigrants in February, 1963. As we entered the country at Montreal, the immigration people took Kelly for a private inspection to determine her sex because her middle name is masculine in French, and they wouldn't believe her passport.

### Priority Construction Projects

The first construction at this remote mining site prior to my arrival had been a hotel, which was followed by barracks and a combination mess hall-recreation hall. The hotel was named the Sir Wilfred Grenfel Hotel for the noted early Newfoundland coastal doctor. A small group of permanent row houses was also completed for use by Wabush Mines staff and construction supervision. There was also a staff house for bachelor construction supervision. KE had one of the permanent houses for a guest house. Our construction supervision occupied about a dozen houses which were very well built and insulated against the cold which sometimes got to -40° F. Vehicles had to have some external heat overnight during the winter. All had head bolt heaters and some also had pan heater strips and radiator heaters. Even so, sometimes we had to drive a mile or more before being able to shift out of low gear in the morning.

Some work was underway during winter of 1963 in the classifier building and in the tailings outfall tunnel as these were on the project critical path. We had a fire in the formwork of the classifier building. This was apparently caused by one of the heaters setting fire to the weather enclosure. There was a high wind and no way to extinguish the fire. I was in Montreal that weekend. The concrete was tested the following summer, and damage was minimal. There was no significant impact on costs or schedule

Another schedule critical item was the tailings outfall corrugated multiplate tunnel. The frozen ground had to be drilled and blasted to excavate and then protected from freezing by covering with hay. After placement of the tunnel the backfill was dry sand to avoid possible freezing problems. After all this effort, when the ground thawed the following summer, the tunnel started to collapse. It was saved only with installation of struts throughout its length.

### Site Is Remote

The site was truly remote. Usual access was via air because there were no roads in that part of

Canada—the only overland access was the railroad built to haul the iron ore out to the port of Sept Isles, Quebec, on the Gulf of the St. Laurence. Radio reception was poor to impossible due to the iron ore deposits, and no TV was available although we had microwave telephone connections to the rest of Canada and the U.S. As of today, there is still no highway access to Wabush.

Our recreation was self-created. We occasionally got together with several families to listen to classical music. This included Mac McKim and Vladdy Filipovich. We also played badminton one night a week at the rec hall. The local younger Canadians played hockey in an outdoor lighted rink, but it was too cold to be a spectator. A community effort (with more than a little help from Wabush and IOC) built a Poma Lift the summer of 1963, and we had good skiing the following winter, 1963-64. Of course, the snow was so cold it took a steep slope or good wax to get up any speed. We had a warming hut with hot mulled wine, which sometimes was the only thing that kept us on the slopes.

There were very poor shopping facilities at Wabush. Bowrings had a market in Labrador City where we shopped once a week. Since all goods subject to freezing had to be shipped in heated railroad cars, the selection of such items during winter was limited to a few basics. Milk was reconstituted. Initially, we had to bake our own bread, too. During winter there were no fresh veggies, and even in the summer the selection was very limited and expensive.

The airport terminal consisted of an 8 x 20 trailer, half of which was for airline operations. The runway was marked by painted barrels standing in the snow. Wabush mines maintained a small hanger for their DC-3 when it had to stay overnight. Commercial planes did not remain overnight. When I first landed with Pat in January,1963, and got off the plane I thought I had landed at the South Pole—it seemed completely desolate and remote. There was nothing in sight except snow plowed for the runway and the hanger and trailer terminal.

JFK was assassinated in the fall, 1964. We were informed of this by a telephone call from Oscar Hanson in Montreal. That evening we hunted all over the radio dial for reception and up-to-date news, but it was almost impossible to get any reception through the static. All we could tell was that he had died. The Canadians were quite distraught over his death while the Americans seemed much less concerned. Pat felt good riddance.

## Navigating the DC-3

Wabush Mines' plane was a renovated DC-3, which was flown by two pilots who had flown for construction of the railroad to Schefferville in the mid-'50s. When weather was bad, which was more often than not, and since there were no navigation aids, they flew just above the railroad tracks using them for navigation. This was called flying the "iron compass." On one trip out of Wabush they showed us what it was like, and it was quite an experience to fly 100 to 150 feet above ground and follow all the twists and turns of the track which meant rapidly banking this way and that. On the flight from Montreal, after leaving Chicoutimi, Quebec, there were no signs of human life or habitation for about two hours of wilderness. It was awesome. The plane was nicely appointed inside, but it was not pressurized nor did it have adequate heating so everyone wore coats, boots, etc. when travelling. On one trip back to Montreal for a weekend home, I had a bad cold. Without cabin pressurization, I was treated to a massive sinus headache.

## Project Personnel

Al Wallach was project manager in Montreal. Bruno Boik was engineering manager, Pat Bedford construction manager, and Oscar Hanson handled costs and estimating, all in Montreal. When I arrived, Fred Wood was site construction manager. During the winter, Fred became very ill and had to be air evacuated and never returned. I was made site construction manager. Others were Al Zimmerman, Charlie Harman, Oscar Carlson, Bert Provost, Lee Schilling, Leo Bonney, Bernard Fury, Joe Polfer, Mike Ruzilla, Carl Watt, Tom Burns, Rufus Chatham, and Byron Nielsen. During final checkout and start-up, Bill Beard, Walt Pentz, Stan Markowitz, Elmer Kern, and other electrical people joined us. The site resident engineer was Hans Koli.

## Our Contract

Our original contract was for design and construction of the concentrator plant. The design of the town site and town-site construction were performed by Canadian companies. This latter work didn't go well the summer of 1963, so KE was assigned townsite construction for the summer of 1964. Charlie Harman and Tom Burns handled this work, and the client was very pleased.

We were building a plant to concentrate iron ore at Wabush Lake. The dried concentrates were transported by rail in covered cars to Seven Islands where the concentrates were pelletized in a plant designed and built there by another Wabush Mines contractor. The reason for the separation of concentrating and pelletizing was the high cost of hauling fuel for pelletizing to Wabush combined with a heavy fuel oil tax by Newfoundland. Interestingly, another similar process plant located at Wabush Lake in Labrador City, just across the lake from Wabush, was designed and built by Bechtel for Iron Ore Company of Canada, another iron ore consortium, and that plant concentrated and pelletized the ore. The plant was placed in operation while ours was under construction, and I was able to tour it several times. Lab City townsite was a few miles away and was the site of the only grocery store within hundreds of miles. Each of the mining operations was on private property and was connected by a public highway. This trip required using provincial roads with licensed vehicles of which we had only two or three because the vehicles were restricted to the mine private property and thus did not require licenses. We ran a bus to Lab City once a week for family grocery shopping—such as it was!

### Churchill Falls Project

Power for construction and later operations was supplied to the complex over about 120 miles of power line from Twin Falls, a small company-owned hydro plant near the present Churchill Falls complex. Hamilton Falls was the original name for Churchill Falls. At the time studies were underway for the eventual facility, which was built several years later. In the fall of 1964 the Wabush plane flew a group of Wabush and KE people to the future site and also the existing hydro plant. The Churchill Falls hydro project was a fascinating project with major weather and logistic challenge and problems and a very short construction season. All materials, supplies, and equipment were shipped to Sept Isles. It was then loaded on rail cars, hauled to a siding about 300 miles north, unloaded onto trucks, and hauled over a bush road several hundred miles further to the Churchill Falls site. Because of the extreme winter conditions, most of the shipments had to be completed during the short summer.

### Six-month Single Status

All the Canadian workers signed six-month single status contracts, lived in barracks, took meals in the mess hall, and worked six 10-hour days each week. These conditions were required to draw needed manpower to these parts. Wabush Mines committed to hire all qualified Newfoundlanders for the project so that most of the unskilled workers were Newfies. We also hired some carpenters and plumbers from Newfoundland. The other more skilled trades came from throughout Eastern Canada—the Maritimes and Quebec. Later during the 1964 construction season, we had to go as far as Ontario to get electricians, and we also had to increase our overtime hours to entice electricians from work in other parts of Canada to come to remote Wabush. Electricians were still usually in short supply, and we used plumbers to install a lot of the electrical conduit. Conduit use was minimized somewhat by use of special armored cable in cable trays in many places. Oakland industrial relations people objected to this practice mostly after the fact. But the owner approved, and it was necessary to adequately man the work.

### Emergency Power

The design called for four 1310-kva diesel generators for the permanent emergency power system which we installed early to be available for emergency power during construction. On several occasions we had to use these when we lost our power. Lee Schilling could get all four started, synchronized, and on-line one by one in about 5 minutes. These generators were incorporated into the plant emergency power system. It was a good feeling to know this could be done. Conditions in winter were severe, and power was essential to survive.

### Construction a Challenge

Construction in the north was always a challenge from the weather, labor availability, or the physical conditions of the terrain. One of the worst was the Muskeg which was an apparently bottomless bog filled with decaying vegetable material which appeared to be solid ground but would not support much of anything. It generated enough heat that it wouldn’t freeze very deep even in the extremely cold winters. We almost lost a backhoe sinking into this muck during construction of the three-mile embankment for the tailings line. I still don’t know how the railroad people did such a good job with the construction of the Quebec, North Shore and Labrador Railroad from Seven Islands to Schefferville and later the Wabush Lake

RR branch from the QNS&L main line to Wabush Lake.

### Material Control

Shipment of materials and equipment required careful control starting with timely design. Delivery was initially to a Montreal site where components were consolidated for water shipment to Sept Isles. They were unloaded onto rail cars and hauled to the site where we had to store until needed. Sequencing of components as needed in construction was very critical due to limited interior storage at Wabush. Items, which could be stored outside, had to be carefully located so they could be found under the winter snows.

### Excellent Relations

We had excellent relationships at the jobsite with the Wabush Mines site manager, Roscoe Stensrud, a veteran of the Minnesota Iron Range. He knew what it took to get the job done and supported us in our efforts to meet schedule whether it was expediting design or engineering decisions, materials or equipment deliveries, manpower, or whatever. At the site we developed a mutual admiration society and tried to help make each other look good. When Roscoe’s boss, Walt, a retired general, U.S. Corps of Engineers was planning to come to the site for a visit, Roscoe would show us the route he had planned for the tour and tell us to do whatever was necessary to make sure this area looked the very best possible. We had usually set aside half an hour a week for all crafts to conduct a general clean-up and tidying of their work. The job was very successful from this standpoint, and it also was completed within the schedule and cost estimates. Oscar Hanson handled KE costs and estimates in Montreal, and relationships in this area with Wabush Mines were also good. He did a great job.

The concentrator plant had a lot of rubber-lined equipment to protect against abrasion by the iron ore. This lining material is highly flammable even though the ore is usually in a slurry form during processing. The launder carrying tailings from inside the plant to the tailing thickener was very large (probably four feet wide and five feet high). The launder was lined with this rubberized material. One day this caught on fire, and it was spreading rapidly from the center of the thickener along the launder toward the concentrator building proper. Fortunately, Walt Pentz was nearby with a large dry-type fire extinguisher and stopped the fire before it gained the main building. We narrowly averted a major disaster and thereafter stepped up fire protection efforts. Several years later, when we were in Venezuela, a fire broke out in the Wabush concentrator building and completely destroyed the facility. KE people were called back on an emergency basis to make repairs, and this was done within about three months during the winter and spring.

### Labor Dispute

Shortly after I arrived on the job, we had a labor dispute with the pipefitters over a matter I cannot recall. The fitters went out on strike and refused to work. The entire mine, townsite, and concentrator site were all private property owned by Wabush Mines. When the men refused to work, the Mounties were called to evict them from the private property. They were all fired and put on a plane to Seven Islands within a couple of hours. Labor relations were rather tough, but we were backed by Wabush Mines, and the men stayed fired. We had no further problems from the pipefitters during the entire job and very little from the other trades either.

### Child Is Born

When we moved to Canada, Jo was pregnant with Gretchen, and the medical facilities were not adequate to handle a birth at Wabush, so it was necessary for her, Kelly, and Kris to stay in Montreal until the baby was born which was scheduled for mid-April. We moved into the duplex house in Hampstead just vacated by the Barries who had returned from Canada to Oakland to prepare the bid for the American River Project.

Our time in Montreal was to be short, so we hardly unpacked. The moving people flew to Wabush to unload everything. This was repeated in reverse on the way home except everything was shipped back to California. Kelly attended a local Catholic pre-school in Hampstead. She was required to wear a school uniform. Our neighbor in the duplex in Hampstead was a Jamaican doctor, Colin McKinley.

While living in Montreal, we had several occasions to go to Eskimo art shows at the art museum. We bought a number of these lithographs while we were in Canada. The art form has became quite popular, and several of the artists became very well known and their works prized. We were fortunate to have selected several pieces by Parr who is now quite well known.

## Have Your Babies in Montreal

Colin McKinley was the doctor in residence at Wabush and lived across the street from us. His advise was to have babies in Montreal and not at Wabush. Jo, Kelly, and Kris lived in Montreal until after Gretchen was born. She was born at the Royal Victoria Hospital. Previously, Jo had left the hospital the day after Kelly and Kris were born, but she had much difficulty getting a release from this hospital which was a little behind the times. In Quebec, the wife had no legal authority for medical procedures for children so I had to prepare a power of attorney giving her that power when I was away in Wabush. When Jocelyn was due, Jo went to Montreal about two weeks in advance to await her arrival. She stayed at the YWCA. My mother came to Wabush to look after Kelly, Kris, and Gretchen while Jo was gone as Doris White was unable to assist us at that time. I went to Montreal the weekend the baby was due.

On Saturday, October 3, we drove down to Stowe, Vermont, and were generally sight-seeing the autumn colors, which were beautiful. We returned to Montreal that night, and early the next morning Jo awakened to announce it was time to go to the hospital, and Jocelyn was born that day. Again, problems with Jo leaving the hospital. We kept Jocelyn in a bureau drawer at the motel the night after release from the hospital until we left next day to return to Wabush on the company plane. Mother was packed and waiting on the tarmac ready to leave immediately, having had her fill of the three children for two plus weeks. She took the Wabush plane on its return trip to Montreal.

## Lost Child

One Sunday I went over to the plant site for my usual inspection, and for some reason Kris wanted to go with me but, of course, this was not possible. After I left and she went out to play, she had started off on her own to follow me to the plant site. She somehow got started down the tailings line road instead of the plant site road and was found wandering there by the Mounties. At the time Jo hadn't noticed that she had wandered off. This could have turned out quite differently but for the Mountie's vigilance and relatively reasonable weather, although there was snow on the ground at the time.

When we moved into our house in Wabush, the townsite work had not been completed. We had plank walks from the road to each house, and there was no "yard," just bare dirt, which in the spring was simply mud. One day Kelly who was about 3 years old went out to play in her boots and got stuck in the mud. Jo eventually heard her crying and rescued her leaving the boots in the mud.

## Short Summers, Short Nights

The summers were very short that far north and, of course, the nights were short. It was hard to get the children to go to sleep at a reasonable hour because it wasn't dark until after 10 p.m. and light again before 3 a.m. We had to black out the windows with shades. Summer was the rainy season. I wore a rain jacket to work almost every day. There were usually about 2 or 3 weeks of warm weather in July or August, which meant temps of 70-75° F maximum. The second summer had a little longer dry spell, and there were forest fires all over the area. At one point there was some concern we would have to evacuate but this didn't materialize. There were seaplane PBY- type tankers flying from our area to fight the fires. They were designed to scoop water from a lake without stopping and then takeoff and drop water on the fires.

## Black Flies

Black flies were a terrible nuisance and although Wabush Mines sprayed the townsite area by air regularly, they seemed to thrive on that. They would get in the children's hair and draw blood from their bites, which were very uncomfortable. I was the least bothered of the entire family. These insects strongly discouraged outside activity. Only the most dedicated fishermen went out even though the lakes were teeming with fish. Walt Pentz was an avid fisherman and often would come back from a Sunday of fishing and give us fish from their catch.

## Christmas Tree

For Christmas of 1963, we had to get our own Christmas tree. Although the entire area was heavily forested with spruce, this was not easy because the snow was 4 to 6 feet deep in the woods, and the trees, although small, were very close together. We went out on skis and had a hard time finding one with sufficient branches to use for lights. The growing season is so short in that area the small trees can be only a few inches in diameter and still be over 100 years old.

### Recreation

One of our recreational activities during the short summer of 1964 was looking for garnets. We brought back many samples. I understand garnets are common in areas of high iron content. Another pastime was picking blueberries. However, they were very small so it took a lot of picking. The weather by that time of the year was usually wet and chilly, and with the constant plague of black flies we got discouraged quickly. I think we picked enough blueberries for one pie.

Jo and I had time off twice while at Wabush. We took two weeks in the winter of 1964 to go south to Stowe for skiing and to the Boston area to visit Aunt Grace and Uncle Awky in Amesbury. Another time in the fall of 1964 we took several days off to take the train from Wabush to Sept Isles. This was one car of the twice-weekly freight train to Wabush. When we got to the main line of the QNS&L, it seemed we were on a siding half the time waiting for an ore train to pass. This was a single-track railroad with automatic train control, and the loaded ore trains running south to Sept Isles had priority as they were 100 cars long at 120 tons each. Once started, they didn't want to slow or stop. Sept Isles was a small boomtown. I don't recall any paved streets, and the sidewalks were planks. Everything was muddy, but at least it had much more than Wabush such as fresh food, etc. It was about this time that paving of the last section of the highway from Montreal to Sept Isles was finally completed. While we were exploring the waterfront, Jo approached a man returning from fishing and spoke a greeting in French. He responded with a long dissertation, none of which Jo understood. Embarrassed, she had to ask him to speak in English, which he did. He had said something about the fishing, and Jo's French had sounded genuine enough that he assumed she spoke the language.

In the evenings after the children were in bed, Jo and I would sometimes take a short walk up to the town water tower on the top of the ridge. The area around the tower had been cleared of trees and there was a spectacular view of the surrounding country. The best was of the sky. At times, there were some fantastic exhibitions of the aurora borealis. These were in all colors, and at times the sky would be shimmering. All this in absolute silence as a color or flare would spread across the sky changing shape and color. A site to see, especially at 30 below zero!

Often Kris, who was about 3 years old, would not go to sleep at night and would come out of her bedroom to sit on the stairs. Sometimes she would come into our cold bedroom (window slightly open) and sleep on the floor. For some reason she preferred the cold to her room.

### Going Home

On one trip Jo made to Montreal on the Wabush plane she bought a potted orange tree and brought it back to Wabush. The tree had blossoms, which produced a number of small oranges. It added much to our small house and was admired by our guests. We left it with the Stensruds when we departed.

Canadian taxes became a financial burden for us and at that time there was no company policy regarding compensation for these matters which arose when working outside the U.S. As a result, I worked out an arrangement with Pat to leave in November, 1964, because at that point taxes would become an unreasonable burden because Canadian taxes we had to pay were higher than U.S. taxes. The excess completely offset increased compensation for six-day weeks, remote location, and high cost of living. Although most of the plant was working except the dryer and a few ancillary facilities, I was disappointed not to be on-site when the entire plant was on-line.

We packed up and moved out headed for Oakland. We returned via Iowa where we spent Thanksgiving. That visit was the last time I have been pheasant hunting when I went out with Aaron, John, Jack, and a few others. After arriving in the Bay Area, we found a new house on Pebble Beach Loop in Lafayette. While we were in Iowa, Frank Bort called to tell me my salary would revert to the same as prior to going to Canada, which was a bummer.

## *Guri Dam*
## *by Jim Miller*

The Guri Hydroelectric Project was the cornerstone of the program for development of the Guayana region of SE Venezuela by a government corporation, Corporation Venezolana de Guayana (CVG). Overall scope of the development program included abundant natural resources, industrialization, and agriculture, together with supporting infrastructure. The Guayana region is rich in iron ore and other minerals, oil, and large rivers, which provide the basis for the development.

Construction of the Guri project commenced in 1963 by Consorcio Guri, a joint venture of major contractors sponsored and managed by Kaiser Engineers. Other participants were Macco International, Tecon international, Inc., Merritt-Chapman & Scott Overseas, Inc. and Compania Anonima de Construcciones, Christiani & Nielsen. Key personnel were primarily from Kaiser Engineers. Design for the project was prepared by Harza Engineering Company, and financing was partially with World Bank funds. Our contract was a fixed-unit price based on estimated quantities with an original value of $73,659,000.

Guri is located in southeastern Venezuela on the Rio Caroni, a tributary of the Orinoco River, about 90 kilometers upstream of its confluence with the Orinoco at Puerto Ordaz. Our project comprised a concrete gravity dam with an earth and Rockwell tie, a powerhouse with three installed 175-mw hydraulic turbines and matching generators, spillway, and switchyard. The dam had a design crest length of 2,160 feet and a crest of 348 feet above the lowest foundation level. The project required approximately 10,000,000 cubic yards of excavation, 2,000,000 cubic yards of concrete, 22,000 tons of reinforcing steel, 2,200 tons of penstock steel, 500 tons of structural steel, and 3,500 tons of spillway gates, draft tube gates, intake gates, trashr acks, and diversion gates. Our contract was the first stage of a multi-stage project. Subsequent contracts would raise the dam height and add to the powerhouse—ultimately creating a complex with a generating capacity of 10,000 mw. According to the construction magazine *ENR*, Guri at the time of completion in 1986 was the largest electricity producer in the world.

## Only One Way In

The dam site was accessed by a paved two-lane highway about 90 km from Puerto Ordaz. A highway completed for the beginning of the project was the furthest south overland access into that part of southeastern Venezuela (south of the Orinoco and west of the Caroni). Except for a power line from Puerto Ordaz, no other infrastructure existed in that remote area of Venezuela. A complete construction town, Campamento Guri, was built by the consortium for the work. Initially, this consisted of 66 prefabricated family housing units, a staff barracks for 25, and mess hall, a water supply, and distribution system, sewage collection and disposal system, electrical distribution system, and a local telephone exchange (no connection to the national system). Our town also included a recreation hall, swimming pool, commissary, schools for Venezuelan and American students, and a 12-bed hospital. Also part of Campamento Guri was a workers' camp with housing, mess, and recreation facilities for over 2,000 workers and supervisors.

Guri required a major construction plant facility. A main office at the worksite and several field offices were established to manage the work. Numerous shops and other facilities were constructed, including a concrete batch plant with three 4-yard mixers; an ice plant; an 8-yard cableway and traveling headtower; central air compressor station, carpenter shop, equipment, air tool repair shop, warehouse, reinforcing steel fabricating yard, rigging loft, welding shop, pipe shop, electrical shop, plus approximately 30 km of jobsite roads, electrical distribution, and telephone system. A complete aggregate plant with crushing, screening, ball mill, and necessary conveyors was built to manufacture the concrete aggregate from rock excavated from the dam, powerhouse, spillway, and tailrace.

## River Diversion

The notice to proceed was issued August 8, 1963, with a contract completion of August, 1968, with liquidated damages for late completion of various project milestones. Our original contract value of $73,659,000 was increased to $81,000,000 by additional quantities and a third 175-mw generating unit and turbine. Work commenced in August, '63, with the river in full flood, on infrastructure construction and preparations for diversion. The staff camp housing was sufficiently complete for families to move to the site by Christmas of '63. The river was diverted on schedule during low water in early '64 with the river at probably the lowest recorded flow during the less than 20 years of records that existed for the river. During that period, peak flow had been recorded at over 17,000 cubic meters per second which places the river flow roughly equivalent to the Columbia in flood. The main upstream cofferdam was larger than 50% of the rockfill dams constructed up to that time. Harnessing this powerful river was a Herculean task, which was accomplished as planned at a location that before the exploration for Guri was uninhabited except for infrequent Indian tribes.

A two-stage plan was developed for diversion of the river. Stage I comprised a cofferdam placed across the main channel of the river during low flow, which normally occurred from January through

March. This cofferdam would divert the river into a secondary channel to the east. This secondary channel was separated from the main channel by a longitudinal cofferdam the length of the tailrace excavation, which then crossed the main channel at the downstream end of the tailrace. The cofferdams enclosed the area for construction of the main dam, spillway, powerhouse, and tailrace channel. The main dam was designed to be constructed with gated sluiceways, or openings, in the dam to allow passage of the river during Stage II.

Stage II diversion was to occur when the concrete work in the main dam powerhouse and spillway had progressed to a height sufficient to avoid flooding, and the tailrace excavation was complete. At that time the upstream cofferdam would be removed, flooding the main dam, spillway, powerhouse and tailrace areas. The cofferdam across the downstream end of the tailrace channel was to be removed concurrently. At this time the gates in the sluiceways were to be opened, allowing the river to flow through the main dam and the tailrace to return to the original river channel below the tailrace. This left the Stage I diversion channel dry, allowing for construction of the concrete and rockfill east wing of the dam in this channel. Upon completion of the east wing, the gates in the sluiceways were to close to fill the reservoir and to force the river to flow through the powerhouse and/or spillway. After closure of the gates the sluiceways were to be plugged with concrete completing the main dam.

### Problems From the Beginning

Difficulties began to surface as excavation for concrete placement in the main dam area commenced. Weathered and fractured rock extended into the designed dam foundation requiring extensive changes to the foundation elevations and exhaustive surface preparation for the main dam. Additional drilling, blasting, loading, hauling, and surface preparation affected efficiency and progress. This condition continued throughout foundation preparation for the main dam and spillway. Similar conditions were encountered later in the tailrace excavation. The lack of good rock at design elevations severely impacted all steps of the excavation, and hauling operations compared to the costs and schedules of the estimate (Murphy's Laws at work).

### Poor Foundation Information

The project estimate had been based on the borings, foundation elevations, typical rock face, and other data provided in the bidding documents. Differences were sufficient to cause Harza to redesign major portions of the project. As excavation for concrete placement proceeded, it became apparent that the extent of the highly weathered and fractured rock conditions had not been accurately represented by the contract documents. Work was taking much longer and costing more than estimated.

### Poor Concrete Design

The first permanent concrete was placed in the main dam in late '64. Concrete aggregates including sand and rock fines were manufactured from the excavated granite gneiss since there were no acceptable natural aggregate deposits in the region. The extensive amounts of weathered and fractured rock were not acceptable to the engineer for use as aggregates. The aggregates manufactured from acceptable rock were very angular due to the crystalline structure of the rock. The designers had specified an aggregate mix, which would not produce a workable concrete. The engineer specified fines manufactured with the ball mill were inadequate to improve the placeability and workability of the concrete mix (with maximum size of 6") which remained harsh, abrasive, and unworkable. This caused excessive wear on all handling equipment, and it was almost impossible to handle and place the concrete efficiently. The engineer would not allow use of concrete additives and only very limited air entrainment and refused to modify the aggregate blend. Additional cement improved workability somewhat, but its use was very limited by the engineer because of concern for increased heat of hydration. The engineer also refused to pay for the cost of the added cement. This issue was never completely resolved until very late in the project. After almost all concrete was placed the engineer finally allowed a change in the aggregate mix after the damage had been done.

A major effort was undertaken to document and support claims for added compensation and time for performing the work due to differing conditions of the rock and the concrete. Substantial, well-documented claims were submitted and aggressively pursued into the early '70's but were never recognized by the engineer or the CVG.

## Terrorist, Labor Headaches

Another complication: major political and local labor problems were also occurring in Venezuela during this time. Cuban-supported terrorists were very active in Caracas and elsewhere. Federal troops overcame armed resistance to take over the University of Caracas, which had served as a haven for terrorists. These "interesting" activities impacted our project with high security requirements for blasting materials plus general labor unrest. A permanent detachment of Guardia Nacional on-site closely guarded and controlled all activities associated with the transport, storage, handling, and use of explosives. Internal political disputes were reflected in the strong labor unions, which were very active over wages and benefits as well as working and camp conditions. Availability of even minimally qualified carpenters became a major problem. Eventually, the consortium recruited 100 carpenters from Italy, resulting in significant improvement in the progress of form work. (Italians make fine construction workers, especially in wood and masonry.) Competent foreman-level supervisors were in continuous short supply.

## Negative Publicity

During '66, Bobby Kennedy was touring South America and drawing huge crowds wherever he went. His advance planning party came to Guri to arrange for him to visit and to make a speech to the workers. In view of the unstable labor conditions, expected security concerns and the anticipated loss of production, the project manager, Don Shupp, recommended to the U.S. Ambassador that Mr. Kennedy's visit to Guri be reconsidered. It was subsequently announced that Mr. Kennedy would visit Caracas and vicinity and then depart Venezuela for other destinations on his trip.

The Guri project received much local attention in early '67 when the Washington, D.C., columnist, Drew Pearson, on a visit to Venezuela stated in one of his columns datelined Venezuela that Consorcio Guri had lost $46 million. He also wrote that negotiations were being held between the consortium and CVG to resolve the issue of responsibility for the increased costs, and this incident was adversely affecting relations between the United States and Venezuela. However, the U.S. Ambassador stated relations were good between the two countries. This publicity and related events were influential in the decision of the Venezuelan Congress to hold hearings into labor conditions and responsibility for increased costs at the project. Some of the hearings were televised and included the personal appearance of project manager Don Shupp who fortunately was fluent in Spanish, and he made a good accounting of the project which helped mute the adverse publicity.

The remote location of the Guri project and limited local facilities often made small difficulties into substantial problems. Power transformers for the 175-mw generating units were imported from Sweden and delivered to the consortium barge on the Orinoco near Puerto Ordaz, which served as a floating dock since river level fluctuated as much as 30 feet. These three transformers each weighed in excess of 125 tons, without oil, and had to be moved to the site over the only road which had three bridges, none of which was remotely adequate for this load. Strengthening or shoring the bridges was impractical due to their height, and no other solutions were apparent. We decided to wait six months for the dry season when the streams and waterways were low or dry and bypass the bridges by fording the three streams. Temporary roads were constructed from the highway to the ford and back again at each of the three bridges. On moving day everyone prayed for no rain, and the all-day trip to the site for one transformer was completed without further incident. The remaining transformers were moved on succeeding days. There was only *one* lowboy available in all of Venezuela, which could carry a transformer of this size. Even so, the tractor pulling the lowboy required the help of a motor grader to make it up the hills. We might still be there if it had rained!

## Solution for Diversion Gate Installation

Installation of the sluiceway diversion gates required a slightly different solution. The gates were assembled in a site-fabricating yard to meet all of the erection tolerances. The gates were too heavy to be moved in one piece by the 8-yard cableway, which was the only means to move them into place on the as yet incomplete dam. So, the gates were cut into two pieces, each of which could be handled by the cableway. They were placed individually in the dam and then welded back together. These were the same gates which later could not be closed at the completion of Stage II diversion, although the method of installation was not a factor in the subsequent closure problem.

During the peak concrete placement period of '66 and '67, project focus was on maximizing production. The increase in plant capacity during the last half of ‘65 was a significant improvement but this was offset by extremely heavy maintenance of all equipment involved with rock excavation, aggregate production, and concrete production and placement. Labor efficiency improvements were achieved with increased supervision and with the previously noted recruitment of qualified carpenters from Italy. Concrete transport with the 8-yard cableway was supplemented by job fabricated flatbeds to haul 4-yard buckets to the spillway and the powerhouse. Concrete production peaked at close to 50,000 cubic meters per month.

## How to Close the Gates

Probably the most significant single construction problem occurred with the closure of the diversion gates at the end of the project. During Stage II diversion, the river flow was passed through sluiceways in the main dam allowing the construction of the remainder of the dam across the Stage I diversion channel. Upon sufficient completion of the main dam, powerhouse, spillway, and tailrace, the gates were to be closed and the sluiceways concreted to complete the work. There were seven sluiceways each with two gates 52 feet high by 21 feet wide.

When the time came in August, ‘68, for permanent closure of the gates, some of them had been damaged by the high flows of water under high head and could not be closed using the designed hydraulic system. Water level of the reservoir was well above the gates causing extremely high flow rates past the gates, which made it impossible to determine the exact problem with the gates, let alone repair them. Other measures were tried to close the gates. A pile hammer was partially successful in forcing some of the gates closed. In October, 1968, studies were initiated and a plan adopted in December which included jacking to reduce the large gate openings and placing a rockfill and a clay blanket to seal the four remaining sluiceways. In the later part of December, 1968, an all-out effort to stop the flow was mobilized. By mid-February of ‘69 the openings in two of the sluiceways had been successfully closed, and the remaining two were expected to be under control by early March. Heavy steel grillages were placed over the openings to retain the large necklaces of rocks and subsequent rock fill which eventually sealed the openings, but only after several significant failures of these components and portions of the gates themselves. One failure forced huge pieces of railroad ore cars and steel grillages through the sluiceway and into the tailrace. *Final closure* of the last opening was accomplished on April 29, 1969, a memorable day!

After dewatering, it was found the cavitation of the water flow had caused erosion of the concrete by as much as 15 feet in places. A catastrophe of immense proportions had been very narrowly averted!

## Work, Work, Work

Guri Dam was a truly remote location, and everyone at the project worked six 24-hour-days a week with maintenance on the seventh day. The expatriate staff regularly logged extremely long hours to perform a difficult job made moreso by the many problems, some of which have been described above. Our location about 7 degrees north of the equator necessarily meant a tropical climate, yet it was still reasonably comfortable much of the time. Most activities were out of doors at our prefab houses and at the camp recreation hall and swimming pool, which received heavy usage. At one dance we sponsored, a local band played, “I Left My Heart In San Francisco,” which caused more than one lump in the throats of many Californians. Often on quiet nights (i.e., *every* night), we could hear howler monkeys in the nearby jungle—if one could stay awake long enough after a long hard day.

## Local Tourist Attractions

The Rio Caroni previously had been known mainly for diamonds which were placer mined by locals with their siroucas (a large dished screen). The source of the river is near Angel Falls (Salto Angel), the highest waterfall in the world, which is approximately 120 miles up river from Guri. Guri is located at the edge of a grassland plain (llanos) and snuggled up to the tropical forest to the south and east. The Caroni is known as a “black river” because its water has a dark brown tint due to the tannin in the water from the upstream jungle. High water in the ‘66 wet season exposed a prehistoric living and burial site on the eastside of the river. This site contained several skeletons as well as numerous stone tools and innumerable pot shards. Some pieces were handles of large jugs. Several of us explored the sit, and eventually archaeologists from Caracas became interested in the burial site and artifacts.

### Flying's Fun

One particular flight of the company plane will be long remembered by those of us who were passengers. On a Sunday in the summer of '65 the company plane made a sightseeing trip to Angel Falls. While circling in the clouds for a better view, one of the two engines konked out!

This event cut the flight short, and the plane limped back toward Guri on one engine with its silent and worried passengers contemplating jungle and river as far as the eye could see. Fortunately, all ended well when the plane landed at El Piar, a field near Guri serving U.S. Steel's iron ore mine of the same name. On another occasion the plane was returning to Guri from Caracas with several management visitors from Oakland when it inadvertently ran into a tropical thunderhead and severe updraft with high winds, hail and extreme turbulence. At one point the plane was rising 1,000 feet a minute with the nose pointed down, flaps extended and engines throttled back. The plane did a "shake, rattle and roll!" in the turbulence and eventually stabilized while all of us aboard heaved a huge sigh of relief. The remainder of the trip to Guri was dead quiet except for the roar of the motors.

### Local Animals, Fauna

The Guri region is home to the howler monkey, parrot, macaw, capabara (a pig-sized rodent), iguana, giant anaconda snake (similar to boa constrictors), bushmaster and coral snake, centipede, tarantula, and periodic invasions of large grasshoppers. Many of our yards in camp contained banana plants and / or papaya trees, which provided a bountiful supply of fruit. At the local market a multitude of different kinds of bananas, platinos, and small finger bananas were available for the adventurous shopper and proved delicious. Platinos (plantains) are very large bananas and only eaten cooked, providing the locals one of their major diet sources along with black beans and rice. These all thrived in the tropical climate where the temperature seldom dropped below 70° F day or night, and during the wet season from May to December, daily afternoon showers often became torrential downpours.

### All's Well That Ends Well

Several major changes at site management occurred during the life of the project. The first project manager was Russ Hoffman, who was followed by Glen Gage. Don Shupp managed the job starting in mid-'65, and he was followed in May '67 by Doug Baker. Jeff Elliott completed the job. Oakland supervision was initially under John Hallett and then Bob Connor, followed by Don Shupp. Lou Oppenheim then took over responsibility followed by Gene Trefethen and then Jim Boyce. Even Edgar Kaiser maintained an interest from '65 on, including many visits to the site. He was actively involved during the latter stages of the work, especially during the gate closure problem when he was on-site for long periods of time. Bob Connor was in residence in Caracas during the claims negotiation stage following completion of the work.

Our Kaiser Engineers expatriate staff was made up of many veterans from civil and industrial construction groups, supplemented by new hires specifically for the project. These dedicated men worked very long and hard hours with little time off, and with their families, made unselfish contributions to an extremely difficult and challenging project.

Unfortunately, Guri was a major financial loss for Kaiser Engineers and its partners even with some redress after claims negotiations at the end of the job. Together with losses on several other major heavy construction projects during the '60s, these were the last of this type of high-risk projects undertaken by the company. It truly was the end of an era of heavy civil construction begun by Henry J. Kaiser after WW I with highway construction and continuing through such famous projects as Boulder, Bonneville, and Grand Coulee dams.

## *Southwire Notes*
## *by Jim Miller*

My initial assignment to the project came after several attempts by Frank Bort to get me to go to Jamaica to be administrative manager on the alumina project. There was no other work for me at the time, and I had just returned from a long vacation following the Guri job, but this was an assignment that did not interest me. I stalled as much as possible and had offered to go to Jamaica on a short-term single status, which didn't fly. In the midst of this maneuvering Bill Ball asked me to be resident manager for the Southwire Aluminum Project. I was very relieved to get this assignment because Bill had the reputation as one of the very best project managers, and this proved to be the case.

## Open Shop Labor

Daniel Construction Company, an open shop contractor, was selected by Southwire to be the general contractor for the construction of the plant on a cost-plus-a-fee basis. As soon as this became known locally, the unions began a campaign to persuade Daniel and Southwire to use union labor. On the first day of preliminary work at the site, a large number of pickets was present at the single entrance to the property. Daniel moved some trailers into the area, and the pickets immediately descended upon them and proceeded to overturn them and attempted to set them afire. As this happened, Daniel called the state police who broke up the pickets quickly. Daniel and Southwire managements protested to the governor, which was effective. After that incident, pickets were limited to one at the main gates, which continued for the remainder of the project. A regular state police patrol thereafter enforced the picket limitation. After the first few days, no one paid any attention to the pickets except the occasional over-the-road driver delivering a shipment.

Southwire started the job with an anti-strike mentality. One of the first steps taken was to build a landing strip for small planes inside the plant boundaries. Later, the strip was paved, and the permanent plant fencing enclosed the landing strip. This provided Southwire with access to the plant during a future strike even if future pickets or other steps were taken to prevent normal access.

The Daniel labor policy was to pay the going union rates for all work. Hiring was done at the job gate, and many local personnel were hired for the early work. Later in the project as manpower needs increased beyond the local non-union labor supply, it was necessary for Daniel to import labor during peak periods. Most of this labor came from the Daniel base in the Carolinas where they had a large following, and the skill level was adequate. There were two important points of the open shop management of the job. Whatever craft Daniel assigned to an item of work, it was done without any jurisdictional issues. The assignment of excessive workers to comply with union rules was also avoided. Furthermore, most of the imported labor had an open shop background, and they weren't about to cause any disturbances.

Our Kaiser Engineers labor relations staff was very leery of our presence at the site under these circumstances and instructed us to keep a low profile at all times. The job sign didn't even mention Kaiser Engineers. We never were involved in any labor issues during the job, and there was no other backlash to our knowledge. The only labor problem of the project was the lack of adequate local housing for the imported workers.

## Aluminum Plant

The plant was located on former farmland along the Ohio River a few miles west of Hawesville, Kentucky. Soil conditions were extremely variable in this river bottomland. Test drilling was extensive and confirmed numerous different conditions within the plant site. Although piling was not required, the bearing capacity of the soil was low requiring large spread footings. One potline was located in soil with especially low-bearing capacity, which required special treatment. A soil surcharge twenty feet deep was placed on that potline area for approximately six months to compress the subsoil. This was monitored for settlement, and after removal the bearing capacity had increased to values comparable with the rest of the plant area.

The process design was based on KACC Ghana plant technology, which was producing very high quality product at that plant. This technology was licensed by KE. As Southwire later built up their operating staff, they hired many former KACC personnel. In later operations the Southwire quality was even better than experienced by KACC in Ghana.

## Different Procurement Policy

Southwire played a very active role in all procurement. All subcontracting was handled by Daniel with approvals by Southwire management. All equipment procurement was initiated by Kaiser Engineers in accordance with standard KE policies which was to accept the price of the low bidder. This had been effective for many years, and suppliers knew they had to come in with their best price the first time to get the work. The Southwire approach was to open negotiations with the low bidder and insist on additional price reductions, which they were successful in achieving. This was counter to KE policy and caused concern with our procurement management with respect to future projects. There was a feeling within our project management that very quickly vendors adjusted their proposals to allow for the further price reductions they would be required to offer to be awarded the work.

### Reusing Form Materials

As Daniel commenced concrete work, we felt they were not taking full advantage of the latest form technology and failing to make adequate reuse of form materials. In order to bring this effectively to their job field supervision, we requested Al Zimmerman, one of Kaiser Engineers' senior experienced field superintendents, to spend some time at the site and then report on areas where improvements could be made. His report was not very complimentary and was not well received by Daniel site management. The points were well taken, and after they spent some time with Zimmerman, a number of the criticized activities improved. The Daniel home office management observed that perhaps the improvement could have been accomplished in a more informal manner. They suggested that their site manager, Jim Freeman, and general superintendent, Ivan Dove, meet regularly each day with me to provide a forum to communicate future issues firsthand before they became serious problems. We began a practice of driving to Hawesville each day to have lunch together and thrash out the current potential problems. This proved to be an effective practice and in addition, we became very close friends.

### Sea of Mud

The project schedule required that concrete work continue throughout the first winter of 1968 - 1969. The site became a sea of mud wherever there was construction or access roads. Truckload after truckload of gravel was spread on the site roads, only to disappear into the mud after the first rain, which seemed to occur almost daily. In order to maintain access, gravel was spread almost continually. Because of the very wet site conditions and regular rainfall during the winter, we recommended that Daniel over-excavate foundations several inches and pour a concrete dry bottom as soon as excavation was finished. This preserved the undisturbed soil against rain and also provided a clean and dry place to form and pour the spread footings.

### Bus Welding

The installation of potline bus required a large amount of welding the heavy aluminum bus bars which were each approximately 2" by 18" in cross-section. The amount of welding required the work to proceed on two shifts. Kaiser Engineers did not have a formal full-time quality control responsibility on the project, and Daniel was responsible that their work met specification requirements. However, KE was responsible for general oversight of work quality but only with the existing construction support staff. There were no provisions for second shift oversight. Not long after the second shift bus welding commenced, the quality of welding came into question, and an inspection service was brought on-site to check bus welds. It quickly came to light that some of the night shift welding was totally inadequate. It was then necessary to completely check all bus welds and repair the deficiencies. With full testing of all welds from that point forward, the quality was restored. Daniel management was strongly criticized by Southwire for this shortcoming.

