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HOWARD R. KING INTERVIEW

"PLANNING FOR POWER: AN INTERVIEW WITH HOWARD R. KING."

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Los Angeles Department of Water and Power

POWER SYSTEM ORAL HISTORY PROJECT

PLANNING FOR POWER:
AN INTERVIEW WITH HOWARD R. KING

Interviewed by Thomas Connors
The Bancroft Group

Dates: November 1, 1989, November 8, 1989, November 22, 1989

January 22, 1990, and January 29, 1990

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BIOGRAPHICAL SUMMARY

PERSONAL HISTORY:

Born: August 31, 1914 in Los Angeles, CA

Education: Los Angeles public schools, Manual Arts High School, Los Angeles City College, University College - USC, UCLA Extension.

Married: 1945, two sons and nine grandchildren

CAREER:

1936	Employed by DWP as apprentice electrical tester.
1937	Assigned to Receiving Stations A and B as station operator.
1938	Transferred to Big Pine Power Plant as powerhouse operator.
1941	Serves in the U.S. Army, 7th Division Artillery.
1942-1945	Serves in the U.S. Navey Seabees.
1945	Returns to DWP as checker in Power Drafting Room.
1946	Promoted to electrical engineering associate, Station Design Section, Power Design and Construction Division.
1954	Promoted to electrical engineer in charge of Generating Station Design Group, Power Design and Construction Division.
1962	Appointed Senior Engineer in Charge of Generating Plants Electrical Design, Power Design and Construction Division.
1963	Transferred as Senior Engineer in charge of Operating Engineering Section, Power Operating and Maintenance Division.
1965	Becomes principal electrical engineer, Overhead Distribution Section, Power Operating and Maintenance Division.
1967	Appointed Engineer of System Development to head that new Division.
1973	Becomes Assistant Chief Electrical Engineer of the Department.
1975	Retires after 39 years of service to the Department of Water and Power and the City of Los Angeles.
1975-Present	Has served as power engineering consultant on a number of state and regional hydro and other power projects and to the Navajo Tribal Utility Authority in Arizona.

MEMBERSHIPS:

Engineering and Planning Committee, WEST Associates, (1967-1973); Power Supply Planning Committee, American Public Power Association, (1967-1973); Planning Coordination Committee, Western Systems Coordinating Council, (1967-1973); Technical Advisory Committee, North American Electric Reliability Council, (1969-1974); also the Institute of Electrical and Electronics Engineers, the Institute for the Advancement of Engineering, American Legion Post 342 and the Electric Club of Los Angeles.

TAPE NUMBER: 1, Side A

November 1, 1989

TC: Let's begin with your family history. Where and when were you born?

HK: I was born in Los Angeles on August 31, 1914.

TC: What were your family circumstances? What did your father do for a living, for instance?

HK: My father worked for the City of Los Angeles in the Police Department. He had started in the telephone section of the Police Department and began to lose his hearing, so he transferred to the Identification Bureau. And in those early days, the identification system consisted of picture identification, photographs, and what was known as the Bertillon System. It had been invented by a French detective, in which there was a coding system based on measurement of bones. He grew up in identification with that system before fingerprints were used in the Los Angeles system.

TC: That's interesting.

HK: And then continued for some twenty-seven years with the Department in that work.

TC: And was your father from Los Angeles as well?

HK: He was born in Indiana, came to California when he was a lad of seventeen years, worked in the mines in California, and he married the schoolteacher in a mining camp in southern California where my mother was the schoolteacher.

TC: Oh, no kidding. What kind of mining? Would that be silver mining?

HK: It was gold.

TC: Gold mining.

HK: It was in the area of Julian, California, which came within a few votes of being selected as the capital of the state of California back in the days following the Civil War.

And on my mother's side, her mother came to California at the age of seven from Michigan in a covered wagon in the days following the Civil War. My grandfather built a road from the mountain community of Julian, California, down to the desert, some seven miles below in a beautiful little valley, and founded the town of Banner. And he constructed this road as a toll road. My mother was born in the tollhouse on that road in 1880. She later went to San Diego, was educated in what was called the Normal School, now it's San Diego State, and was educated as a teacher. After that she went back to the community where she was raised and taught in the one-room schoolhouse until she married my father. They moved then to Los Angeles where he originally worked for a short time as a motorman on the old yellow car street railway system and then finally with the Los Angeles Police Department.

TC: Would he have been with the Police Department at the time that the L. A. Times was bombed in 1910?

HK: No, they were married in 1910 and it was shortly after that that he began with the Police Department. He retired, I think, about 1938, 1937 or 1938, but he was not with the Department at the time of the [James B.] McNamara bombing. But his brother was also with the Police Department and he might have been there at that time.

TC: He was.

HK: My father's brother served some twenty years with the Los Angeles Police Department, mostly in work as a detective in homicide. He then retired in 1924, so that he would have started in 1914. I guess he wouldn't have been there in 1910.