### Field Staff

The KE field staff was Stan Barkalow, Rick Larson, Jim Miller, Byron Nielson, Stan Rognlien, Bob Rotenberry, Mike Ruzila, Paul Skvarna, Cal Smith, and Grif Tiller.

An excellent relationship developed between the jobsite staff and Bill Ball, the project manager. He fully supported the field staff whenever a contentious issue developed and provided tactful guidance through day-to-day problems. A very close family relationship evolved as Bill was frequently our guest at home during his visits to the site.

Southwire key personnel were Roy Richards, Chap Chandler, Gordon Johnson, and Gary Satterwhite. Daniel Construction Company key personnel were Ivan Dove, Jim Freeman, and Bill Lloyd.

Our field electrical personnel were very highly qualified and played a major role with the design engineers when the first potline rectifier system was ready for checkout. This was a very time-consuming procedure, which extended over several days and nights when no one in the test group left the site. The checkout was completed successfully, and the potline placed on-line and turned over to the operations personnel of Southwire. I seem to recall that there was a test bus section, which bypassed the individual pots for checkout of the rectifier system.

## On Schedule, Under Budget

The overall project was completed on schedule and under budget. There were sufficient savings on the first three potlines that the fourth potline was completed within the original budget amount. Credit must be given to the project manager and his estimating support for developing a realistic estimate of cost for the project, which was capable of being met.

## Construction Problems

During the course of any construction project, many problems arise on a daily basis. Most are resolved fairly expeditiously and are soon forgotten. Others are more difficult and remain in one's memory. Erection of the anode press was one of the latter. The press was so large that it had to be erected before the press building was erected. A number of the components were very heavy, and Daniel did not have any heavy-lift cranes on-site. The press was finally assembled with brute strength and awkwardness and a few headaches. Another problem was pitch circulation in the carbon plant. Positive displacement pumps were used to circulate the pitch, and a special heating medium circulated through jacketed pipe was used to keep the pitch hot enough to circulate. We couldn't get all these things to work at the same time for several days and nights until a couple of minor design changes were made, and all was well.

Scrubber system and stack, duct work, and lining had early deterioration for the entire system. The plant included two such systems where the major component was designed and manufactured in Europe.

The vacuum unloader is used to unload the basic raw material, alumina, which arrived by barge. This is a large vacuum blower connected to a pipe, which sucks alumina out of the barge and transfers it to a conveyor to storage silos at the potlines. The best of these unloaders is manufactured in Germany and a local technician is provided to assist in erection and later in training the plant operators. This individual was very competent in his work but did not speak a word of English. It is a wonder the unloader was ever completed. Initially, mostly sign language was used. Eventually, a Daniel employee was located who was married to a German woman, understood a limited amount of German, and became the de facto translator. In addition, the technician eventually had to learn enough English to survive in Kentucky on his own. Fortunately, the unloader was well designed and built and, in spite of communications difficulties, performed flawlessly.

The anode-handling crane in the potlines was the other component, which was from France. The erection technician spoke only French and had no intention of learning English. No one was located who understood French, so the erection assistance was exclusively in French, which meant much sign language. This machine was more complex and had innumerable components which made erection seem to take forever until the repetitive steps for the four potlines taught both sides enough of the other's vocabulary to eventually complete the work.

## Assigned to New Madrid

Upon our return from a vacation in Mexico in the spring of 1970, I had a message to contact Frank Bort immediately. He told me that I was to be reassigned to our New Madrid aluminum plant project because the project manager, Don Barrie, had resigned and would be leaving shortly. Frank suggested that I visit the project as soon as possible to familiarize myself with local conditions, housing, our staff, etc. We did this and spent time with Don and many of the staff whom I knew from prior projects. I found the design details were essentially identical with the Southwire plant, which turned out to be a big timesaver for me in coming into a project half completed. Don went to Oakland following a week on business about a prior project. While there, he became seriously ill and spent two months in a hospital. As a result of this illness his resignation was cancelled. In the meantime my transfer to New Madrid was accelerated to immediate. Fortunately, the Southwire plant was already producing aluminum and very close to completion, and permission was granted for my departure. The Daniel Construction Company staff was very gracious in giving a departure dinner in my honor. I'm not sure whether they were glad to see me leave or truly appreciative of our association. Rick Larson was named as my replacement as I left for a completely different experience from the Southwire Project.

## *New Madrid Notes by Jim Miller*

Upon my return from vacation in the spring of 1970, Frank Bort advised me that Don Barrie had resigned from his position as resident manager of the Noranda Aluminum Plant project at New Madrid, Missouri. He told me I was being assigned to take his place at New Madrid. He asked me to visit the site over the weekend to familiarize myself with the job, personnel, and housing availability. We made the trip and spent some time with Don who seemed distracted from job events and indicated he intended to enter the brokerage business locally. The following week Don visited the Bay Area on the American River project business when he became seriously ill and was taken to the hospital where he remained for an extended period of time. This change of schedule required accelerating my moving to New Madrid. George Roberts came to the site until I arrived and planned to stay for a “transition” of two weeks. After about a week of transition, we agreed George would return to Oakland. Frank had warned me there would be many labor problems, but I really didn’t realize just how miserable it would become. He also told me to let him know if I needed to replace any of the people on the job. The only change was eventually that it was necessary to have the general superintendent replaced, and he was quietly transferred to Australia.

### Confidential Log Not Confidential

Ken Polly, project manager, instructed me to prepare a daily confidential log, which I dutifully prepared. Later I found after I had criticized someone or something in the log that it was not at all confidential and was being distributed in Oakland. From that point onward, I was much more careful about expressing my opinions. Granny Holman was engineering manager, and we had no problems with either the engineering or equipment procurement.

### New Madrid Less Efficient Than Southwire

The basic design of the plant utilized KACC Technology, and many details were identical to Southwire, which saved me much learning. It was thus quite easy to pick up on work activities. The project problems were meeting the scheduled progress and estimated costs. Construction costs in man-hours of labor were substantially over Southwire. Aluminum bus installation, for example, was double the Southwire man-hours. Almost every item of work was costing more manhours than Southwire. Physical progress was always behind schedule due to lack of cooperation of the crafts to work on critical path items when necessary. When resources were finally allocated to critical path work by union craft supervisors, it was too late to meet completion dates without either added manpower or overtime work—both of which drove up the costs.

### Labor Unrest

The two worst crafts for cooperation with project schedule needs and cost performance were the pipefitters and electricians, followed closely by millwrights. Many of the labor problems were jurisdictional as this was the first aluminum plant built in the area, and each craft union was trying to be assigned jurisdiction of all work remotely in their trade to establish jurisdiction for the future. Our IR people tried every strategy possible to control work assignments, but the more powerful unions always seemed to win out. This was to have a significant impact later in the job.

The millwrights went on strike for two weeks on a jurisdictional issue immediately after my arrival on the site. After the job was over, Noranda filed a lawsuit against the union. Prosecution of the lawsuit relied mostly on KE personnel testimony. Brad Johnson was most important in relating how international union was involved in manipulating the strike. This provided the basis to recover damages because the local union had no money. Noranda had a very sharp and ambitious lawyer handling the case. About ten KE people spent two weeks in St. Louis—one preparing for trial, and the other for trial. Noranda eventually won damages in excess of a million dollars.

### Frank Bort Retires

Frank Bort retired in 1974 while we were at New Madrid. The KE construction people held a big dinner for him in New Madrid. They came from jobs all across the country. It was a great evening of stories and remembrances of Frank's years on many projects related by the loyal people who had participated with him. We all realized how significant our associations with Frank had been over many years.

Just before his retirement date, Frank took a trip around the world to visit the various KE jobs. While on that trip, Lou Oppenheim called him back to New Madrid to try to stabilize our labor problems. Frank spent many hours and days trying to cultivate our various union representatives. This proved to be an almost impossible assignment. The fitters completely ignored him, even though he had carried a fitter card at one time. The other trades gave him lip service but didn't change their ways to any extent.

## Staff Personnel

KE personnel were John Aiello, Ed Airth, John Anderson, Clyde Baker, Dudley Bass, Forest Bradfield, Don Brown, Jack Brown, Charlie Clifton, Dick Cranston, Ed Day, Rick Driver, Chuck English, Bill Fowler, Lou Fox, Walt Gammill, Gene Green, Roy Hamilton, Bob Hammersmith, Charlie Harman, Tom Hawkins, Brad Johnson, Bill Jones, Jim Miller, Cal Nara, Dave Palmer, Dave Philipson, Bob Rokey, Jim Sandlin, Al Self, Ken Smith, Don Smith, Bill Smith, Bill Teal, and Don Walbovd. The electrical work was performed by Comstock who did a very poor job in managing and controlling their work.

Concurrent civil work on AEC power plant personnel were Jim Hobble, Harold Mackelpraing, Jim Short, Cal Smith, Ken Willis, Don Willman, Earl Woodward, and Doil Yocham. Ernie Baker was the owner representative.

## Meanest, Most Difficult Trade

The pipefitters were the meanest and most difficult of all the trades on the job. Ed Steska was their business agent. Later, after the job was over, he was murdered in his office in St. Louis. The police never found the murderer so far as we know. Cecil Dewees was pipefitter general foreman and ran a tight show for the union. He assigned work crews when and where he pleased in spite of the valiant efforts of Don Smith to identify critical work requirements. Don, who was "managing" the fitters, would tell Cecil where and when we wanted him to do certain work in accordance with our schedule. Cecil did as he pleased which was not where he was needed. Later, we would have to work overtime to meet schedule commitments. Manpower requirements for working overtime on Saturday involved heavy union overhead whether needed or not. The fitters were as arrogant as it was possible to be. Cecil even tried to get us to pay him overtime for Saturday when he had spent the day at union headquarters in St Louis.

It was always an interesting day when Steska visited the job. He came on-site in his big black Lincoln Continental driven by a tough-looking guy and usually accompanied by one or more other "heavies." They drove slowly around the job so everyone could see them—stopping occasionally to talk to a personal acquaintance and then cruising slowly on and eventually stopping at the fitter shop to meet with the jobsite fitter hierarchy on our payroll.

Many of the union people carried guns on the job. At one point we came very close to a pitched battle on the job between the fitters and the electricians over some jurisdictional issues. Ken Smith finally got things calmed down, but much time was lost and work disrupted for some while. While Chuck English was general superintendent on the job, his tires were slashed several times.

I remember one walk I took into "fitter territory" to look for Cecil. He had two goons (on our payroll) who essentially served as his bodyguards. They didn't want me to go into the fitter field office, shop and warehouse—just as if they owned it! They didn't care that we were the prime and had paid for all of this, and I was the site manager. This was typical of their attitude.

Another time I spent a day with Al Gordon while he was trying to convince Steska to accept our approach to something—probably a work assignment. We went into some bar, and they drank all afternoon. I was exhausted and finally went outside to await their decision in the smoke-filled bar.

We had a major problem constructing the pit for the hydraulic cylinder for one of the continuous casting machines. The pipe casing for the cylinder was installed out of plumb, and we could not install the hydraulic cylinder until it had been modified by cutting out a section at the bottom. The bottom was many feet below the water table, so the surrounding sand had to be stabilized before cutting the pipe casing. We tried chemical grouting the sand, and when we cut the pipe, we found the grouting was inadequate to stabilize the ground and keep out the water. Eventually, it was necessary to flood the casing to equalize the pressure and perform the work underwater with divers. The installation method for the casing had worked well for the first pit but not for the second. (Later, we successfully used an oil well drilling rig to install similar hydraulic cylinder housings for the steel plant in Iran.) Construction of the casting pits was developed by Chuck English using caissons. This worked quite well! A similar method was used for constructing the power plant coal unloading caisson in the Mississippi River with jets built into walls. Doil and Cal did this job.

When Noranda started operating the potline, they had several burnouts of pots because of low voltage during the late summer heat waves. For a while, there was almost one a day. The best photo of the job is pouring the first metal with Strinich and some of our people.

## The Fight

Doil Yocham had a fight with the master mechanic on the powerhouse job. Doil beat the sox off him! Then he got worried there might be union retaliation, and I had to call the sheriff to ask for protection. He didn't seem to be the least bit interested. On another occasion Doil gave a talk to local the Lions' Club about his experiences on the Guam housing project which was reported in the local newspaper. John Strinich was upset that the talk and article had not been cleared with him first and also about the fight. I told Doil that it was a good thing that he won the fight but not to do it again. The master mechanic later became very supportive of Doil.

## My Car Is Firebombed

My assignment (at specific direction of Oakland IR) of the erection of the jib cranes which handled launders in the casting area for transferring molten aluminum was made to the fitters instead of the ironworkers and electricians. This was the straw that broke the camel's back. My company car was firebombed in the driveway at home, and there was no doubt that this was the work of the electricians who were very upset at the assignment. Efforts of local sheriff, who was called Cowboy, and our neighbor to find culprits was a farce. We all figured he knew who had done it. The U.S. Bureau of Alcohol, Tobacco, and Firearms was even worse. They spent their time several days later picking up shell casings, cigarette butts, etc. around the yard after the entire town had gathered to watch the excitement and never even bothered to interview me. I moved the family away the following week, bought ammo for my shotgun and .22 and moved into a motel myself for the remaining six weeks or so of the job. The Oakland office gave very little support to efforts to find culprits, either. I told them that Daniel would have moved heaven and earth to find the guilty party, including hiring private investigators, etc. All to no avail! Following that incident, John Strinich of Noranda refused to allow me to leave the project until all hourly construction personnel were off the payroll.

As I wound up the work and was down to the last few men on the job, there was a dispute with the operating engineer's steward who I was laying off while keeping another operator who could run the remaining equipment while the steward couldn't. He still insisted on being kept on and took a poke at me when I said "no!" I laughed at him, and he stayed fired!

Well, after the job was over, I reflected on Don Barrie's resignation and illness and realized how much the labor problems must have upset him and completely disrupted his orderly, systematic, and logical approach to the work. It was no surprise he decided to throw in the towel. I consider the Noranda job was the most trying on me personally of my entire career. The only good thing about it was when it was over.

## Miscellaneous Recollections

We had a membership at the New Madrid Country Club. Jo never played golf because she took the children swimming there and spent all day counting heads. The mosquitoes were a foot long, and the humidity discouraged other outdoor summer activities. I never used any of the club facilities except to have lunch there a couple of times.

Time off to go to Florida to finally settle Doris White's estate.

We became good friends with Jo and Jack Battles who were neighbors. He worked for the civil design firm who did the industrial park.

Our house was large enough for all of us. Needed a window air conditioner for upstairs bedroom. Electrical bills were huge in summer months. Pecan trees in our yard. No storage areas. Had a lot of stuff in the carport.

Frank Bort shipped the Ghia convertible to Missouri for us. Unfortunately, we had to pick it up in St. Louis, and we didn't get there for several weeks and the top was not up—only the wind cover was on the car, and it got completely soaked and smelled terrible when we finally picked it up.

Our days on the job were long and difficult. Home late, to bed exhausted to wake up later worried about the work. Only job where this happened more than occasionally. I was in bed when the car was firebombed, and it was not too late in the evening.

Jo took the kids to a sweet corn farm where it was processed on large scale for shipment to large cities. She brought home a crate of corn, which we ate for days—it was great. She also took them to a chicken-egg “farm” which turned out to be totally depressing.

Roger got head lice at Head Start where Jo assisted as I recall. Jo got ringworm at the same place.

Final project was over budget by quite a lot and also behind schedule. The surprising thing is that it wasn’t worse considering the labor problems. All work was cost reimbursable plus a fee.

Archaeological dig on mounds nearby. Jo got involved with the university, and this turned out to be quite a good site. Found a number of baby bones buried in the living quarters. The crew came over to our house for a final get-together meal at the end of the project.

A big deal for us was an occasional dinner out at Cape Girardeau about 60 miles away. There were no restaurants worth visiting in New Madrid or Sikeston. We had some wonderful retreats from the heat up in the Ozarks and canoeing down the Currant River.

Jo made friends with Harriette Campbell in Sikeston who collected Indian points from her family farms. Jo went hunting with her on several occasions and collected a number of points. Best hunting was after ground was plowed in the spring and then after a rain. Harriette had a collection of thousands of perfect intact artifacts to be donated to the museum in New Madrid.

The local banker, Sam Hunter, was the one person mostly responsible for the development of the St. Jude Industrial Park and subsequent attraction of Noranda and Associated Electric Cooperative to build facilities in the park. Sam was featured in some banker’s commercials on national TV. Nice guy! New Madrid was still a very sleepy town on the Mississippi, and its only prior claim to fame was the earthquake of 1812 or there about.

## Additional Comments

Early phases of the job were somewhat delayed by poor ground conditions and significant rainfall. This is second-hand information.

The work was performed on a cost reimbursable basis for Kaiser Engineers and our major subcontractor for electrical work, Comstock. Most of the work was performed by Kaiser Engineers’ crafts with the exception of electrical (above) and sheet metal siding. We performed excavation, concrete, steel erection. equipment installation, piping, painting, etc.

Schedule and costs were the major problems. During my tenure, we reviewed two-week schedules weekly after work for several hours. The crafts would not work where directed by our supervision to the extent needed, and eventually this caught up with us with critical work incomplete by needed dates. Eventually, manpower and overtime cured the problem with added costs.

Jurisdiction was a huge problem with several trades claiming work, which was unique to the aluminum processes. Fitters, electricians, and millwrights were the main culprits. We eventually held monthly jurisdiction meetings with the crafts in an attempt to resolve trade jurisdiction before the work started. This helped, but there were still arguments. Our industrial relations people often favored the pipefitters because of their powerful position in the state.

Another labor problem was over-manning the work with too many men on a particular job as these assignments were made by the craft foremen and general foremen. Sometimes there was a joint crew for a disputed activity, which usually doubled the men assigned. Each craft assigned enough people of their own to do the work. Other times, the work was divided into such small increments of responsibility that a number of men had to be present to perform their work while others stood by for their part of the job.

The electrical bus work was one of the worst. This was electrical work, and the bus was prefabricated to the fullest extent in outside shops. However, there were still a lot of field welding and bolting of one pot section to the next. The man-hours expended by the electricians at New Madrid on comparable bus work were twice those expended at Hawesville for similar work.

## *Ishpheming Notes: The Tilden Project by Jim Miller*

The first day in Oakland after returning from the mess at New Madrid, I had lunch with Vic Cole and Jack Havard who told me they had been waiting for weeks for me to return from the Noranda job. They wanted me to go up to Ishpeming and prepare the construction program portion of the preliminary engineering job being completed by Les Trew for a green-field (woods) iron ore concentrator and pelletizing plant for a consortium headed and managed by Cleveland Cliffs Iron Company. They wouldn't listen to my request for a short vacation as they felt this part of the program should have already been completed, and the only reason it wasn't was because I had taken so long to finish at New Madrid. Being a good loyal employee, I headed for Ishpeming the next day, which was very early October, 1971. Although I didn't know it at the time, this was to become my working life through the first pellet production in December, 1974.

### Construction Plan

After a week at Ishpeming during the peak of the spectacular fall colors, I had gathered enough information and learned enough about the preliminary engineering report which was being finalized that I could return to Oakland to complete the construction plan, review it with George Roberts, and prepare it in report form. This was to be a huge plant annually processing ten million tons of ore and producing five million tons of pellets all based on a completely new separation process due to the makeup of the ore. My report consisted of a schedule for the major phases of the project, an approach to the major subcontract packages, concerns about labor conditions and housing, and other secondary issues. It would be necessary to start immediately on final design with construction to commence in the field as early in the spring of 1972 as possible to allow completion by the end of June, 1974, which was a very ambitious, if not unrealistic, schedule.

### Contract Negotiations

By November, 1971, we were meeting in Oakland with CCI engineering and management personnel to negotiate a contract for the project. With the assistance of Earl Woodward, I had developed a schedule to complete at the end of September, 1974, which I considered achievable with good luck, much expediting and a lot of hard work. However, this did not meet the date set by the client which upset George Roberts, Jack Havard, and Vic Cole so they directed us to make a schedule for the client which met their date. We did this in a few hours while discussions were being held with CCI on other aspects of the project. We told them we would do our best to achieve the accelerated schedule, but it was entirely unrealistic under the circumstances. The actual project completion in December, 1974, proved to be consistent with our projections after taking into consideration justifiable lost time due to strikes and delays. We were awarded the contract about the first of December with a completion date the end of June, 1974.

### Labor Situation

During the next few months we developed a comprehensive pre-construction program for subcontracting all of the work based on design commitments, forecast material, equipment deliveries, and the weather. A major concern was the labor situation. CCI wanted to have the job done with union construction labor, and the manpower requirements were far in excess of availability in the Upper Peninsula of Michigan (UP). In addition, having been badly burned with labor conditions at New Madrid, we were all leery of potential strikes due to contract negotiations and jurisdictional disputes. Our other major concern was housing for our jobsite staff as there was essentially no available housing in the area.

The approach to the labor situation was to negotiate a project labor agreement with all of the building trades. The agreement was a good move although there were strikes during contract negotiations. The biggest labor problem was the supply of qualified manpower, which was short in the more skilled trades such as fitters and electricians.

Prior to the start of construction, we negotiated the project labor agreement with all of the building trades. The most important single item was the agreement which precluded any strike over any jurisdictional issues. Among other things, it provided that coffee breaks could only be taken at the immediate work area, and there were to be no coffee makers on the site or in shops, etc. George Roberts extended that, logically, to do the job management and decreed that there would be no coffee makers in our offices either. As a result, everyone carried his own thermos of coffee each day

—mine was a full quart. There were several strikes during the life of the job, which had to do with contract renewal as the project agreement precluded strikes due to jurisdictional disputes. Since initially all of the work was subcontracted, the productivity control of manpower was the subcontractor's responsibility. Generally this was handled fairly well although quitting time was somewhat abused.

Staff housing was a concern from the beginning due to practically no surplus housing available, and for that reason rental rates were high for whatever was available. We persuaded CCI to let KE rent housing in Ishpeming as a few units became available and to subsidize the rent for our staff people. We also set up a small compound of prefab houses in one of the local trailer parks. Together with some housing a little further away in Marquette, we managed to get by this obstacle.

At the time of this project, there was not much work available for our construction staff. In order to keep several key people on the payroll, George Roberts assigned Rufus Chatham, Dan Blackwell, and Don Cardarelle to the project even though each was qualified to run a project on his own. Because of their subordinate positions as well as local living conditions, all three of these men left KE for other opportunities within six months. So much for George's good intentions! Eventually, each of them returned to KE as work picked up a few years later.

### Mill Orders for Steel

Most of the winter of 1971-72 was spent in Ishpeming conducting site meetings with prospective subcontractors and coordinating with CCI operations who were doing the site preparation, primarily rock excavation, with their heavy equipment and personnel. This left only building-specific excavation for individual foundations to be performed by our subcontractors. Most of the concentrator plant site excavation was performed during the winter of 1972, so we could start concrete work beginning in May, which was the earliest practical date because of weather conditions. The designers committed to mill orders for steel by December 1, 1971, to assure material for steel fabrication so the erection could start by July 1, 1972. We conducted site visits for the steel fabricator and erector during the middle of the winter.

The steel fabricator and our designers worked together very closely. Our designers traveled to the detailers to review and approve shop drawings. The first steel was on-site, and erection started as scheduled in July, 1972. The mill building and ore storage were erected and enclosed for the winter of 1972-73 as we had scheduled. The fabrication and erection of the pellet plant steel were somewhat later and we had to continue the erection through the winter of 1972-73. Often the ironworkers would need to sweep the snow from the steel in the morning prior to starting the day's erection. The subcontractor for this work did quite well in meeting our schedule, although he suffered high inefficiencies during the winter. We worked out a formula to calculate an inefficiency factor to compensate him for the extra cost of winter erection, which he incurred. There were also some administrative problems regarding design, detailing, and fabrication, which were handled by the project group.

### Many Subcontracts

Over the course of the project, we had about 55 major subcontracts on the job. Some contractors were successful on more than one contract so the actual number of different subcontractors was probably more like about 40—still a lot of operations to coordinate. We bonded only one sub, the thickener supplier as his price was $1 million low on a $4-million contract. We had some quality problems with that contractor which required special attention, but it was a trade-off for the very favorable price. Our steel fabricator and erector did a pretty good job. Although there were steel delays, these were caused as much by mill delivery problems and design delays as by the fabricator-erector. These delays during the summer of 1972 set us back enough that we had to keep the erector active in the pelletizing plant through the winter 1972-73. At times the ironworkers would have to go up and sweep the snow off the steel before starting the day's erection. The work was far from efficient, but we made enough progress that it proved worth-while schedule wise. Jim Tabor did a fine job of managing the steel erection sub. Unfortunately, we had two ironworkers die in falls.

### Building Construction

The mill building was enclosed for the winter of 1972-73, which allowed us to install temporary heating and proceed with concrete work for the mill foundations and other interior concrete work. Mechanical, piping, and electrical work commenced during the spring and summer of 1973 under a number of individual subcontracts which were scheduled and packaged based on availability of design information and equipment deliveries. This work was completed during the summer and fall of 1974. The checkout and testing of the mill building process systems commenced as the work was completed. Material was introduced into the mill building systems during the fall.

The pelletizing plant steel erection continued throughout the winter of 1972-73, and it was enclosed during the spring and summer of 1973. The major equipment items such as the kiln were erected prior to the steel because of their size. Some of the design in this facility was controlled by information from the process designer and equipment supplier, Allis-Chalmers. The work in this facility was scheduled later than similar work in the mill building. All the work in the pelletizing plant was performed under different subcontracts from other portions of the project. As in the mill building, checkout and testing of the pellet plant process systems commenced as the work was completed during the fall of 1974.

### Earthwork Extra

Later in the project, during the summer of 1973, CCI engaged KE to supervise some major earthwork they were subcontracting for added water supplies nearby. Chuck Lindberg came up to oversee this work. He was extremely well qualified for this, and CCI was very happy with this little extra. Chuck and I had an opportunity to catch up on what had happened since the Guri days together.

### Staff Personnel

Tilden personnel included: Mac McDonald, Griff Tiller (who died of a heart attack), John Aiello, Jack Lipner (who died of cancer while on the job), Dan McCormick, Earl Woodward, Tom Vanderheiden, Ray Dorr, Byron Neilsen, Gene Green, Ed Day, Don Walhovd, Doil Yocham, Clyde Baker, Joe Polfer, Bill Beard, Charlie Harman, Ken Thomas, Chuck Graff, Jim Tabor, Gary Thronson, Don Willman, Mack Horowitz, Roy Hamilton, Paul Skvarna, Walt Pentz, Dick Cranston, Dave Palmer, Dick Shaver, Don Phillips, Floyd Eckles, Jim Roberts, Lachlan McBean, Dave LeCount, Jim Taylor, Cal Nara, Ken Lukins, Dick May, and Mike Ruzilla. Charlie Watkins was field design engineer.

On the whole, we had good relations with the CCI management. Bob DeGabriele was chief engineer with full direct project responsibility, and he was assisted by Gene Bilkey. Ron Harma and Clarence Rivers worked with DeGabriele and Bilkey. Einar Lindquist was the superintendent for the Tilden Mine.

### Empire Mine

In 1973, CCI awarded us another contract to construct an additional mill line at the Empire Mine which was located only a couple of miles away from the Tilden site. Ken Willis was site manager. Initially, I had responsibility for this work but really had little time to devote to it, and Ken was well qualified to handle it on his own, so after a year or so he reported directly to CCI. Our staff at the Empire Mine in addition to Ken Willis was made up of Jack Martin, Earl Woodward, Herb Lien, and Ken Schuerman.

### Mechanical Erection at Tilden

Later in the job, CCI directed KE to perform some of the mechanical erection work on the autogenous mills with our own forces. We had Dick Shaver for our superintendent for this work, which went fairly well. About the only significant vendor problem were some defects in the bull gears, which we repaired by welding under direct supervision of a vendor representative. Apparently later, CCI felt the gears furnished by their vendor, Philadelphia Gear and Allis Chalmers, were not up to standard, and a big dispute arose among the three. I was called for two days of depositions in 1983 on the matter well after I had left KE.

The pelletizing plant was a complex mechanical installation. This work was divided into several installation contracts, and one contractor was successful bidder for all of this work. The kiln erection was one of the more interesting and spectacular pieces of work. The shell was about 20 feet in diameter with the tires about 23 feet in diameter. These components were fabricated in Japan and shipped via the St. Lawrence Seaway to Marquette. The kiln was erected on piers about 75 feet high, and some of the lifts were over 100 tons, which required the largest mobile cranes available at that time. Once in place on the piers, the kiln sections had to be welded together, and since the metal was about 2 inches thick, there were a lot of problems with the welds cracking. After some trial and error, a procedure was developed to slowly preheat the metal to over 1,000 degrees before welding and then gradually allow the metal to return to normal temperatures over a period of 24 hours. This pretty much resolved that problem.

There was another major quality problem in addition to the kiln welding. This was the concrete quality in one of the mill piers. The concrete probably had either frozen or there was a batching error. What amounted to about a mixer load in the top of the pier did not come up to strength, and it had to be removed. We eventually decided that there had been a batching error and charged the corrective costs to the contractor although he strenuously objected. The adequacy of the remainder of the pier tended to convince us it was a single load of offending concrete. In any event, at that time CCI was looking for someone to blame, and we caught it. Too bad, as that along with their apparent dissatisfaction with some of the design aspects of the job and probably other aspects of the job were the bases for them several years later to award Tilden Phase II to Bechtel. This was underway when I visited Ishpeming in 1977. KE later heard through our contacts at CCI that the Bechtel project did not turn out well and that CCI was very sorry they didn't have KE do the work! So there!

### Finishing Up

The project was a very much-expedited program, and subcontracts were awarded as soon as a reasonable amount of information was available from design. As might be expected, the incomplete information required changes during the course of the work, and these were not getting resolved very quickly as our staff was fully occupied with getting the work completed to meet the pressures of the schedule. CCI felt these matters were not being resolved quickly enough (although they weren't too cooperative on this matter in approving increased costs due to the changes). They insisted that George Roberts come to the site full-time for a period of several months in 1974 to supervise the resolution of the claims of the subs. The purpose of this was to leave me to focus entirely on completion of the construction and checkout of the facilities. For all practical purposes I moved my office into the mill building and spent about 12 hours a day on these activities. First pellets came off the line about mid-December, 1974, and at that time I was allowed to return to Oakland. Mac stayed in lshpeming for a number of additional months to finalize the many outstanding subcontract changes and other administrative matters to close out the project.

## *Escape from Iran by Sam Ruvkun*

It was the end of 1978 when the Shah of Iran still ruled that country but was very shaky politically. Kaiser Engineers had two steel projects going on in Iran at the time. One was Ahwaz in the interior and the other Bandar Abbas, near the Strait of Hormuz. I was assigned to initiate planning and scoping of the Bandar Abbas, working with the assigned Iranian staff located in Teheran.

We had a small group of three visiting engineers and myself working in the client's offices where I was on my second visit in December, 1978. At the same time Kaiser Engineers' area vice president for Europe and the Middle East area, Dick Lowell, became seriously ill, and I was asked to substitute for him in running the Ahwaz project. Ahwaz had 15 of our engineers and families working there. The site is located some 350 miles from the capital city of Teheran.

### Unrest in Iran

As I finished up my duties on Bandar Abbas, my first order of business for Ahwaz was to visit the site and review progress of the work and consult with our people. Now, picture the situation in Teheran at this time. We could hear large military helicopters constantly hovering over the city. The citizenry was in a state of unrest and was very agitated by the Shah. The U.S. Embassy kept warning and advising U.S. citizens to be alert and cautious and to stay away from strange places. As the helicopters continued to hover, there were rumors that shots were being fired at innocent civilians.

At that time, I got a simple clue that something was amiss when in one of my conversations with one of the young Iranian engineers on the Bandar Abbas project stopped referring to approvals obtained from “His Majesty” but now referred to “That son-of-a-bitch.” That he dared say it was a sea-change in Iranian attitudes.

## Ahwaz Was a Hot Spot

Then in keeping with my plans, I prepared to travel by airplane to Ahwaz, but an urgent message came from the embassy suggesting that I not go. They reported that Ahwaz was the hot spot for the expected revolt and travel was not safe. *(Editor's Note:* See Jim Miller's "Ahwaz Notes" next for his description of events from the jobsite viewpoint.)

As it turned out, our project manager there was an old friend of long standing, Wes Driver. For a number of years before this, Wes had been my client and the chief engineer of a large copper company for which we did lots of work in Chile. When he decided to leave that job, he joined us and was project manager under my supervision for the Somisa steel project in Argentina. So we knew each other very well. When I phoned him about the change of plans, Wes readily agreed. And since it now became apparent that he was in a very hot spot, he and I were to keep in constant phone contact over the next few days.

## My Christmas Weekend

Back in Oakland we were coming up to the Christmas three-day weekend with the offices closed and all other top executives out of communication for three days. My home became like a central command post as telephone calls kept coming in at a rapid pace several times a day. Saturday things were more serious. Wes had decided to move all families out of their housing near the steel plant to the local hotel. It was too dangerous to stay in the houses.

By Sunday morning, things were worse. Our conversation went something like this:

SR: "Where are you now, Wes?"
WD: "I'm in a phone booth across the street from the hotel. The phones are so busy I couldn't get a line."
SR: "What's that noise I hear in the background?"
WD: "Oh that. That's rifle fire in the street. There are people shooting all over the place."
SR: "Well, Wes, what more do we need to know to make a decision to get the hell out? It's too dangerous to stay."
WD: "You're right."
SR: "Do you want some help in getting an airplane?"
WD: "That would be nice. It's a little difficult doing it from here now."

The decision to move quickly was made because we knew that after the weekend, everyone in the U.S. would be seeking means of escape. We had to strike early to get a jump for our people.

## Chartering a Plane

And so that put the wheels in motion for a series of phone calls from me to John Davidhazy, the office administrator in Kaiser Engineers' London office. The plan was to hire one of British European Airlines' jets since they were the airline with lots of flights and lots of experience flying out of Iran. Late on Sunday, we received confirmation that we could hire their last plane to fly the group to Bahrain some 400 miles to the south for a fee of $10,000. I thought this over for 20 seconds and said, "Okay. Let's do it."

Now I had something to relate to Wes. With the change in time zones, we both lost a lot of sleep. He now knew the flight and the British European Airways contact person. The next series of calls concerned planning the move. Passports had to be picked up from harried officials and properly stamped. A caravan of cars and Jeeps was arranged for, including extra cans of gasoline, and extra tires and wheels to go a fairly long distance to the airport. And each family was instructed to travel lightly. Household effects were abandoned. Company records were abandoned, as it was too dangerous to return to the steel plant to get our files. Just get the hell out.

All this planning was done in haste as we reasoned that when the official word would come down from the embassy or elsewhere, there would be chaos as people would compete for cars, gasoline, and airline space. Since the country was now in a state of confusion, there were no rules to follow and office workers and officials had to use their own judgment. Airports were not yet closed, telephone service was not yet restricted, and movement was allowed, even though somewhat dangerous because of random shooting. So we decided to move now.

## British Government Wants the Plane

While all of this was going on, I got another urgent telephone call from Davidhazy in London. The British government had now been informed that we had tied up the last plane available to leave Ahwaz. They needed it also. Because we were only using a few of the plane's seats, they proposed that they take over the charter. They would guarantee passage for our people. And they agreed to pay the full $10,000 charter fee. How could anyone not trust the British government? So we did it.

### Monday Morning

Monday our time was evacuation day. Back in the Oakland office on Tuesday we eagerly awaited word from Bahrain. By mid-morning, they had arrived. Two days later Wes and his group were back in Oakland. They had escaped from Iran.

Within a few days, the Shah was overthrown, and then the U.S. Embassy in Teheran was stormed by insurrectionists, and embassy personnel were held hostage. For over a year Presidents Carter and Reagan were personally involved in trying to obtain their release. It will long be remembered as one of the United States' most serious international problems.

But our people were out of there.

## *Ahwaz Notes*
## *by Jim Miller*

The National Iranian Steel Industries Company (NISIC) was formed by the Shah of Iran in the '70s to develop a national steel production capability with the objective that Iran would become self-sufficient for its basic steel needs. Other than a small facility at Isfahan, the Pahlavi Steel Complex, located at Ahwaz in southwest Iran, was the first of several production plants planned. The Ahwaz facility was to produce basic steel in a semi-finished state. Ahwaz is located about 120 kilometers north of Abadan at the head of the Persian Gulf and is the center of oil production in Iran. During oil production, a huge amount of gas by-product (flare gas) was wasted due to the lack of facilities to capture and the lack of a use for the gas. The Pahlavi plant was planned to utilize captured flare gas to produce iron by the direct reduction process instead of the conventional blast furnace process that reduced iron ore to iron.

Kaiser Engineers entered into a contract for construction management services for the complex's material handling and direct reduction facilities on April 26, 1975. KE associated in a joint company (KE/TSL) with Tadbir Sanat, Ltd. (TSL), an Iranian engineering company, to perform the work.

Projected annual capacity was 5 million tons of pellets and 2.2 million tons of steel. This was the first stage of a national program to eventually produce 11 million tons of steel annually. Iron ore concentrates were produced in India and shipped to Ahwaz. The Pahlavi plant would convert the concentrates to pellets in a Lurgi pelletizing plant. Pellets were to be reduced to sponge iron in direct reduction reactors using one of three licensed processes incorporated in the plant: Midrex, HyI, and Purofur.

The direct reduction process utilizes reducing gases (hydrogen and carbon monoxide) manufactured from natural gas (flare gas) to pass at high temperature through a bed of iron ore to convert the ore to sponge iron (99% iron). Sponge iron is then converted to steel in electric furnaces. Finally, molten steel is continuously cast in DC casting machines into slabs and billets for rolling into semi-finished product.

NISIC entered directly into contracts for design and supply of all materials and equipment for the major process portions of the project such as unloading, storage and handling iron ore concentrates, pelletizing, direct reduction, sponge iron handling and storage, electric furnace melt shop, DC casting, and other major equipment components.

### Our Contract

NISIC engaged KE/TSL to perform construction management services with KE to provide expatriate (foreign nationals) personnel for management, technical and administrative services, and TSL provided Iranian supporting personnel to be trained on the job.

In February, 1975, KE representatives entered into contract negotiations simultaneously with NISIC and with our Iranian associate TSL. The NISIC team was headed by Dr. M. R. Amin, managing director, and included Dr. Davoud Ardibili, assistant managing director, and S. Ghasemi, Ahwaz plant manager. TSL was represented by owner George Megerdoomian. The KE team was headed by Bob Wolf and included Paul Meyer, Mike Janner, and Jim Miller. During the five weeks the team spent in Iran, we visited the project site in Ahwaz and experienced our first exposure to the crazy driving practices of Iranians while traveling between Abadan on the Persian Gulf and Ahwaz. We also visited Shiraz to inspect local construction work and to visit the famous ruins at

Persepolis, about 500 km SE of Ahwaz. After many late hours of meeting and negotiations, a contract draft was initialed by the parties on March 26, 1975, and signed in final form a month later.

Work commenced immediately in Tehran preparing for major erection contractor selection. Candidates were combines each made up of a leading international contractor in association with an Iranian contractor. This approach applied throughout the project with respect to international contractors and/or suppliers at the direction of NISIC in order to develop and train Iranian companies and individuals.

## Construction Contractors

NISIC had engaged Solperse and Sit Bachy, a French joint venture, and Mana Construction Company, an Iranian company, to perform the concrete foundations, sub-structures, and other concrete work. The initial task of KE/TSL was to recommend selection of a process plant erection contractor who would perform structural, mechanical, and electrical work in erection of the process portion of the plant. Late in the summer of '75 ,Foster Wheeler U.K., in association with Teheran Jonoob, was selected for this role.

## Ahwaz Environment

Ahwaz is located in the desert of southwest Iran on the Karun River. It is also on the main highway and railroad connecting Teheran with the sole major Iranian port of Khorramshahr on the Persian Gulf. Irrigated farming is practiced along the Karun River and some dry farming nearby, but the village "population" exists mostly by grazing flocks of sheep and goats. Ahwaz is the oil industry production center for Iran. It is very close to the Iraqi border and was the site of a large military base. Although ostensibly friendly relations existed with Iraq at that time, border areas were off-limits, and it was difficult to cross into Iraq in the unlikely event you wanted to visit Iraq.

Southern Iran's climate is similar to Fresno or Sacramento, California. Summer days reach temperatures up to 50° C (120°F) with occasional dust storms and the nights cool to 100° F. Winter overnight lows are in the 40s. Annual precipitation ranges from 5 to 15 centimeters (less than 6") in winter months. The land is very flat ,and the alluvial soil contains large amounts of clay. This prevents the rainwater from percolating into the subsoil, so rain stands in large lakes for weeks sometimes, although only a few centimeters deep, until eventually evaporating. This leaves the surface almost perfectly flat. We heard stories of Americans in south Iran during World War II shipping supplies through Iran to Russia who would drive 60+ mph across the roadless desert hardpan plain between Ahwaz and Abadan.

## Everybody Wanted in on the Act

By '75, Iran was experiencing a huge boom as industrial development was proceeding everywhere at the same time. This boom continued up to the Revolution in '78-'79 when this activity stopped abruptly. Oil prices had skyrocketed in the early '70s through OPEC controls of production. This provided a large growth in revenue for Iran, which was being used for military, industrial, and commercial development. Although the government had five-year development plans, infrastructure development seemed to be last instead of first on the list of priorities. Everything produced outside of Iran was in short supply and expensive. Business, sales, and military people from around the world flocked to Iran hoping to get a piece of the action. Hotel accommodations were almost impossible to secure.

The KE negotiating team remained in the country for five weeks, well beyond original plans and hotel reservations. Eventually, we were locked out of our rooms at our hotel when we returned late one night from contract negotiations! We had stayed well beyond our reservations and were only allowed to remain that night upon our promise to vacate the rooms the next day (we had previously already doubled up in our rooms). After much effort, George Megerdoomian managed to find rooms at a no-star hotel on a very busy main street. This provided basic shelter only. The dining room was so filthy and overrun with cats and other creatures that only breakfast was safe to eat at the hotel. (Still, it beat sleeping in the street.)

Housing was in very short supply throughout the country. NISIC was unable to provide housing for the KE expatriates as they arrived in Ahwaz in the fall of '75. Most families had to stay in the only local hotel for months before housing was available. This was a period of very low morale due to the hotel conditions and especially because the hotel kitchen sanitation practices were poor or non-existent, and most of us experienced periods of intestinal illnesses. This problem went away after we were able to move into our new houses.

### Housing Problems

Standards for housing construction were naturally different from those in the U.S. When NISIC- furnished housing finally became available, and families moved in, it proved to be substandard construction even for Iran. Finally in early '76, KE had to locate and commit for housing for the staff, as NISIC in its early stages of organizing for the plant in Ahwaz had been unable to fulfill its commitment. We had to pay a full year's rent ($25,000) cash in advance to lease a house. Even these houses had to be upgraded through our own efforts to reach moderately livable standards. Fortunately, Ahwaz had a suitable English language school, which had been established by companies working in the oil industry. There were about 550 students in K through 8th grade with a truly international student body with over 25 nationalities. The school conformed closely to the British system and was a positive aspect of living in Ahwaz. The cost of about $5,000 per year for a day student was roughly equivalent to the cost of boarding schools in the USA.

Personal transportation for expatriates was a continuing headache for all concerned. Vehicles were furnished by NISIC which utilized an outside contractor. As a result, reliability was usually questionable. NISIC agreed to furnish a driver for up to two weeks for each new expatriate arrival to allow time to become familiar with driving practices and to learn the layout of the city since city maps were non- existent. Most new arrivals were usually so frightened by the caliber of driving that they dispensed with their local drivers after the first day feeling they were safer driving on their own.

When the first expatriates began to arrive in Ahwaz in the fall of '75, we all started to take lessons in the Persian language, which is called Farsi. Classes were held in the bazaar at the Iran-American Society. Almost everyone learned the basics to be able to communicate in the bazaar and elsewhere and several became quite fluent —especially Marcia Smith who taught classes at the Ahwaz medical school. At that time everyone was still living at the hotel, and the route to classes took them through part of the bazaar and past a restaurant where Iranian men were eating their evening meal. We could see soup being served from a large vat as we were going to class. On our way back to the hotel after class, the kettle was empty except for a pile of sheep bones and skull remaining in the bottom. This quickly discouraged anyone from eating at the bazaar "restaurants."

### Historic Area

Ahwaz is located near the ruins of Shush (the historic Susa of yesteryear), the royal city built and used by Darius the Great, King of Persia around 500 BC. Also within visiting distance, is the more famous complex of Persepolis, early capital of Persia, conquered by Alexander the Great in 351 B.C., in southeast Iran near the modern city of Shiraz. The remains of historic irrigation systems testify to the early prosperity of the valleys of the rivers Karun, Diz, and Karkha. Sugar cane was grown there in the past and had been re-established under the administration of the Shah. Nearby at Haft Tapeh are the partially restored ruins of a major ziggurat (Babylonian temple). Today, oil is the major product of the area. The pastoral Bakhtiar people of the Zagros Mountains to the north of Ahwaz continued to migrate annually through the Ahwaz area with their fat-tailed sheep, goats, camels, and big black tents seeking winter pastures closer to the Persian Gulf. Many were employed in the oil industry, the extensive housing, and commercial construction. We often saw them on the job wearing their traditional cylindrical hats, wool coats, baggy bloomer-like pants, and sandals.

Construction work for the direct reduction plant, like any steel plant, consisted of extensive large concrete foundations, large steel structures and vessels, and electrical, piping, and mechanical installations. Although the entire area is desert and flat alluvial plain, the water table is only 1 to 2 meters below the surface. That water has a very high sulfate content, which corrodes everything including regular concrete and especially iron and steel. Type V cement was used for substructures. It produces concrete resistant to high sulfate conditions. The local labor force had metal working skills developed with the oil industry and some masonry ability, but little carpentry, mechanical, or electrical experience. All materials, supplies, construction equipment, skilled labor, and supervision were in very short supply. Prepared and packaged food as we were used to purchasing at a U.S. supermarket was usually unavailable or difficult to obtain except for locally produced items such as dates, grapes, cucumbers, tomatoes, melons, etc. As the years passed, more imports became available, and the life of the expatriate wife easier.

### Inevitable Personnel Problems

NISIC was a newly formed company and during the initial period of the KE/TSL contract, it was organizing and building its staff for operations. It was also competing with many other enterprises within Iran for very limited resources of personnel and finances. A similar situation applied to TSL which was attempting to secure qualified Iranian personnel to supplement the expatriate personnel furnished by KE. NISIC's contractor for civil and foundation work, Mana Construction Company, was also experiencing shortages of supervision, skilled manpower, construction supplies, and construction equipment.

Early concrete work was formed with rough sawn boards imported from Russia, made into form panels, which completely disintegrated upon being stripped the first time and had to be scrapped. Due to equipment limitations, concrete was mixed in small one-meter batches and transported in front-end loaders, generating serious quality control concerns. Over several years these conditions improved somewhat. Patented concrete forming systems were finally instituted and concrete mixer trucks acquired for concrete transport. These changes improved efficiency, progress, costs, and quality. A very long campaign instituted by KE helped educate and persuade NISIC to instruct Mana to adopt these basic improvements in techniques.

By late '75, early '76, KE had built its expatriate staff on schedule for NISIC's program. Due to the many difficulties previously mentioned, NISIC was behind with its own staffing. NISIC then changed its mind about KE/TSL acting for NISIC and performing construction management of the project with a sizable staff (16 KE expatriates and 25 TSL Iranian technicians, engineers, and clerical). TSL had been successful in recruiting only a small number of staff. KE concurrently had become discouraged at its inability to secure decisions from NISIC to allow implementation of a construction program which could meet the NISIC 1978 project completion date.

### Reduced Staff

Contract Amendment in March 1, 1976, reduced the KE staff to 11, TSL to five and changed the KE/TSL services to advisory and technical assistance for NISIC who would be responsible for its own management of the work. Subsequently, KE relocated seven staff members to other projects outside of Iran. Contract Amendment 2 in August, 1977, added the electric furnace melt shop and continuous casting to the scope of the facilities in the KE contract. This increased the number of expatriates to 19. Services by TSL were eliminated after April, '78. Our contract completion date was extended into 1980 based on progress, which had been achieved to date.

### Importation Bottlenecks

During the early stages of the project, everyone had significant problems with importation of materials and equipment. All imports to Iran came by sea and had to come through the port of Khorramshahr, the only port, with significant docking facilities. The traffic overwhelmed the capacity of the port and ships routinely had to wait as long as six months before unloading during '75 arid '76. Some had very vulnerable cargoes. Bananas, oranges, and other perishables rotted. Even sheep being imported to upgrade Iranian stocks died. Activities were so disorganized that materials and equipment were often dumped helter-skelter in the port area with little or no records as to what was located where. With KE's logistical experience, it was arranged to have NISIC representatives and transport equipment available so the steel plant components could be unloaded directly from the ships to transport equipment for movement to Ahwaz. Construction was usually delayed due to incomplete foundation work, but seldom due to delivery of components. As construction proceeded, the need for major erection equipment such as large cranes became more important. KE provided NISIC with specifications and other procurement information and assisted NISIC with purchase and delivery of large-capacity erection cranes and other specialized equipment. Recommendations were also made to use vendor specialists for help with concrete forms and other equipment.

We provided technical administrative services in the development of schedules and cost control systems with the use of KE proprietary computer programs. A series of reports were developed to regularly inform NISIC on the status of the work and compare it to the planned NISIC objectives. These reports and other special studies became the tools by which KE was able to assist NISIC in assessing its performance.

## Advisors One on One

In the role of advisor and providing technical assistance to NISIC, each KE expatriate worked closely with one or more NISIC Iranian personnel. Their acceptance of KE advice and assistance was accomplished largely through establishing a personal relationship between KE and NISIC individuals. An atmosphere of understanding and confidence developed which facilitated acceptance of the KE advice. This was an on-going effort with the degree of success very much dependent upon the personalities and attitudes of the individuals involved. Overall, this was a successful strategy which was confirmed by later negotiations in '78 between KE and NISIC toward forming a joint company to perform similar work on other upcoming projects in Iran. Little did we know what the future held!

## The Shah Comes to Visit

Work progress for the Pahlavi Steel Complex direct reduction facility (57% of the total project) was relatively slow by western standards, but it was steady at 2 to 3 percent per month through '76 and 30 percent complete at the end of that year. In March, 1977, the Shah himself visited the project which was approximately 34 percent complete at the time. He also visited the site again in March, '78, when the work was 57 percent complete. The progress schedule was updated to actual in September, 1977, at 46 percent completion with final completion set by NISIC for March, 1980. The planned increase in progress failed to materialize although the prior rate of progress was maintained. By August, 1978, progress was 68 percent when it was scheduled for 78 percent. After that time the impact of political events locally and nationwide reduced progress even further.

The direct reduction plant was approximately 73 percent complete at the time all work effectively stopped at the end of '78. Work on the melt shop facility (43 percent of the total project) started in early '77 and was about 3 percent complete at the end of '77. By August, 1978, progress was 19% and also falling behind the schedule for completion by June, 1980. The melt shop facility was approximately 23 percent complete at the end of '78. Estimated manhours for the combined direct reduction plant, the melt shop, and continuous casting facility were 29,413,065. To the best of our knowledge, there has been no effective construction work performed on the Pahlavi Steel Complex after '78. What a terrible waste of time, materials, and money.

## International Community

The KE expatriate staff lived in local housing scattered throughout Korush, a major residential district of Ahwaz near the airport, wherever we could find or have built suitable houses. This district was populated with a mixture of Iranians and expatriates of many nationalities. Many worked for the National Iranian Oil Company (NIOC) or the Oil Service Company (OSCO), the NIOC operating contractor. Others were employed by various OSCO contractors and / or suppliers. Other government agencies were also represented including the Iranian Armed Forces. There were also a number of French expatriates working on a nuclear power station further down the Karun River. Even a group of Russian women with "handlers" (security) from a nearby Russian power plant project occasionally showed up for shopping in the bazaar at Ahwaz.

Our houses were basic one-story masonry structures with flat roofs. The roofs of many of the houses were sealed with a mixture of clay and straw which was surprisingly effective although weeds grew on the roof in the spring after the winter rains and the "roofing" had to be replaced every few years. The houses were equipped with room air conditioners, basic furniture, and major household appliances. This reduced shipping requirements for personal effects. Accommodations were spartan but adequate and reasonably comfortable.

## Buying at the Bazaar

Supplies of local food products and basic commodities were generally available in the bazaar with reasonable quality and prices when we arrived in Ahwaz. Imported foods and especially meat were available only infrequently initially. By '77, several general food stores had opened in our residential area with a fair selection of imported and packaged foods. There was also one shop in the bazaar, which would sometimes have ham and other pork products for sale. (This shop was owned by an Armenian.) When a shipment of imported food arrived in town, the grapevine spread the word quickly, and everyone who could do so quickly stocked up while the supply lasted. Prices for all foods except locally produced basic commodities were much more expensive than in the States. Since food was one of the relatively few cash expenses for most families, the availability of items became more important than the price. When shopping in the bazaar, it was necessary for women to be conservatively dressed but not covered as in Saudi Arabia.

Local diet staples consisted of flat bread cooked on the sides of open ovens, goat cheese, tomatoes, melons, onions, dates, pomegranates, yogurt, and milk. The melons were truly wonderful. Our wives spent much time looking for fresh food in the colorful bazaar along with the local women clad in their black chadors. (Expatriate women were not allowed to work in Iran.) The “sabzi” (green) market had a fish corner, spice shops, meat market with the occasional headless camel hanging up among the sheep and chickens. Branches of dates, fresh and dried, were all available in the bazaar if one explored a little. The bazaar was organized with similar merchants grouped together; thus it featured a “tin” street with pots, pans, and miscellaneous hardware shops and a “gold” street with the jewelry shops.

### Never a Dull Moment

Utilities were a varied lot! Public potable water came from the muddy Karun River. During very high or very low water stages of the river the system was often inoperative. Water was sometimes off for up to two weeks at a time. When this occurred, water wagons were placed at various locations around the city for public access, and everyone filled their containers daily. Electrical service was usually fairly reliable, fortunately, as we had to run our air conditioners more than six months of the year. However, there was one electrical outage of more than 72 hours for the entire city of Ahwaz when the only transmission line into the city failed due to collapse of a number of towers during a storm, which caused many problems and much anxiety. Some expatriates lost imported frozen food during the outage. Others gathered their freezers in the front yard of one house and connected them to a portable generator. One group cooked all the thawing food and had a huge potluck party.

Telephone service was not available for private houses, so communications among KE families had to be by word of mouth. However, we all lived within half to three-quarters of a mile from one another. Phone calls home to the States had to be made on public phones at the telephone office in town which entailed long waits. Bottled gas was available in the bazaar for hot water and for cooking. Garbage was picked up daily by a little old man with a wheelbarrow. He hauled it to the nearest vacant lot (1 to 2 blocks away) and dumped it for scavenging by nearby villagers and their livestock. Needless to say, flies were a nuisance the year round. A sanitary sewer system existed but lines within the houses often clogged because of the inadequate pitch of piping drains and westerner’s use of toilet paper for which they were not designed. The houses had no heating systems so we were quite chilly with only portable electric heaters during the three or so months of “winter.”

### Spare Time

Recreation for expatriates living in Ahwaz was surprisingly good though largely self-created. Our only TV reception was in the Persian language, and the only radio reception in English was short wave from Moscow. People of all ages and both sexes played a lot of slow-pitch softball. At one time there were 39 softball teams playing two to three times weekly. This was also a popular spectator activity with soft drinks and beer available. KE sponsored a team (which was usually in the cellar), but we generated good participation and much enthusiasm and fun. Tennis courts were available at the NIOC facilities and were regularly utilized by our tennis players. There was also a golf course in the desert with sand greens, which was later planted with grass to become one of the few grass courses in the Middle East. The course had to be fenced to keep out the local flocks of sheep and goats. There were also, of course, active groups of bridge players. Swimming was available at a price at several semi-private facilities. Several religious congregations held services in Ahwaz on Fridays (the local Sunday) which were well attended.

### Local Driving Worse than Paris

Erratic Iranian driving habits were a constant worry for all of us. On occasion, they were so ludicrous as to become humorous. Example: one morning the two-lane highway leading to the steel plant and which also carried much of the oil field traffic was blocked by an accident. Traffic immediately backed up on both sides of the accident since there were no alternative routes. As was their habit, the Iranian drivers quickly filled the left-hand side of the road in their impatience to keep moving. When that became fully blocked on either side of the accident, they then started driving on the shoulders on both sides, quickly filling these too. The highway was completely blocked by four lanes of traffic facing each other opposite the accident. At this point the impatient drivers began to race off the highway driving wildly across the desert in all directions—rather like the Keystone cops in early movies. It took hours to untangle and restore traffic to normal.

With a six-day week work schedule, the excessive summer heat, different living conditions, and the cultural stresses of life in Ahwaz, vacation time was cherished and eagerly anticipated. Many families (dependents) tried to travel to more moderate climates during the summer, leaving the staff largely as bachelors. When the staff took time off, they had opportunities to travel easily to Europe, Africa, and Asia as well as to return home to the U.S. These travel opportunities were an important compensation for working and living in a place like Iran.

## Troubles Began in '78

During '78, several events were transpiring concurrently which made the year especially unforgettable. The implementation of Contract Amendment 2 required recruiting additional expatriate personnel and all the related efforts of securing adequate housing, preparing for their arrival, and their indoctrination to the local culture as well as the unique working relationships with the Iranians. NISIC and KE held negotiations and developed a prospective agreement to form a joint company to perform advisory and technical assistance for future Iranian industrial projects.

The personnel recruiting effort was extensive. Screening of applicants and families was in much greater depth than for the usual overseas position to be sure some of the earlier experiences with expatriates in Iran did not recur. Some had been unable to contend with the unusual working arrangements as advisors, the difficult living conditions, and / or the cultural shock of a Muslim society. Furthermore, there were not many professionally qualified individuals who were interested in assignments to a project in Iran when other opportunities were available at home or in more desirable locations. Some of those who were qualified and interested were simply unable to accept the differences with which they would have to contend. In spite of these conditions, the staffing was gradually increased through the joint efforts of the Oakland personnel staff, jobsite input, and site preparation for the new arrivals.

NISIC started work in '78 on another steel plant to be located at Bandar Abbas on the Persian Gulf. The association with KE on the Pahlavi Steel Complex had evolved into a good working relationship. NISIC suggested the two organizations combine their resources to form a joint company to perform advisory and technical assistance services for the Bandar Abbas Rolling Company (BARCO) plant and other anticipated future industrial projects in Iran. A series of meetings were held to develop the concept further and by the fall of '78 an extensive draft of a new company agreement had been developed and agreement to proceed with capitalization was close at hand. During the interim, KE performed services for BARCO, both in Oakland and in Iran.

## Revolution Brewing

The political sentiment toward the government of the Shah was growing more adverse and evolved from open protests and demonstrations into an eventual outright revolution. The departure of the Shah from Iran took place in January, 1979, with takeover of the government by supporters of Ayatollah Kohmeini. The Iranian revolution caused a complete stoppage of all work on the Pahlavi Steel Complex and all government relations with foreign companies.

Numerous articles, books, and other dissertations have been written about events leading up to the Iranian revolution. The "beginning of the end" came during the summer of '78 so far as we in Ahwaz were concerned. Fires were set in restaurants and clubs catering to foreigners and / or serving liquor. Similar events were apparently occurring elsewhere in Iran although not usually reported in the English-language newspapers, so we knew of these only through the grapevine. There were also some demonstrations of a rather small nature in the Ahwaz bazaar, at several public buildings as well as at various commercial enterprises in the area. One of these took place at the Pahlavi Steel Complex. The NISIC management informed us of the demonstration in advance and advised us to remain out of the immediate area. NISIC also advised us of expected demonstrations in Ahwaz with strong recommendations to avoid them.

In early September, there was a demonstration at the steel plant during which one of our expatriates was injured by a rock thrown while he was assisting workers to secure one of the large cranes in the melt shop area. This event, while apparently not overt, served to put all of us on the project on a much more alert status and made us aware we could be affected by these events. Up to that time, most of us had not given much concern to the seriousness of these happenings. How naive we were at that time!

### Relations a Bit Dicey

On an individual basis, a few of the NISIC personnel were becoming more hostile to our staff personnel. Notes would be found on vehicles in the morning warning to "Leave the country by December or die!" Concurrently during September and October, elsewhere in Iran demonstrations were occurring and were finally being reported in the local newspapers. NISIC management assured us that there was nothing to worry about in the long run, and the Shah would maintain order as necessary. A similar and even more optimistic attitude was the public position of the U.S. Department of State representatives who indicated there was no reason for expatriates to be concerned, but they could always leave the country if they were uncomfortable with political events. (These were the same State Department people who later spent a lot of extra time in Iran as "guests".) This position was ridiculously unrealistic since most people do not "walk away" from their jobs 10,000 miles from home without good cause. During this period, the Iranian cabinet ministers were beginning to change frequently although Dr. Amin, the founder of NISIC, who had been Minister of Mines and Industry since '76, continued in that position.

The hotels and stores, which dispensed or sold liquor, had essentially discontinued that service. Strikes and demonstrations became a way of life by late October, 1978, in government companies and agencies as well as the private sector. Iran Air went on strike and discontinued all air service in Iran at the end of October, and the Ministry of Finance was on strike so expatriate taxes could not be paid each month as required. In Ahwaz a midnight to 6 a.m. curfew had been imposed during October. Troops, guns, and tanks were placed at major traffic circles and major intersections, etc. throughout the city. During November and December, oil production by NIOC was frequently interrupted in spite of OSCO attempts to maintain operations.

### Work Comes to a Halt

At the steel plant less and less was being accomplished until December, 1978, when production came to an almost complete stop. The KE policy at that time was any expatriate who felt uncomfortable with political conditions could leave or send his family on leave temporarily. We still believed that matters would be settled by the Shah at the appropriate time. This view changed completely during December, and by Christmas


As related by Jim Miller in his 'Ahwaz Notes,' the impending clouds of a revolution in Iran hovered in mid-1978. One of our KE people awoke one morning to find a threatening warning appended to his windshield (above).

essentially all dependents had departed. About half of the staff had also departed at least for the holidays. The remaining expatriates consolidated themselves into several houses for security and companionship.

Attitudes of the Iranians at the project had become very anti-American, so the working situation varied from tense to openly hostile. The pro-revolution NISIC Iranians were pressuring KE personnel to leave or be in great danger. Workers had ceased to even give the appearance of work on the project, and there was nothing to be accomplished by the KE staff remaining in Ahwaz. Even travel to the plant site was hazardous. There was all sorts of nighttime activity by the military and revolutionaries.

### Time to Retreat

Finally, on December 27, 1978, Oakland management decided to evacuate the remaining nine expatriate staff and one dependent during the first week of January, 1979. *(Editor's Note:* See the previous oral history entitled, "Escape from Iran." That oral history gives the stateside view of the evacuation.) This group of ten, each with one suitcase, pooled their gas to drive to Abadan where they were evacuated by a charter flight to Bahrain on January 3, 1979. Everyone had left personal belongings in their houses, turned keys over to the NISIC housing coordinator, and hoped for the best. In February, '79, domestic events had settled sufficiently for movers from Teheran to go to Ahwaz to pack and ship personal belongings to Teheran for further shipment to the U.S. Fortunately, the houses and contents had not been disturbed! All of our possessions were eventually delivered to us during the summer of '79. Unfortunately, there had been weather damage to many of the shipments. There was no opportunity at the time of evacuation for securing or storage of KE project files, although they were consolidated and NISIC was to preserve them. These files and records never were recovered.

Overall, Oakland management of the project was directed by Vice Presidents Bob Bernard and Dick Lowell with administrative assistance from Joe Tilt, Wendell Eaton, and many others. Sam Ruvkun directed the BARCO activities which developed during 1978. The people who served in Iran were the following: Ed Airth, *Lionel Aspin,* Ron Beltz, *George Boyde, Wes Driver, George Gates,* Gene Green, *Ilmar Kurrusk,* Len Lee, Vince Litman, Gary Materna, *Gordon McDonald,* Bud Metcalf, Bob Miller, Dale Miller, Jim Miller, Rich Redgrave, Tony Rugis, *Cal Smith* (both at Ahwaz and on BARCO), Jim Taylor, *Lee Walhovd,* Frank Walker, *Chuck Whitford, Frank Walker, Kirke Whittingham,* and Doil Yocham. The italicized, including *Mrs. Whittingham,* were evacuated on January 3, 1979.

During these difficult times for the expatriate staff, KE Oakland management also had a full platter in establishing an appropriate contract justification for removing the staff without being accused by NISIC of abandoning the work. These issues were discussed during '79 and '80 through frequent political changes in Iran and rapidly changing NISIC management, which became dominated by revolutionaries. Several more years were to pass until KE and NISIC finalized all open issues and KE received an acceptable final payment (truly surprising) for the work on the Pahlavi Steel Complex and the Bandar Abbas Rolling Mill Company.

For many decades the participants on this project performed work on all types of projects worldwide for Kaiser Engineers, but none compared to this one.

This ended one of the most interesting, challenging, and well-remembered undertakings, both personally and professionally.

## *How We Got the Krakatau Job by Sam Ruvkun*

*(Editor's Note:* This little vignette is placed here as an introduction to Bill Smith's experiences within Indonesia on the Krakatau job. It was not an ordinary job, as he relates.)

### Background

The oil crisis that hit the world in 1974 gave oil-producing countries massive amounts of money they had not seen before. They all reasoned that they needed to safeguard their future by industrialization and by upgrading the livelihood of their work force. Consequently, several of them turned to the steel industry as a place to invest their newfound wealth.

The same story repeated itself in Venezuela with its SIDOR steel plant; in Iran with its Ahwaz steel plant; and in Indonesia with its Krakatau steel works. In each case they had large oil-producing facilities and were amassing large amounts of cash; and they had natural gas from the oil fields and were burning off the gas. A new steel-making process hit the world at about the same time. It was the direct reduction of iron ore using natural gas as a means of reduction. Each of the three countries rushed into contracts to build large steel plants, and each ran into technical difficulties.

Enter Kaiser Engineers. We were called into rescue missions at Sidor and Ahwaz and were well underway in mid-1975 when we received an inquiry for assistance from Krakatau. The inquiry had been flushed out by Jesse Taylor out of Australia. The inquiry came in the form of a cablegram requesting an immediate response.

## Landing Two Major Jobs in One Month

By this time I was assigned to developing large projects for our newly formed marketing division. Carl Lovegren had been brought into KE to head it up. In 1975, I participated in my most interesting marketing ventures. It just so happened that two projects upon which I was the proposal manager were awarded to us within the space of about one month. One was the Krakatau job, and the other was the Didier Coke Oven project for Dofasco in Canada. A little discussion of that job follows the Krakatau project. As one can surmise, landing two large and important jobs like that in a month's time did not occur often in one's career.

## Krakatau Inquiry

About the time the inquiry came in, Carl Lovegren was visiting Southeast Asia and stopped by in Jakarta, Indonesia. One day I got a telephone call from him. In the background I could hear music from a band at a local bar. Carl was with Jesse Taylor who was our local sales representative out of Australia. They were chasing the hot lead for the Krakatau Steel Project. Carl called me to ask that I prepare a proposal since the people were in a big hurry.

I asked him what the project was. His answer was that he didn't know. All that he knew was in our files. I asked what the people were like. Did they have any expertise in the business? He did not know. I asked about the project status. He didn't know much about that either. Finally, he said, "Sam, you know what to do. Just do it."

So for the next week, I tried to find out what little I could from the files without much success. We did know that equipment suppliers had sold a "turnkey" project and that engineering was late and deliveries were late. The project was similar in many regards to projects in Iran and Venezuela where, because of the crisis of OPEC in the previous years, oil-rich countries had lots of money, which they wanted to invest for the future for industrialization. Oil had gone from $2 a barrel to $25 a barrel. In addition because they were pumping out oil so fast, they were flaring off and wasting lots of natural gas.

At the same time, a project in Mexico had been developed where waste gas could be used to make something called sponge iron which could make good feed material in the steel-making process. So all the oil rich countries rushed to get into a good thing. The trouble was that all of the so-called know-how was held by equipment suppliers who had patents on the process. They were selling their abilities beyond the sponge iron process into selling steel-making equipment. And they all go way over their heads.

We knew all this because we already were on missions to rescue projects that were in trouble in Venezuela and in Iran. As it turned out, I was involved in those rescue missions. They were not equipped to design tie-in facilities, nor material handling, nor utilities, nor could they manage complex programs like this.

## Making Assumptions for the Proposal

Back to the proposal for Indonesia. I was left with little knowledge of the local environment and so I had to make some assumptions. I assumed that the project had the same troubles as did Venezuela and Iran. I assumed that the people in charge had little knowledge of the steel industry and while they may have graduated as engineers, they probably were quite young and inexperienced. Like countries of Latin America, I assumed that Indonesia was underdeveloped with limited materials, equipment, and trained manpower, even though I had never been there.

## Our Proposal

As it turned out, all of my assumptions were correct. I was able to assemble a proposal in which I outlined how we would re-assess the status of the project, evaluate existing contracts, and would set up to advise and assist where necessary. We would provide a small key staff of experts to work with the Indonesian staff. The proposal consisted of 11 pages of details contained in a telex message which, at the time, was the cheapest and fastest mode of communicating and would satisfy the urgency dictated by the client. We proposed that we be compensated on a multiplier on the salaries, higher than any that we had proposed theretofore, since this would be taking key personnel away for long periods of time. Then because we didn't have time to select a staff, I proposed myself as the interim project manager until we could assemble a permanent staff. Along with the telex, I sent my resume which read pretty well, showing a number of steel projects and those similar to Krakatau upon which I had worked.

Within a week, I received a telex back. We were hired. Meet our president and the AID economist in Amsterdam next week to start the work.

Later, I found out that our competitor, McKee, had responded that they would not be able to make a proposal for several weeks. Koppers Company said they wanted to send someone to Indonesia to investigate the project first. Because the Indonesians were in such a hurry and with the assistance and persistence of the AID (Agency for Industrial Development) economist, we were selected right away.

Ten years later, KE was still at work on Krakatau projects as other expansions took place. KE earned good fees over the years.

### Interesting Coincidence with Coke Oven

At exactly the same time, we were being awarded the Krakatau job, I was intimately involved in a complicated proposal to build a coking coal plant for a steel mill in Canada. KE was trying to break into this field, and the steel division and the marketing division had arranged to try a joint venture with the Didier firm out of Dusseldorf, Germany. Didier were experts in the field and had a newer type of oven, which appealed to the Canadian steel firm Dofasco.

At this time our steel division was somewhat upset with the marketing group because of differences of opinion about whom should do the marketing for the steel division. Arrangements were made for a team of technical people from the steel division to go to Germany to assemble a proposal. After two weeks of efforts in Germany, word came back to Oakland that things were not going well between our engineers and Didier staff.

I was asked to join the group to help out. The first thing I discovered was that we sent two people who knew nothing about the technical side of the endeavor and absolutely nothing about how to go about making a proposal. Besides that, they did not get any cooperation from Didier and did not have a clue about solving the dilemma. Add to the mix the fact that negotiating a joint-venture agreement was not a routine matter. It was obvious that these men needed help.

I proceeded to discuss and negotiate with the president and technical director of Didier terms of the proposed agreement and to outline how our proposal would look. This took a lot of tact and educating since Didier did not know how general contractors worked and did not have too much experience working outside of Germany. Their cost accounting system was entirely different than KE's, and we had to decide which method of costing would be used. We were paving new ground.

After laying the ground work, I was able to draft a proposal agreeable to both sides, arranged for Hal Hunsaker, our lawyer, to come to Germany to review and approve it, and had the proposal delivered on time. We were awarded the job with great fanfare on both sides of the ocean.

A couple of interesting side lights occurred. A few days before the proposal was finished and as I awaited the arrival of our attorney, I asked Dr. Weber, the technical director, for a recommendation for a place to have dinner. When I got seated and ordered my meal, I was approached by the headwaiter who said, "Mr. Ruvkun you have a telephone call." It was Dr. Weber who knew where I was going and had described me to the headwaiter. He said he had an important telex message that he thought I would want to get right away. It was a telex that announced that we had been awarded the Krakatau project. Weber sounded as delighted as I was.

The second interesting sidelight occurred a week later when I was in Amsterdam meeting the Krakatau management and initiating the work. I received a phone call that we were awarded the Dofasco Coke Project, and I was needed back in New York immediately.

## *Krakatau Job*
## *by Bill Smith*

### Project Background, Rationale

Indonesian government plans to enter the steel industry began in the late 1950s while the country was still friendly with the Soviet Union. At that time, as one of many aid projects, the USSR agreed to establish a small steel plant at Cilegon, West Java. The plant would produce 80,000 tons per year of wire rod, small sections, merchant bar, and sheet via the open hearth and ingot-rolling route. A contract was signed in 1962 and by late 1964 had been executed to the point of machinery delivery and building construction. In early 1965 Indonesia was swept by an anti-Communist revolution, USSR personnel were expelled, and the Trikora Steel Project, as it had become known, was abandoned.

In the following years, while the site and equipment steadily deteriorated in conditions of field storage, consideration was given to ways of resuming the project. The result was the creation of P. T. Krakatau Steel (PTKS) on August 31, 1970, under the sponsorship of the national oil company, Petramina, with the stated purpose to revive and complete the original Trikora project and to develop additional national steel industries. The results of five years of field storage had foreclosed possibilities of completing the original project as planned. PTKS did construct a cold wire drawing plant, oxygen generating facilities, and small bar and section mill at the site of the proposed Soviet facilities using much of the Soviet-supplied equipment. Attention mainly focused on a much larger project of 500,000-tons-per-year capacity to be built at a site 4 km west of the original location. The Director General of Basic Industry gave preliminary approval of this plan on March 15, 1973.

At this point, things developed exponentially. PTKS formed a joint venture with Ferrostaal AG, P.T. Krakatau Ferrosteel (PTKF) which joint venture, over a period of thirteen months, generated a plan which included:

- An iron ore pelletizing plant of 3,000,000 tpy capacity
- A four-module HyL direct reduction plant of 2,000,000 tpy capacity
- A steel billet plant of 500,000 tpy capacity, with electric arc furnaces and continuous casting machines.
- A steel slab plant of 1,000,000 tpy capacity, also EAF/CCM based
- A wire rod and narrow strip mill of 250,000 tpy capacity
- A wide hot strip mill of 1,000,000 tpy capacity
- An inter-plant transportation system

By the end of June, 1974, PTKS and PTKF had entered into contracts with Ferrostaal AG with a total contract value of DM 2,655 million for the supply of this equipment. Additional contracts were entered into for a 400-megawatt power plant and 150 kv distribution system, a 2-cubic-meters-per-second water supply and distribution system, and a deep-water dock for receiving iron ore and scrap and shipping mill products. The initial 1,500,000 tpy steel plant was to be capable of expansion to 6,000,000 tpy.

The terms and conditions of the contracts were heavily in favor of the sellers. with no provisions for termination or force majeure, no provisions for owner review of design and construction, no performance test details, no provision for progress reports, no definition of escalation, no provision to supply the owner with documentation and drawings during construction, and no financing arrangements. The project started with Petramina financing via short-term loans. Not surprisingly, this huge and hastily assembled project quickly began to falter. By late 1974, PTKS and PTKF began to be delinquent in payments. In April, 1975, the Minister of State for Administrative Reform / Vice Chairman of BAPPENAS (the National Planning Agency) called for an urgent review of the project and before the end of that month such review was confirmed by Presidential Decree. “Team Krakatau Steel” was formed to undertake a comprehensive review and evaluation.

## Reassessment Renegotiation, Master Planning

On May 23, 1975, Kaiser Engineers International, Inc., in association with Armco Steel Corp., was selected from a number of firms submitting proposals and appointed consultant to Team Krakatau Steel (TKS). The first assignment was the evaluation and preparation of a recommendation for the initial steel plant facilities. A report, commissioned by TKS, and published by McLellan & Partners on June 12, 1975, had reviewed the progress of design, manufacture, and delivery against the contracts then in force and was used for guidance in making proceed or cancel decisions. The Kaiser / Armco team’s Reassessment Report, submitted in mid-July, 1975, recommended building half of the direct reduction plant, the billet steel plant, and the wire rod and narrow strip mill. The pellet plant, slab steel plant, and wide hot strip mill were to be deferred or cancelled. The report also evaluated several alternative construction programs with order-of-magnitude costs for each. These all formed the basis for discussions, which began in early August to renegotiate the contracts.

The contract renegotiations with Ferrostaal, were concluded on August 13, 1975, with the signing of a Memorandum of Understanding under which it was agreed that Krakatau would proceed with the completion of construction of the entire direct reduction plant, the billet steel plant, and the wire rod and narrow strip mill (Expanded Phase I). The pellet plant, slab steel plant, wide hot strip mill, and interplant transport contracts were cancelled. There was a charge of DM 360 million for these cancelled contract, but under certain conditions Krakatau could recover these charges as credits against reinstated orders for them or for similar equipment. The contracts for plant infrastructure (dock, electricity, and water) were not greatly affected, and the Memoranda of Agreement covering changes made necessary by the reduced scope of steel plant facilities were agreed upon and signed with the responsible contractors during November, 1975.

Beginning in late 1975, and continuing through 1976, the Kaiser / Armco team developed a Master Plan to define and recommend orderly development beyond the Phase I plant. The completed Master Plan was issued in late 1976 and recommended a three-phase program for the future:

- Phase II Pellet Plant
- Phase Ill Slabsteel Plant, Hot strip mill, Electric resistance weld pipe mill
- Phase IV Expansion of slab steel plant and hot strip mill, Cold rolling mill and Tinning line.

During 1977 and 1978, the outlook for DRI sales was not optimistic, and also, considering market and construction cost studies, the final program of execution was:

- Phase I 1975-1980
  Basic utilities infrastructure (electricity, water, dock),
  Direct reduction plant, billet steel plant, wire rod and narrow strip mill
- Phase II 1980-1984
  Slab steel plant, wide hot strip mill, electrical infrastructure expansion
- Phase III 1983-1987
  Electrolytic tinning line
- Phase IV 1984-1989
  Cold rolling mill complex

Phase III was executed by a new firm, P. T. Pelat Timah Nusantara, sponsored by the national tin mining company, P. T. Tambang Timah, PTKS, and private interests.

Phase IV was executed by a new firm, P. T. Cold Rolling Mill Indonesia, sponsored by PTKS and private interests.

The total cost of the first two phases was approximately U.S. $2 billion, including foreign supply, transportation, and civil works supplied by PTKS. The final phases brought the total cost to about U.S. 2.5 billion current dollars.

Throughout Phases I, II, and III, Kaiser Engineers continued to perform or participate in studies necessary to refine the broad decisions contained in the Master Plan, utilizing personnel in the Chicago and Oakland offices as well as those in Indonesia. In addition to this study work, KE Jakarta personnel assisted in supplier selection and contract negotiations for iron ore pellets and helped the PTKS marketing department in export sales of steel products and DRI. Assistance was also provided in the preparation of initial operating cost budgets, the development of personnel and safety programs, and many other tasks not usually associated with an engineering and construction program.

## Project Execution, Phase I

Kaiser Engineers' services were provided from offices in Jakarta and at the plant site in Cilegon, West Java. For the construction advisory services, the site staff at Cilegon was to consist of six personnel, construction coordinator, control engineer, infrastructure contract administrator (CA), billet plant (CA), power supply (CA), and administrative engineer. Later, a mechanical engineer, power supply, and an electrical engineer wire rod and strip mill were added, and the administrative engineer was moved to the Jakarta office. Jakarta personnel, housed in an office at PTKS headquarters, included project director, resident manager, administrative engineer, and later at PTKS request, civil engineer, and personnel consultant. The first Kaiser personnel arrived on the scene in August, 1975; as work progressed, additional positions were filled, and all 12 were active by June, 1978.

The first site meeting at which KE personnel were introduced to the contractors took place in September, 1975. At that time, none of the contractors were performing any substantial amount of work, since payments to them had yet to be resumed, and the renegotiation meetings had yet to be concluded. Once agreements were reached and a schedule of interim payments agreed to the contractors returned to work on-site and in their foreign locations. Also loan agreements between German and Indonesian banks were finally reached in July, 1976.

The commencement of administration of the contracts by PTKS and KE officially began in

January, 1976. Regular site inspections and meetings with the responsible contractors, supervisors were initiated with the purpose to improve the overall quality of the work and establish control by the owner. Methods of measuring field progress were defined, and actual progress was compared to scheduled progress at regular monthly meetings, with agreed minutes issued for each. Copies of drawings and specifications were progressively made available, reviewed by PTKS/KE during inspections, and subsequently corrected as necessary by the contractor. As sections of the work approached completion, final inspection and cold testing procedures were established to ensure that each plant was correctly completed and tested prior to provisional acceptance by PTKS. Performance test procedures were also established to define conditions of final acceptance.

The receipt, loading, and transport of materials from harbor to the site was a major problem. Initially ships were unloaded at the town of Merak, some distance away, and barged to shore storage areas until customs clearance was obtained and then trucked to the site.

Road and bridge limitations required special handling of heavier items. When PTKS harbor at Cigading was opened in 1977, barging was no longer necessary, and trucking conditions were improved. Some heavier and larger items still required special handling.

The DRI plant proved to be the most troublesome area. Although civil work was begun in February, 1976, and the first unit (of 4) commenced cold testing in February, 1978, the last unit would not achieve final acceptance until February, 1982. Problems included delivery delays, design deficiencies requiring correction, faulty construction procedures, and unavailability of raw materials. Operation of the first unit began in August, 1978 only to reveal more operating problems requiring design changes for solution. At the time this DRI plant was by far the most ambitious in the world with many first-time features, Slowly, and with dedicated determination by all concerned, it finally became able to support the steel-making as intended.

Work on the Billet Steel Plant (BSP) began in October 1984, and by February 1976 the building was ready to receive cranes and other machinery. Delays caused by contract negotiations prevented the start of crane erection until November. Almost 24 months later in October, 1978, the final provisional acceptance was granted, and at the end of November the first heat of steel was produced. While useful production was obtained throughout 1979 and 1980, performance tests were not completed until 1981 when sufficient supplies of DRI, consumables, and personnel became available.

The Wire Rod and Narrow Strip Mill (WRSP) site preparation had begun in July, 1974, but all work was suspended in April, 1975, pending the Review and Reassessment. Equipment manufacture in Germany was 45 percent complete at this time, and by October, 1976, over 70 percent was ready for shipment. To avoid storage charges in Germany, shipments to Cilegon were made in 1977 even though erection was not possible before the first quarter of 1978. Some handling damage resulted during unloading and storage. While PTKS' insurance provided coverage, claim procedures were slow, and some replacement equipment was not received as late as May, 1980. Civil work restarted in June, 1976, building erection began in June, 1977, mechanical erection in April, 1978, and electrical work in June, 1978. Many delays were encountered which resulted in initial hot operation on August 6, 1979, about two weeks later than the planned official start-up date of July 21. Performance tests were carried out as personnel gained experience. The mill was accepted for production of 12 mm rod in October, 1979, and finally, for 5.5 mm rod in July, 1980.

Work on the 400-mw steam power station commenced in May, 1976, and despite many problems, the first of five units was ready to supply power in August, 1978. Commissioning of the remaining units followed at two-month intervals until April, 1979, according to schedule. The unconventional seawater cooling system had numerous problems including corrosion of the steel pilings, and several redesigns were required to achieve solutions. The plant power distribution system was located underground and operated at 150 kv. Some construction difficulties were encountered, but overall performance of the electrical system was satisfactory and timely.

The infrastructure for the plant included the harbor and material handling facilities including pier, two bulk ore unloaders, and a conveyor system to the pellet stockyard at the DRI plant; a DRI loadout system with a conveyor system to the pier and shiploader at the pier; railroad line between pier and plant; and water supply facilities consisting of a water intake pump station at the nearby Cidanau River, pipeline to a storage dam, a 2-cubic-meter-per-second purification plant, and a distribution system to the steel plant facilities. Work was performed by three foreign contractors and more than 20 local contractors and execution were complicated by many design changes and additions. In spite of difficulties, most requirements for steel plant operation were met, although some problems such as storage dam failure and DRI loadout were not finally resolved until late 1980.

## Project Execution, Phase II

At the request of PTKS early in 1978, Kaiser Engineers prepared a request for proposal for a hot strip mill, and a proposal was received from Ferrostaal AG on July 20. After review and negotiation by a team of Indonesian officials, assisted by Kaiser for technical and others for legal advice, a contract resulted which became effective on September 14 ,1979. Kaiser used experts from the Phase I team then working in Indonesia, augmented as needed by specialists from the Oakland and Chicago offices to ensure coverage of all technical and contractual details. In a similar manner, contracts for the Slab Steel Plant and Expansion to the Electrical Infrastructure were negotiated and became effective March 1, 1980, and October 24, 1980, respectively. In contrast to the cancelled contracts of 1974, the new contracts were fully protective of Krakatau's rights, guaranteed vendor performance, and included financing provisions. The total value of the three contracts was DM 1730 million, of which DM 329 million were offset by recovered cancellation charges, DM 31 million were lost by reason of not reinstating the Iron Ore Pelletizing Plant. Kaiser Engineers detailed participation in negotiations assured that the content and form of the contracts adhered to the highest standards. The fact that they were written in English between native speakers of Indonesian and German guaranteed Kaiser a key role in resolving any disputes as to contract interpretation.

As in Phase I, Kaiser operated from offices in Jakarta and Cilegon and with similar manning and functions. Shortly after the Hot Strip Mill contract became effective, Krakatau opened an office in Essen, Germany, with a force of three engineers, one transportation coordinator, one administrator, and one secretary. This group, with part-time help from Kaiser specialists, developed the format for civil bid packages due under the contract, established a chart of accounts for the Hot Strip Mill, finalized bar-chart schedules, and developed progress measurement worksheets. It became clear to Krakatau that the total workload for the Essen office would require a very organized approach, and they requested Kaiser to assign a permanent consulting staff. Kaiser Engineers' resident manager / civil engineer was added to the office in March, 1980; a mechanical engineer and electrical engineer were added in August. This permanent staff of three was supplemented from time to time by specialists from Oakland or Chicago. Under procedures drafted by KE resident manager and issued by PTKS on July 9, 1980, the Essen office made a significant contribution to the success of the project by establishing controls; reviewing designs, drawings, control philosophies, lists, and manuals; inspecting and measuring manufacturing progress; controlling freight and insurance; and coordinating training activities in Europe.

Kaiser participation in Essen office activities ended in September, 1982, with the departure of the resident manager / civil engineer. The resident manager and mechanical engineer returned home; the electrical engineer joined the Kaiser team at Cilegon as administrator of the Electrical Infrastructure Expansion contract.

While design and manufacturing problems were being solved by the Essen group in Europe, the Kaiser team at Cilegon was grappling with civil works problems. All civil works were built by local contractors hired by PTKS. Ten different local contractors were involved. The motivation and coordination of these many groups proved to be a daunting task, and by the end of 1981, with several contracts four to six months behind schedule, a meeting was set for early 1982 to review the entire project schedule. At this time, the final completion date and official inauguration by the President of Indonesia were advanced by one month to February 24, 1983.

As a consequence of this commitment and with much adjustment, coaxing, and continuous monitoring, delays in areas urgently required by Ferrostaal to maintain erection schedules were generally held to a minimum. All erection work was performed by Indonesian workmen under the close supervision of Ferrostaal, their suppliers, and, in the case of the electrical infrastructure, by Siemens. The quality of erection work was held by these meticulous German supervisors to a very acceptable international level. As erection was completed, the arduous task of commissioning could begin.

Commissioning procedures were specifically described in the contracts and consisted of four discrete phases: (1) Cold Testing, (2) Adjustment Trial Runs, (3) Fine Tuning Period, and (4) Performance Testing. Cold testing consisted of what is commonly known as no-load mechanical and electrical checkout. Adjustment trial runs checked all operating sequences not covered in cold testing, including automatic and computer modes, followed by operation to produce product. Once initial production had been achieved, Provisional Acceptance Certificates were executed. All cold test and adjustment procedures were documented, scheduled, performed, and witnessed in a formal manner, becoming part of the permanent project records. Provisional acceptance of the last major equipment was achieved in August, 1983.

The fine-tuning period began after provisional acceptance and ended with completion of performance tests specified in the contracts. During this period, PTKS production and maintenance personnel were assisted by technical teams provided by Ferrostaal under a supplementary agreement. Extensive training of PTKS people at a steelworks in Europe and classroom training in Indonesia also were provided.

Performance testing was carried out strictly in accordance with a mutually agreed program designed to show clearly the ability of the equipment to meet all quality requirements while producing at design rate on a sustained basis. The tests were rigorous and included meeting targets for consumption of consumables and utilities. Performance testing of the slab steel plant ended with final acceptance in January, 1984, 38 months after groundbreaking in November, 1980; the hot strip mill was granted final acceptance in November, 1983, 43 months after groundbreaking in April, 1980.

The official dedication of the plant with operational demonstration to the President and other high officers of the Indonesian government took place on February 24, 1983, as planned and with great and pompous ceremony.

## Project Execution, Phase III

Serious consideration of Phase III began in May, 1980, when a consortium of PT Tambang Timah (the state-owned tin producer) and PTKS commissioned Kaiser Engineers to prepare a feasibility study for the project, including a market study and technical evaluation. The study demonstrated the project to be feasible at a level of 130,000 tons per year of product.

The original consortium was joined by a private company, PT Nusantara Ampera Bakti, named the new company PT Pelat Timah Nusantara (later shortened to PT Latinusa), and engaged KE to prepare turnkey bid specifications for international tender, to analyze bids and to assist in final negotiations with the successful bidder. On March 15, 1983, a contract became effective between PT Latinusa and a consortium of Mannesmann Demag Sack of Germany and Hitachi Zosen of Japan calling for project completion with acceptance testing within 30 months of the effective date.

The plant was to be a self-sufficient, stand-alone facility located in the vicinity of PTKS Cilegon plant. Tin mill black plate would initially come from foreign sources, later from PTKS Phase IV cold rolling mill. All necessary infrastructure for tinning line operations was included, electrical distribution, water treatment, tin anode manufacture, roll and repair shop, and management information system. In addition to the tinning line itself, a shear line and packaging lines were also provided. The 8.5-hectare plant site provides ample room for future expansion.

The construction site was a virtual United Nations with people of many nationalities and origins working together, often around-the-clock, to build the plant. The project was completed on schedule in 30 months and under budget. The Presidential inauguration was successfully endured two months after start-up.

In addition to acting as study manager, owners engineer, and construction manager, Kaiser Engineers also undertook to provide operations management and training for two years after the start of commercial production. This was a unique experiment in cross-cultural synergy between ten “hardboiled” U.S. operators and engineers and their pleasantly smiling Indonesian counterparts who had to learn how to make quality tinplate and to do it correctly all the time.

## 12 1/2 Years of Involvement

In September, 1987, after almost 12 1/2 years of continuous involvement, Kaiser Engineers’ work on the Krakatau project came to an end as the electrolytic tinning line team took their leave. By this time Phase IV was well underway with a new set of suppliers, engineers, and even owners. Krakatau personnel entered this era with a sense of confidence and optimism due in no small part to their years of close association with many, many outstanding Kaiser engineers.

## Lessons Learned

The differences between the contractual status of the owner during Phase I and subsequent phases were like night and day. During Phase I, innumerable meetings were held with the contractors to attempt to gain some control over the work and the adequacy of the facilities being furnished, and such control was never, really fully established. The later contracts were entirely different, and Krakatau had excellent control throughout. The original contracts were single-source negotiations with exorbitant prices and perhaps other irregularities. The cancellation charges later negotiated made it impossible or very difficult to be sure that some later prices were proper. The situation was unfortunate but did lead to reform of many procedures and checks by the Indonesian government when contracting with foreign suppliers.

### People Who Did It

**Phase I**
Dick Hart, Project Director
Edgar Abreu, Mike Anderson, Grove Fox, Peter Goldsmith, Bruce Grube, Dave Harley, Harvey Hautala, Dick Kuhl,Curt Jensen, Carl Mertens, Duke Milford, Doug Robbins, John Rosten

**Phase II**
Bill Smith, Project Director
Jim Allen, Mike Anderson, Elmer Barthel, George Botting, Fred Brunner, Earl Denner, Peter Goldsmith, Ebby Johnson, Dick Kuhl, Carl Mertens,Duke Milford,Doug Robbins, Key Ryan, Bill Stolmack

**Phase III**
Kuniar Mukerjee, Project Director
Jess Maya, Harry Birks, Jose Campos Myron Cinque, John Gilday, Chuck Harness, Ben Lara, Bob Lasher, Bill Messier, Charlie Riddle, Dave Shifflet

**Client Personnel:**

**Phases I & II**T. Ariwibowo, President Director
H. Gumuruh S., S. Hutapea, Jaxnas S., Kadarisman, Kirman, Moesdijono, J. L. Rombe, Sudarmadi, Sunarno, Sutoro, Waspodo, D. Widodo

**Phase III**
K. Batubara, President Director
A. Juzar, Sawardjiman, F. Syahdi, H.Yatim

*(Editor's Note:* At the initiation of the project, the client requested immediate assistance because of the urgency of reassessing the project and possibly renegotiation. As promised in our proposal, an interim team was assembled to start the work while we mobilized staff from worldwide locations to take up residence in Indonesia. The interim staff included Sam Ruvkun as interim project manager, Jack Hughes as resident manager, assisted by temporary team of Harry Bernat, Dick Kuhl, Hugo Daems, and Ed Lowell with his estimating staff. The interim staff was in place for the first few months of the project.)

## *Stanford Linear Accelerator by Bill Sproule*

### Project Background

In the mid-Seventies the high-energy physics community was continuing its search for the fundamental particles believed to be the indivisible constituents of matter. They believed that the protons and neutrons comprising atomic nuclei were formed by a new set of particles called quarks. A team at the Stanford Linear Accelerator Center (SLAC) and an independent team at Brookhaven National Laboratory had almost simultaneously discovered the J / psi particle, a massive quark / anti-quark pair. The discovery at SLAC was made on a low energy (1.0 to 2.0 GeV) positron-electron collider machine called SPEAR.

Since it was believed that as many as six different quarks would be found if higher energy collisions could be produced, physicists at SLAC and Lawrence Berkeley Laboratory (LBL) were able to obtain funding from the U.S. Department of Energy (DOE) to design and build a new positron-electron collider to take advantage of SLAC'S 22 GeV linear accelerator as a direct source of high energy positrons and electrons. Each of these particles would be injected into a storage ring consisting of a continuous vacuum chamber and circulated as counter-rotating beams that would be directed by a series of special magnets that would make the two beams collide at six separate points around the perimeter of the storage ring. At each of these points, massive particle detectors surrounding the collision points would be used to capture the events on electronic media for further study and evaluation.

### Project Summary

Kaiser Engineers, in joint venture with PBQ&D, Inc., performed the design and construction management for the site development, utilities, buildings, and underground structures housing the

Positron-Electron Project (PEP) located at the Stanford Linear Accelerator Center in California. The project included the design and construction of (1) a road network connecting six experiment halls located at the six beam collision points around the beam storage ring; (2) five experiment halls and one experiment chamber; (3) cut-and-cover and mined tunnels housing the beam storage ring and the beam injectors; (4) a 13.2-kv primary and 480-v secondary electrical distribution system; and (5) a low-conductivity water treatment and distribution system used for cooling magnets and power supplies. Preliminary design started in October, 1976, and fast-track construction started in March, 1977. The project was completed in December, 1979.

## Project Description

As with all DOE-funded projects, PEP started life as a conceptual design prepared by the project advocates, SLAC and LBL. One of the first tasks performed by the joint venture of KE and PBQ&D, hereafter called PBKE, was preparation of a preliminary cost estimate for the conventional facilities that housed and served the PEP "machine," as it was called by the physicists responsible for its design, construction, and operation. The machine was in fact an extension of the existing 2-mile long Stanford Linear Accelerator that is situated at the northwestern edge of the Stanford campus in San Mateo County, California. The SLAC accelerator is housed in a concrete tunnel buried some 30 feet below ground level. One of the longest buildings in the world covers the entire length of the accelerator. It contains the klystron gallery that provides the rf power that accelerates electrons and positrons to the 22 GeV energy level used in the PEP machine.

The accelerator tunnel continues for several hundred feet beyond the end of the accelerator and splits into several branches that can deliver the particle beam into stationary targets where collisions are recorded by sophisticated detectors. The PEP beam housing connects to both sides of the accelerator tunnel at a point just beyond the klystron gallery, 30 feet below existing grades.

The north and south PEP injection tunnels diverge outward and downward from the accelerator for a distance of about 600 feet where they join the PEP storage ring tunnel at a level 26 feet below the accelerator tunnel floor. The storage ring tunnel has a circumference of 7,216 feet and a horseshoe cross-section some 11 feet wide and 10 feet high. About two-thirds of the tunnel length was designed for cut-and-cover construction, and the other third was designed as a mined tunnel with a shotcrete liner. Economics dictated the maximum depth of cut and cover construction but other factors such as existing buildings including the Stanford Computer Center located above the tunnel also eliminated the choice of this method.

## Experiment Halls

At six equally spaced points around the ring, experiment halls were designed to house the massive particle detectors that different research groups had designed to capture and record the particles created when the two counter-rotating beams of electrons and positrons collide and annihilate one another at a combined energy level of 44 billion electron volts (440ev). Four of these 65 foot by 130-foot halls were built in open cut and one smaller one was housed in a mined chamber some 90 feet below ground level. One hall was designed and constructed by the SLAC / LBL team on a building pad designed by PBKE. The above ground halls consisted of pre-cast and cast-in-place concrete boxes with one side open and connected to a standard steel frame building fitted with a large roll-up door and insulated panel siding.

Each of the four halls contained a 50-ton radio-controlled bridge crane used to assemble the heavy particle detectors and to stack a wall of interlocking concrete radiation shielding blocks some 20 feet high and 3 feet thick. As the stacked blocks could not be placed up to the roof level in the hall, PBKE designed a 1-foot thick by 66 feet wide by 18 feet high monolithic concrete wall that was cast on the floor of the hall, rotated to a vertical position, and jacked 20 feet up into the air where it was connected to steel-wheel assemblies that ride on corbel-mounted rails on each side of the hall. The bridge crane can be fastened to this elevated shielding curtain to move it out of the way when the crane is being used for detector assembly.

The roofs of the above ground colliding beam interaction chambers at the experiment halls also served as a radiation shield. They were constructed of 3.25-foot deep tee-shaped precast post-tensioned concrete beams each some 70 feet long. The beams were inverted and lifted into place on the upper edge of the walls forming the interaction chamber. After all the beams were in place, the voids between the beams were filled with poured-in-place concrete to produce a solid 3.25-foot thick diaphragm. EPDM membrane roofing was applied to this roof and to the adjoining insulated steel deck that covered the steel frame building connected to the interaction chamber. The floor of the above ground experiment halls was an 18-inch thick monolithic concrete slab on grade that had a series of 12-inch wide, 1-inch thick steel plates embedded at the surface. These were used as tracks to support the steel rollers that carried particle detectors weighing up to 2,000 tons from the assembly area of the experiment hall to the shielding chamber surrounding the interaction area.

### Support Buildings

Four support buildings of various size were also constructed for the project. At region 8 of the storage ring, an operations control center and a klystron gallery were combined in one support building of standard steel frame construction. This building and the other three support buildings were situated directly above the storage ring. Two other klystron gallery buildings were constructed at regions 4 and 12 of the ring. (Region numbers correlate with the face of a clock with region 12 located at the top of the ring in plan.) The support building at region 10 housed power supplies and control hardware. Due to the topography of the site, it was some 90 feet above the floor of the storage ring tunnel to which it was connected by a 4-feet-diameter shaft.

### Tunnels

Two types of tunnel design were employed for the project: a cut-and-cover concrete box structure for some 4,700 lineal feet of the beam housing, and a mined shotcrete lined horseshoe-shaped tunnel for the remaining 2,000 feet of beam housing. These two designs were also used for the 600-foot long injection tunnels that connected the PEP storage ring to the existing 2-mile long linear accelerator. The south injection tunnel was a cut-and-cover design and the north a mined tunnel design. Except for the 18 feet wide by 16 feet high mined tunnel forming the region 10 interaction area, all mined tunnels were 11 feet 5 inches wide and 9 feet 7 inches high. Cut-and-cover tunnels were of the same width but only 9 feet 5 inches high except at short regions adjacent to the interaction areas where the dimensions increased to accommodate rf power cavities and proton galleries. The rf power cavities were used to maintain stored beam energy levels that would otherwise decay with time.

Mined tunnels were unsupported during the excavation cycle. After the Alpine Miner “roadheader” excavator had advanced some 50 feet in a typical 24-hour work day, it would shut down while a shotcrete concrete liner a few inches thick was sprayed on the exposed sandstone roof and walls of the tunnel. Tunnel muck and shotcrete rebound material were transported from the heading to stockpiles located near the tunnel portals by diesel-powered haul units. Steel ribs were used for roof support at the wide tunnel in region 10, at the junction of the north injection tunnel and the storage ring tunnel, and at the tunnel portals where overburden stresses exceeded the support capabilities of the shotcrete liner. Cut-and-cover tunnels were backfilled with excavation spoils to a depth of 16 feet to provide the necessary radiation shielding levels.

### Other Project Elements

The remainder of the project elements included a 13.4-kv primary power distribution system connected to the 75-Mva substation serving the entire SLAC complex, a 480-v secondary distribution system including 6 substations, a buried cooling water distribution system that connected an existing cooling tower complex to 5 mechanical equipment pads that included heat exchangers, pumps, expansion tanks, and ion exchange canisters used to produce low-conductivity water (low) for cooling tile beam power supplies and guidance magnets, a low distribution system that included supply and return lines in the tunnels and experiment halls, a hydrostatic piping system used for precise beam line leveling measurements, and sprinkler, cable tray, and remote controlled smoke purge systems for the buildings and tunnels. Paved roads connect the experiment halls to one another, and all areas of the site disturbed by construction were landscaped to control erosion and maintain the park-like setting of SLAC.

### Project Challenges

The most challenging aspect of the PEP project was completing the design and construction of the connection to the existing linear accelerator within 9 months of receiving notice to proceed with preliminary design in October, 1976. Geotechnical investigations started immediately after receipt of the notice. Preliminary and final designs for the complicated connection were completed in only three months, and a competitively bid construction package was awarded in March, 1977, to produce this underground junction between the north and south PEP injection tunnels and the existing accelerator tunnel. The accelerator could be shut down for only three months to make the connection, and the above and below ground level structures located above the accelerator tunnel roof had to be kept in operation until the shutdown. Thus, only a limited amount of preparatory work could be accomplished before shutdown.

An existing road leading to the south side of the 2-mile long SLAC klystron building, the main SLAC substation, and the central control room crossed the accelerator just above the western limit of the junction point. This road had to be kept open during the tie-in to the accelerator. On the east side of this road a 16-foot-high retaining wall separated the road from the shielding embankment over the accelerator switchyard that was just downstream of the connection point. A pole-mounted cable tray system ran along the south toe of this embankment between a power supply building and the main SLAC control room further to the east. This power supply building was directly over the south injection tunnel. A concrete encased electrical duct bank serving the entire SLAC site crossed the accelerator just below the existing road surface at the PEP connection point, and another concrete duct bank entered the accelerator tunnel near the tunnel roof just above the south injection tunnel. The only work that could be performed before accelerator shutdown included demolition of the retaining wall, excavation of the 16-foot-high embankment west of the power supply building, and installation of several drilled piers to support steel beams from which the existing duct banks could be suspended.

## Excavation Begins

The accelerator operations were suspended in July, 1977, at which time excavation work was started to expose the roof and walls of the accelerator tunnel. In order to support the existing road, the contractor designed a soldier pile and timber whaler retaining wall that extended from the road surface to the bottom of the accelerator tunnel on the north and south sides of the tunnel and to the tunnel roof line above the tunnel. The other three sides of this excavation were cut at side slopes of about 1/2 to 1 inch undisturbed sandstone and about 1 to 1 inch existing embankments. When the base of existing structures was reached, steel beams were laid over the two duct banks and under the power supply building. Cables were wrapped around the beams, building foundations, and duct banks so that the excavation could continue down to tunnel base levels.

Once tunnel base levels were reached, rectangular openings were saw-cut through the existing tunnel walls, heavy steel portal frames were placed in the two openings to support the existing roof, and epoxy grouted dowels were drilled into the walls of the tunnel to bond the short north injection tunnel stub and the longer south injection tunnel stub to the linear accelerator. After pouring the floor slab, roof, and walls of these tunnel stubs, timber barricades were installed at the ends of the stubs so that backfilling of the excavation could proceed while the last major activity in the tunnel stubs was completed.

## Radiation Shielding

That activity involved placing 1,600 sacks of sand in each of the injection tunnel stubs to provide radiation shielding when another contractor would complete the injection tunnels while the SLAC accelerator was in operation.

## Final Design

Final design of the remaining conventional facilities was completed, and contracts for construction of the remaining tunnels, drainage structures, embankments, roads, and the reinforced concrete shells of the experiment halls were let while this first construction package was completed in just over 6 months. Design and construction of the six support buildings and the steel frame portion of the experiment halls followed completion of the linac junction and main tunnel/hall, roads, and utility contracts.

## In Summary

In summary, preliminary design started in October, 1976, and construction was completed on schedule in December, 1979, at cost of $28.3 million for construction and $4.5 million for design and construction management. Total cost of the project, including owner-furnished materials and services was $78.0 million.

## Lessons Learned

Underground construction is fraught with the potential for accidents and litigation since only a limited amount of geotechnical data can be collected during the design stages of the project, and most owners are unable or unwilling to award cost-type construction contracts for underground work. In such an environment, contractors must rely on changed conditions clauses of their contracts to recover added costs incurred during tunnel construction, the most risky of underground activities. Although litigation was avoided on the PEP project, a substantial monetary claim was submitted by the Fred J. Early Construction Company, the contractor that constructed the mined and cut and cover tunnels at PEP. The basis for their claim was unexpected hard rock tunneling conditions encountered over short lengths of the 2,500 feet of mined tunnel work in their contract.

The bulk of the mined PEP tunnels was cut in relatively soft sandstone and stiff sandy clay. Given the uncertainty of conditions to be expected over nearly 1/2 mile of mined tunnel construction, the PBKE project director, Paul Gilbert, the project manager, Elwyn King, the tunnel engineer, Birger Schmidt, and Bill Sproule of KE agreed that PBKE should provide 24-hour-a-day tunnel inspection coverage for safety, quality control, and record keeping purposes. Early's tunnel claim was based on lost productivity as a result of encountering several occurrences of highly cemented sandstone that slowed down its tunneling operations. However, Early was unable to fully document the extent of delays encountered since its records were quite fragmented. On the other hand, the PBKE tunnel inspectors' records were so complete that it was able to show that Early's tunnel excavation productivity as measured by the average tunnel heading advance rate when digging in the anticipated soil conditions was no different than the rates achieved when it allegedly was slowed by hard digging conditions. As a result of PBKE's tunnel records and daily activity logs, the Early tunnel claim was settled at a small fraction of its initial value.

### People Who Did It

The PEP project director for SLAC/LBL was John Rees; the conventional facilities manager was Tom Eliott; and the business manager was Eugene Rickansrud. The SLAC laboratory director, Wolfgang Panofsky, was an active participant during project construction, particularly when schedule slippage was evident.

Tom Eliott is fondly remembered for his generous contributions of excellent wine served during many working lunches.

Key PBQ&D personnel have already been mentioned, and the KE team included Phil Bush and Herb Thomas, successive members of the project directorate; Gerry Abraham, construction division manager for government projects; Bill Sproule, resident engineer; John McGinnis, procurement; Fred King, scheduling; Harvey Ceaser, office engineer; Howell Wood and Bob Huttlinger, construction engineers; and Amar Master, cost control.

## *Remembrances: LNG, Australia by Al Wallach*

In early 1981 Kaiser Engineers was invited to join a consortium of Kellog Engineering Company of Houston, Texas, and Japan Gas of Tokyo. This consortium had been formed to propose on a major liquified natural gas project to be built in Western Australia.

Kellog and Japan Gas (a large Japanese engineering company) had just completed a similar project in the Far East. That project had been quite a bit smaller than the one projected for Western Australia. They invited Kaiser Engineers to join them because of our experience in Western Australia and our active engineering office in Perth, the major Western Australia City. We had completed many projects for Hamersley Iron Proprietory Ltd, Australia at Dampier just a few miles from Karatha the proposed location of the new plant.

### Proposed Project

The proposed project consisted of a plant built to receive gas from offshore wells and to liquify the gas for shipment to Japan. Very large and powerful compressors would be utilized, and prodigious amounts of seawater would be needed. Major by-products would be produced and shipped to markets worldwide.

Infrastructure, including a new port for loading of ships of 100,000 tons capacity, maintenance and repair shops, and a large number of 1 million-gallon capacity tanks were to be built. Also required would be a power plant, a desalizination plant, and a town for employees. Incidentally, the million-gallon tanks for the storage of liquified gas would be double walled, in effect, huge thermos bottles. The project would cost at least $2 to $3 billion and require a number of years to complete.

### Proposal Preparation

It was agreed to approach Royal Dutch Shell, who was presenting the consortium that had been formed to build and operate the plant. The consortium consisted of Australian, Dutch, English and Japanese corporations. The approach was made and our group was invited to prepare and submit our qualifications to design the plant, procure the necessary equipment and building materials, and act as construction managers. We were informed that we were competing with a large number of major companies and consortiums throughout the world.

Granville Holman, vice president, Autralasia, represented Kaiser Engineers in the consortium and borrowed me, Al Wallach, to work with his assistants, Wes Driver and John MacKenzie of our Sydney office, in the preparation of our portion of the qualification brochure. After the initial work, we moved down to Houston, Kellog's home office, to continue the work and help coordinate the qualification of the consortium. Granny Holman headed our effort, and a very extensive and complete document was prepared. This was submitted to Shell Development Company, the subsidiary designated by Royal Dutch Shell, in the Hague, Holland.

## Oral Presentation

After a number of weeks our consortium was notified that it had been selected, with a number of other groups, to give a presentation to the partners in the Northwest Shelf consortium in the Hague. A large number of topics was listed to be included in the presentation.

Holman and the management of Kellog and Japan Gas agreed on the best members of the three companies to verbally present the various qualifications. Kaiser Australia construction and engineering personnel traveled to Houston, as did engineering managers from Tokyo, and each group's members prepared their talks and visual aides. Wes Driver and I provided assistance as required.

The participants wrote and rewrote, practiced their verbal presentation, and then participated in "dry runs" of the total program. This was done in a large conference room with all the participants as the audience. In addition, the vice president of sales for Kellog and I acted as "Devil's Advocates" asking detailed questions in great numbers. In fact, we at times interrupted the speakers and asked questions not concerned with the immediate subject at hand. We had all encountered that problem with prospective clients in the past.

We were impressed by the presentation of Kaiser Engineers' Oscar Hanson and his masterful use of charts and other visual aids. His work covered scheduling, estimating, cost accounting and cost and schedule control. His examples were all of those, which would undoubtedly be encountered during the coming project. It was reported after the Hague visit that many meaningful questions were asked by the members of the audience and answered by Oscar to the satisfaction of the questioners.

## Does Anyone Have Any Money?

A period of weeks passed, and I was back at work in Oakland. On a Saturday evening I was relaxed at home, my wife was finishing getting dressed while we waited for our dinner guests. The guests were a doctor, his wife, and son and daughter-in-law. I had never met these people due to my frequent trips away from home.

The phone rang, and I answered to find Jim McCloud, president of Kaiser Engineers, on the line. He told me that Shell Development had requested members of our consortium meet with them on the coming Monday. Jim had been trying to reach Granny, who had left Bangkok for some other point in the Far East, and could not be reached. Kellog Vice Presidents were ready to leave Houston, and Japan Gas executives had already left Tokyo en route to Antwerp.

Jim stated, "That means, Al, that either you or I have to go to the Hague, and you are the most knowledgeable about our proposal." I got the message but stated I couldn't see how I could get there in time. Jim said that there was a flight leaving San Francisco at 6:30 a.m. the next morning for Houston, and that Kellog had a ticket for us on a direct flight to Antwerp. I could make the connection with good luck.

I realized that I did not have any money and was discussing the matter with Jim when the doorbell rang, and I asked Jim to wait while I answered the door. I greeted our guests, introduced myself, and asked, "Does anyone have any money?" Luckily, the doctor had something over a 100 dollars he could let me have. I asked them to be seated and went back to the phone to tell Jim I would be going.

As I returned to the living room, my wife appeared, and I told her I was leaving the house at 5:30 the next morning and would require any cash she had.

### Short Listed

All went as planned, and a rather bedraggled group of us went to their office where we met with the Shell Development Co. executives, who told us they were to manage the Northwest Shelf project for their consortium. They told us that we and one other group had been selected to submit a formal proposal for the project execution. The proposal would include all financial terms, fees, salary lists, and a preliminary estimate of the cost of our services. They told us that they had already shipped a large crate containing a preliminary estimate of the cost of the project as well as their suggested terms and conditions, a sample contract, and eighteen four-inch thick volumes of specifications and preliminary drawings for the project.

We thanked them, had a nice lunch in their dining room, and then dragged ourselves happy but exhausted to a hotel for a night's sleep before leaving for home.

### Proposal Preparation

Each of the participants in our consortium prepared estimates of our portion of the work, salary structures, names of senior personnel proposed for the project, and answers to the questions from the clients. Meetings were held in Houston for a number of weeks to consolidate the information, smooth overlaps, and to further divide the work so that each partner would perform roughly one-third of its dollar value. We worked many hours and, in fact, on one of the Sundays we interrupted our work to watch the Superbowl game and eat hot dogs, potato chips, and drink beer.

### We Were Selected

The proposal was submitted by the required date, and subsequently we were notified of our selection pursuant to agreement of contract terms. Granny Holman proved to be an excellent negotiator and headed the group that signed the contract in Perth, Australia, after a hectic few weeks.

### Very Successful Project

The project was started, and before its conclusion, its capacity was increased by 50 percent, and the additional work awarded to us. This turned out to be one of the most successful and profitable projects for each member of our consortium.

## *Concerns Over the Chernobyl Accident by Alex Lindsay*

At 1:23 in the morning on April 26, 1986, a severe non-nuclear explosion destroyed the Chernobyl Unit 4 reactor in the USSR, which resulted in a very major release of radioactivity to the atmosphere. At the time of this accident, Alex Lindsay was president of Kaiser Engineers Hanford, one of DOE's Hanford site contractors. The major questions that we at Hanford had were what was the cause of the accident and what concerns might there be for Hanford's N reactor, the only U.S. reactor that is somewhat similar to the Chernobyl reactor. Both the N Reactor and the Chernobyl reactor are dual-purpose power and plutonium production reactors, fueled with slightly enriched uranium, graphite moderated and light-water-cooled. Reactor specialists from Hanford were part of the international team that investigated the accident.

The results of the accident investigations showed definitely that one particular design characteristic led directly to this accident: the Chernobyl reactor had a *positive* void coefficient of reactivity, which causes intrinsic instability in operation. What this means is that when this type of reactor overheats, and steam forms in the cooling water, the reactivity of the reactor *increases,* the power level increases, and the reactor tends to overheat even more. In the U.S. this is considered a serious design flaw, and thus the N reactor as well as all other U.S. light-water power reactors have *negative* void coefficients of reactivity.

The Chernobyl accident occurred during a poorly planned and conducted experiment in the middle of the night. They had reduced the reactor's power to a very low level, which makes it hard to control. They bypassed or disengaged emergency safety systems such as the emergency core cooling system. While attempting to control the reactor and conduct the experiment, the operators got the reactor in a situation of a rising power level which produced steam in the cooling water, and the ramp-up of reactor power was autocatalytic—increasing steam output increased power sharply and a runaway situation resulted. The reactor may have exceeded its thermal design output level by a factor of 20 - 30 times for a short time. A *thermal* explosion resulted which destroyed the reactor and a large part of the building. This explosion, and the continued burning of the graphite, served to propel fission products into the atmosphere for an extended period of time.

There were apparently no lessons to be learned from the Chernobyl accident that should cause any concerns for the N Reactor, or any other U.S. power reactor.

## *Space Shuttle Assembly Building by Dick Hulseman*

### Building Description

The SAB (Shuttle Assembly Building) is probably one of the most unique structures in the world. It is a high-bay structural steel, metal-sided structure approximately 165 feet wide by 170 feet long by 250 feet high and weighs in excess of 9.5 million pounds. It is mounted on a self-contained computer-controlled drive system capable of moving the facility on two sets of double tracks approximately 350 feet. One end of the building is completely open and mates with another building to form a weatherproof enclosure around the launch mount. The other end contains the world's largest vertical lift door that is 130 feet wide and 180 feet high. This door contains six vertical lift panels to allow the passage of payload change-out room to transport the cargo to the shuttle in the launch position. A two-drum 125/15-ton bridge crane is mounted at the 200-foot level of the building. This crane is used to stack the two solid rocket boosters, the external tank, and the orbiter on the launch mount. The combination of size and mobility make the SAB the largest volume moveable building in the world.

*(Editors Note:* A photograph of the SAB is included in Chapter 12, "Space, Defense and Postal Projects.")

The Shuttle Assembly Building was the last major structure required at Vandenberg Space Launch Complex 6 (SLC-6) to support the planned Air Force Shuttle Program. Its function is to shelter the shuttle components at the launch mount and assist in their assembly. This building was a late addition to the site plan and had to be constructed on a very compressed schedule in order to meet the requirements of the scheduled first launch. Therefore, to save valuable time, the Corps of Engineers (COE) established the contract as cost-plus-fixed-fee (CPFF). With the CPFF contract, the COE was able to select a contractor prior to the completion of the design.

### Kaiser Steel in Joint Venture

Upon review of the RFP, it was noted that there was a requirement for a joint venture to fulfill the fabrication and erection of the structural steel. After talking to several joint-venture candidates, Kaiser Steel Corporation was selected. Kaiser Steel was the ideal candidate for the following reasons:

They had just completed a contract involving the erection of the structural steel for the Access Tower at SLC—6 VAFB and had established a good reputation and relationship with the Corps of Engineers.

Kaiser Steel had the ability to engineer and manufacture the complex fabrications required for the drive trucks, tie-downs, and hydraulic systems at their facility in Napa, California, and had the excess fabrication capacity at the Fontana plant to support the critical steel fabrication schedule.

They had knowledge of the labor market in the Vandenberg area from previous work at the site, and they had experienced field supervision available to erect the steel.

### Our Joint Venture Is Selected

On October 28, 1982, a site visit was conducted by the Corps of Engineers. A proposal was prepared and submitted on December 13, 1982. On December 20, 1982, the joint venture made its oral presentation to the Corps' selection board, and on December 29, 1982, the joint venture was selected for contract negotiation. Negotiations, based upon 80 percent complete design drawings, began on January 19, 1983, and were concluded on January 27, 1983, when the contract in the amount of $32,669,000 was signed.

### Construction Methods

Several unique construction methods were implemented to comply with the requirements of the contract. The contract required that we use off-site assembly of the building where possible to reduce the congestion at the construction site. To comply with this requirement, we developed a 5-acre assembly area one-half mile from the launch pad. In this area we assembled 41 modules that made up the main structure of the building. These modules weighed approximately 40 tons and were completely finished, including structural and miscellaneous steel, all electrical including conduit runs with boxes. They were also finish painted with the epoxy coating required. The assembled modules were transported to the site by trailer and then installed in the structure. The largest module was the main roof girder and weighed 74 tons.

KSC provided several items to the joint venture. Probably the most important was the fabrication of the structural steel in their Fontana plant. This was extremely handy since partial assembly of the steel could be done in the plant, and then it could be trucked to the site. Also, KSC provided all direct hire labor at the site for steel erection and the installation of the hydraulic propulsion system for the SAB. KSC had experience at the site with local union labor since they had previously performed work for other contractors. They were well aquainted with the quality of the craftsmen available and did not have to weed through them to find qualified workers. Approximately 150 craftsmen were hired for the work and KSC provided five superintendents and engineers at the site.

KE provided the remainder of the personnel for the joint venture, including the overall project management for the project. Accounting, procurement, subcontract management, and field inspection and engineering were all handled in the field with a staff of twenty-five at the site.

### Finished Ahead of Schedule

This project was extremely successful and finished ahead of schedule at a final cost of $33,894,000. Based upon this success, the Corps of Engineers awarded KE an additional $11 million worth of work. This included much of the unfinished work on the facilities that was required at the site to support the first shuttle launch. With this extra work, it was necessary to provide 20 additional staff members at the site and 100 additional craftsmen.

**Management of the Project**

Don Sahlberg, Vice President, Field Operations
Don Barrie, Vice President, General Construction to July 1984
Dick Hulseman, Division Construction Manager after July 1984

**Jobsite Project Organization**

Dick Hulseman, Project Manager to July 1984
George Morschauser, Project Manager after July 1984
George Morschauser, Construction Engineer to July 1984
Robert Franklin, Construction Engineer after July 1984
Steve Miller, Procurement Manager
Everett Spencer, Accounting Manager
Dick Gisiner, Construction Coordinator
Al Orne, General Superintendent (Launch Mount Optional Work)

## *Montana Talc Plant by Omar Finsand*

The Montana Talc plant is located 15 miles south of Three Forks, Montana, at old Sappington Junction on the Great Northern Railroad. This location provides a suitable site for the milling, processing and shipment of product. The ore body is 53 miles south of the mill near Ennis, Montana.

### KE Awarded the Contract

In 1984, Kaiser Engineers entered into a contract with NICOR Minerals Ventures to provide engineering, design, procurement, and construction management for the planned 100,000-ton plant. Initial production was 20,000 tons per year and to increase with demand requirements. Engineering and design was accomplished in Kaiser Engineers' Denver office, while procurement and construction management were provided by Oakland. Engineering began late in 1984 followed by construction in July, 1985, and project completion in June, 1986.

The mill facilities and mine were both green-field construction requiring support services such as roads, drainage, power, sewage handling water supply, and telephones. Montana Power installed a 9-mile gas line to connect the plant with their trunk line near Three Forks. Electric power was provided by substations connected to nearby existing power. Wells provided water for fire and potable use.

### Fine Talc

The plant is designed to transform raw ore into finished product to be loaded and shipped by truck and rail to market. The finished product after grinding is very fine—about ten times finer than talcum powder. It feels smooth, almost liquid, when rubbed between the fingers. The 94-percent purity of the ore is also a plus for this plant, requiring little processing to bring it up to 99-percent purity.

Product is shipped mainly to industrial customers for the manufacture of paints, plastics, and paper products. The paper and plastic industries are high growth. Therefore, the demand for talc is expected to increase. Raw ore is about 100 pounds per cubic foot when it arrives at the mill, and after grinding it bulks to about 10 pounds per cubic foot. This makes it expensive to ship. Therefore, much of the talc is pressed into pellets before shipping. This multi-million-ton ore body, one of the largest in the United States, is expected to last well into the 21st century.

### Expedited Construction

Early in the project, following Kaiser Engineers' notice to proceed with design, the owner became eager to build the plant as soon as possible. To comply with this desire, construction was bid and awarded on a unit-price basis using conceptual drawings and estimated quantities. Final quantities and progress payments were established as design and construction progressed. This approach required considerable details in various disciplines.

Cold weather in November of 1985 resulted in several lost days of steel erection. Following this period, milder conditions allowed good construction progress as the contractors geared up for winter work. An overtime program supported by the owner also improved progress. Engineered Equipment began arriving at the job in January, 1986, and by April 15, plant start-up was under way. The project was completed and in production by early June, 1986.

### Contractors

Sletten Construction Company of Great Falls, Montana, performed the major construction of the plant. Vogl Brothers of Townsend, Montana, built the office and laboratory facilities.

Other support organizations included:

Montana Power - sub stations and natural gas supply
Mountain Bell - telephone lines and services
Burlington Northern - track work
Chamberlain Pump - wells
Fairbanks Morris - truck scales
Washington Construction - mine development

Key personnel on this project for Kaiser Engineers were:

| | |
|---|---|
| Division Manager | Sherrill McDonald |
| Project Manager | Robert Shaw |
| Construction Manager | Omar Finsand |
| Purchasing Agent | Peter Flemetis |
| **Nicor Minerals Ventures Personnel** | |
| Vice President Nicor | Frank Pereira |
| Vice President Mining | Michael Richings |
| Project Manager | Jock McGregor |
| **Contractors** | |
| Vice President Sletten | Cliff Blankenship |
| Superintendent Sletten | Ronald Spragg |
| President Vogl Bros. | Ronald Vogl |

On June 22, 1986, the owner celebrated the grand opening of the $8-million Sappington Junction plant. Special guests included Montana Governor Ted Schwinden. The grand opening capped, for the owner, more than three years of planning, marketing, and engineering. The plant is jointly owned by NICOR Mineral and Meidian Minerals, a Burlington Northern subsidiary.

## *Some Pithy Remarks by Jim Thompson*

Jim Thompson was a prolific writer in his own right. He published articles in technical journals as well as authoring numerous technical reports within Kaiser Engineers. He is, of course, the guiding light who first proposed the preparation of this book.

He was also well known for his sense of humor. One piece he wrote for *Skillings Review* (a technical mining journal) carried the title of "The Visitation Engineer." This was his own invention of a title for an engineer who did little productive work but did manage to visit a project now and then.

To give a flavor of Thompson's humor, we quote below from a memo written on October 3, 1995, when he was discussing his drafting and editing an introduction to the minerals section for the proposed book.

"Anyone can find reason to change this by addition or subtraction, or to differ over details. The PR types can add snap, crackle, and pop. The 'novelist' can add romance."

"It is my belief that we are writing history first, and at times history is going to be dull, but it need not be a bore."

"This write-up may start to sound like a textbook on metallurgy. There is a point where we have to stop talking down to the reader and assume that he has some knowledge about the subject matter."

## *A Short Interview with Lou Oppenheim*

In 1995, there was an editorial board meeting to discuss progress being made on publication of this book. Lou Oppenheim was in attendance and made several comments about the history and organization of the company. He said that he felt that one of the reasons for the success of the company was the feeling of "family" that was engendered by the founder and by KE's management.

In discussing the organization, he felt that an important aspect of management's role was the frequent job visits by the chief executives. This gave a sense of discipline, recognition, and importance to the field personnel. And it acted as a basis for checking actual field progress and to avoid potential problems. Further, it was the best way for management to assess how projects were going and for management to interface with the client.

## *An Architect's Story Regina 'Becky' Salomon*

In 1959, I immigrated with my husband and children to the United States. I had worked in the architectural profession for 15 years abroad and had been trained in the metric system. We stayed over one year in New York City. During that year, I attended Pratt Institute evening school in Brooklyn to learn to work in inches and feet instead of the metric system and to learn the terminology for the American building profession.

In 1960, we moved to Oakland, California. After getting settled, I started looking for a job and applied to a number of architectural offices in the East Bay and San Francisco. I was told outright, "We do not hire women," or more politely, "We do not have a position open." I was very disappointed. At a social gathering, I met Mrs. George (Judy) Havas. During a casual conversation, she mentioned that Kaiser Engineers had an architectural department and referred me to Morry Wortman, chief architect, at Kaiser Engineers.

Morry interviewed me and on January 4, 1961, I received a letter confirming his verbal offer of employment. I accepted the offer and worked in Kaiser's architectural department until my retirement on April 30, 1982. I was very pleased, and am still grateful, that Kaiser Engineers gave me the opportunity to work in my profession at a time when it was almost impossible for women to be employed in this field. I received the same benefits and salary as men in the same position and was always treated as an equal. I am also proud to have worked on the following projects during my 21 years at Kaiser Engineers:

**Projects**
Kaiser Foundation Hospital Garage
San Francisco
Mission Control Center NASA,
Interior Design of 3 Buildings
Volta Aluminum Co., Ghana
Office Building, Lab, Support Buildings
**Kaiser Foundation Hospitals**
Oakland, Broadway
Sacramento
Santa Clara
Bellflower
West Los Angeles
**Kaiser Medical Facilities**
Oakland
Pittsburg
Walnut Creek

**Industrial Plants**
Cal Portland Cement
Martin Marietta Cement Company
Oklahoma Cement
Kandahar Cement, Afghanistan
Hong Kong
New Jersey Zinc, Cordonsville

**General Arrangement Drawings of Unbuilt Projects**
Sheraton Hotels, various
Kaiparovitz, Coal Gasification, Utah

Chapter 18

# Antecedents

## Overview

Kaiser Engineers' forebears gave it a good start, indoctrinating its staff with the can-do spirit of the Kaiser organization. KE was organized by and staffed with people who grew up working on Kaiser projects and learned how to operate the Kaiser way. The Kaiser way was to do it well, do it fast, and never say it can't be done.

Henry Kaiser was a man of mottoes and one-liners. They were shorthand methods of conveying his philosophy. He said that he hoped to each day of his life accomplish one thing. Actually, when he was observed closely, he accomplished many things every day. Henry Kaiser said, "Don't tell me how not to do it. Tell me how to do it."

The foundation for KE was the construction work handled by the Kaiser organization beginning in the mid-1930s. The inner circle of construction engineers who worked directly with Mr. Kaiser established working procedures and disciplines that showed the way for Kaiser Engineers. Staffing came from dam jobs, the shipyards, and other Kaiser operations.

## The Boss

Henry Kaiser was the boss. His life spanned a full 85 years from 1882 to 1967. Defining him briefly is a difficult task. He accomplished so much during his lifetime because he worked all the time. Work was his hobby. He enjoyed working and eschewed vacations and holidays. Actually, he worked 15-hour days, seven days a week. His working life covered several lifetimes as compared to any ordinary individual.

Books have been written about him. No one seemed to be able to describe him briefly; the many ventures that he was associated with better describe him. To try to encapsulate his life, we resort to the biography contained in *Who's Who* (even with a few inaccuracies) as follows:

> **Kaiser, Henry J.** in full HENRY JOHN KAISER (b. May 9, 1882, Sprout Brook, NY, US-d. Aug 24, 1967. Honolulu, Hawaii). American industrialist and founder of more than 100 companies, including Kaiser Aluminum, Kaiser Steel, and Kaiser Cement and Gypsum.
>
> In 1913, Kaiser was working for a gravel and cement dealer in Washington when one of his clients, a Canadian road-building company, went out of business. He got a loan to take over the company's project and finished it with a profit. From 1914 to 1930, he built California dams, Mississippi River levees, and highways, including 200 miles of road and 500 bridges in Cuba, while establishing sand and gravel plants to supply his own materials. Between 1931 and 1945, he helped organize combinations of construction companies to build the Hoover, Bonneville, and Coulee dams, as well as other large projects. To supply the more than 6,000,000 barrels of cement needed for the Shasta Dam, he erected a cement plant in Permanente, California, and a 9-mile conveyor belt across a mountain to the dam site in 1939.
>
> During World War II, he ran seven shipyards that used assembly-line production to build ships in as little as 4 1/2 days. By the end of the war, his yards had produced 1,490 ships for the U.S. Maritime Commission. In 1941-42, he built the only integrated steel mill on the West Coast of the United States to make steel for his shipyards. He established Kaiser Gypsum in 1944. He bought up aluminum plants from Alcoa to supply his Kaiser-Frazer automobile business; but, because of an industry slump, Kaiser stopped making cars in 1953. By then Kaiser Aluminum and Chemical Corporation had become profitable. From 1954 to 1960, he directed construction of the Hawaiian Village Resort Centre, which was sold in 1961 to the Hilton chain for more than $21,000,000.
>
> In 1942, Kaiser established the first health maintenance organization for his shipyard employees. A model for later federal programs, the Kaiser Foundation went on to build 19 hospitals by the time of his death, providing preventive health care for 1,000,000 people.

## Testimonials

One of the biographies written about Henry Kaiser is entitled *Western Colossus*, by Al Heiner, written in 1991. In its introduction he describes the man as follows:

"He was America's boldest, most spectacular entrepreneur: a Western maverick with a Midas touch. With the guts of a gunslinger, he plunged into a dizzying diversity of ventures that built a legendary industrial empire, established the nation's most successful health care program, helped win WW II, and changed forever the face of Western America. Here is the larger-than-life builder who raised free enterprise to a new level."

Even as early as 1935, Henry Kaiser's genius was recognized. His role in building Hoover Dam is not always recognized. But on the day of inauguration of the dam, the man who provided the security bond for the joint-venture group, one Leland Cutler, gave an oration entitled, "Henry J. Kaiser, in appreciation on May 6, 1935." In it he gives further testimonials:

"Henry Kaiser is a builder, strong willed and eager for the new ways of doing worthy things and unrelenting in his scrutiny of accepted order and the orthodox."

"Although commending all tried methods of the past, he frankly feels there must be found someday a better way. He is respectfully destructive because he knows that the first essential of progress is dissatisfaction, that doubt is the instigator of investigation, and that investigation breaks clear the worthless chains of precedent. No catalogued machine has ever fitted his ideas; this gear or that must be adapted to the job at hand as he sees the job to do. Machinery to Henry Kaiser must be the proudest and most perfect workman on the job and must understand and love the work it has to do."

"Henry Kaiser is a dreamer and because he dreams, builds better than most men."

## Books About Kaiser

There are several books written about the man:

*The Kaiser Story* was published by Kaiser Industries in 1968.
An *All-Kaiser* brochure published in 1954.
*Henry J. Kaiser, Builder in the Modern American West* by Mark Foster, 1989.
*Western Colossus* by Al Heiner in 1991.
*Big Dams and Other Dreams...The Six Companies Story* by Donald E. Wolfe, 1996

For some reason not fully evident, all of these books ignore Kaiser Engineers. It was as if all authors took KE's accomplishments for granted. The authors of those books would no doubt be amazed to read this history to find the numerous accomplishments they did not record.

## Inner Circle

From the earliest beginnings of the Kaiser organization, Henry Kaiser recruited the best help he could find, and over the years they became his closest lieutenants in seeking new enterprises and arranging to set them up and to operate them. This original group were engineers who could translate Kaiser's dreams and ideas into practical projects. They constituted his inner circle.

His first employee was A. B. Ordway, "Ord" to everyone who knew him. Ord joined Henry Kaiser in his pursuit of construction contracts in 1912. In 1919, Tom Price was hired. George Havas came aboard in 1928, followed by Chad Calhoun in 1931. Along the way at about the same time, Clay Bedford and Mike Miller rounded out the inner circle of engineers.

When his son, Edgar, graduated from college in the mid-Thirties, he along with Gene Trefethen, became managers of industries that were founded. They were not engineers but were excellent managers. So the inner circle was expanded to include them. Now, the inner circle consisted of the following:

| | |
|---|---|
| Edgar Kaiser | Chad Calhoun |
| Gene Trefethen | Clay Bedford |
| A. B. Ordway | George Havas |
| Tom Price | Mike Miller |

Chad Calhoun started with Henry Kaiser as a civil engineer, playing a key role in preparing the Six Companies' winning bid for the contract to build Hoover Dam. His organizational and negotiating skills were recognized early so that Mr. Kaiser put him in charge of Kaiser Industries' Washington public affairs office where he helped negotiate a number of large contracts and paved the way for entry into a number of new businesses. Calhoun has written the beginnings of what he hoped to be a book on his years with Kaiser entitled, *Recollections of Henry Kaiser, 1931-1950.* It was drafted in 1970 but was not published because of his untimely death. In it he records his life with Kaiser. Some excerpts follow:

"To write about Henry Kaiser presents many problems. To be logical and orderly in sorting out the many facets and achievements of this great man detracts from the true character. However, to preserve reader interest, it is necessary to view the man and his activities in some semblance of order. If what I will relate at times seems confusing and illogical, it is because that is the way it was."

"Life with Kaiser was very hectic at the mildest. The intermediate and high points were wild. His drive, appetite for work, quick changing moods of despair, elation, anger, pique, frustration, impatience, bitterness, disgust, satisfaction, disappointment, kindness, understanding, and down-right soft-heartedness made each day a most varied experience. There was never a dull moment."

"Kaiser did not have a master plan or even a concept of building an industrial empire. He was strictly a visionary activist; a rare combination. The things he did fell into place naturally and formed the basic building blocks, the foundation upon which the Kaiser Empire was built. It is that era of foundation building that will, I hope, provide the thread of unity around which to weave a partial but eventful and interesting record of Henry J. Kaiser."

Calhoun's description of how Kaiser became involved in the building of Hoover Dam is contained in the "Oral History" section of this book.

This inner circle of engineers established a method of working with Henry Kaiser. Henry Kaiser was impatient. He wanted things built now. His engineers had to find ways to build the way Henry Kaiser dreamed. Unconventional means had to be adapted. The discipline of the trained engineer had to be adapted to build in overlapping phases and to start operations of new facilities while engineering and construction of the plants were still going on.

It was with this discipline that newer generations of Kaiser employees were indoctrinated. Many of those people went on to become the internationally-known and respected Kaiser Engineers.

## Affiliated Companies

Kaiser Engineers traces its early beginnings to its construction of facilities for the many Kaiser-affiliated companies. KE did the building because it knew how to build factories rapidly as Mr. Kaiser dictated. We knew the processes, knew the management, and had contractual relationships already in place so that we could start fast and finish fast. And the companies had confidence in the integrity and abilities of the men who would be assigned.

The affiliated companies were as follows:

Kaiser Aluminum & Chemical Corp
Kaiser-Frazer (automobiles)
Kaiser Steel
Kaiser Jeep
Kaiser Sand & Gravel
Industrias Kaiser Argentina (automobiles)
Kaiser Cement
Willys Overland do Brasil (automobiles)
Kaiser Gypsum
Kaiser Metal Products (dishwashers, cabinets)
Kaiser Permanente Medical Care
Kaiser Aerospace & Electronics
Kaiser Industries
National Steel & Shipbuilding

An interesting perspective of the affiliated companies is contained in the publication *The Kaiser Story*, which commemorated Mr. Kaiser's 80th birthday. It was published in 1968. Excerpts from the *Kaiser Story* are included in Appendix 7.

# Afterword

## Afterword

This history of Kaiser Engineers covers a period of 45 years, ending in1986, a time when its editors and authors had retired from the company. The history includes 35 years under Kaiser ownership and the ensuing 10 years under Raymond ownership and management. This Afterword includes a brief description of the next 13 years of the company's existence, until the year 2000, when the name "Kaiser Engineers" ceased to exist.

## Then and Now

There is a marked difference in how we did projects during the KE history period covered by this book and the limited responsibilities of today's successful construction management consultants and companies. An object lesson can be learned from this history. It shows the way for the future when, and if, major industrial expansions or other national or international situations require the resources of large turnkey engineering and construction contractors.

At the time of our exit from Kaiser Engineers in 1986, the environment for our kind of work was changing. It was a time when over-built manufacturing industries began to consolidate. It was a time when…

- Rust-belt industries for which we constructed projects were now eliminating facilities rather than building new ones. The steel and aluminum industries today are not the flourishing industries that we knew.
- Global competition increased significantly in all construction markets. In addition, foreign firms began buying up U.S. design and construction companies in order to gain access to the U.S. market.
- Increasing use of construction services 'advise-and-assist' contracts began to make in-roads into some of the work traditionally done through turnkey contracts..
- Construction management and consulting firms (particularly some of the Big 5 accounting companies) began to perform more of the work that previously had been done by full-service engineer contractors.
- It was the time that computer-assisted design began to be supplanted by fully automated computer-driven process engineering, detail design, and production of construction drawings, eliminating the requirement for engineering firms to have large staffs of engineers, designers, and drafters.
- It was a time when environmental impact considerations, regulatory constraints, and construction permitting requirements became even more important, causing extended project schedules, delays, and increased costs.
- Owners continued to require contractors to assume more and more project risk, thus expanding contractors' liability insurance coverage (when available) and cost.

## KE's Demise

By the time the manuscript for this history was completed, the firm Kaiser Engineers as an entity had ceased to exist. While it survived for 23 years under successive owners, their managers had different management philosophies and different priorities and, at the same time, as described above, the market for firms like Kaiser Engineers changed. Trying to cope with the changing business environment and their own priorities, the succeeding companies used their own staffs to manage KE's activities. Some failed to capitalize on KE's engineering and construction expertise. Their contracting policies and decisions appear to have been dictated and decided upon to a large extent by the company's business development people, few being experienced in the engineering and construction business, particularly with the risks associated with fixed-price contracting, especially for work in some foreign countries. Others used KE's revenues to finance other activities. The results were failures that caused the company's demise.

For the purpose of historical closure regarding the once great company that was Kaiser Engineers, the editors have included below a brief description of what is known of the company's activities following 1986, leading up to the dissolution of its second successor owner, 13 years later.

## Background
*(1977-1986)*

In 1983, five years after its purchase of Kaiser Engineers, Raymond International undertook a leveraged buyout of its public shareholders under the new name Raymond Holdings, Inc. The shareholders received cash for their shares, and Raymond Holdings issued its own common and preferred stock, primarily to a newly-formed Employee Stock Ownership Program (ESOP). About $180 million of financing were provided by a consortium of banks led by the Bank of America. About $30 million of excess funds in Kaiser Engineers' employees' retirement plan was also used as a source of funding for the leveraged buyout.

The leveraged buyout and formation of the ESOP was undertaken in the face of economic weakness and declining markets for Raymond's capital-intensive marine construction divisions and its drill rig fabrication operations. Additionally, these activities, and other Raymond subsidiaries, experienced continuing, significant operating losses and working capital shortfalls in the years following the leveraged buyout.

At the time of the leveraged buyout, Raymond Kaiser Engineers' traditional markets were also in a decline. The company's $2.33 billion backlog at the end of 1981 had fallen to $499 million by the end of 1983, the year of the leveraged buyout. The company's projects were profitable, but funds for new business development were limited because of the parent company's needs for cash.

During early 1985, the banks provided Raymond Holdings additional working capital and financing and issued letters of credit on behalf of Holdings, thus enabling them to continue in business. However, Holdings' financial condition continued to deteriorate, and there was an interest payment default in October, 1985. The company had a net loss of $3.2 million in 1986 and a negative net worth of $46 million at the end of the year. Its total indebtedness then was $191 million.

## Raymond Holdings, Inc.
*(1986-1988 )*

Choosing between liquidation or restructuring, Raymond Holdings was reorganized on December 10, 1986. Its drill rig fabrication yard and the offshore marine construction division were sold. The drill rig, pile-driving, and related businesses were spun-off to a newly-formed corporation, "New Raymond, Inc." The banks forgave $41 million of the total indebtedness of $191 million in exchange for equity, and the residual was reclassified as secured debt and preferred stock.

The engineering groups, including Raymond Kaiser Engineers, were consolidated with the parent corporation and renamed "Kaiser Engineers Group, Inc." (KEGI). The residual indebtedness was allocated as follows:

| | |
|---|---|
| New Raymond, Inc. | $40,000,000 |
| Kaiser Engineers Group, Inc. | 110,000000 |
| Total Indebtedness | $150,000,000 |

KEGI had a net loss in 1986 of $3.2 million. Further declines in KEGI's overall market and its insufficient working capital and equity base caused its net loss in 1987 to increase to $7.7 million. Additionally, the company had been unable to make its interest and principal payments on secured debt since the middle of 1987. In October, KEGI proposed to its banks a write-down and restructuring of its indebtedness. The banks rejected KEGI's proposal and decided to sell their interests in the company and to reduce their risk exposure under the KEGI letters of credit.

KEGI's "guaranteed value" Series A Preferred Stock, in which its employees' supplementary savings and retirement accounts had been invested following the 1983 leveraged buyout, became essentially worthless.

At some time after the sale of Kaiser Group International (see below), New Raymond, Inc.'s remaining assets were sold, and the company was liquidated.

## American Capital and Research Association Buys KEGI, 1988

In 1988, the firm American Capital and Research Corporation (ACR) learned that KEGI was for sale.

ACR was an employee-owned professional services holding company formed in 1987 to own the family of companies that had developed around ICF, Inc. during the period 1969-1987. In 1987 ICF's Environmental and Facilities Management Group had a staff of over 800, including 600 professionals providing services nationwide in environmental engineering including hazardous waste remediation and management.

Aware that KEGI had an Australian subsidiary, Kaiser Engineers Australia Pty. Ltd., ACR began discussions with representatives of Elders Resources, a New Zealand company, to determine whether and to what extent ACR and Elders might work together in acquiring Kaiser Engineers Group, Inc.

A deal was worked out, and in September, 1988, KEGI was merged into ACR. The merger was effected through a complex arrangement with Elders involving stock transactions and the sale of Kaiser Engineers Australia Pty. Ltd. to a subsidiary of Elders. Kaiser Engineers Hanford Company was merged into a subsidiary of ACR. .

Subsequent to the merger, the name of the holding company (ACR) was changed several times and again in late 1988 to ICF Kaiser International.

## ICF Kaiser International
*(1988-1999)*

It is not the purpose of this book or within the intent of this Afterword to cover ICF Kaiser International's work following the acquisition of Kaiser Engineers Group, Inc. in 1988. But we do review its financial conditions which, ultimately, led to the company's demise. The company sustained major losses during 1997, 1998, and the first six months of 1999 in an aggregate amount of $129 million, significantly damaging the company's financial condition. These losses resulted from continuing major cost overruns experienced by its Engineering and Construction Operations Group (ICF Kaiser International) in performance of four large fixed-price contracts to build nitric acid plants.

In 1999, the company found itself saddled with what was termed by its annual report as a "crushing debt service" of $18.1 million a year on debt that included about $140 million in 13-percent notes. Efforts were made to restructure the company and, as a result of that process, its Environmental and Facilities Management Group and its Consulting Group were sold for aggregate proceeds of approximately $145 million, resulting in a net gain to the company of $40.1 million. These sales were not enough to restore the company's financial condition. In addition to its cash drain and continuing obligations associated with the nitric acid plants and other losses, a significant outstanding debt remained, principally $125 million in subordinated notes.

In late 1999 and early 2000, a restructuring plan was developed which involved the sale of some of the company's assets. On December 27, 1999, the company's name was changed again to Kaiser Group International.

## Kaiser Group International
*(1999-2000)*

On June 9, 2000, the company voluntarily filed for Chapter 11 bankruptcy protection. The Plan of Reorganization included the sale of its remaining Engineering and Construction Group assets as follows:

- Sale of its transit and transportation, facilities management, water/wastewater treatment, microelectronics and clean technology sectors to the EarthTech unit of Tyco Industries, Ltd. for about $30 million. This sale was effective July 17, 2000.

- Sale of its alumina/aluminum, iron and steel, and mining industry sectors to Hatch Associates, a subsidiary of the Hatch Group of Canada, for approximately $7 million. This sale was effective August 18, 2000.

The principal remaining asset of the company, following the sale of its engineering and construction entities, was ownership of a 50-percent interest in the Kaiser Hill Joint Venture to perform site remediation services for the former Rocky Flats Nuclear Weapons Plant at Rocky Flats, Colorado. This is a $3.6 to $4.8-billion contract with a completion date between March, 2006, and March, 2007. In 2002, it is Kaiser Group Holding's only remaining source of income.

As of December 18, 2000, the Kaiser Group Holdings, Inc. (successor in bankruptcy to Kaiser Group International) Plan of Reorganization became effective, and the company and its entities were no longer subject to supervision by the Bankruptcy Court.

## KE Retirees Committee

This committee is an ad hoc group of retired KE executives organized in July, 2000, to represent the retirement benefits interests of the company's retirees during the Chapter 11 bankruptcy proceedings of Kaiser Group Holdings, Inc. The committee is active today, overseeing administration of the benefits by Holdings.

## Esprit de Corps, Camaraderie of KE's People Continue Today

The friendships, loyalties, and camaraderie of KE's personnel have survived the company's changes in ownership, the loss of its name, and its final demise. Three groups of people, some of whom have known each other and worked together since KE's origins 60 years ago, meet regularly to visit, reminisce, and maintain friendships:

- *The Breakfast Club,* consisting of some of the company's former most loyal and hard-working people, the women of KE, meets four times a year to visit and socialize. Bea Kimsal is the organizer of this group. For many years this group, chaired by 'can-do' Anke Altermann, has sponsored and organized the annual Christmas luncheon for former employees. More than 150 people attended the 2001 Christmas party, some traveling long distances to attend. Anke also established and maintains a website that features the activities of the former employee groups.

- *The Dinosaurs,* have been meeting monthly for lunch at the Crab Pot Restaurant in Oakland, California, for nearly 20 years. Organized originally by Tim Ho, Oscar Nieponice, Bill Stolmack, and A. H.'Wink' Winkler, the group continues with a membership of about 50 people today.

- *The Deadwood Associates,* with about 60 members, also meets monthly for lunch at the Hungry Hunter Restaurant in Lafayette, California. The group was organized about 20 years ago by Mike Janner, Al Wallach, Vic Cole, and Bob Wolf. Carl Olson and Maury Wortman were among its early members.

It is fitting to conclude this Afterword with the foregoing references to the groups of former employees of Kaiser Engineers who remain active today. Their members are representative of the overall loyalties, work ethics, and professionalism of the entire Kaiser Engineers organization that, over the years of the company's existence, were the key factors contributing to and responsible for its growth and accomplishments. KE

# Acknowledgements


## Beginnings

This book is the work of many, but the fact that it has been written is due to the initiative, imagination, and dedication of Jim Thompson, formerly KE's principal mining and metallurgical engineer. On July 21, 1994, at the Park Hotel in Lafayette, Jim arranged and chaired a meeting of 14 former KE people to explore his idea that the works of Kaiser Engineers and its people should be recorded in a history book. The group agreed with Jim's concept, and a Publications Committee was formed, consisting of Jim as managing editor and John Gilcrest, Jim McCloud, Harry Thayer, and Al Wallach as members.

An advisory and review committee was also formed, consisting of Bill Ball, Phil Bush, Vic Cole, Lou Oppenheim, and Sam Ruvkun. Over the next several years, both the Publications Committee and its advisors were active in determining the book content, collecting data, and recruiting and organizing authors. Jim remained active in working on the book until his untimely death in November, 1996. He is especially one to whom the editors wish to dedicate this book.

Following Jim's passing, John Gilcrest picked up the reins to continue his work.

## Editorial Board

Between 1997 and 1999, a great deal of planning, outlining, styling, and even writing of manuscripts was accomplished. It was then realized that more oversight was required. Consequently in 1999, the Publications Committee was reconstituted as an Editorial Board.

The Board consisted of Bill Ball, John Gilcrest, Jim McCloud, and Sam Ruvkun. The Board provided guidance until publication of the book.

## Editors

With the large amount of data accumulated in the prior years, it was necessary to organize the information, edit it for consistency, and to continue to recruit additional authors where information was lacking. John Gilcrest and Sam Ruvkun jointly edited the book.

*Editors' Note:* This paragraph was written by John Gilcrest. Sam Ruvkun's contribution to this book has been immense. His corporate memory, his writing skills, and organizational abilities together with his "can-do" philosophic approach to a job waiting to be done have been key to the quality of the book and its completion and publication. His prime editorial contributions include editing most of the first ten chapters of the book, the oral histories, and the appendices. His editorial focus included providing transitions for the various chapters so they tied-in as a whole and were in proper context of the company as a whole. In addition, he located, interviewed, and screened the candidate editorial coordinator and printing firms, leading to the ultimate selection of the book's editorial coordinator / desktop publisher and the printing company. Without Sam, this book might not have seen its completion and day of publication.

*Editors' Note:* This paragraph was written by Sam Ruvkun. John Gilcrest has led this effort as a nearly full-time activity for the past five years, acting as managing editor. He organized the book, made assignments of chapters to authors of chapters or subchapters, edited their content, authored parts of the book, handled marketing details for selling the book, and directed its publication. His study, and until recently his garage also, was littered with files, drafts, photographs, and manuscripts. He single-handedly directed the editing and publication of this book.

## About the Authors

The authors were project managers, project engineers, construction managers and other experts. Some 68 KE people contributed to this history. They are listed in the Appendix. Their tenures spanned the full history of Kaiser Engineers, covering the period from 1942 through 1986. The memory of some even went further into the past before there was a Kaiser Engineers, but when Henry Kaiser was building great dams in the 1930's and building ships during World War II.

The authors' perspectives are fresh reviews, as they look backward some 10 to 25 years since retirement. The book is enriched by their contributions and the stories they have told.

## Addition Assistance Received

Many people contributed their time and assistance to this project. In late 1994 when we began to write this book, ICF Kaiser Engineers was beginning consolidation of its office space in the 1800 Harrison Street Building in Oakland. The KE library was in the process of being dismantled, along with all of its stores of KE project history. Dan McCormick, then with ICF KE, arranged an opportunity for our Publications Committee to rescue some of the project data files and reports that had not yet been discarded. Harry Thayer, Al Wallach, and John Gilcrest spent a couple of weeks collecting this material, which became the only historical data resource for the book, other than the memories and personal files of the authors.

Harry Thayer did a monumental, month-long job of inventorying and cataloguing what turned out to be some 56 files boxes of company and project records and reports that had been salvaged from the library. Cliff Gambs and Paul Irminger sorted through, inventoried, and catalogued a vast, mixed-up collection of 35-mm color slides and other photo materials to organize the photographic history resource for the book. All of this material resided in John Gilcrest's garage until it was sorted through to select reference data useful for the writing of this book.

Mary Ann Gilcrest is recognized and thanked for her expertise, efforts, and long hours in viewing, scanning, composing, and storing on CDs as camera-ready copy all of the book's photos and illustrations, together with their accompanying captions. She worked with an inventory of more than 200 individual photo originals consisting of 35-mm color slides, black and white film negatives and photos, and halftone illustrations. Complicating her task was the fact that some of the originals were in poor condition because of age or improper storage and handling.

Additionally, our thanks and appreciation go to Anke Altermann, her helpers, Rick Driver, Chuck Mussara, Donna Schusske, and others for compilation of the more than 4,100-name roster of Kaiser Engineers' personnel; and also for compilation of the special roster of the women of Kaiser Engineers, who are among those to whom this book is dedicated. In the absence of official personnel records, these rosters were compiled from a variety of sources, including telephone books, service award announcements, and other media. Anke also composed the "string" of names of KE people that are featured on the book's cover.

Many thanks to Steve Armknecht who, from day one of our efforts to write this book, has been here to help us. Steve made storage space and a work area in the company's offices available to our publications group and assisted us in many other ways, including use of his office copier machines.

And lastly, a special vote of thanks to the many former Kaiser Engineers people and friends for their faith and patience in having prepaid for the 340 books that have been ordered since January, 2002. The funds received have helped us to pay for the book's editorial coordinator and for printing and distribution of the book as these expenses were incurred.

# Dedications

## Dedications

This book is dedicated to the men and women who were Kaiser Engineers and accomplished the projects we have described. Each of the people of KE share equally in the credits due for the successes and accomplishments of the company. Together we were a team. We share the dedications in five groups.

### To the Men Who Did the Work

They number in the hundreds and thousands of engineers, construction people, and staff. They share the credits for the company's accomplishments with the women of KE and also, with their wives and families

### To the Women Who Did the Work

The women of Kaiser Engineers were administrative assistants, accountants, data processing specialists, editors, graphic artists, technical writers, proposal managers, librarians, secretaries and typists, and architects and engineers, too. All were essential to the work we did.

The editors and authors of this book lived in a different time. We didn't have a personal computer at our desks, so we couldn't send e-mail messages or compose and type our own work. Our secretaries took our dictation, or working from scribbled notes, corrected our English, and made sense out of what we were trying to say. They arranged our schedules, made travel arrangements, and when we were gone, took care of our offices. They were extensions of our own capabilities.

The women of KE are remembered with this dedication. They are listed by name in Table A.1, taken from old phone books or recalled from memory by the authors.

### To Our Families

Behind our men and women, were their families at home. Our spouses raised our children when we went to far-off places and when we put in untold hours at the office. They maintained our homes and supported our efforts. Oftentimes, our wives and children wouldn't see the man of the family for days or weeks at a time. Construction people faced even more challenging problems as they moved from job to job, sometimes every two or three years. One wife noted that it seemed to her that every move came just as she hung her curtains. She decided to solve that problem once and for all. She simply didn't put up curtains anymore.

### To Our Presidents

An especial note of dedication is given to three of the presidents of Kaiser Engineers who served for 41 of the 45 years covered by this history. George Havas founded the company and led it for the first 16 years. He was followed by Lou Oppenheim, then by Jim McCloud. These three leaders are identified in the minds of the thousands of loyal employees as being the heart and soul of the company. Thus, this dedication to them.

### To Jim Thompson

Without Jim Thompson, there would not be this lasting memory of Kaiser Engineers. It was he who in 1994 proposed the preparation of this history. He had the foresight and the drive to get it started. A hearty dedication greeting is given to him also.

# The Women of Kaiser Engineers

**Table A.1**

Abbas, Mary
Abrams, Bonnie
Adams, Sylvia
Ahlberg, Linda
Altermann, Anke
Aquitania, Aster E.
Arriaga, Renee
Avalos-Lopez, Nydia
Ayen, Rose

Bain, Ernestine
Barragan, Julia
Barron, Terry
Beaty, Virginia
Beck, Mari
Bibb, Frances
Bishop, Bea
Blackwood, Vicky
Blanchard, Linda
Block Marasco, Giselle
Bodisbaugh, Susan
Boone, Patricia A.
Boulware, Irene
Bray, Fonda
Breazeale, Susan
Bressem, Donna
Bride, Helen
Brown, Gail
Brown, Phyllis
Bullen-Sjogren, Janice
Bundy, Madeline
Burger, Maria
Burns, Marilyn
Burns, Myrtle

Campbell, Cynthia
Campbell, Sandra
Canas, Sharon
Carneghi, Theresa M.
Carter, Judee
Carter, Penny
Castillo, Nilda F.
Chapman, Lynne
Cochrane, Judith
Conant, Dana
Costa, Christine
Croft, Patricia
Cullen, Dell
Cullins, Donna
Custino, Irene

Dahl, Kay
Dahm, Eva
Darzes, Lynne
De La Figaniere, Lee
de los Reyes, Bella
de los Reyes, Fe
Ding, Helen
Dobson, Ardith
Domenico, Antoinette
Doritty, Louise
Drummond, Donna
Drury, Gerri
Duarte, Sherri
Dunnigan, Dolores

Ehrheart, Aloah
Emery, Barbara
Esquivel, Bertha
Eustice, Ella

Fernandes, Barbara
Fernandez, Lita
Ferrante, Norine T.
Ferrif, Angela
Fisherman, Yelena
Fithian, Doreen
Fitzgerald, Maureen A.
Flemetis, Becki
Fohl, Yvonne
Fornalski, Margarita
Forrest, Jeannie
Freed, Nancy
Freested, Janese

Gabriel, Antonina E.
Garner, Lori
Gasparetti, Lee
Gates, Madge
Gonzalez, Angelina
Goodwin, Evelyn
Graham, Gail
Greer, Maren
Groschke, Helen
Gross, Bernice
Groves, Dudley (Mrs.)

Haire, Jane
Hall, Shelia
Hansen, Kathryn
Haragan, Dorothy
Hardin, Marjory
Harris, Roxie
Hawley, Edna
Hayes, Donna
Henderson, June
Hibbard, Marnell (Scotty)
Hight, Sue
Hill, Jan Marie
Hiserote, Emma
Hodge, Nancy
Hoit, Ann
Holliday, Nancy
Hoover, Kathleen
Howker, Sandra

Ingmire, Wanda
Jackson, Nettie
Jacob, Elaine
James, Melba
Jeans, Cindy
Jenkins, Edith
Jepsen, Darlene
Johansen, Marian
Johnson, Ruby

Kaiper, Gina
Kaiser, Beatriz
Kalogrithis, Harriett
Karimi, Sylvia
Kinney, Kay
Kravif, Diane
Krivak, Elba

Laniel, Betty
Laskowsky, Zelda
Law, Josephine
Leathers, Ann
Lee, Mary
Lee, Shirley
Lewis, Charlotte
Liddicoat, Mary Jo
Litzenberger, Janet
Lozano, Dorothy

Magana, Grace
Manildi, Debie
Martin, Allison
Maston, Patricia
Maxon, Donna
Mayberry, Sandra
Mayes, Jean
McAdams, Nina
McBroom, Joanne
McDonough, Nancy
McKay, Helen Marie
McKee, Carolyn
McKnight, Susan
Menefee, Sharon
Miller, Gwendolyn
Mirzaian, Flora
Mitchell, Vicki
Moneta, Karen
Montez, Mary
Mooney, Dorothy
Morris, Bytha M.
Mosbaugh, Harriet
Mraz, Jeanne
Mullen, Jean
Murdock, Bonnie
Murphy, Dianne
Muth, Goldie

Nelson, Alice
Nelson, Nancy
Niva, Nettie
Nordseth, Clarice
Norwood, Susan
Nunes, Evelyn
Ogrey, Marlene
Overtone, Nancy

Padgett, Anna
Paulsen, Patricia
Payne, Karen
Pederson, Trudy
Peebles, Debra
Pinson, Judith
Plumley, Lillian
Powell, Terry
Pritchard, Jean

Quals, Tracy
Quast, Shirley
Quinn, Janine
Quintana, Jocelyn

Raede, Dorothy
Ramelli, Viona
Ramos, Karen
Randisi, Elaine
Rath, Karen
Raulston, Annette
Reeve, Barbara
Reihl, Dorothy
Renter-Pinney, Debra
Revote, Susan
Reynoso, Kendal (Mrs.)
Rice, Charlene
Riley, Helen
Robert, Barbara
Roberts, (Ruby) Ellen
Robinson, Jeanne
Rodriguez, Beatrice
Rood, Inez
Roodvoets, Dorothy
Russell, Carol

Salomon, Regina R.
Scammell, Kris
Schusske, Donna
Shannon, Mary
Sharp, E. C. (Betsy)
Sheenan, Donna
Sheets, Cherie
Shelton, Rosemary
Shipp, Edna I.
Shoemake, Marie
Shreve, Patricia
Shrimpton, Cathy
Sjogren, Janice
Souza Fenity, Mary
Spengler, Doris
Stankus, Anna
Stauffer, Judith
Stempihar, Jane
Stevens, Carol
Stevenson, Claire A.
Stinnet, Fannie
Stone, Edna N,
Stuckgold, Lorna
Stuhlmacher, Barbara
Sukkar, Linda
Suyama, Karen
Swing, Donna

Tawfik, Eleanora
Taylor, Patricia
Templeton, Susan
Thiessen, Arlene
Tidwell, Joann
Tjon, Jennie
Toki, Lavinia
Topete, Sherry
Torrison, Judy
Trantham, Pauline
Tsang, Anna

Ugolini, Joann

Virardi, Gail
Voris, Marvaly

Washington, Wanda
Waterman, Katherine
Watkins, Beatrice
Watkins, Susan
Weaver, Wilma
Weldon, Lisa
Welsh, Virginia
White, Leora
White, Opal
Wiegand, Della
Will, Joan
Williams, Frances K.
Willis, Betty J,
Witkowski, Evelyn
Wong, Amy

Zacher, Elaine F.
Zadorkin, Doral

# Editors' Notes and Authors

## Editors' Notes

This book was written by the men who built the projects that we discuss. It is written in the editorial first person. We refer to our friends by their familiar names because that's how we addressed them. They were Lou, Jim, Vic, Bob, and so forth.

We had an excellent *esprit de corps*—a can-do attitude. We've tried to convey that in how we edited this book.

The book had a difficult birth. The idea was proposed by Jim Thompson in mid-1994 with a broad mission statement, which met with immediate enthusiasm. Then, an ad hoc editorial board took over and defined an outline of the book contents and selection of volunteer authors. Over several years, the outline was altered, modified, and expanded.

We began this project by having authors write summary project descriptions. It soon became apparent that there were thousands of projects that KE was involved with, and such sheets would comprise a voluminous book themselves. One day in an editorial board review session, Lou Oppenheim asked the question, "Who in the hell do you suppose will be interested in reading such dull stuff?" No one could answer that question. So, it was agreed that we needed to refocus the direction of the book. The result was the format that we now have.

We started this new format with the idea that good planning required that each author follow a "style guide." In publication circles, a style guide is an art form in itself telling the writer the format of language usage and the style of type, for example. It didn't take long for us to realize that we were dealing with a bunch of talented individualists who, when performing their managerial and engineering tasks, never let a bit of bureaucracy stand in their way. They didn't like our format. We decided that it was more important to get the facts down on paper than to have the authors constrained. We would iron out the inconsistencies in final editing.

Editing proved to be a very time-consuming chore. Each author had his own style and format, and we now faced the challenge of trying to make each write-up sound like the other. That was the chore undertaken by the editors. After five years, we had the manuscripts of some 68 individual authors. Editing took on a number of aspects: scanning them for adaptation to a common typeface; editing text as to style; arranging paragraphing; installing subtitles and correcting misspelled words. In all, the editors estimate that it took from one to two hours to edit each page of text.

Many of the facts and names recalled come from the collective memories of the authors. Actual documentation from old company files was limited to those files that were rescued when new owners of the company decided to close the old morgue and dispose of the contents of our library. It was John Gilcrest, Harry Thayer, and Al Wallach who were able to salvage some 50 boxes of files and photographs, all of which wound up in John's garage. So, some corporate memory survived, and some came from memory or personal files of the authors.

We tried to make the story sound like something other than a progress report. Most of us grew up writing progress reports, technical specifications, and technical reports. It was a challenge to avoid naming the number of cubic yards of concrete or tons of steel in a project. It took courage to edit words prepared by process engineers to eliminate descriptions of the process flow diagrams.

When we questioned a group of retirees about what they wanted to see in the book, they overwhelmingly responded that they wanted to see the names of the people involved. Unfortunately, the corporate memory was not complete. A roster of company names did not survive the archive destruction. Instead, we relied on the memories of the authors. The results are an uneven handling of names. Some authors were fortunate to have files with complete records of key staff members. Others relied on their memories, trying to remember names of people involved in projects completed several decades ago.

We, of course, had the advantage of 20/20 hindsight in writing this book. All of the authors could now stand back and recall events that occurred several decades before. That's an advantage as one can reflect upon what was truly important rather than focusing on the problems of the day.

We started the book upon the birth of Kaiser Engineers in 1942. We ended it when Kaiser no longer owned the company, and most of the KE old-timers had retired. We selected the year 1986 as the date that occurred, just prior to separation from Raymond International.

## Editors

The first editor was Jim Thompson. On his passing, John Gilcrest took over and managed the authors, editors, and the publication of the book.

Editorial input was provided by an editorial board consisting of John Gilcrest, Jim McCloud, Bill Ball, and Sam Ruvkun. John Gilcrest and Sam Ruvkun edited the manuscripts prepared by the authors.

## Authors

The text was written by people who managed most of the projects described. They include a *Who's Who of Kaiser Engineers.* The work of researching and organizing chapters or sections of this book took place over a span of some five years. Some 68 different authors were involved in these tasks. They are listed in Table A.2, "Authors of Together We Build."

# Authors of *Together We Build*

**Table A.2**

| Chapter | | Authors | Edited by* |
|---|---|---|---|
| | Foreword | John Gilcrest | SR |
| 1 | History | Bill Ball, John Gilcrest, Jim McCloud, Sam Ruvkun | SR |
| 2 | Organization | Bob Bernard, Sam Ruvkun, Bob Fitzgerald (Industrial Relations), Don Spiker (Personnel), Don Rowlings (Project Finance), John Gilcrest (Government Marketing), Del Young (Insurance), Bill Ball (Engineering) | SR |
| 3 | Construction | Sherrill McDonald and Sam Ruvkun, Don Barrie (Construction Management), Vince Palmer (Snowy Mountains), John Gilcrest (Project Lists) | SR |
| 4 | Steel | Frank Kast (Armco), Ray McNeill (Armco), Bill Smith (Krakatau), Sam Ruvkun (Foreign) | SR |
| 5 | Aluminum | Bill Ball, Bill Deeths, Ray Ware (Anglesey) | SR |
| 6 | Cement | Art Tousley, Alden McElrath, Arnold Kackman | JG |
| 7 | Mining & Minerals | Al Wallach, Jim Thompson, Jim Miller (Tilden), Sam Ruvkun (Brazilian Ores) | |
| 8 | Transportation | Herb Thomas, Gene Stann, Jim Ellis, Dave Pleau, Margaret Brown, Paul Landis, Cliff Gambs, Roger Troxell, Dick Herbeck, Adelbert Warren, Morris Burgess, Andy Edelson, Chris Anderson, Giff Randall, Farrel Shell, Dave Allen, Bill Custer, Ron Rypinski, and Dick Line | SR & JB |
| 9 | Marine Terminals | Vello Kiisk, Fred Nielson | JG |
| 10 | Hydroelectricity | Bob Koch, Ray Ware (Volta) | SR |
| 11 | Nuclear Energy Technology | Wally Dodson | JG |
| 12 | Space, Defense & Postal | John Gilcrest | SR |
| 13 | Water, Waste Water | Dick Ringwood | JG |
| 14 | Air Pollution Control | Jim Murray, Jack Lagarias | JG |
| 15 | Institutional | Fred Porta | JG |
| 16 | Automotive | Jim McCloud, Sam Ruvkun | SR |
| 17 | Oral Histories | Chad Calhoun, Bill Ball, Phil Bush, Bob Rice, Burr Tupper, Vince Palmer, Jim McCloud, Sam Ruvkun, Harry Thayer, Frank Kast, Jim Miller, Al Wallach, Harvey Ceasar, Omar Finsand, Dick Hulseman, Jim Thompson, Lou Oppenheim, Vic Cole, and Sherrill McDonald | |
| 18 | Antecedents | Sam Ruvkun | JG |

* Manuscripts prepared by the authors were edited by John Gilcrest (JG), Sam Ruvkun (SR), or John Bergerson (JB).

**Table A.2 con't**

| | | | |
|---|---|---|---|
| Afterword | | John Gilcrest | SR |
| Acknowledgements | | Sam Ruvkun | JG |
| Appendix | | | |
| 1 | Dedications | John Gilcrest and Sam Ruvkun | SR |
| 2 | Editors Notes and Authors | Sam Ruvkun | JG |
| 3 | Bibliography | John Gilcrest and Sam Ruvkun | SR |
| 4 | Photos and Illustrations | John Gilcrest | JG |
| 5 | Checklist of Project Management Services | Sam Ruvkun | |
| 6 | Updating Project Costs | Sam Ruvkun | SR |
| 7 | The Kaiser Story | John Gilcrest and Sam Ruvkun | SR |
| 8 | KE Personnel Roster | Anke Alterman | JG & SR |
| | Index | Sam Ruvkun | |

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"Raymond Holdings Inc., Proxy Statement, November 18, 1986"

"Kaiser Engineers Group, Inc., Proxy Statement, Sept 7, 1988"

Project Records and Photographs from the former KE Library

# Photos and Illustrations

Page Where Located

Chapter 4 – Steel



Chapter 5 – Aluminum



Chapter 6 – Cement

# KE's Checklist of Activities

The following checklists have been prepared as a summation of specific items of work, which must be accomplished by the project staff or supporting personnel during conduct of a project. The list is intended as a general guide and is only sufficiently extensive to include normal project requirements. Items unique to a project or requiring little activity, even though important to a particular aspect of project execution, have been omitted.

The checklist* is organized into three major chronological phases of project execution:

- Project Initiation
- Project Execution
- Project Close-out

The work items included in each phase are further classified into the following types of activities:

- Managerial
- Engineering
- Procurement
- Construction
- Administration

In most instances, the types of activity within each phase are interrelated and are performed coincidentally. The segregation of type of activity does not necessarily imply that the item of work was performed by a corresponding staff position; for instance, the procurement activities listed include some items normally performed by the project engineer and some performed by the Procurement Department.

## Project Initiation

This phase starts the work and includes all early activities preceding build-up of the major project effort. The project initiation phase is completed with accomplishment of overall preliminary organization and planning for the project.

### Managerial

1. Review contract
2. Meet with client to determine requirements and desires
3. Investigate history of project development
4. Establish scope of services by Kaiser Engineers
5. Establish scope of services by client
6. Decide upon basic approach to execution of project
7. Conduct initial departmental briefing meeting
8. Determine basic organization of project and duties and responsibilities of key positions
9. Assign key staff members
10. Request delegations of procurement and administrative authority
11. Prepare and submit preliminary program, schedule and order of magnitude estimate for approval of Division Management and client

### Engineering

1. Review studies, plant requirements, or other information available from the client
2. Obtain plant site location data
3. Determine applicable design codes
4. Establish process design
5. Make preliminary layout of facility
6. Develop general flow scheme and material balance
7. Select major equipment items
8. Initiate general arrangement drawings
9. Initiate preparation of Project Criteria documents
10. Establish general design program based on estimate of number of drawings and degree of design detail required
11. Prepare preliminary design schedule and estimate of cost

### Procurement

1. Determine site logistics
2. Investigate transport economics
3. Determine availability of any critical materials
4. Prepare forms for procurement documentation
5. Develop bid lists for major equipment
6. Develop preliminary delivery time for critical major equipment
7. Outline major bid packages
8. Make general designation of items to be procured in Field and Oakland
9. Assess extent of expediting effort required

* Reproduced from KE's *Project Management Manual,* issued 8/18/67.

10. Prepare preliminary procurement program, schedule, and estimate of cost

## Construction

1. Determine site access and conditions
2. Arrange utility connections
3. Determine need for permits or other local governmental requirements
4. Initiate site surveys
5. Determine size and location of site office and construction facilities
6. Develop site information such as foundation conditions and meteorological data
7. Determine availability of labor
8. Install site fencing or other security measures
9. Determine scope of site development work and foundation construction
10. Develop construction methods for major work items and prepare requisitions for major items of construction equipment
11. Prepare preliminary construction program, schedule and estimate of cost

## Administration

1. Determine office facility requirements and arrange accordingly with Office Services Department
2. Arrange for communications service
3. Prepare personnel requisitions
4. Arrange with Accounting Department for establishment of cost ledgers, accounting procedures, and banking facilities
5. Arrange for preparation of chart of accounts
6. Arrange for negotiation of labor agreements
7. Advise insurance manager of information necessary to apply for coverage
8. Initiate reporting of progress and costs
9. Arrange for preparation of order of magnitude estimate
10. Develop preliminary project procedures

## Project Execution

This phase encompasses most of the project work. Because of the increased scope, items listed are more general than those included above for project initiation. In many instances, these activities are of a repetitive nature continuing over the life of the project.

## Managerial

1. Maintain close client contact
2. Keep Division Management informed concerning project activities
3. Meet with heads of supporting departments to establish the approach and provide needed information
4. Finalize organization of work and staffing structure
5. Select personnel for project group and concur in assignment of supporting division personnel
6. Assign work, delegate responsibility, and clearly define individual authority
7. Establish the detailed project program and schedule
8. Establish the project budget as approved by Division Management and client
9. Approve and issue the Outline of Procedures
10. Ensure staff compliance with company policies and procedures
11. Submit contract change orders reflecting modifications in scope of work.
12. Maintain quality of work through reference to standards
13. Control progress of work through references to schedules and CPM reporting
14. Control costs by relating expenditures to budget
15. Establish effective project-wide communication through distribution of reports, correspondence, and personnel contact
16. Ensure that complete project records are maintained through files and written confirmation of significant conversations
17. Approve major procurement actions requiring engineering review
18. Determine design concepts consistent with construction needs and operating economics
19. Provide balanced overall direction of the entire project team

## Engineering

1. Produce detailed and client-approved project criteria including:

   Plant arrangement and flow schemes
   Design criteria
   Plant operation data
   Utility and supporting facility requirements:

Building materials requirements
Clearance tolerances
Ventilation and waste disposal requirements
General plan for construction effort

2. Produce detailed designs in accordance with approved general arrangements and project criteria
3. Establish standard specifications
4. Prepare specifications for all equipment
5. Prepare bid package specifications
6. Establish and maintain number identification systems for equipment, drawings, and specifications
7. Prepare requisitions for all Oakland-purchased items
8. Provide technical evaluation of quotations
9. Recommend purchase of items requiring engineering review
10. Determine requirements for vendor information
11. Review and approve vendor drawings and technical data
12. Institute a vendor drawing control system
13. Provide for in-plant inspection of equipment during manufacture
14. Utilize computer programs as appropriate
15. Employ staff and outside consultants as required
16. Provide reports on progress of design effort
17. Prepare information for company forecasts and management reports
18. Coordinate design with construction needs
19. Ensure an effective flow of information between the project office, the field office, and departments providing technical supporting services and vendors

## Procurement

1. Establish procurement organization
2. Prepare all bid lists
3. Issue requests for quotations
4. Receive bids in accordance with procurement policies
5. Prepare bid tabulations including commercial evaluation
6. Negotiate purchase agreements
7. Obtain project and legal approval of purchase orders and subcontracts.
8. Issue notices of award
9. Process change orders
10. Handle communications with vendors
11. Institute expediting program
12. Issue Status of Procurement Reports
13. Maintain procurement schedule
14. Issue shipping instructions
15. Arrange for freight forwarders and other traffic requirements
16. Establish and maintain numerical control system for procurement documents
17. Verify vendor payments

## Construction

1. Establish field office and construct temporary facilities
2. Assign and move in staff
3. Specify and requisition construction equipment, materials, and supplies
4. Move in construction equipment
5. Perform construction work
6. Administer construction subcontracts
7. Provide on-site inspection and quality control
8. Perform field accounting and payroll functions
9. Perform field industrial relations function
10. Perform field cost engineering function
11. Establish and maintain warehousing facilities
12. Provide site information to project office
13. Prepare field progress and cost reports
14. Perform construction scheduling and maintain overall project schedule
15. Compile CPM schedule and prepare reports
16. Initiate subcontract change orders
17. Verify payment of subcontractors
18. Establish and maintain safety program
19. Ensure site security
20. Maintain contact with client's site representative

## Administration

1. Prepare organization chart and manning tables
2. Prepare and administer project procedures
3. Establish and maintain project files and records
4. Coordinate project-wide cost control activities
5. Prepare and issue Project Progress Reports
6. Prepare and issue Cost and Comparison to Budget reports
7. Coordinate furnishing of information for inclusion in overall project schedule
8. Distribute CPM reports
9. Coordinate furnishing of information for company forecasts

10. Ensure legal review of contractual documents
11. Administer personnel policy requirements

## Project Close Out

This phase completes the project effort with turnover of the completed facility to the client.

### Managerial

1. Develop outline of turnover procedure with client
2. Approve operating and maintenance manual and completion reports
3. Determine compliance with all contract requirements
4. Approve cost analysis report
5. Arrange for reassignment of staff when no longer required
6. Negotiate and settle any claims
7. Submit notice of completion and obtain client's formal acceptance of work

### Engineering

1. Compile final vendor data
2. Prepare as-built drawings
3. Finalize record file of engineering calculations
4. Prepare Operating and Maintenance Manual
5. Prepare procedures for acceptance testing
6. Complete final report on engineering

### Procurement

1. Determine completion of contract requirements by vendors
2. Approve final payments to vendors
3. Provide record file of procurement activity
4. Dispose of construction equipment and excess inventory

### Construction

1. Conduct start-up and acceptance testing
2. Complete punch list items
3. Verify final quantities and approve final payments to subcontractors
4. Remove temporary facilities
5. Clean-up site
6. Move out construction equipment
7. Reassign staff when no longer needed on job

### Administration

1. Compile project records and documents for turnover to client and Kaiser Engineers storage
2. Coordinate preparation of Final Report

KE

# Updating Project Costs

Many projects built by Kaiser Engineers in the 1942-1986 period were very large by any measure. Costs cited in this book reflect the costs that occurred then. A convenient way to reflect the current equivalent costs (and to judge the size they represent today) is by comparing cost indexes published by the *Engineering News Record* and by *Chemical Engineering* magazine. The *Engineering News Record* indexes are those covering *civil works/infrastructure construction costs.* The *Chemical Engineering* indexes cover *industrial plant construction costs* that include the costs of process machinery.

Throughout the book, costs are shown at the then current costs. Only in summarizing have the costs been updated (escalated) to show "costs as of the year 2000 period." This appendix shows how the updated cost factors were derived.

## Summary of Multipliers (for selected years)

| Year | Civil Works/ Infrastructure Multiplier | Industrial Plants Multiplier |
|---|---|---|
| 1940 | 26.4 | 16.9 |
| 1942 | 23.2 | 14.9 |
| 1945 | 20.8 | 13.7 |
| 1950 | 12.5 | 8.2 |
| 1955 | 9.7 | 6.6 |
| 1960 | 7.8 | 5.4 |
| 1965 | 6.6 | 4.9 |
| 1970 | 4.6 | 3.7 |
| 1975 | 2.9 | 2.5 |
| 1980 | 2.0 | 1.7 |
| 1985 | 1.5 | 1.3 |

## How Multipliers are Used

### Results for Several KE Projects

| Project | Date Started | Project Cost (x millions) | Mult | 2001 Updated Composite Costs (x millions) |
|---|---|---|---|---|
| Armco Project 600 | 1964 | $600 | 5.0 | $3,000 |
| Tata Steel India | 1956 | $130 | 6.2 | $800 |
| Fontana Oxygen Steel | 1955 | $113 | 6.6 | $700 |

## Derivation of the Indexes

We have tabulated those indexes for the period of 1940 through 2001. The *ENR* construction cost index in 2001 was 6396. The *Chemical Engineering* plant index for 2001 was 395.4. These are shown in columns (1) and (3) of Table A-3, entitled "Derivation of Multipliers."

Using 2001 as the base year, annual indexes for each year were compared to arrive at multipliers for each index for each year as shown in columns (2) and (4).

Finally, a composite index was derived using 60 percent of the *Chemical Engineering* index for process equipment and 40 percent of the *ENR* index for civil works and infrastructure. That is because large process industries have a large component of equipment costs for which the increase in costs over the years has been less than the civil works costs. Results are shown in column (5).

Table A-3
Derivation of Multipliers

| Year | ENR Index see Note (1) | Civil Projects ENR Multiplier see Note (2) | Chem Engr'g Plant Index see Note (3) | Chem Engr'g Multiplier see Note (4) | Process Plants 60% Chem. Mult. 40% ENR Mult. see Note (5) |
|---|---|---|---|---|---|
| 1940 | 242 | **26.4** | 37.2 | 10.6 | **16.9** |
| 1941 | 258 | **24.8** | 39.7 | 10.0 | **15.9** |
| 1942 | 276 | **23.2** | 42.5 | 9.3 | **14.9** |
| 1943 | 290 | **22.1** | 44.6 | 8.9 | **14.1** |
| 1944 | 299 | **21.4** | 46.0 | 8.6 | **13.7** |
| 1945 | 308 | **20.8** | 47.4 | 8.3 | **13.3** |
| 1946 | 346 | **18.5** | 53.2 | 7.4 | **11.9** |
| 1947 | 413 | **15.5** | 64.8 | 6.1 | **9.9** |
| 1948 | 461 | **13.9** | 70.2 | 5.6 | **8.9** |
| 1949 | 477 | **13.4** | 71.4 | 5.5 | **8.7** |
| 1950 | 510 | **12.5** | 73.9 | 5.4 | **8.2** |
| 1951 | 543 | **11.8** | 80.4 | 4.9 | **7.7** |
| 1952 | 569 | **11.2** | 81.3 | 4.9 | **7.4** |
| 1953 | 600 | **10.7** | 84.7 | 4.7 | **7.1** |
| 1954 | 628 | **10.2** | 86.1 | 4.6 | **6.8** |
| 1955 | 660 | **9.7** | 88.3 | 4.5 | **6.6** |
| 1956 | 692 | **9.2** | 93.9 | 4.2 | **6.2** |
| 1957 | 724 | **8.8** | 98.5 | 4.0 | **5.9** |
| 1958 | 759 | **8.4** | 99.7 | 4.0 | **5.8** |
| 1959 | 797 | **8.0** | 101.8 | 3.9 | **5.5** |
| 1960 | 824 | **7.8** | 102.0 | 3.9 | **5.4** |
| 1961 | 847 | **7.6** | 101.5 | 3.9 | **5.4** |
| 1962 | 872 | **7.3** | 102.0 | 3.9 | **5.3** |
| 1963 | 901 | **7.1** | 102.4 | 3.9 | **5.2** |
| 1964 | 936 | **6.8** | 103.3 | 3.8 | **5.0** |
| 1965 | 971 | **6.6** | 104.2 | 3.8 | **4.9** |
| 1966 | 1019 | **6.3** | 107.2 | 3.7 | **4.7** |
| 1967 | 1074 | **6.0** | 109.7 | 3.6 | **4.5** |
| 1968 | 1155 | **5.5** | 113.7 | 3.5 | **4.3** |
| 1969 | 1269 | **5.0** | 119.0 | 3.3 | **4.0** |
| 1970 | 1381 | **4.6** | 125.7 | 3.1 | **3.7** |
| 1971 | 1581 | **4.0** | 132.3 | 3.0 | **3.4** |
| 1972 | 1735 | **3.7** | 137.2 | 2.9 | **3.2** |
| 1973 | 1895 | **3.4** | 144.1 | 2.7 | **3.0** |
| 1974 | 2020 | **3.2** | 165.4 | 2.4 | **2.7** |
| 1975 | 2212 | **2.9** | 182.4 | 2.2 | **2.5** |
| 1976 | 2401 | **2.7** | 192.1 | 2.1 | **2.3** |
| 1977 | 2576 | **2.5** | 204.1 | 1.9 | **2.2** |
| 1978 | 2776 | **2.3** | 218.8 | 1.8 | **2.0** |
| 1979 | 3003 | **2.1** | 238.7 | 1.7 | **1.8** |
| 1980 | 3237 | **2.0** | 261.2 | 1.5 | **1.7** |

| Year | ENR Index see Note (1) | **Civil Projects** ENR Multiplier see Note (2) | Chem Engr'g Plant Index see Note (3) | Chem Engr'g Multiplier see Note (4) | **Process Plants** 60% Chem. Mult. 40% ENR Mult. see Note (5) |
|---|---|---|---|---|---|
| 1982 | 3825 | **1.7** | 314.0 | 1.3 | **1.4** |
| 1983 | 4066 | **1.6** | 317.0 | 1.2 | **1.4** |
| 1984 | 4146 | **1.5** | 322.7 | 1.2 | **1.4** |
| 1985 | 4195 | **1.5** | 325.3 | 1.2 | **1.3** |
| 1986 | 4295 | **1.5** | 318.4 | 1.2 | **1.3** |
| 1987 | 4406 | **1.5** | 323.8 | 1.2 | **1.3** |
| 1988 | 4519 | **1.4** | 342.5 | 1.2 | **1.3** |
| 1989 | 4615 | **1.4** | 355.4 | 1.1 | **1.2** |
| 1990 | 4732 | **1.4** | 357.6 | 1.1 | **1.2** |
| 1991 | 4835 | **1.3** | 361.3 | 1.1 | **1.2** |
| 1992 | 4985 | **1.3** | 358.2 | 1.1 | **1.2** |
| 1993 | 5210 | **1.2** | 359.2 | 1.1 | **1.2** |
| 1994 | 5408 | **1.2** | 368.1 | 1.1 | **1.1** |
| 1995 | 5471 | **1.2** | 381.1 | 1.0 | **1.1** |
| 1996 | 5620 | **1.1** | 381.7 | 1.0 | **1.1** |
| 1997 | 5826 | **1.1** | 386.5 | 1.0 | **1.1** |
| 1998 | 5920 | **1.1** | 389.5 | 1.0 | **1.0** |
| 1999 | 6059 | **1.1** | 390.6 | 1.0 | **1.0** |
| 2000 | 6221 | **1.0** | 394.1 | 1.0 | **1.0** |
| 2001 | 6396 | **1.0** | 395.4 | 1.0 | **1.0** |

## Definitions

Note (1) The ENR Index is the Construction Cost Index published by the magazine the "Engineering News Record. It is published monthly and annually.

Note (2) The ENR Multiplier is used here for **Civil Works** Projects. It is defined as a factor for the year 2001, using the ENR Index as a base (the numerator) divided by the relevant ENR Index.
[i.e.; for the year 1942 divide 6396 by 276 for a multiplier of 23.2.]

Note (3) The Chem Engr'g Plant Index is the index published by the magazine "Chemical Engineering". The plant index covers process plant equipment.

Note (4) The Chem Engr'g Multiplier as used here is developed by taking the Chem Engr'g Plant Index for the year 2001 as the base year (the numerator) and dividing the the Plant Index for a relevant year.
[i.e.;for a process plant in the year 1942 divide 395.4 by 42.5 = 9.3].

Note (5) For **Process Plants** this system uses 60% of the Chem Engr'g Multiplier plus 40% of the **Civil Works** multiplier. We estimate that such plants have 60% equipment and 40% infrastructure.
[i.e.;for a process plant in the year 1942, take .6 x 9.3 + .4 x 23.1 = 14.9].

Note (6) The methodology used here was defined jointly by Harry Thayer and Sam Ruvkun

# The Kaiser Story

## Introduction

Most of us who were Kaiser Engineers have impressed our children with Henry Kaiser's undertakings, especially the works of his engineers and builders with whom we made our own livings. However, many others of our children's generation, and perhaps the entire generation of our grandchildren, may never have heard of Henry Kaiser, his life accomplishments, and the empire he built. We have written *Together We Build*, the history of Kaiser Engineers, to record this Kaiser company's accomplishments. The editors believe also that *Together We Build* offers a timely opportunity to recant a bit of history about Henry Kaiser's other enterprises and companies, especially their origins and what has happened to them.

The book, *The Kaiser Story*, published in 1968 by Kaiser Industries Corporation, contains many interesting stories about Henry Kaiser's undertakings and the origins and growth of his industrial companies. Several of the authors of *Together We Build* have included references to or have quoted parts of *The Kaiser Story* in their writings. Additionally, the editors elected to include in this Appendix selected chapters of *The Kaiser Story* because the history of Kaiser Engineers is so intertwined with Henry Kaiser's undertakings and his industrial enterprises.

The included chapters of *The Kaiser Story* are described briefly below.

## Prefabricated Captain

This is the story of the Kaiser Shipyards during World War II. It was the largest, most productive, most economical, and profitable of all of the private ship- building operations during the war. Its earned profits were the capital for Henry Kaiser's postwar enterprise start-ups. KE, as an entity, did not design or build these yards. Each yard complex in Richmond and in Oregon-Washington had its own staff of engineers and construction people who built the yards and then ran them. A number of these people, upon completing their tours of duty in the shipyards, eventually migrated to KE, becoming key executives helping direct the growth and accomplishments of the company. They include the following:

| | |
|---|---|
| Bill Ball | Jack Hughes |
| Tim Bedford | Einar Larsen |
| Harry Bernat | Jim McCloud |
| Vic Cole | Carl Olson |
| Jim Foster | Bob Rice |
| Joe Friedman | Sam Ruvkun |
| Clarence Granger | Maury Wortman |
| John Hallett | |

## Uphill Drive

This is the story of Henry Kaiser's Kaiser-Frazer automobile manufacturing enterprise, perhaps the most ambitious of all of his undertakings. On August 9, 1945, Kaiser-Frazer was incorporated in Nevada, five days before V-J Day. The company made quality automobiles that were ahead of their time in concept and styling. However, despite its initial successes, the company fell victim to a number of coinciding factors, including a market downturn, the Korean War, and insufficient capitalization. But the automobile business was a precursor for two of KE's projects described in *Together We Build*. They are the Industrias Kaiser Argentina and Willys Overland do Brasil automobile plants built in Argentina and Brazil. Equipment, management and supervisory operating personnel for these plants came from Kaiser-Frazer.

We include a concise description of the Kaiser-Frazer venture because we built the South American successor plants and because so many of KE's personnel eventually migrated to KE from K-F. The following lists the people who came to KE. Note many of the names also appear in the listing of the shipyard roster of management people who went to KE.

| | |
|---|---|
| Harry Bernat | Jim McCloud |
| Vic Cole | Don Mielbeck |
| Joe Friedman | Carl Olson |
| Clarence Granger | Max Pearce |
| John Hallett | Bob Rice |
| John Heffernan | Sam Ruvkun |

## Postwar Gamble

This is the story of how Henry Kaiser, building upon his prewar enterprises, his war-time-built steel mill, and his war-time shipyard profits launched into new enterprises, including aluminum production, home building materials, and expansion of his cement and steel manufacturing operations. The article fails to describe KE's role in designing and building the new plants and the cement and steel plant expansion programs that were undertaken during the initial postwar years. This was a period of rapid growth for KE and the times of some of the company's most impressive accomplishments.

## Years of Expansion

This period includes the evolution of Kaiser Industries Corporation from Kaiser Motors Corporation and the expansion of the company's aluminum and steel businesses. Henry Kaiser "invaded" the Hawaiian Islands.

## Prescription for Health

This chapter of the *Kaiser Story* is a historical perspective of the origins and early years of the Kaiser Foundation Health Plan, now known as the Kaiser Permanente Medical Care Program. The article notes that by 1968 the plan had 1.7 million members in California, Oregon, Washington, and Hawaii. It had become the nation's largest, privately sponsored, direct service, pre-paid health care program.

*(Editors' Note:* By 2002, Kaiser Permanente, still the nation's largest and highly rated Health Maintenance Organization had grown to a total membership of 8.3 million people. Its annual revenues in 2001 exceeded $14.3 billion. On May 1, 2002, *(SF Chronicle)* Dale Crandall, president of Kaiser Permanente, said that the company's 2002 capital budget—used to improve and build hospitals and clinics—is $1.6 billion, up from $1 billion spent in 2001 and $650 million in each of the two years before that.)

## Kaiser Companies in 1968

The final chapter of *The Kaiser Story* included an assessment of the status in 1968 of each of the Kaiser organization's affiliates. It is quoted below:

"Diversification is the theme of **Kaiser Aluminum and Chemical Corporation** as the Seventies approach. From a standing start in 1946, the company, under President Tom Ready and former President Dusty Rhodes, has grown to be the largest of the affiliated Kaiser companies with over 27,000 employees, sales (1967) of $772 million and earnings of $54 million. During the Sixties, the company consolidated its position as the fourth largest producer of aluminum in the world and one of the nation's leading producers of refractories and agricultural chemicals. It is also engaged in industrial chemicals and magnesium. With Societe Le Nickel of France, it has recently entered the nickel business. Kaiser Aluminum's strength also lies in its access to an abundance of raw materials, with extensive bauxite deposits in Jamaica and Australia and other mineral deposits from Utah to Peru.

**Kaiser Steel Corporation**, led by President Jack Ashby, set production and sales records in 1967 en route to record earnings of $33 million and firmly solidified its position as the largest integrated steel company in the West. Providing steel for skyscrapers, bridges, pipelines, and hundreds of other uses, Kaiser Steel has emerged as a leader in mining and raw materials, not only in the United States but worldwide, thanks to its 36-percent share in Hamersley Holdings Limited (iron ore and pellets) in Australia and its 100-percent ownership of Kaiser Coal, Ltd. in Canada.

**Kaiser Cement and Gypsum Corporation**, under President Peter Hass, showed sales of $94 million in 1967, and recent expansions have left the company in a good position to take advantage of the large-scale growth that economists foresee for the next decade. A Pacific-oriented company in the Fifties, **Kaiser Cement** moved farther afield in the Sixties, with production plants in Montana and Texas and then overseas in Thailand and Okinawa. Served by its own steamship line, five manufacturing plants, and 18 distribution plants, the company's markets extend from Alaska to Mexico and from Texas to the Far East. **Kaiser Gypsum**, under President Claude Harper, paralleled its parent company's expansion during the Sixties by moving into Eastern markets with plants in Florida and New Jersey. It is the fourth largest producer of wallboard and other gypsum products in the United States.

**Kaiser Engineers**, a division of Kaiser Industries, traces its antecedents back to Henry Kaiser's earliest projects. In 1968, Kaiser Engineers was operating in 21 states and 13 foreign countries and had a work backlog of $600 million. Lou Oppenheim is Vice President and General Manager of the engineering division.

**National Steel and Shipbuilding Company**, a joint-venture company owned by Kaiser Industries and Morrison Knudsen, operates a shipyard in San Diego, California, under management of Kaiser Engineers.

The oldest Kaiser operation with a product, **Kaiser Sand & Gravel,** has been growing in the Sixties, spreading to 27 plants in California and Nevada. It provides such related products as ready-mix concrete, lightweight aggregates, and asphaltic paving materials as well as sand and gravel.

Led by President Steve Girard, **Kaiser Jeep Corporation's** annual sales grew to $471 million in 1967. The company introduced the sporty "Jeepster" vehicles at Toledo, Ohio, highlighting its commercial 4-wheel-drive line, and manufactures heavy-duty trucks and other vehicles for the government.

Headed by President Clay Bedford, **Kaiser Aerospace & Electronics Corporation** moved ahead with its work supplying aircraft and missile components and electronic equipment.

**Kaiser Hawaii Kai Corporation**, under Vice President and General Manager K. Tim Yee, carried on Henry Kaiser's dream of building a new city in Hawaii.

And **Kaiser Broadcasting Corporation**, directed by Vice President and General Manager Richard Block, opened UHF television stations in six of the eight largest U.S. markets and began feasibility studies for a new television network."

## The Kaiser Story–An Afterword, 1988

The decision of the editors of *Together We Build* to include in its Appendix the abstracts from Kaiser Industries' 1968 publication, *The Kaiser Story*, was made because of the historical relationships between KE and the affiliated Kaiser companies. *The Kaiser Story's* "upbeat" assessment in 1968 of the affiliated companies' status and future suggests the need to provide closure as to their status today.

Such closure is included in Al Heiner's book, *Henry J. Kaiser, Western Colossus.* In it, he discusses the life and vast accomplishments of Henry Kaiser. Its Afterword includes a description of the status of Henry Kaiser's companies, 20 years after *The Kaiser Story* was written. Excerpts from Heiner's Afterword are quoted below:

"Now in 1988, only 21 years after his death, all of his industrial companies have been sold or have gone out of business. Operated generally under the name Kaiser, but with entirely different ownership, many of these companies are reasonably successful. The two major entities that have remained unscathed are:

- The immensely successful and growing Kaiser Permanente Health Care Program.
- The Henry J. Kaiser Family Foundation which had $80 million shortly following his death and which has grown to over $350 million.

Typical of the travails that have beset the industrial companies are:

- Kaiser Aluminum and Chemical Corporation which sold off most of its chemical operations and huge real estate assets to help offset operating losses, and which is now subject to different ownership, under the name Kaiser Tech, Inc. (Editors note, Kaiser Tech filed for Chapter 11 bankruptcy protection in 2002).
- Kaiser Cement Corporation which, after selling off all except its main plant, now appears to be a viable company under foreign ownership.

By far, the saddest—and most shocking—collapse of all (except for the demise of Kaiser-Frazer automobile company when Kaiser was still alive) has befallen the once mighty Kaiser Steel Corporation, which was plundered by corporate raiders bringing on bankruptcy in early 1987 and making it impossible for the company to keep up its payments on health insurance, life insurance, and even some pensions for the retired employees who actually built the company.

Heiner, in his Afterword, suggests causes for the "shocking disintegration of the Kaiser family of companies." He suggests that the reasons include 1) the radical changes in costs of production and market competition, and 2) lack of dynamic, forward-looking leadership comparable to that provided by Kaiser himself when he was alive. He ends with the following paragraph:

"It's for those industrialists who deeply believe in our free enterprise system; it's for students of history; it's for young people who dream mighty dreams of their own, to keep alive the memory of what he did and how he did it—this man, Henry J. Kaiser, America's bold and spectacular entrepreneur."

# The Prefabricated Captain

To construction men, fresh from the conquest of rivers, a ship was nothing but a dam that wouldn't stay put. A steel plate was just some cement that had spread out flat and hardened in the rain, and a keel plate was nothing but bedrock.

Nor were their bosses much more knowledgeable in the lore of the sea. They called a bow "the front end," and a bridge was something across a river. Before the first Kaiser meeting in New York with maritime officials, these "hard hats" picked up a glossary of shipbuilding terms from the public library so they would at least sound professional.

It all began with a ship almost nobody has heard of—and a man then unknown outside of the construction business. The *Dorington Court* was a rolling, pitching, maid-of-all-work, built in Britain in the mid-'30s. She was ugly, but willing. She could make 11 knots on good days with a following sea. A fancier ship would take too long to build; a faster ship would be wasted in a convoy of older freighters; a more powerful ship would burn too much fuel.

The *Dorington Court* was an example of what the British urgently needed to replace the merchant ships torpedoed in the early months of the war. Those ships were Britain's lifeline because she had to import huge quantities of food for her people and raw materials for her factories. Without those ships Britain might be starved into submission.

It was Britain's darkest hour as the Admiralty sent its Technical Merchant Shipbuilding Commission to the U.S. "to endeavor to obtain, at the earliest possible moment, the delivery of merchant tonnage from U.S. shipyards, at the rate per annum of about 60 vessels of the tramp type of about 10,000 tons deadweight."

The British mission landed in New York in September, 1940, when Hitler's bombers were pulverizing British cities, and his armies were massing in France preparing to invade. The mission took off on a whirlwind tour of shipyards, but found them all choked with war work.

Someplace along the route they met Mr. Kaiser as the British mission later reported. It was a fair assessment of the Kaiser publicity rating at that time.

The *Saturday Evening Post* commented in a story at this time, "Ever heard of Henry Kaiser? Probably not." But a contemporary remembers Kaiser's first step into a field that soon made his name a byword, "Almost all of the members of the Six Companies had been thinking about shipyards, in a casual fashion, ever since the Maritime Commission announced its plan to renovate the Merchant Marine, 90 percent of which was World War I-vintage or older.

"Through association with J. A. (Jack) McEachern of Seattle's General Construction Company, there were talks with R. I. Lamont and John O. Reilly of Todd Shipyards. Then in 1939, the Maritime Commission called for bids on five C-1 cargo ships and, with a contract to shoot at, the parties went into action. The Seattle-Tacoma Shipbuilding Corporation was put together, some of the Six Company group and McEachern splitting the company 50-50 with Todd. Their bid was accepted, and a new shipyard was blueprinted for Tacoma, Washington, to do the work.

"While this was underway, the same group created the Todd California Shipbuilding Corporation and got the order from the British, worth $120 million for the 60 tramps, 30 of them to be built at Richmond, California, which still were mudflats when the deal was made; the contract called for the other 30 to be built in the East, and a partnership was formed with the Bath Iron Works of Maine."

The Six Companies, with Henry Kaiser as sponsor, went to work. Hard-core of the shipbuilding force were seasoned workers from Grand Coulee Dam, and these were split between shipyards-to-be at Richmond under Clay Bedford and at Portland, Oregon, with Edgar Kaiser in charge.

The first yard was started at Richmond in December, 1940, and the keel of the first ship for the British, the *Ocean Vanguard*, was laid there by April, before construction of the yard was half finished.

During 1941, three U.S. emergency programs for Liberty ships were begun, culminating in the nation's declaration of war and the President's call for shipbuilding of historic dimensions. In answer, seven Kaiser-managed shipyards containing 58 shipways rose in California, Oregon, and Washington. Four of the yards were a partnership among various members of the Six Companies, and the other three were owned outright by the Kaiser organization (which also had financial interests in Calship of Los Angeles and shipbuilding companies in Indiana and Rhode Island).

Here, in the shipyards, came into play all the dynamics of materials flow, the rhythm of operations, and the management of masses of workers that the company had learned in a quarter century of building roads and dams. New ships had to be produced much faster than ever before, and traditional methods simply wouldn't get the job done. Shipyards had previously been thought of in terms of acres; Kaiser yards covered miles so that the mountains of materials could be handled efficiently. Fast welding techniques just about eliminated laborious riveting; the traditional piece-by-piece way of putting ships together was scrapped in favor of prefabrication. Finally, yards were laid out like assembly lines with the steel and parts flowing smoothly from flat cars to completed vessels.

The action never stopped. Great floodlights turned night almost into day, just as at the dams. At night, a wandering "hand gang" of men—too new and unskilled to do anything else—picking up bits and pieces of scrap to keep the assembly areas safe, would burst into song. The rich voices of Tennessee and Georgia would chant, "Praise the Lord and pass another section." There was a kind of glory to it that hasn't been seen since.

Spirit-plus organization paid off in time and production. The first Liberty ship was delivered in 226 days, a new U.S. record, but records became commonplace. There was a new one with virtually every succeeding ship. Keel-to-launching was progressively chopped down to but 27 days—one-eighth the old time—as the Portland and Richmond yards competed for honors. In time, freighters were being launched at the rate of one each day. When the first ship, the *Ocean Vanguard*, was launched at Richmond, Britain's Sir Arthur Salter was making the introductory speech prior to the naming ceremony. He spoke enthusiastically of the speed at which the ship had been built: "She is ahead of her time," he said, and at that moment, without waiting for her baptism of champagne, the ship slid majestically—and prematurely—down the ways.

Nowhere was the pace and efficiency of this mass production displayed more than in the construction of the Liberty *Robert E. Peary* at the Richmond Yard Two in 4 days, 15 hours, and 26 minutes.

Alyce Mano Kramer described it in her book, **Story of the Richmond Shipyards** . "Yard Two became hushed in the silent awe that precedes the critical engagement. Her people had publicly promised America a second home front in the form of the fastest shipbuilding job in history.

"At the stroke of 12, Way One exploded into life. Crews of workers like a champion football team swarmed to their places in the line, within 60 seconds, the keel was swinging into position...Hull 440 was going up.

"The speed was unbelievable. At midnight, Saturday, an empty way—at midnight, Sunday, a full-grown hull met the eyes of graveyard workers; they came on shift. Feverish, yet sure and methodical was the march against time. Orders were explicit, work was controlled, muscles were strained, hearts were busting with hope and pride..."

While many of the techniques used for Hull 4 already had been devised at the Kaiser yards, the Peary was a laboratory for new ones, which had became standard practice on subsequent hulls. Prefabrication of the peaks—the front and back ends—of ships was old stuff. On Hull 440 these giant sections were completely fitted out, even to the ship's name on the bow, before being lifted into position.

On this job, welding achieved the smoothness of a ballet. Seventeen banks of welding machines were used on each side of the hull. Each crew had a specified job and location, and new shifts moved on the spot before the rods of departing work had cooled.

Each of the deck sections resembled a mammoth stage set. On earlier Liberty ships, the main deck had been lifted into position in 23 pieces. On Hull 440, it was delivered in seven large sections. As cranes swung parts of the deckhouse into position on the hull, bunks, chests of drawers, mirrors, electric fans and fixtures, washstands, and flooring were already in place.

The main deckhouses weighed 250 tons each, and the cranes weren't big enough to carry them.

So, after they were assembled, they were cut by torches into four pieces, hoisted on to the deck, then welded back together again. Since there were 26,000 feet of welding in an entire deckhouse, and it took only 526 feet of weld to fasten the pieces together again, it made sense to slice the deck apart after it was built.

Less than three days after launching, the *Robert E. Peary* sailed away under her own power 7days, 14hours, 29 minutes after her keel was laid.

Two years later, the War Shipping Administration released a report about the ship that was "thrown together as a stunt," as her critics described her. "On her maiden voyage out of San Francisco in November, 1942, this phenomenal vessel covered 19,000 miles, carrying cargoes to or from Noumea, New Caledonia; Esperito Santo, New Hebrides; Tulagi, Solomon Islands; Suva, Fiji Islands; Antofagasta and Iquique, Chile, finally reaching Savannah, Georgia.

"In her first year of war cargo transport, the Robert E. Peary voyaged more than 42,000 miles. Masters and engineers reports show that her mechanical and navigational efficiency equals that of sister ships much longer on the ways."

The Commission's statement was perhaps the ultimate testimonial to both the construction methods and the resulting hardiness of the Liberties. At first, a few had sprung cracks along their weld lines, and investigations showed that the ordinary mild steel used to build them became brittle at low temperatures. Cracking was stopped by "stitching" key welds with rivets and the problem was solved. Altogether, out of the U.S. Maritime Commission's grand total of 4,694 vessels of all types, only eight ships were lost at sea due to weld failure during the entire war.

Built "to last five years" many of the great convoy of Liberty ships have yet to meet the rendezvous with the Hong Kong shipbreakers. The average Kaiser-built Liberty cost about $1 million to build. As late as 1963, the Russians paid $168,000 for a 1943 Liberty, and during every war crisis, such as Korea and Vietnam, the demand for them and their prices—goes up dramatically.

The liberties were dubbed "Ugly Duckling," and in the early months of the war they had a bad public image. Admiral Emory Land then sent out a press release that contained the first use of the words 'Liberty Fleet," and President Roosevelt used the phrase in a special announcement. From then on, virtually every "Liberty" became a symbol of American invention and productive genius.

Despite unprecedented speed of construction, ships were being torpedoed and sunk faster than they could be built, and Henry Kaiser was concerned at seeing them "go down without serving their purpose." During a routine launching speech at Portland in 1942, he proposed adapting shipbuilding techniques to building 5,000 "aerial freighters"—flying boats carrying up to 1,000 men or equivalent cargo—to hop over the submarine menace and virtually eliminate losses.

At about the same time, he also announced that a small aircraft carrier had been designed for Kaiser—basically a cargo ship with a flight deck that could be turned out quickly—to take convoys through the submarine packs and also give them protection from air attack. This second idea, initially vetoed by the Navy, finally was adopted and 50 of the "baby flat tops" were delivered from the Vancouver, Washington, yard at the rate of nearly one a week.

Mass building of ships required building an army of workers fast; at peak there were 197,000 of them in the Kaiser yards. They came by train, by bus, in old cars, and by hitchhiking. They were teen-agers and grandmothers, the strong and the weak, the skilled and the unskilled, all races, creeds and colors.

The drive to recruit workers began in June, 1942. Manpower was scarce. Live-wire recruiters scraped up several thousand workers in the Los Angeles area and sent them north. In October, the recruiters headed east. By November, they were set up in Minneapolis and offering to pay transportation as a form of advance against workers' salaries. Some 38,000 employees were found in this way. Another 60,000 at least picked up employment referral cards and came out on their own.

Vanport City, built by the Six Companies in 110 days in swampland between Portland and Vancouver, became Oregon's second largest city. At its peak there were 10,400 housing units and hospitals, schools, and shops for more than 40,000 people.

In New York City, the *Herald-Tribune* said: "Henry Kaiser has two personnel representatives here to see if 20,000 laborers can be hired for his West Coast shipyards. A harassed official at the U.S. Employment Service reluctantly confirmed it. Primly, one said, 'Those connected with the plan hope that New York workers will avoid nurturing false hope, for if it should collapse, it would be too bad.'" The 20,000—and those who followed—soon proved the value of coast-to-coast recruiting.

It was a constantly changing work force. Some went overseas, and others moved to other defense work. Eventually, more than 1 million names found their way into the shipyard personnel files. A surprisingly large number were women in a field that always had been considered a male domain. By the middle of 1944, women constituted a fourth of all shipyard employees; special childcare centers were built for their children.

Home-to-work traffic constituted a special problem. For Richmond, the moribund New York elevated electric cars were shipped across country and put into service on a special “Shipyard Railway” from Oakland. Ferry boats were dug out of the mud, refitted, and began shuttling across the Bay.

Once on the job, most of the workers had to be trained quickly. Only 2 percent of them had ever worked in a shipyard, and some had never seen a ship before. Skills, once mastered, were focused on a single operation. All fabrication was divided into components, and the same people worked on the same components day after day. They became experts, not in shipbuilding, but in performing one small job out of the total. This was the real secret—the job was made to fit the man.

Along with the problems of insufficient manpower, training, facilities, and transportation, there was always a shortage of materials. The role of the “expediter” was created. To this day, the expediter remains a symbol of the Kaiser spirit. He was a salesman in reverse, a boomer who was buying hard to get parts and materials from coast to coast. Not allowed by railroad regulations to ride in the freight train caboose, he grabbed passenger trains, went on ahead, and waited in the freight yard for the cars with their big “Kaiser” stickers to come in. Then he bothered everybody in sight until the freight car was on its way again, hopped another passenger train, and did the same thing at the next terminal.

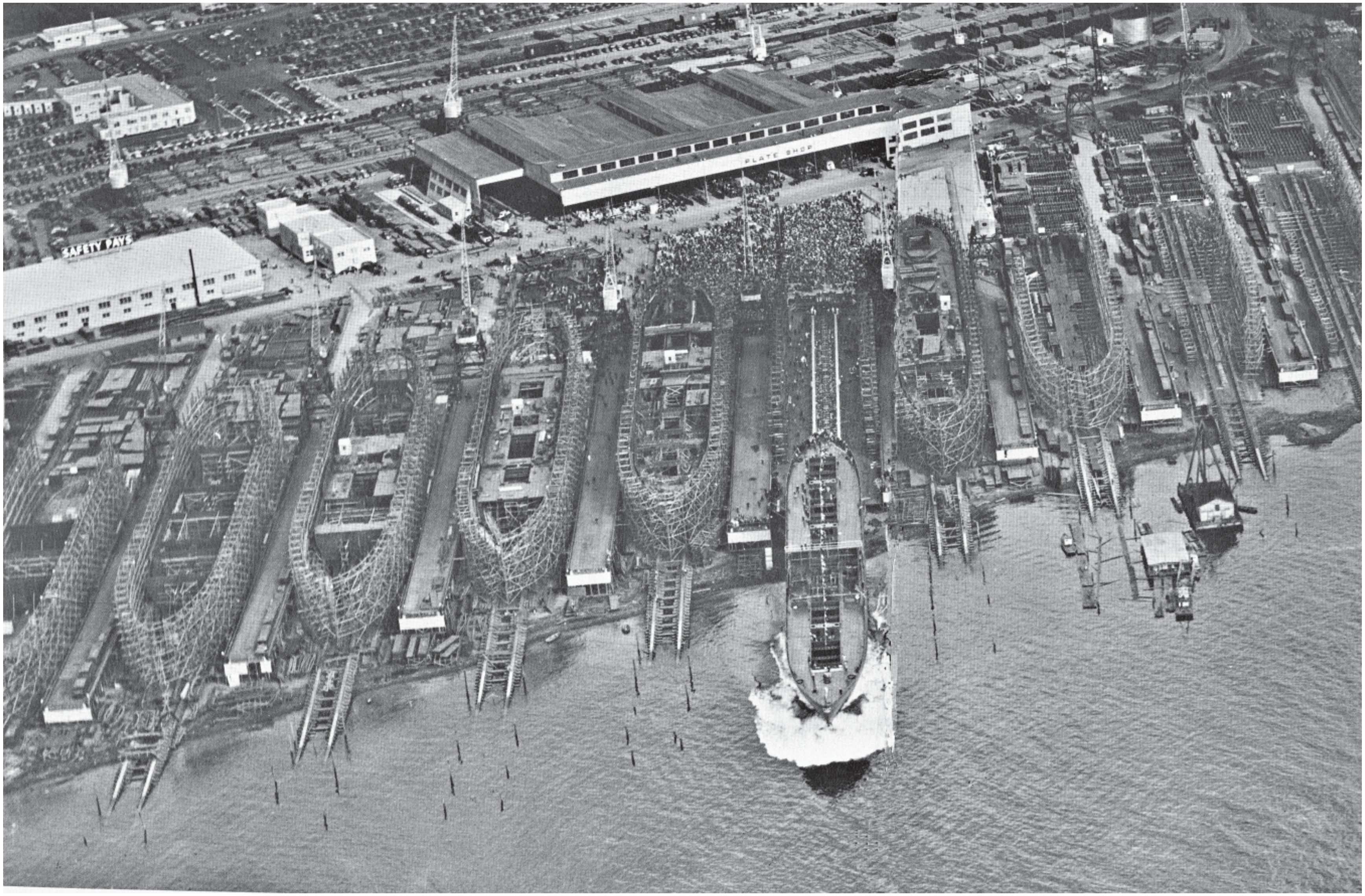
It was said that there were only two ways for an expediter to get fired. One was to bully a supplier; the other was to take “no” for an answer. They must have worked it out some way, for hundreds of them stayed on the payroll and are now scattered through the Kaiser organization, making life miserable for everybody who says, “It can’t be done.”

The net result of all this was that the Kaiser Shipyards delivered 1,490 vessels, including 821 Liberties, 50 small aircraft carriers, 219 Victory cargo ships, 24 miscellaneous freighters, 45 troop transports, 87 combat transports, 45 landing ship tank vessels (LST’s), 12 frigates for convoy escort duty, and 147 tankers—more than 15 million deadweight tons of shipping—equal to 27 percent of total U.S. Maritime Commission construction. On Liberty ships alone, government records show that the Kaiser yards saved the U.S. more than $266 million over the average cost of the same type built in other yards, and on all ships combined, built them in two-thirds the time and at 25 percent less cost than the average of all other shipyards. An officer of the company recalls, “Edgar Kaiser had said early in the war that ‘the only limit seemed to be how much we could absorb.’” Obviously, that limit was not reached in the shipyards, for simultaneously in engineering and construction, other Kaiser people were participating in the building of air bases, aqueducts, harbors, power plants, tunnels, housing, troop facilities, dry docks, dams, naval installations, and pipelines.

Others were manufacturing fighter aircraft and components and producing 1 million artillery shells and an equal number of fuses and boosters. In the raw materials field, they were producing 12 million tons of aggregates, 7.2 million barrels of bulk cement for the Pacific Theater of operations, 1.2 million tons of steel ingot, 21 million pounds of magnesium metal, and 82 million pounds of magnesium incendiary material.

“There also was excess energy somewhere to get into the non-business field of medical care.”

Altogether, the volume of the 5-year war job performed by the Kaiser organization and its partners totaled about $5 billion; the net profit was $40 million, or about 1 percent. Kaiser had entered the war years as a construction and engineering firm; it emerged with the skill to manufacture things that would help rebuild the postwar world. KE




The seven Kaiser Shipyards in World War II were actually gigantic factories designed to mass produce one of the most complex and exacting structures known to man—an ocean-going vessel on which men could live for weeks or even months. The Portland, Oregon, yard was one such ‘assembly line,’ comprising ships in varying stages of completion from keel block to a finished hull at the moment of launching.

# Uphill Drive

It is doubtful if any manufacturer had ever stormed Fort Detroit riding such a wave of public support as did the Kaiser-Frazer Corporation that first year after the war. The initial offering of K-F stock at $10 a share in September, 1945, was over-subscribed six times; a second issue shortly thereafter in January was snapped up at $20.25 as soon as it hit the market. Together with K-F's initial capitalization of $5 million, it amounted to more than $54 million with which to get started—a lot of money, but not in the auto world. General Motors was setting aside hundreds of millions—just to retool for its new models.

On January 20, 1946, two hand-made models of the Kaiser and Frazer cars were displayed at the Waldorf-Astoria in Manhattan. So excited was the car-starved public that a display window was crushed as people lined up two abreast in wintry weather and filed past the models until 10 o'clock at night. Orders were taken—on an automobile that hadn't been built yet, and at a price as yet unknown —for some 9,000 cars.

Detroit had seen a thousand would-be automobile makes come, and all but a handful go. There was no reason for K-F to fare any better, despite their renowned skill in mass production techniques and a sellers' market—the immediate backlog demand was estimated at 12 million cars, more than twice what all the companies could produce in one year.

Henry Kaiser had given thought to automobiles for some time. During the war, his engineers built prototypes, aluminum engines, front-wheel-drives, Fiberglass bodies, and other new features. There were even visions of a true "people's car" selling at low cost through gasoline stations and aimed at those who normally could afford only used cars. The selling slogan: "A dollar a day and throw it away."

Also inclined toward a new postwar automobile was Joseph W. Frazer, who once headed Willys Overland and later acquired control of Graham Paige; he had the noted designer Howard Darrin draw up some models. Mutual banking friends got Kaiser and Frazer together, and within an hour after they met, the two ambitions were merged. Kaiser-Frazer was incorporated in Nevada on August 9,1945, and part of the bold plan was to build the plant on the Pacific Coast where there had never been an auto manufacturing plant before. But the postwar era arrived suddenly just five days later — V-J Day—and there was no time for such geographical pioneering. A lease was secured on a huge war surplus plant at Willow Run, Michigan, in the heart of the established automobile-manufacturing complex. It had been designed to mass-produce bombers. Steel could enter one end, travel down and around almost 2 miles of assembly line under one roof, and come out the other end a car ready to drive away. It was the shipyards all over again, and the two shipyard bosses, Edgar Kaiser and Clay Bedford, took over.

The anticipated surfeit of basic materials after the war turned out, instead, to be scarcity. Whereas K-F was able to tool up to fabricate bodies and manufacture its own steering gear assemblies and some of its engines, it was dependent on some 3,000 suppliers. The lid was off rationing, and the pent up demand swallowed all the steel and glass and rubber in sight. Everybody was in the same boat, but with K-F there was a difference—it was a newcomer. New customers went to the end of the line.

The company didn't wait its turn. A corps of expediters, as in the shipyards, hit the road again and literally scoured the world for materials and parts. Sometimes steel actually was *flown* in to Willow Run in the morning and would be part of a finished car rolling off the assembly line the same day. In some months, there was never more than a two-day supply of engines standing between production and shutdown.

The company ferreted out the odd lots of steel; it bought a small steel plant of its own, leased and purchased blast furnaces for iron, and secured interests in steel rolling and fabricating mills. It financed new tooling for suppliers, so those suppliers could make the parts K-F needed.

Necessity eventually made the company so proficient in "miscellaneous" steel that by 1947 it became a source of supply and was loaning steel to other automakers when they ran short—Ford, Studebaker, Nash, and Hudson. In time, of course, "Big Steel" was in a position to help even the newcomer. Ultimately, K-F got crucial help in other ways; General Motors supplied hydromatic drives and gearboxes when a suppliers' strike threatened the whole Willow Run operation.

Extraordinary barter arrangements were commonplace. A manufacturer supplying K-F with radiators could not obtain copper to maintain delivery schedules; K-F learned that the bottleneck lay in the inability of a copper producer to increase output because he needed additional supplies of natural gas; the gas company could not deliver because it was unable to obtain steel pipelines to connect with the copper producer; the steel companies lacked pig iron to make the pipe; and blast furnace operators lacked coke for production of pig iron to be fabricated into steel.

Step by step, Kaiser-Frazer surmounted each obstacle. It obtained a supply of coke, which it swapped for pig iron at an Eastern furnace; the pig was shipped to Chicago where it was made into steel, which in turn was fabricated into gas pipe. The pipe was made available to the gas company, copper output was increased, and the radiator manufacturer received enough additional metal to meet his commitments to K-F.

Ingenious perhaps, but all the expediting, leasing, bartering, and scrounging cost K-F about 40 percent more than the regular mill prices for steel. This item alone meant millions of extra dollars.

When Car No. 1 rolled off the assembly line June, 1946, just eleven months after the firm had incorporated, many were surprised, not only that a car was actually produced, but that it was a quality car to boot.

The Kaiser was a middle-sized, four-door sedan seating six. It had a 6-cylinder, 100- horsepower L-head engine and was considered somewhat underpowered.

Otherwise, independent professional testers gave it their “good car” seal of approval. What was really different was the body design, immediately liked by the public and well ahead of the competition with its wide vision and lavish use of bright exterior and interior color combinations. The Frazer was virtually the same chassis and engine, but with custom appointments inside and out. The Kaiser originally was intended to compete with Fords, Chevrolets, and Plymouths, but it came on the market at the price of the next higher class. The Frazer was slightly more.

Some 11,750 cars came off the line that first year, about enough for display-only purposes in dealers’ showrooms; the company lost $19 million. In 1947, the first full year of production, Kaiser-Frazer turned out 144,500 cars and showed a profit of $19 million, an encouraging turnaround. The company was now the nation’s fourth largest passenger car producer, overtaking, for a period, such veteran names as Studebaker, Packard, Hudson, and Nash. The production race was momentarily won by K-F, but the marketing race was not.

The foundation of successful automobile merchandizing is a strong dealer organization—the men the buyer shakes hands with—and this, K-F was not able to build. It did not have volume production early enough to lure established dealers away from the older manufacturers, nor could it hold onto the best ones it developed once they had become successful.

Then there is the relationship between the American and his car, half of it psychological. By and large, auto buyers stick to makes having an established reputation, backed with good service, and carrying a high trade-in value. This is what Detroit is built on. An auto writer at the 1950 Chicago Auto Show said of the Kaiser car: “If they slapped a Buick label on it. It’d sell like hot cakes.” You do not create this sort of buyer-manufacturer relationship in just a few years.

No one knew it at the time, but the peak profit year already had been realized in 1947. The peak year for production, 181,000 cars, was reached in 1948—4.6 percent of total U.S. passenger car production—but profits slipped as costs increased. To stay in the market, Kaiser-Frazer now had to play the “new models” game for the first time; new models took tools; tools took major financing. An attempt was made to sell a third stock issue to the public in 1948, but that ran aground when an underwriter maneuvered out of an obligation to market the issue.

After the banks refused further help, the Reconstruction Finance Corporation was approached in mid-1949, and a contract was written up by October, but by then a full year had been lost. The 1950 model-to-be never got beyond the blueprint stage.

Consequently, a completely redesigned 1951 Kaiser car was introduced extra early in 1950. It was considered out in front of the rest of the field and influenced future designing by the industry. It had a low silhouette with a 60-inch overall height, a low center of gravity, “Continental” styling, a larger glass area than any other sedan, a 115-horsepower, high-torque engine, and exceptional roominess. Most important to K-F dealers, there were 12 body types, including a refinement of the “hard-top” sedan, introduced first by K-F two years earlier. The cars sold well, 151,000 coming off the line that year, and 49,000 more in the first quarter of 1951.

Another bright K-F note was the introduction of a new kind of car at the Chicago Auto Show in 1950. It was engineered to sell at a price about $500 below the standard-size car with a "fast-back" design, low maintenance, and operating costs, 4-cylinder engines advertised at 40 miles to the gallon, and an optional 6-cylinder power plant.

It did not have a name. *Newsweek* called it "showstopper—the long-awaited, revolutionary, low-priced "You name it" car, a 2-door, 5-seater with a modified Studebaker-like silhouette, plus Cadillac-like tailfins.

Ultimately named the "Henry J" (through a national "name the car" contest), it was the first popular American-made compact car. It had arrived on the scene about 10 years ahead of its time—but even so, 30,000 units were sold in the first three months and another 45,000 the next year.

The company was at the five-year mark in its history; its efforts had resulted in an accumulated loss of $34 million. The Korean War began, and a new round of restrictions on metals, rubber, and parts came back to haunt Willow Runners. The period was marked by the test marketing of the Allstate, a slightly modified Henry J, which was to be sold, like refrigerators, by Sears Roebuck, with a money-back guarantee. The Darrin appeared, a sports car with fiberglass body. Korean defense work was added, and aircraft. "Flying Boxcar" cargo carriers once again began to go down the assembly lines at Willow Run along with automobiles.

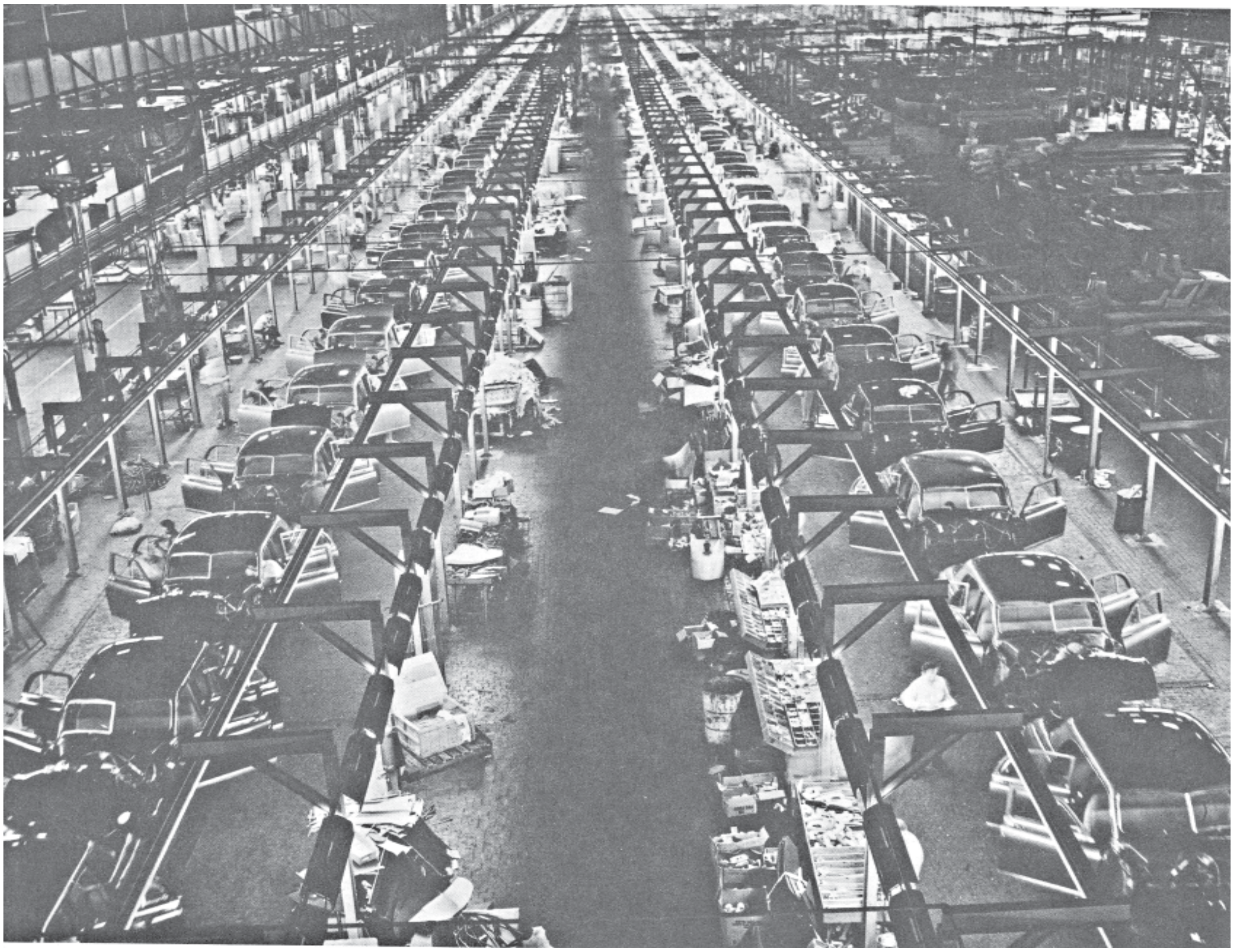
But then the general car market took an unexpected nose-dive. It turned out to be the start of three bad car years for the entire industry. K-F could afford it least.

Sales dwindled to 70,000 in 1952 and 34,000 in 1953, and losses mounted. In April, in order to establish a new base for its automotive operations, a subsidiary of Kaiser-Frazer bought the assets of Willys-Overland Motors, Inc. and its profitable Jeep business in Toledo, Ohio, for approximately $60 million. The funds came from the sale of preferred stock and bank borrowings. The name of Kaiser-Frazer was changed to Kaiser Motors Corporation. Willow Run was sold to General Motors, and operations were consolidated at Toledo.

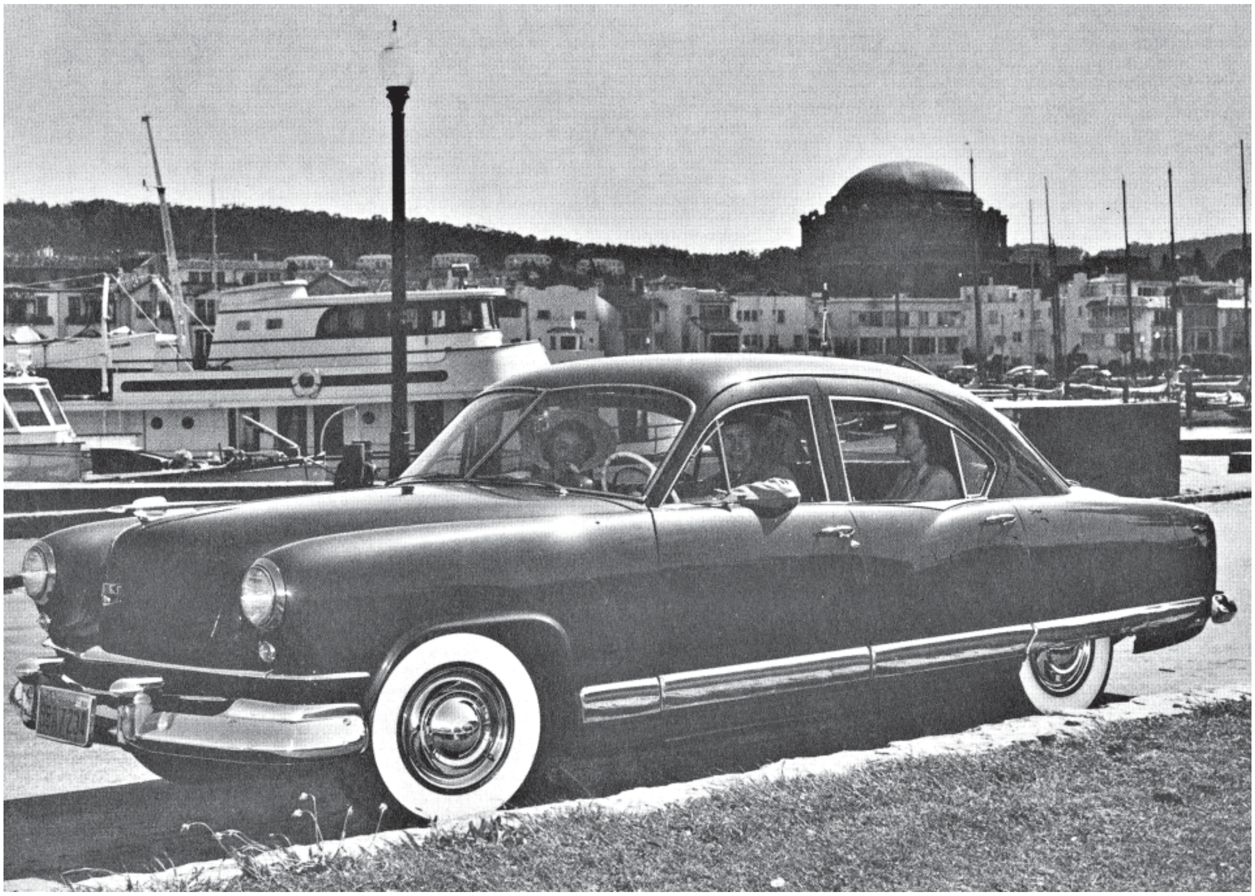
By late 1954, it was evident that the Kaiser team was losing its hard-fought postwar invasion of the passenger car field. Formal announcement of the withdrawal came in early 1955. In nine years, Kaiser had broken production bottlenecks to put 750,000 autos on the road, among them models that anticipated later Detroit trends—the compact, the personal car, and the "safe" sedan. But the company had foundered on its lack of capitalization.

The battle of Willow Run had left two sound survivors. There was the growing Jeep business and a promising subsidiary in the aircraft and electronics fields. Of unknown value were the other leftover assets from the passenger car business—several millions of dollars worth of surplus tools and dies, and a nucleus of men who had learned the hard way how to start an automotive enterprise from scratch and now wanted to stay in the business. If these Willow Run veterans could be put to good use, it would be a big step toward solving Kaiser Motors' problems. Two thousand miles to the West, the man who had redeemed a lost bid on Shasta Dam—by producing its cement supply—considered what might be salvaged from Willow Run.

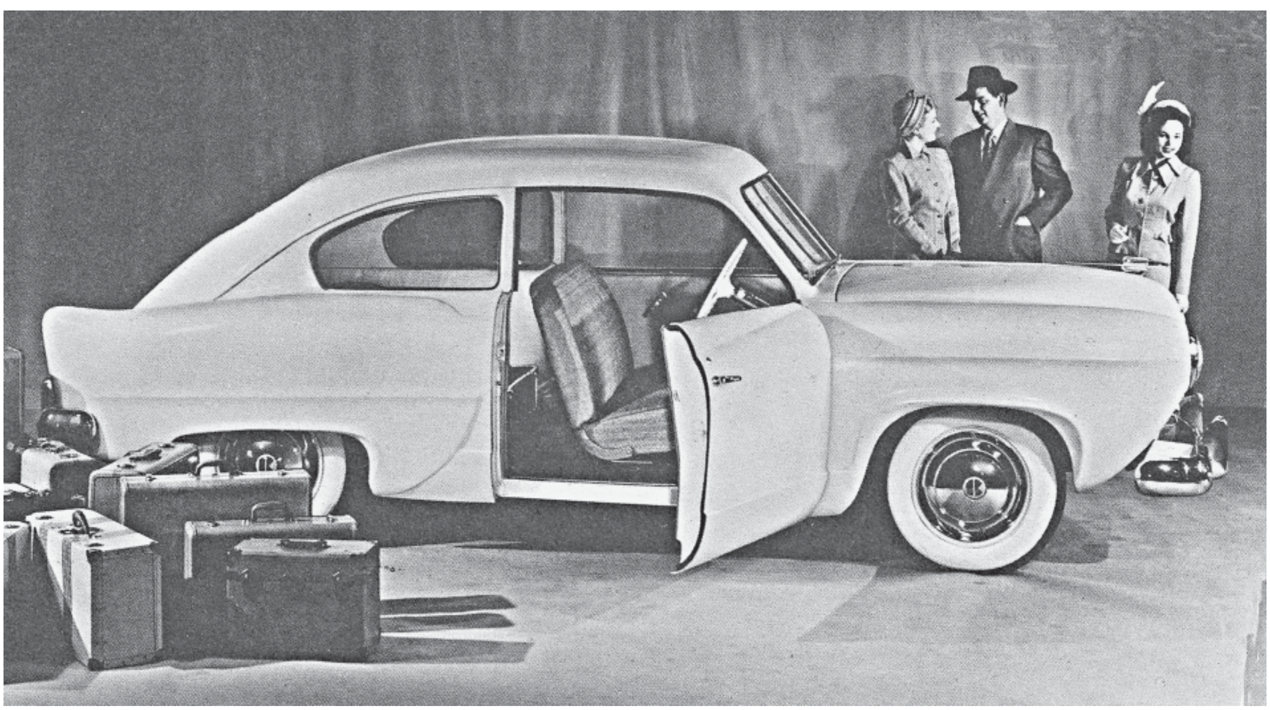
*(Editors Note:* Chapter 16, "Automotive," describes Henry Kaiser's trip to South America in 1954, his meeting with President Peron and other officials of Argentina, and the resulting formation of the first automobile manufacturing plant in South America, Industries Kaiser Argentina, utilizing $30 million of Kaiser Motors' surplus tools and dies from Willow Run.)



Manufacturing site for Kaiser-Frazer was the vast Willow Run Plant in Michigan. One of the largest industrial structures ever built, it had been used to build bombers in World War II. It was possible to construct a continuous assembly line, nearly 2 miles long from end to end, so that steel would enter one end, travel along and around the line, and emerge at the other end a car ready to drive away. In the sense of a linear movement of raw materials to a completed product, it was the shipyards all over again.



The 1951 Kaiser (above), low, roomy, and colorful was a prototype for the design of future passenger cars by the automotive industry; the Henry J (below), introduced early in 1950, was a forerunner of today's 'compacts.'



# Postwar Gamble

Associates of Henry Kaiser had gotten used to his hell-for-leather ventures into untested business undertakings, and after his proven successes in dams, aggregates, cement and ships, few questioned his inclinations. But Henry Kaiser surprised everyone with his simultaneous entry into a dozen different enterprises after the war—including aluminum, automobiles, appliances and housing.

There should have been no surprise. Less than a year after Pearl Harbor, when there was little news to suggest that World War II would end soon (or even in favor of the Allies), he addressed the National Association of Manufacturers on the subject of planning for after the war: “There is a grave and compelling demand that our preparation for life after the war should begin here tonight; the mobilization of the tremendous forces of American production—for housing, for transportation, for highways, for essential medical care...”

His people were already building new models of products, exploring new businesses, and preparing for the family airplane, the dishwasher powered by tap water, the compact car, and the all-magnesium bus.

Henry Kaiser saw the needs of the postwar world, and they fascinated him.

The world after V-J Day had needs for cement, aluminum, steel, automobiles, homes, lath, wallboard, plaster, concrete, sand and gravel, refractories, chemicals, and appliances. To invade most of these businesses, Henry Kaiser would have to start from scratch.

The physical holdovers in the Kaiser bag were a one-plant cement business, a steel mill with a product “mix” of steel plate and structurals just right for ships or tanks, two refractories processing plants, a small sand and gravel business, and a wartime aircraft plant in Pennsylvania.

But the organization’s primary asset was a seasoned management, supported by a cadre of can-do engineers and a core of hard-bitten expediters. Henry Kaiser was ready for anything. After all, he was only 63 years old.

When he jumped into industry, one of his associates in the Six Companies remarked, “Henry will come back to us.” Actually, he never left. It just seemed that way.

He wanted his old partners to go with him, and some of them did take part financially, but generally they were inclined to stick pretty close to the construction game, in which each was to establish an international reputation. (The Six Companies, Inc., ceased to be an official corporation in 1942, but its members continued to work together in various combinations.)

Kaiser did keep his hand in the heavy construction business after the war. There was Kaiser sponsorship in the $28-million Detroit Dam near Portland, Oregon, and participation in joint ventures building dams and tunnels—but the immediate enthusiasm was in the direction of industry.

## Cement, Aggregate Before the War

Appropriately, the cornerstone on which the postwar Kaiser world was built was cement, a business started 24 months before Pearl Harbor. This first “industry” was no stranger. Henry Kaiser had handled cement ever since his first wheelbarrow. “Cement represents a major part of a contractor’s costs,” he said, “but there is little he can do about it.” The cost was not always the same to contractors bidding for the same job, and that was often the difference between winning or losing.

The organization began exploring a dozen limestone deposits in California early in the ‘30s and took an option on one in the Santa Clara County hills along Permanente Creek. The push to exercise that option came from a contracting bid that missed. In 1938, the Bureau of Reclamation asked for bids on the construction of Shasta Dam in Northern California. The partners, flushed with success at Hoover, Bonneville, and Grand Coulee dams, bid for it, but lost the $36-million job by a scant $263,000. Determined to salvage something, the partners, with Kaiser as a sponsor, went after the consolation prizes—to supply nearly 6 million barrels of cement and more than 11 million tons of sand and gravel to build Shasta. The new Permanente Cement Company’s bid shocked the cement industry. The company had no cement plant, but its bid of $6,902,000 was a substantial 20 percent less than the bid by a combine of six established cement firms. However, as a prominent railroad official commented at the time, “When Kaiser decided to go after the cement people, he didn’t take on any corporals. Some people called Permanente an "imaginary" bidder, and existing producers contended that the West had no need for more cement capacity. But the bid was awarded. A winning bid of some $4.4 million for the aggregates followed.

Henry Kaiser knew exactly where to get the aggregates. Nearly 20 years before, on a road job in the same area, he had found a gravel bank that looked so promising he bought it for the future. Getting that aggregate to the dam site was not as simple. When the railroad asked a 27-cent-per-ton hauling rate, Kaiser considered it prohibitive. Instead, in 60 days, his engineers spanned the nine and one-half miles from the gravel plant to the dam with what was, at the time, the world's longest conveyor belt—19 miles (since it had to go both ways). The "rubber road," resembling a roller coaster through the mountainous country, moved gravel at a steady rate of 1,000 tons per hour, day and night for four years, at a delivery cost of 18 cents per ton.

(Somebody thought that such an enormous volume of aggregates ought to be processed for its gold content, and a small gold recovery plant was put up; $206,000 worth of gold actually was sluiced out.)

Supplying the cement was a different kind of problem, but the Kaiser engineers were equal to it, designing their own plant, building it in about half the normal time, and also coming up with some innovations. A contemporary issue of the *Saturday Evening Post* described it as "the most efficient cement plant on earth."

"A giant power shovel scoops up the raw material 6 tons to the bite, and dumps it into crushers that feed a 2-mile conveyor belt which carries the material by gravity down to the plant in the canyon. The brakes on the steeply inclined belt are generators, which produce the power needed to harvest the limestone. This is as close to perpetual motion as Kaiser has come so far."

Just seven months after groundbreaking on Christmas Day, 1939, Henry Kaiser was given about the finest present he ever received—the first bag of cement from Permanente. It had a great impact on everyone in the organization because it proved they had the capacity to go industrial. Said the founder, "Shasta was the best thing we ever lost."

In 1940, Henry Kaiser learned the Navy was perturbed over slow delivery of cement to build Pacific military facilities. He suggested pouring bulk cement directly into ship holds without using the conventional bags, thus taking only one-fifth the time to load and unload. The experts believed such a procedure would result in lumpy, unusable cement and ruined ships, but had no proof. Mr. Kaiser said, "I'll guarantee this cement from our San Jose plant to the wheelbarrow in Hawaii."

Storage silos were built, and the first of more than 7 million barrels of cement supplied during the war years began moving to the Islands, most of it in bulk. Two days before the attack on Pearl Harbor, the Islands' silos were finally filled to the top. By December 9, four days later, they were empty as the Navy began its emergency rebuilding program.

## Steel For the Shipyards

Shipbuilding had one of the top priorities at the beginning of World War II, but the steel industry was able to supply only about 65 percent of the demand from shipbuilders, who had to share production with equally important tank builders, shell makers, and producers of railroad rolling stock. Looking back, a postwar government report concluded that "steel plate was the most outstanding and emphasized product needed for defense and war; the demand was of unprecedented proportions, persistent, urgent, and ever increasing." On the Pacific Coast, the need for structurals was equally urgent.

As the biggest shipbuilder of the war and also the farthest away from the steel mills, all of which were east of the Rockies, Henry Kaiser felt the pinch early in the game. He bombarded official Washington with telegrams, memos, and personal visits, trying to get the Reconstruction Finance Corporation's Defense Plant Corporation (RFC) to erect a complete mine-to-metal steel plant in California, which would be the first on the West Coast. He made little headway. Contradictory reports didn't help the situation; a supposedly reliable survey in 1941 described steel as plentiful to which Henry Kaiser retorted, "I can't build ships with reports." When a government official promised him more steel by taking it away from somebody else, he replied, "Just because I yell louder than anybody else, you give it to me. What we need is more steel plants."

Late that year, the obvious prevailed. About $1.3 billion worth of new steel facilities would be financed and built by the government—but none of them was ticketed for the West Coast. An investigator for the RFC, charged with the responsibility of negotiating the contemplated steel expansion, said, “It was maintained that the future industrial development of the Pacific Coast made it essential that steel from raw materials be produced on the Pacific Coast...We then approached various steel companies whom we thought perhaps were best able to carry that venture out. I think, almost without exception, those steel companies who were familiar with the territory and large enough to carry out a large program of this kind on the Pacific Coast, were very loath and unwilling to do it.”

At this point, the simplest way for Henry Kaiser to get a steel plant was to build one himself. In early 1942, with a construction go-ahead from the War Production Board, Henry Kaiser got a loan from the RFC by pledging not only the plant and its proceeds, but also the earnings from three shipyards.

“The plant was designed while it was being built, described Tom Price. “That is one of the most difficult conditions under which one can either design or construct, but it has one outstanding quality, it’s the fastest way. It is not the cheapest way, but wars are not won on cheapness. Innumerable times plans still wet from the blueprinters were rushed down by air (from Oakland) to keep the construction crews going.”

In nine months, the West Coast ceased being a branch office in steel. And it might never have happened if competitors had not helped. When the first blast furnace at Fontana was blown-in on December 30,1942, Henry Kaiser spoke of it as “a convincing demonstration of the fact that American industry has learned how to temper the brutality of competition with the spirit of fair play.” Republic Steel had made available engineering designs and plans with which to build a plant; Bethlehem Steel Company fabricated and erected most of the steel beams; U.S. Steel supplied much essential material; and Consolidated Steel Company fabricated and erected the blast furnace.

Fontana’s war record was good. It had produced 1.2 million tons of steel ingots at low cost—for 230 desperately needed ships. But, with the war struggles behind it, it still had to cope with the peacetime world, or disappear like many another war baby.

Its primary product, steel plate, had little peacetime demand, and it was saddled with a huge mortgage and dwindling reserves of iron ore. More money was necessary to overhaul the plant, and even if the money were there, which it wasn’t, there were the postwar priorities to contend with. Such expansions needed a government okay.

Because the government was now disposing of its war-built steel plants to the highest bidder, receiving an average of 33 cents on the dollar for them, Henry Kaiser appealed to the RFC for equal treatment. He asked for a write-off of part of his debt on the plant he had built at his own risk for the war effort; he could then put the difference into modernizing Fontana and acquiring essential reserves of raw materials. The RFC turned down this suggestion but offered to raise the amount of its loan. The *San Francisco Chronicle* reported that financiers interpreted this reply as the “kiss of death for a Western steel industry.”

The next five years were touch-and-go, with perhaps a stroke of luck spelling the difference in Kaiser Steel’s eventual survival. A company expediter ran into the president of Transcontinental Gas Pipe Line Corp., which wanted to build a pipeline but had to prove it could secure the necessary steel supply before the government would let it go ahead. An agreement was reached with Kaiser Steel for a $53-million order. The company got an advance of $10.6 million and immediately invested it in facilities needed at Fontana.

Kaiser Steel turned the corner in 1950. The company was entirely refinanced with private capital for $125 million, including the sale of $40 million in stock to become a publicly held company. It retired its remaining debt to the RFC in one $91-million lump (not including interest of $23 million paid to the RFC over the life of the loan) and began constructing the new expansions that would put it on the map in the world of steel.

## Aluminum – The Beginning

The “mother of industry” ordinarily would have been enough in the metals line for one organization, but circumstances dictated otherwise. Whetted by their wartime magnesium operations, some of the Six Companies’ construction men turned into aluminum producers.

Kaiser Aluminum & Chemical Corporation began, in part, because of the Kaiser-Frazer operation, also just budding. The shortage of steel that plagued postwar automobile makers caused Henry Kaiser to consider using aluminum instead of steel in his cars. In 1945, he began building prototype aluminum vehicles and experimental engines, wheels, bumpers, and doors.

Four years previously, he had tried to enter the aluminum industry by proposing the building of reduction plants in the Pacific Northwest, but there had been no response from Washington, D.C.

Now, the situation had changed. By the summer of 1945, $793 million worth of government-built, war-surplus aluminum plants lay idle across the nation. To the Reconstruction Finance Corp., they were a serious problem. A telegram, dispatched in August to 225 potential aluminum companies soliciting their interest in the idle plants, provoked but three answers, two of them unacceptable to the War Surplus Board. The third was from Permanente Metals Corporation, signed Henry J. Kaiser, president.

The reluctance of postwar industry to get into the aluminum business appeared to be soundly based. "The peacetime market for aluminum is an unknown quantity—all predictions for it are built on nothing more substantial than fears and hopes," declared the U.S. Attorney General.

There were more things to fear than to hope for. The war-built aluminum plants were mostly unstrategically located in respect to peacetime markets. Shipping costs would have to be offset by low operating costs, and the plants had not distinguished themselves for low-cost operation under wartime conditions. In addition, a new producer would have to develop his own sources of bauxite, the ore from which aluminum is made. During the war, domestic capacity to produce aluminum had increased seven-fold, fabricating capacity in some lines as much as 45 times. Nearly all this had been for military needs. There was no indication a peacetime market would—or could—absorb the output of even the production capacity that remained in operation after the war.

The pessimist, of course, sees the glass half empty; Henry Kaiser chose to see it half full. And there were some positive factors. An unprecedented market was arising out of the bottled-up demand for houses, automobiles, appliances, trailers, mobile homes, school buildings, and commercial structures. All of these were—or could be—markets for aluminum.

So in Oakland, California, in March, 1946, the Board of Directors of Permanente Metals, originally formed to produce ships and magnesium, voted hesitantly to go into the aluminum business. Three of the partners—Pacific Bridge Co., J. F. Shea Investment Co., and General Construction Company—joined Henry Kaiser in what was, at the outset, a doubtful-looking venture.

Leases were signed for war surplus plants at Trentwood and Mead near Spokane, Washington. Initial financing was modest; Permanente Metals had, as assets, two refractories processing plants in California, a net worth of $5 million, and working capital of $15,750,000 secured on a bank loan on the directors' personal guarantee.

The small nucleus of men Henry Kaiser chose to head the new aluminum division had one thing in common: they knew nothing about aluminum. But they shared his infectious confidence. Communication in the Oakland office was easy. "When we wanted to say something," an aluminum executive remembers, "we would just open the door and yell."

They had leases on an aluminum reduction plant at Mead (where alumina is refined into metallic aluminum) and a sheet and plate rolling mill at nearby Trentwood. Now they needed a source of raw material. A contract was negotiated with Alcoa to supply bauxite ore from Surinam, and negotiations were begun in Washington, D.C. to obtain a lease on a war surplus plant at Baton Rouge, Louisiana, where bauxite ore could be converted to alumina.

As the spring of 1946 turned into summer, the pace quickened. Trentwood began production from reserve metal stock purchased from competitor Alcoa, and Mead tapped out its first primary metal in July. Management in Oakland watched the sales curve climb to $45 million in the first 12 months of operation as the sales force marketed nearly 60,000 tons, for a net profit of nearly $5.3 million.

By 1950, the company had purchased the plants it had first leased—at Mead, Trentwood, and Baton Rouge. It had acquired a second reduction plant at Tacoma, Washington, a foil mill installed at Permanente, California, and a rod, bar, wire, and cable plant at Newark, Ohio. Later, it leased Jamaican bauxite reserves and organized the Kaiser Bauxite Company to mine them.

In 1949, the corporate name was changed from Permanente Metals Corporation to Kaiser Aluminum & Chemical Corporation  a year after the company had offered sale of common stock to the public for the first time. The company had completed the first chapter of what was to become the most remarkable growth story in the history of light metals.

## Building Materials and Homes

Homebuilding for the postwar United States intrigued Henry Kaiser, particularly in the West, where defense plants and shipyards had already attracted thousands of new families.

During the war, he had constructed large housing projects adjoining his shipyards at Richmond and Vancouver, complete with recreational facilities, childcare centers, and civic buildings. Putting together the temporary housing was a lesson in shortages. Lath, plaster, and wallboard were non-existent. Bathtubs, stoves, and refrigerators were priceless commodities to be fought over at farm auctions or salvage yards. Individual family homes, desired by nearly everyone, simply could not be built because of wartime restrictions.

Henry Kaiser knew the war workers and returning G.I.s would create a tremendous demand, and he planned to be ready for it.

The lack of plaster, lath, and wallboard seemed the immediate problem. Spurred by the approach of peace and by the complaints about "paper walls" from inhabitants of wartime housing, Kaiser interests in 1944 purchased control of a plaster mill at Long Beach, California, and a gypsum quarry at San Marcos Island on the Gulf of California. A million-dollar expansion program started immediately to produce gypsum, lath, and wallboard in addition to plaster. By 1949, demand had increased to the point where a second plant was acquired at Redwood City on San Francisco Bay to serve the Northern California market. Kaiser Gypsum Company had found a need and filled it in a classic sense.

A second demand was for kitchen appliances—white goods. Kaiser's idea men had worked on a jet-propelled dishwasher and a garbage disposal unit in their wartime dream laboratory, but getting those dreams on a production line was a new problem. Again, a wartime venture provided the answer.

At a plant in Bristol, Pennsylvania, Kaiser Fleetwings had built wings, fins, rudders, and other parts for Navy Corsairs, Avengers, Havocs, and Air Force Flying Fortresses. With war's end, the expectation was that the plant would close down. But Kaiser-Frazer needed someone to stamp out doors and other parts from sheet steel, and the Kaiser dishwasher looked like a good bet for consumer acceptance. After retooling, the Fleetwings (later Kaiser Metal Products) plant began manufacturing a large array of appliances and auto parts. In the spring of 1947, Sears, Roebuck & Company signed a working arrangement with Fleetwings to produce its bathtubs and other steel, porcelain, and aluminum items. The Kaiser organization could no longer say it made everything but the kitchen sink. For a time it was turning out the latter at 200,000 units per year. Kaiser cement, aluminum, steel, gypsum, plaster, lath, and appliances were all helping to build homes in the postwar West. It is typical of Henry Kaiser that he wanted a hand in the actual laying up of the roof beams.

In 1945, he formed a partnership with Fritz B. Burns, a nationally prominent Los Angeles builder, to build entire communities of homes in Northern and Southern California and near Portland, Oregon. By using 700 variations of one basic floor plan and laying out streets on winding patterns, Kaiser Community Homes was able to avoid the mass tract look. More than 10,000 homes were constructed and sold by the partnership, including the 2,000-home community of Panorama City, California, one of the first large planned communities in the nation.

## Automobiles

To many observers, the Kaiser organization of late 1954 was like a winning racing car that had developed an engine knock. Willow Run was a psychological setback for all Kaiser people, but more important, its legacy of more than $100 million in red ink posed a serious financial threat. Another turning point had been reached in the Kaiser story. It had become clear before year-end 1954 that Kaiser could no longer hope to compete with the Big Three in passenger car production, but should concentrate on the line of Jeep' specialty vehicles. This left a large surplus of tools and dies and other machinery, most of it comparatively new. If it were broken down and sold piecemeal, it would bring only a fraction of its worth.

The late deLesseps S. Morrison, then mayor of New Orleans (and later President Kennedy's Ambassador to the Organization of American States), knew the Kaisers through the aluminum operations in Louisiana. He also knew Latin America well. He suggested that Kaiser move his surplus equipment to Latin America and set up an automotive industry: "Think of it, Henry, two hundred million people in Latin America without an automobile industry. In some towns, a 20-year-old automobile is considered a new car. Why don't you take your 30 million dollars' worth of tools, your trained personnel, and your experience, and transplant it all to Latin America?"

Henry Kaiser was intrigued. In August, he flew south to Latin America, visiting nine countries and 17 cities in 27 days. On his first stop in Brazil, he told President Getulio Vargas, "We have the know-how, we have the tools, and, if we locate here, we would want the Brazilians to own the majority of stock in the company." The government was impressed by this unusual approach, and asked for further negotiations. But it was in Buenos Aires, Argentina, on his second stop, that Kaiser found the most simpatico reception.

Morrison, who accompanied him, described the scene in his book, *Latin American Mission*, "Huge signs at the airport, saying, 'WELCOME KAISER!' a red carpet stretching from our plane to a reception area; a welcome by high government officials; the road to the city lined for miles on both sides by cheering crowds waving small American flags; and when we reached our hotel, the Plaza, another enormous electric sign across the street, saying 'WELCOME KAISER!'"

The enthusiasm was infectious. Before the week was out, Henry Kaiser had agreed to work for Argentina's first automobile industry. In October, papers were signed, and Kaiser's surplus passenger car tools and dies became the seed for what was to grow into Latin America's largest automobile manufacturer—Industrias Kaiser Argentina.

In 1956, another offshoot of Henry Kaiser's Latin American trip took form. Willys-Overland do Brasil was reorganized along the lines he had sketched for President Vargas two years before: Brazilians owned the majority control of the company, and all plans were directed toward giving the country an all-Brazilian vehicle. WOB quickly grew to become the largest auto manufacturer in Brazil.



When Kaiser sold its holdings in the two companies in 1967 (paradoxically because each had become dominant in passenger car manufacture—an area which Kaiser could no longer augment with models from the U.S.), it wrote a happy ending to a mutually satisfactory association. Kaiser had recouped some of the loss from its Kaiser Motors operations, and Brazil and Argentina had developed self-sufficient automobile industries. These industries would now have the support of the strong passenger car manufacturers who purchased the Kaiser interests—Ford in Brazil and Renault in Argentina. By emphasizing partnerships with the people, and by scrupulously staying out of politics, the Oakland-based Kaiser companies had discovered an approach that was to lead them into business on every continent of the globe.

# Years of Expansion

## Kaiser Industries Corporation

Putting its surplus tools and dies back to work had solved a minor portion of Kaiser Motors' problems and had given the entire organization a needed lift, but the automobile company still had a snowballing $88-million debt to consider. It meant bankruptcy—or else.

Or else—what? No one in the organization wanted to attach the stigma of a bankruptcy to a Kaiser-managed company (nor the other Kaiser companies). And, besides the creditors, there were thousands of shareholders to be considered. Early in 1956, the answer came from George Woods of the First Boston Corporation, financial advisor to the Kaiser companies, and Gene Trefethen, executive vice president, whose grasp of financing placed him next to his boyhood friend, Edgar Kaiser, as part of the one-two punch in the new generation of Kaiser management.

The solution included an exchange of stock whereby Henry J. Kaiser Company (owned, in the main, by the Kaiser family), which held substantial interests in the aluminum, steel, and cement companies, became a wholly-owned subsidiary of Kaiser Motors Corporation. The name of Kaiser Motors Corporation was then changed to Kaiser Industries Corporation.

The March, 1956, reorganization also involved a $95-million term bank loan obtained on the credit of Henry J. Kaiser Company. This financing permitted the automobile company to clear all its prior debts and allowed the owners of its shares to participate in the long-term growth potential of the combined operations of these two companies.

*Fortune* magazine commented, "It is even possible that the near-disastrous venture into passenger car manufacture, with all its blood-letting, will turn out to be one of the best things that ever happened to Kaiser…The experience precipitated a type of reorganization that Kaiser long needed. The privately owned Henry J. Kaiser Company was not the proper base for such a broad-gauged organization of such proportions, and such public interest, as Kaiser had become. Kaiser Industries Corporation provided not only better management control of existing companies, but flexibility for branching out into industries that aren't related to current operations."

## Kaiser Aluminum & Chemical Corporation

Settling of the pressing financial ills of the automobile company seemed to signal a new round of expansions by the other Kaiser companies, and Henry Kaiser himself showed the way. His needling message was constant: "Let's move. Let's keep on being the kind of organization that's never satisfied with itself!"

At that time, Kaiser Aluminum could supply good reasons for standing pat. During the Korean crisis, the company had answered President Truman's call for more aluminum by spending $230 million to more than double its capacity. It had built a big reduction plant at Chalmette, Louisiana, in a quick ten months. Now, defense requirements were trimmed, and the economy was lagging. The problem certainly was not one of an aluminum shortage.

Yet between 1955 and 1958, Kaiser Aluminum's people completed their biggest expansion to date—a $400-million bet on the future. They built new ingot, sheet, and plate, and foil facilities at Ravenswood, West Virginia, in the heart of the aluminum markets of the East, where shipping costs from their coastal plants had previously curtailed business. In Gramercy, Louisiana, they constructed a second alumina plant. And in Pennsylvania, Ohio, Illinois, Florida, Rhode Island, and California, they began producing a whole new line of products from wire and cable to food containers.

## Kaiser Cement and Gypsum Company

Kaiser Cement (then Permanente Cement) also had growth fever. During the early 1940s and 1950s, it had steadily expanded its cement plant at Permanente until it was the West's largest, had purchased Glacier Sand & Gravel Company in the Northwest, and moved into the gypsum business. From Alaska to California, the coast was dotted with its cement bulk storage facilities.

"By the mid-1950s, we were a financier's dream," recalled an officer of the company. We had paid off our long-term debt, split our stock, increased our common dividend, and in five years had doubled our sales. But good as our growth rate was, we couldn't keep up with the growth of the West." The answer, in the Kaiser tradition, was expansion. A $35-million program to increase cement capacity by 60 percent and gypsum production by nearly 90 percent was begun, using bank borrowings to cover most of the expense. A second cement plant was built on the desert in Southern California, and a sixth kiln was added to the giant Permanente plant. A new gypsum facility was built near San Francisco Bay, and the Long Beach plant was expanded. Finally, the gypsum rock facilities on San Marcos Island in the Gulf of California were doubled, and the company's "navy" expanded to carry the additional rock.

## Kaiser Steel Corporation

Kaiser Steel, which had been steadily expanding since its inception, chose the mid-Fifties for the most ambitious expansion of them all. First, it moved into the fabricating field by establishing plants in Northern and Southern California. Then it rounded out its raw materials sources by buying a limestone deposit on the desert across a mountain range from its Fontana, California, mill, and a huge coal producing acreage in New Mexico. Finally, in a pair of announcements that dazzled the industry, it announced a capacity-doubling expansion program that would cost a record $214 million, and install, among other things, three of the revolutionary oxygen steel-making furnaces.

On February 1, 1959, Henry Kaiser flew to Fontana to dedicate the new facilities. With California Governor Edmund Brown, and before network television cameras, he pushed the lever that poured out the first heat of 30,000° F steel from the new melon-shaped oxygen furnace. The television commentator held a microphone toward him: "Now that the expansion program is completed..." he began, but the founder, president, and chairman of Kaiser Steel interrupted him, "We're building a business that will never know completion," said Henry Kaiser.

## Kaiser Center, Inc.

The Broadway Building in Oakland had long since been outgrown as a headquarters for all Kaiser Oakland employees, and key personnel were scattered among 26 downtown structures. In keeping with the expansion mood, Kaiser Center, Inc. was formed in 1955 to build a 28-story, curved building on Oakland's Lake Merritt, complete with shops, 1200-car garage, and a three-acre roof garden. Some years later on a block in Oakland adjoining the Kaiser Center, the 28-story, all aluminum exterior Ordway Building was constructed. The building was named in honor of A. B. Ordway, Henry Kaiser's first employee, hired during his early road-building days.

## Hawaii

Henry Kaiser himself started a new thrust when he visited Hawaii in February, 1954, for a vacation and found hotel rooms scarce. Waikiki Beach hotels were turning away would-be visitors by the thousands; passenger ships were booked a year in advance.

The 71-year-old mainlander solved his own problem by buying a Kahala Beach home, but this didn't soothe his irritation over the shortage of hotel rooms. "Waikiki is too wonderful to deprive so many people from enjoying the islands," he said. "It's nonsense to say that there's no room left to build more hotels on Waikiki Beach. Why not extend the world-famous beach and build a great vacation industry?"

Nobody had to ask whom he had in mind for this project. When Henry Kaiser returned to Oakland, he was refreshed and bubbling with plans to purchase a 20-acre parcel on the end of Waikiki, dredge a lagoon, build a beach, and improve and expand the small hotel already located on the land; his partner would be Fritz B. Burns.

In a style unmatched since the days of the shipyards, he began altering the map of Oahu. He scooped out a salt-water lagoon (complete with island), trucked in 3,000 loads of sand to form a beach, and built a 100-room hotel addition in 89 days, one precious day ahead of schedule. He hired 40 Samoans to weave coconut frond roofs for guest cottages, while not far away, modern machinery helped his men put up an aluminum dome in just 20 hours to seat 2,000. A 14-story ocean tower was erected, and then a 13-story companion. When the 1,1 46-room Hawaiian Village was sold to Hilton in 1961, the project, which financiers had predicted would fizzle, brought in a $4.7-million profit.

Kaiser's invasion of the Hawaiian Islands brought forth the resistance that so often confronted his major undertakings. Construction of the Hawaiian Village required approvals from the Territorial Legislature, the Congress of the United States, and the President, before it could begin. When Henry Kaiser talked of plans for construction of a $4-million Kaiser Foundation Hospital overlooking Honolulu yacht harbor, the Island's doctors opposed him. When he proposed a $13.5-million cement plant for Oahu, using coral from the sea as the raw material, he was fought at every turn. "I've never seen it fail," he said. "Where you get anything new, and you don't have the traditional approach, you have to fight. Usually, it takes a year to break down the major obstacles."

Eventually, he won over his severest critics as he completed project after project, and began to be thought of as a "Kamaaina," the Hawaiian word for "native."

As a promotional device for his hotel, Kaiser began radio and television broadcasting in Hawaii in 1957 and soon had the top-rated TV channel in the Territory. More important, the stations, since sold, became the starting point for Kaiser Broadcasting Corporation, now building an Ultra High Frequency television network on the mainland.

From the pink surroundings of the Hawaiian Village, Henry Kaiser kept in daily telephone contact with son Edgar, recently returned from Toledo, with Gene Trefethen, and with the managers of the various companies and divisions.

## Henry Kaiser Steps Down

In 1959, Henry Kaiser formally acknowledged that a new generation of Kaiser management had taken over the day-to-day chores of running the organization. His son, Edgar Kaiser, succeeded him as chairman of Kaiser Aluminum, Kaiser Cement, and Kaiser Steel. Gene Trefethen took over as vice chairman. And four trusted lieutenants, Jack Ashby, Steve Girard, Wally Marsh, and Dusty Rhoades, were named presidents and chief executives of the steel, Jeep, cement, and aluminum companies respectively.

In many organizations, such a realignment would have been followed by farewell parties for the boss, and then his quiet retirement. But not for Henry Kaiser. He remained active in a policy role as chairman of Kaiser Industries and founder chairman of the other principal companies.

He began building Hawaii Kai, a new project on the eastern side of Diamond Head—a resort city for an eventual population of 70,000 people. He supervised the job himself, driving out in his pink Jeep at sunrise and often returning home after dark. At the same time, through frequent flights to the mainland and daily phone calls to Kaiser offices all around the world, Henry Kaiser kept close watch over the organization that bore his name.

He also kept looking ahead. When Kaiser Steel and the United Steelworkers developed the highly inventive Long Range Sharing Plan several years later—prodded and encouraged every step of the way by Henry Kaiser's telephonic needle—a reporter asked him if he thought the Plan might be too radical to be practical. "The times," said 80-year-old Henry Kaiser, "require something new."

# Prescription for Health

One of the awards Henry Kaiser treasured most was presented to him in May, 1965, by the AFL-CIO. It was the Murray-Green Award for individuals whose achievements in health and welfare inspired others to work for the common good. Previous winners were President Truman and Mrs. Eleanor Roosevelt. In his acceptance speech, Mr. Kaiser told how his mother died in his arms when he was a boy of 16. “We were poor. We could not afford a doctor nor the hospital care, which could have saved her life. I resolved then and there to do something about people dying for lack of medical care.”

Later, his father went blind, though his sight might have been saved if the family had had the money for proper care. His wife had a major operation on the kitchen table. “This only increased my desire to do something so that average people could afford to be sick.”

Henry Kaiser often spoke of this rather vague ambition to associates during the long train rides between Oakland, Washington ,and Hoover Dam in the early 1930s. What he needed, he’d say, was a direction in which to move, a spark, a catalyst. He was like the Kaiser of 1926, figuring on the Philbrook Dam job, and knowing he could build it easily if only a LeTourneau would come along to invent proper earthmoving equipment.

The catalyst he was looking for was taking shape 100 miles south of Hoover on the same Colorado River. There in 1933, more than 5,000 men were cutting a canal to carry fresh water from the Colorado to Los Angeles, through country only a horned toad could love. Along the stretch from Parker Dam on the Colorado, to Indio, the army of “desert rats” spread over 400 square miles. If they were hurt or sick, they faced a 200-mile trip to Los Angeles in an “oven-on-wheels’’ ambulance.

The total absence of any medical care in the desert area looked like an opportunity to a young surgeon named Sidney Garfield. He made his way to the little town of Desert Center, organized a small team of physicians, and, with $2,500, built a 12-bed hospital.

“Building his little desert hospital, Dr. Garfield went deep into debt trying to turn it into a little heaven. The building was pleasantly decorated inside with a blend of colors easy on the eye. The bed linen would not have offended the body of a movie queen. The blankets matched the decorations and were of a quality you’d find in a luxury hotel. Against the glare of the desert sun, the eyes of the sick people were protected by the then expensive and new-fangled Venetian blinds. Against the hellish desert heat—bad enough for a well man—the sick men were guarded by a complete air conditioning system...Its technical equipment was the last word in science...It was a miniature modern city hospital, fantastic in this desert.”

Thus Paul de Kruif, in his book, *Kaiser Wakes the Doctors,* describes the forerunner of today’s Kaiser Foundation Medical Care Program’s facilities, including its School of Nursing, Research Institute, and programs in research, medical education, charitable care, and rehabilitation center for persons with neuromuscular handicaps.

The aqueduct contractors liked the new setup. The doctors offered economical service by pooling skills and equipment. And they built a reputation for returning men to health fast—which meant getting them back on the job quickly.

But things didn’t go so well. The Los Angeles-based insurance companies thought it was cheaper to bring the injured workmen into the city to their own doctors and hospitals for treatment. And those patients who came into the little desert hospital with non-industrial ailments were often slow in paying their medical bills, and some didn’t pay at all.

The doctors had been collecting their fees on the traditional fee-for-service basis, and it soon became evident that unless a more stable method of financing was found, the little desert hospital would have to close.

Groping for solutions, the employers and the doctors worked out a plan with the insurance carriers; 15 percent of the insurance premium—$1.50 per month per man—would go directly to the hospital, which would provide the necessary care. Fee-for-service payments were discontinued. The next step was to offer to treat non-industrial ills and injuries for a voluntary, payroll-deducted, nickel-a-day. With a base income that was predictable, the project moved into the black and paid for two more desert hospitals and several first-aid clinics. Long before the first water passed through the concrete aqueduct, the doctors had proven something.

Quality medical care could be provided at a price people could afford. And this could be done without an increase in taxes, without charity, without endowments, and could be done in a way that would generate income, which could be used to buy more equipment and build better hospitals.

Among those most impressed by the hospital at Desert Center was A. B. Ordway. By the mid-Thirties, Kaiser's number-one employee had become general manager of an insurance firm owned by Kaiser and other contractors. When the company received some of the industrial insurance business for the Los Angeles Aqueduct job, it was natural that the paths of Ordway and Dr. Garfield would cross. Ordway liked what he saw. Injury costs were reduced and employee morale was increased wherever the desert doctors extended their service.

By 1938, the construction camps along the aqueduct had closed, and Dr. Garfield was back in private practice in Los Angeles, when a Kaiser-sponsored group was the successful bidder on the dam at Grand Coulee.

Coulee's foundations had begun several years before, so there already was a privately owned hospital at the dam site, but the unions were dissatisfied with it. However, they didn't really want a contractor running it either. Edgar Kaiser persuaded the union leaders to give him a chance, and looked around for someone to run it. A. B. Ordway remembered Dr. Garfield, and the desert miracle was repeated in Eastern Washington State.

At the dam-site rose a sprawling new community of 5,000 workers and their families. Henry Kaiser convinced the partners to agree to advance the funds to renovate the existing 75-bed hospital and to air condition it throughout, while a talent-hunt recruited a young, enthusiastic medical staff. The employers pre-paid the cost of industrial accidents, and workmen gave 7 cents a day for other prepaid medical care that was virtually unlimited. Later, their wives and children were included; wives for 7 cents a day, children for 25 cents a week. The idea of non-industrial medical care for whole families was underway.

An unexpected dividend from Grand Coulee was revealed as the weeks and months passed. A doctor commented later: "To oversimplify it, people came to the hospital with early symptoms. There wasn't the factor of medical cost to keep them away. They could come with the first pain in their abdomen, when they first felt their colds, when we could catch the appendix before it ruptured, and would get their pneumonia cases before they were terminal. We would take care of them, and they would get well.

By now, the main lineaments of the Kaiser Foundation Medical Care Program had been drawn. It had not come about through deliberate planning; no one sat down and said, "Let's design a medical care plan that fits certain principles." The whole thing developed through a process of devising practical solutions to solve specific problems.

First, prepayment, allowing families to budget for health and at a lower cost in the long run, because the total bill for medical care was spread among many families. These prepayments went to finance medical services provided directly to members, instead of being used to create a fund for paying off medical insurance claims.

Then, group practice—medical specialists had been brought together under one roof, where each concentrated on pursuing his own specialty to the utmost and could call on the specialized skills of his colleagues as needed.

Together with these, went the principle of integrated facilities, with a hospital, doctors' offices, laboratory, and x-ray department, all under one roof. Duplication of facilities and personnel was eliminated, and the equipment itself received more intensive use.

And finally, preventive medical care had been accented. Because there is no economic barrier between doctor and patient, the member will visit the doctor early in an illness—and early detection and prompt treatment can save lives. And because neither the doctor nor the hospital profit from services rendered, the old saying that "the most expensive bed in a hospital is an empty one" no longer holds true.

There was an added benefit to the plan that Henry Kaiser later called "the fourth dimension." It was simply morale. Men in good health, and whose families were in good health, not only could think more quickly and work harder, but they did it with a spirit and an enthusiasm lacking in men who were worried about their health or their families' health.

When the Kaiser organization began work on its first shipyards in San Francisco Bay in 1941, the medical resources in the area appeared able to take care of the workers streaming in. At first, they did. Then, Pearl Harbor. Within a month, the number of shipyard workers jumped to 30,000, inundating the area's already over-taxed medical facilities.

The doctors from Grand Coulee were called in to organize a medical plan—this time in the center of a large permanent community. They located an old building that once had housed Fabiola Hospital in Oakland, and then built another right on the Richmond shipyard site. A similar hospital was set up at Vancouver, Washington, to take care of the Pacific Northwest yards, and one at Fontana, California, served the newborn Kaiser Steel mill.

To take care of the financing, Henry Kaiser created a non-profit foundation, called Permanente, whereby operating income from the program could be used to improve facilities and build more hospitals. It would function completely separate from the Kaiser industrial organization and not be connected with the business operations in any way.

The medical care program got underway in April, 1942, and eventually took care of a wartime work force that soared to 200,000. This was no hand-picked group of workers; they were all ages from 16 to 80 and in all sorts of physical conditions. Even those with chronic illnesses could join. A veritable "pathological museum," one doctor called it. At the same time, it was a tailor-made opportunity to put the Plan to its severest test.

The Plan worked, and quite well, considering the handicaps. Then in the spring of 1945, as the war phased out, shipyards began to close, and tens of thousands of Permanente Health Plan members were discharged from shipyard employment. As membership in the Plan dropped to a low of 32,000 by the end of the year, the question developed: Should—or rather could—the medical care program continue?

On the side of continuance were some powerful forces. The most powerful, of course, were the ex-members themselves. Though no longer employed in the shipyards, many workers still belonged to their unions, were still living in the area, still needed the kind of medical care at low cost they had enjoyed under the Plan.

The doctors themselves had found the advantages of prepaid group practice to their liking and wanted to keep on working that way.

But against continuance was the fact that nobody knew, for sure, whether the program could be made to work in a well-populated area where it would have to compete against established medical insurance plans and where it would lack the stimulus of concentrated shipyard employment. And there was opposition from the tradition-minded medical community.

The balance was tipped by the aggressive optimism of Henry J. Kaiser. "When my mother died in my arms years ago, I said I'd do something about helping people afford good health care," he told his wavering associates. "Well, here's our chance, boys." The challenge was accepted, and enrollment opened to groups and individuals on a voluntary basis.

To assure that no one could be forced to join this new type of plan, all prospective membership groups were offered an alternative plan. This gradually became the fifth principle of the program—voluntary enrollment with dual choice.

And to reduce the opposition from the medical community, a separate non-profit Health Plan was set up to enroll members and collect their monthly dues, and the participating physicians organized their own independent medical groups to contract with the health plan. Gradually, the opposition from the medical associations diminished.

Explained Dr. Clifford H. Keene, president of Kaiser Foundation Health Plan (as well as the sister hospital organization), "The common denominator of all good physicians is an interest in high-quality medical care, and because we had this interest honestly and sincerely, we felt that at some point other differences with organized medicine could be ironed out."

The postwar health plan caught hold. In ten years, membership climbed to 520,000, and, by early 1968, there were 1.7 million members in California, Oregon, Washington, and Hawaii—the nation's largest, privately-sponsored, direct service prepaid health care plan.

Dr. Keene notes, "We've demonstrated that it is possible within our free enterprise system to organize medical care on a financially self-sustaining basis—so that the consumer is satisfied, and the physician is gratified by his role."

The U.S. Government's Advisory Commission on Health Manpower notes another advantage—economy. In its November, 1967, report to the President, it said, "...the average Kaiser member obtains high-quality medical care for 20 to 30 percent less than the cost of comparable care obtained outside the Plan."

On his 85th birthday, several months before he died, Henry J. Kaiser looked back on a career of achievement and told reporters, "Of all the things I've done, I expect only to be remembered for my hospitals. They're the things that are filling the people's greatest need—good health."

"Henry J. Kaiser may have missed his calling. He undoubtedly would have made a most energetic physician. Also, he probably would have been his own best patient because of his love for medicines. The one bag he personally carried was his medicine chest, and he never let it out of his sight.

"In 1944, the Associated Press carried a story from Chicago about Mr. Kaiser. It seemed that a cab driver—one Morris Wold—cut his hand putting the luggage in the trunk. Mr. Kaiser amazed the press by producing a first-aid kit and bandaging Mr. Wold's hand in a very professional manner. " All his life he could always be depended upon to brighten up and be completely happy if you would tell him you were ill. He would never fail to prescribe for you."—Tom Price

# Kaiser Engineers Personnel Roster

The listings on the following pages comprise a reconstructed roster of Kaiser Engineers' employees. The total is 4,215 names. Official KE personnel records listing all employees during 1942-1986 were not available. The roster was compiled by Anke Alterman from a number of references as follows and was checked also by a number of people.

- KE telephone directory March, 1955
- KE key personnel index October, 1964
- KE administration organization charts February, 1972
- Kaiser Industries telephone directory, 1975
- KE telephone directory, 1979
- KE telephone directory March, 1985
- KE company organization charts January, 1983
- KE personnel locator (includes outlying domestic offices), 1984
- KE employees retirees list June, 2000

Because this roster has been compiled from the limited sources listed above, some names of KE personnel inadvertently may have been omitted or improperly listed in the roster:

A

James Abando
Carmen Abate
Joseph Abbas
Mary Abbas
A. Abellar
Steven Jay Abernathy
James Abernathy
Rosauro Abjelina
Alfredo Ablaza
Michael Ablaza
Gerry Abraham
Bonnie Abrams
Edgar Abreu
Elpidio Abulencia
Gudrun Adair
Charles R. Adams
Dana Adams
Gerald Adams
Hank Adams
Marilyn Adams
Sylvia Adams
Terry Adams
D. J. Adcock
Walter Addison
John Adela
Howard Adkins
V. Jean Adrewsen
Robert Affalter
Ricardo Agana
V. E. Aghazarian
Annette Aguiar
Velloso Agusta
Linda Ahlberg
Gulzar Ahmed
Dave Ahwesh
John Aiello
George Aiken
Ed Airth
Yoshiaki Ajari
Earl Akerlow
Nivaldo Alameida
C. E. Albert
Mark Albertin
Joan Alberts
Mike Albrecht
Romulo Alcasabas
Fred Alcocer
Bill Alcorn
R.J. Alessio
Robert Alexander
Sam Alexander
Josefa Alfonso
R. Q. Alfonso
D. L. Alivia
Alta Allen
Bruce Allen
Dave Allen
Doug Allen
Jim Allen
John D. Allen
Laurel Allen
Steve Allen
Luis Allende
John Allender
Virgilio Alonzo
Frank Altenburg
Anke Altermann
V. T. Alvear
John Amadei
D. L. Amacher
C. Amato
Robert Amos
Allen Andersen
Cecilia Anderson
Chris Anderson
Dana Andersen
E.C. Anderson
Jim Anderson
John Anderson
Kay Anderson
Keith Anderson
Mike Anderson
Guillermo Andrade
Hal Andresen
Lilian Andrew
David Andries
Burt Angle
Frederick Angliss
E. H. Angus
Rhonda Anhalt
Pedrito Aniez
M. C. Annen
Antanig Antaramian
Fred Anton
Julie Apcar
Mabin Apolinario
Horst Appenroth
D. Apri
Aster Aquitania
Sanulla M. Arain
Hal Archibald
Yoav Arkin
Steve Armknecht
James Armstrong
Kenneth Armstrong
P. Singh Arora
Leonel Arostegui
David Arpi
Renee Arriaga
Ellen Arsenau
Roy Arun
Turhan Arundar
J. D. Asbaugh
Paul Ashford
M. F. Asmussen
Lionel Aspin
Henry Atiles
Charles Atkinson
Bob Auld
Gerald Aulet
C. R. Austin
Marvin Autio
Nydia Avalos-Lopez
Annie Avedissian
D. Avery
M. Avramescu
Rose Ayen
Jim Ayres

B

Edwin J. Bacharz
Roxanne Bachman
Craig Bachmeier
Frank Backman
Robert Badeleou
Jim Bader
Alfred C. Bagdon
Danny Bailey
Ernestine Bain
Terry Barron
Bonita Baisch
Helen Bajos
C. Jack Baker
Cecil Baker
Clyde Baker
Donald Baker
E. D. Baker
Mary Ann Baker
Richard Baker
Ed Baldinelli
Angela Baldwin
Neil Baldwin
Phillip Balhorn
Bill Ball
Jim Ball
Karen Ball
Oscar Ballheim
Benjamin Balter
Crispin Balugay
Gavino Banares
Paul Bancel
James Bandura
Ajoy Banerjee
Frank Banka
Anant Bankar
John Banks
Sam Banks
Kay Bardwell
John Bargas
Ahmad Barjaoui
Robert Barkalow
Stan Barkelow
Edsel Barker

W. J. Barkley
C. L. Baranakas
Wendell Barner
Joseph Barnett
A. A. Barracca
Julia Barragan
Fresia Barraza
Paul Barrett
Don Barrie
Olivia Barrios
Jerry Barron
Terryl Barron
Rudolpho Barrus
L. Barshaw
Lodema Bartels
Roger Barth
Elmer Barthel
H. L. Barton
Al Barzoloski
Elizabeth Bash
George Baskerville
Dudley Bass
Jose Basteiro
Clifford Bates
Eugene Bates
Ralph Bates
Shanker Bathwal
R. A. Bateman
Leslie Batten
Theodore Baumberger
Kenneth R. Baumgarten
Richard Baumi
N. F. Bautista
Chris Baxter
Linda Baxter
McDonald Baxter
Agnes Bazsa
Gary Beach
Bill Beard
William Beard
Lowell G. Bearg
Herb Beasley
John Beatty
Virginia Beaty
James Beberdick
W. B. Beck
Mari Beck
Ed Becker
Ernest L. Becker
Jeffrey Becker
Adela Bedford
Pat Bedford
Tim Bedford
Reuben Beebe
John Beitelman
Reynaldo Belardo
Charles Belcher
Elmer Belfanti
Kent Bell
Blacky Belt
Kenny Belt
M. Belvin
Sterling E. Bench
A. G. Bender (Add)
Betty F. Bender
George Bender
John Beneke
John Benes
Phil Bengston
John Bennett
A. J. Benoza
Diana Benson
Ina-Mae Benton
James Benton
John Berentis
Bob Berenz
John Beresford
Joseph Beretta
David Berg
John Bergerson
Sandra Bergman
Bob Bernard
Harry Bernat
Eartis Berry
George Berry
R. Keith Berry
Robin Berry
Eleanore A. Bertelsen
Earl Berthold
F. J. Bertolone
G. D. Bertolani
J. M. Bertram
Bill Bertwell
J. E. Betz
Ron Betz
Utpal Bhaumic
John Biasatti
Frances Bibb
Peter Bibbes
Bill Biebesheimer
Jeffery Bigelow
Virginia Bigornia
D. Biller
Barbara Billings
James P. Billings
George Billman
Bob Bills
Arthur Billy
Nedelko Bilobek
Frank Bilotti
C.W. Bingham
D. M. Bird
Ronald Birkhead
Harry Birks
Janice Biscamp
Bea Bishop
Donna Bishop
Manash Biswas
Robert Bixby
Barry Black
Leslie Black
Robert Black
Rodney Black
Dan Blackwell
Don Blackwood
Lloyd Clyde Blackwood
Vicki Blackwood
D. H. Blair
Ron Blaj
Shalom Blaj
Donald Blakely
Judy Blakely
Linda M. Blanchard
Michael Blanchard
Rolando Blanco
P. O. Bland
Don Blankmeyer
Berle Blehm
Bob Blehm
Oakie Blehm
Giselle Block Marasco
Frank Block
Robert Bloomquist
Joyce Blosser
Gene Blymeyer
Jolene Board
Charles Bobinecz
Charlotte Boblow
John Bocks
Susan Bodishbaugh
John Bodner
Robert Boehm
Robert Boerwinkle
William Boerwinkle
Michael Bogan
Marco Bogantes
Jo Ann Bogart
Tommy Bogart
Vicki Bogenberger
Harry Boggs
Bruno Boik
Eugene Bollinger
John N. Bombay
R. J. Bomstalli
Ronald Bond
Steve Bonde
Dick Bonitz
I. E. Booker
George Boone
Patricia A. Boone
Irene Boulware
Sterling Booth
Yvonne Boots
J. S. Boparai
Dave Bordo
Bertha Bornstein
Guillermo Borquez
Debbie Borst
L. C. Borst
Susanne Borsuk
Frank Bort
Beverly Bose
Dilip Bose
Theresa Bospflug
Nora Boston
Doug Bonney Boswell
William Bosworth
Thanasis Bothos
F. B. Bothwell
George Botting
Isabelle Zentner Bottorff
Henry Boucher
Irene Boulware
Robert Bouman
Remmi Bourgeois
V. Bowers
Fred Bowling
Sigana Bowling
Richard Bowman
James E. Bowser
John W. Bowser
Jim Boyce
Dunston Frank Boyd
Dusty Boyd
George Boyde
Rosemary Boyle
Henrietta Boyles
Murray Boyles
Roger Brackett
Forrest Bradfield
Elizabeth Bradford
Gerald Bradley
S. V. Bradley
Steve Bradley
Harry Bradshaw
Thomas Brady
Shelly Braidman
Carol Brajkovich
Ann Branderberger
Cyril Brandt
Earl V. Brandt
Raymond Branecki
John T. Brassil
Frank Brauns
C. Bravo
Dennis Bravo
Donald Brauns
Fonda Bray
Wm. Braymen
Susan Breazeale
Lynn Bredeson
John W. Breeme
Dick Brennan
Donna Bressem
Brian Brett
John Brezina
Marian Brian
Ruby Brice
Helen Bride
Edward Bridge
Barry Bridges
Terry Bridges
Larry Brighton
Walter Brim
Robert C. Brineman
George R. Bristol
Derrick Britt
James Britt
Hal Brock
Paul Brooberg
David Brooks
Charlie Brown
Choate Brown
David Brown
Dell Brown
Dick Brown
Don Brown
E. A. Brown
Edward Brown
Ernest Brown
Gail Brown
Garth Brown
Gene Brown
Gregory Brown
Hunter Brown
Jack Brown
Jack H. Brown
James Brown

Jorge Brown
Julian Brown
Margaret Brown
Millie Brown
Nick Brown
Oliver Brown
Phyllis Brown
Robert Brown
Ross E. Brown
Stephen Brown
Terry Brown
William Brown
Willie Brown
Gail E. Brown-Virardi
David Browne
Leslie Browning
David Browse
Jamie Brox
Ruth Bruce
Dan Brunner
Fred Brunner
John Brusher
D. D. Bryan
T. W. Bryan
Cezar Buan
S. Bubanja
Shashi Bubna
J. Buchtenkirch
George Bucic
J. Buchanan
Cloyce H. Buckert
E. Buckholz
Michael Buckley
George Buckwald
James E. Bulger
Sandra Bulger
Janice Bullen
Fabian Bumatay
Madeline Bundy
William Bunker
Man Bunkowski
Gale Bunnell-Wyrick
Nick Burcholts
Donald Burge
Maria Burger
Morris Burgess
M. E. Burke
Ed Burk
Bob Burns
Gloria Burns
John Burns
H. B. Burns
Marilyn Burns
Myrtle Burns
Tom Burns
David Graham Burr
Bennie Burrows
Bill Burstedt
Richard Burtnett
Sharon Bury
Joe Busch
Paul Busch
Charles Bush
J. E. Bush
Phil Bush
Charles Butler
Melzia Butler

C

Lorenzo Cadapan
James Caddell
Orhan Caglar
Richard Callender
Jim Callis
Ian Callow
Michael Callow
Curtis Calloway
Karen Calloway
Chad Calhoun
Dorothy Cameron
Vivian Camp
William Camp
Gary Campagna
Cynthia Campbell
Dave Campbell
Donald Campbell
Edna Campbell
Harriett Campbell
Jay Campbell
Sandy Campbell
Thomas Campbell
Jose Campos
Dean Canahan
G. A. Canales
Sharon Canas
John Cannella
Dean Cannon
Gloria Cannon
Stacy Cannon
Jose Cantu
V. H. Cao
Bob Cape
J. G. Capka
Frank Caplan
K. J. Caplan
Alfredo Caprile
Ralph Capriola
Don Cardarelle
Edward Carey
Gary Carleton
Cecelia Carlile
Carl A. Carlson
Dave Carlson
Don Carlson
James Carlson
Oscar Carlson
Pamela Carlson
Marsha Carmody
Theresa Carneghi
Donald Carow
Mary Ann Carp
G. N. Carpenter
Lew Carpenter
Thomas Carpenter
Frank Carr
R. C. Carr
John K. Carroll
Brett Carruthers
C.P. (Penny) Carter
Chester Carter
Jack Carter
John Carter
Judee Carter
Marilyn Carter

William Carter
John Carver
Marybert Carveth
Horacio R. Casati
Chet Case
H. M. Castillo
Nilda Castillo
John Castle
Charles Castrovince
Pedro Casuga
H. A. Catalog
Tracy Catledge
Jim Cavalet
Albert Cavaliere
John P. Cavanaugh
Michael Cavanaugh
Charles Cavaretta
Ben Cavin
Harvey Ceaser
Sandra Cebers
Steven Cehovec
Carmen Cervantes
Jose Cervantes
Paul Cervenka
Susanne Cervenka
Ricardo Cesped
S. Chakraborty
Ashok Chakradeo
Dipa Chakravorty
Gerald Challenger
Russell Chamberlain
Stephen Chambers
Al Chan
Edward Chan
Melvin Chan
Phil Chance
Howard Chandon
Eddie Chang
L. M. Chang
Ming D. Chang
Paul Chang
Walt Chang
Ju P. Chao
Stan Chao
Joseph Chaparro
Agnes Chapman
Lynne Chapman
J. R. Chapman
Nancy Charles-Goodman
Michael Charlos
Fred Charyn
Rufus Chatham
David Chau
Soma Chaudhury
Daniel Chavez
Dave Chedgy
Janice Chedwick
Chris Cheff
A. S. Chen
Arthur Chen
Chuang Chen
Kou Lin Chen
Ma Chi Chen
Shy-Men Chen
Hsiang-Chi Cheng
I-Ming Cheng
Tom Cheng

Clarence Cherry
Sherry Cheshire
David Cheung
Deanna Cheung
Joseph Chianese
Dean D. Chiang
John Chiang
Kida Chiang
J. R. Chikiamko
E. B. Childs
Joan Chin
Lester Chin
Mac Chinek
Kong Choa
Chang-Joon Choi
Bonnie Chong
Richard Choo
Francis Chow
Antonio Choy
Coston L. Christensen
Dorothy Christensen
Harold Christensen
Vance Christensen
Nancy Christiansen
Harry Christianson
John Christianson
Curly Christmann
Dan Christner
Plato Christofides
George Christophorakis
Kin Chu
Mike Chu
Peter Chu
Stephen Chu
John Chulick
James Churchill
Myron Cinque
Boyd H. Clark
H. W. Clark
Joe Clark
Ruby Clark
Linda Clatone
Antonio Claudio
Uwe Clausen
Fritz Clemm
Zola Clemmer
Earl Clemons
Charlie Clifton
David A. Clitter
Ed Cloris
James Cochran
Judith Cochrane
Joseph Coelho
Charles Coffer
Richard Coffin
Ron Coffman
Diana Cogburn
Benjamin Cohen
Barbara Cohrssen
Erik Cole
Vic Cole
H. Coll
E. M. Collins
Lee Collins
Albert Collock
Patricia Colombero
Richard Colt

George Colville
Francisco Comayas
Albert Comeau
Michael Comstock
Dana Conant
Bob Condit
D. C. Cone
William Cone
John Coner
William Conker
Paul Conley
Tom Connaughton
William Connell
Michael Connelly
Noreen Connolly
Robert Connolly
Bob Connor
William Connor
Clifford Conrad
Hal Conradsen
Roberto Conrique
Ray Conti
Bruce Contino
George Contreras
Robert Conway
Gene Cook
Jerry Cook
Michael Cook
D. A. Cookston
Robert Cooley
Paul Coolidge
Alice Coombe
Benjamin Coombe
Bonita Cooney
Fred Coope
J. A. Cooper
Q. Cooper
Christine Copeland
John Coppedge
Phil Coq
Herman A. Cordes
Rose Mary Corica
R. M. Cornforth
Charles Corn
Dave Corn
Christine Costa
Chuck Costa
S. F. Costa
Donald Cotra
Debra Cotter
David Coury
Donald Coventry
C. O. Cowan
John Cowee
Charles Cox
George L. Cox
Howard Cox
Julie Cox
James V. Coy
James T. Coy
John Coyle
Connie Crady
William Craig
Julie Crane
Dick Cranston
Bill Crass
James E. Crawford
James Cribbes
Fred Crocker
Patricia Croft
H. L. Crooks
Homer L. Crooks
C. D. Cross
Carol Cross
John Crow
Peter Crow
Reynaldo Cruz
Del Cullen
Donna Cullins
Allison Cummings
E. C. Cummins (Glen)
F. O. Cummins
Larry Cummins
Mike Cuniffe
Charles Cureton
Dick Curry
C. A. Curtis
Bill Custer
Edward Custer
Irene Custino
Peggy Cutteridge
Mike Czaruk

D

Richard D'Amato
Charles J. D'Ancona
Hugo Daems
Kay Dahl
Eva Dahm
Ahmed Dajani
Judy Dake
Alan Dale
Don Daly
C. R. DaSilva
C. F. Dalziel
Nancy Damm
Donald Daniel
James Daniel
John Danielson
Laura Darby
Quirino David
John Davidhazy
Howel Wynne Davies
Lionel Davies
A. T. Davis
C. G. Davis
David Davis
Frank Davis
James Davis
Jon Davis
Mark Davis
Maurice H. Davis
R. A. Davis
Ronald Lee Davis
Rose Davis
Robert Davyot
Michael Dawkins
Percy Dawson
Edward Day (Ed)
Robert L. Dealey
Irene Debeste
Eugene DeBorioli
Rich Debski
Douglas Decker
Scott Decker
Charles Deckert
Helen DeClaive
Don Deere
John Deerwater
Bill Deeths
Dr. Bernie DeHovitz
Antonio DeLa Resma
Lee De La Figaniere
Abelardo DeLaCruz
Jean DeLaFontaine
John Delaney
Nibardo De La O
Sandy Dellaverson
Kenneth Delong
Bella DeLos Reyes
Fe DeLos Reyes
Katherine DeLuchey
David DeMario
Judith Demeter
Keith Dempsey
Andrew Denes
Mark Deng
P. Denisevich
Earl Denner
R. M. Denney (Roger)
Patricia Dennis
Bill Deras
Richard Derski
Jack Desmond
Carol Desper
Guy DeSpeville
Richard Dettman
P. B. Dettmer
Alberto DeVigal
Richard Devise
Marie DeVito
Beverly Devours
Cecil Dews
Frank Dews
Carlos Diaz
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