TC: But you had heard stories of this event?

HK: Oh, yes, I was raised on Los Angeles crime. My uncle, after leaving the Police Department in 1924, worked for the district attorney's office as a special investigator for some eight years before he finally retired. And there were some pretty exciting cases in those early days. The Department was small, most of the officers were well-acquainted throughout the Department. It was totally different than it is today.

One of the very first horror crimes was committed by a man named Hickman, in which he kidnapped and murdered and mutilated the body of a small girl. The arrangements for ransom were made. He was to drive up to a particular street corner with the girl sitting in the seat next to him. The father was to throw a bag of money into the back seat of the open touring car. He would drive another block and let the girl out. When he arrived at that intersection, the father threw the money into the car; he drove a block further, and threw the pieces of the little girl out onto the sidewalk and escaped. And the only clue as to his identity came through a mistake he made. He reached up and adjusted the rear-view mirror on that car and my father identified him from that single thumbprint.

TC: The thumbprint, yes. Who defended Hickman? Would that have been Earl Rogers, by any chance? Do you know?

HK: I can't recall that.

TC: It seems to me, in my L. A. history reading, I came across that. Did you go to L. A. public schools?

HK: Yes.

TC: Where did you live?

HK: I lived in southwest Los Angeles on Forty-sixth Street between Normandie and Western, in that general area.

TC: Was that mainly a residential development?

HK: Yes. That was rather sparsely settled when I was born. The house my parents bought was, I think, only a year or so old when they bought it about a year before I was born. I was actually born in the house and attended schools locally there, a little grammar school on Normandie Avenue, James A. Foshay Junior High School and Manual Arts High School. And then I went to Los Angeles Junior College for three years and the rest of my education was obtained at night.

TC: And it was at L. A. Junior College that you took some engineering courses. Is that right?

HK: Yes. I took electrical engineering and received an Associate of Arts degree in that field. And I stretched that program out for some three years, although it was a two-year program, because I was working as a janitor in the school system to help pay expenses in those days. It was an interesting and simple life. We didn't have an automobile until I was ten years old, but you could go anywhere in the city for five cents on the yellow car. Or you could take the red cars out to Sierra Madre and climb the mountains, Mount Wilson, or go down to Redondo [Beach] and spend a day at the beach. And people got along quite well without automobiles.

TC: Yes. I always like to ask about the air quality in those days. And people have said, oh, it was a comparison of day to night. I don't know if that's romanticizing it or not, but was there a significant difference in the kind of air quality?

HK: Oh, yes, a very significant difference. It was always hazy. Los Angeles, even at the time when the first visitors to the area in the early days, back in the 1600s, found the area to be hazy from the natural fog. And we had that in those days, too, of course, but nothing compared to smog. And it was quiet because there weren't very many vehicles.

TC: How did the Depression affect your family? You would have been about fifteen, I guess, when the Crash [Stock Market Crash of 1929] happened.

HK: Oh, the Crash didn't hit us as bad as most people because my father was employed by the City of Los Angeles, although his income was very low. When my parents purchased the house, it was on a very tight budget and there was a problem in city finances back in those days. Shortly after they bought the house, my father's salary was cut considerably, and for many years all they could do was pay the interest on the mortgage. It took a long time to retire that. My mother had some medical problems that required a couple of rather serious operations, so my father took a leave of absence from the Police Department for three years and operated a mine out on the Mojave Desert for the Peerless Laundry Company in order to earn enough money to pay for those operations.

This was a fascinating experience and we spent one whole semester out there. We avoided school for one semester when I was approximately six years old and stayed with my father. But he was there for three years operating a soap mine. It was between Barstow and Daggett, [California], and I can't tell you the chemical name of the substance but it came out of the ground in the form of a tallow-like substance, kind of yellow. It was shipped to Peerless Laundry in Los Angeles, used in their laundry directly. It was also shipped and marketed without any further treatment.

TC: No refinement, just as is.

HK: No refinement. Most unusual material.

TC: And then he returned to the Police Department?

HK: Yes.

TC: When you were growing up, what was your view of the Bureau of Water Works and Supply and the Bureau of Power and Light? Were they fairly noticeable forces in the city, from your recollection?

HK: Well, prior to going to work for the Power System, I don't recall having much of an opinion at all. We had electricity and that was that.

TC: So [William] Mulholland and [Ezra F.] Scattergood didn't necessarily figure in your boyhood mythology or the kinds of things you noticed when you were that age?

HK: No.

TC: So did you go directly to work for the Department after junior college?

HK: Yes. The Department had started the frequency change project and asked the school for some recommendations of a few people. And my principal teacher recommended two of us. The arrangement was that we would have to go to work immediately if we were to take the position, and that was a week before final examinations, and the Dean of Men said that if I didn't stay and take my final examinations, then I couldn't graduate. My professors were quite upset because the opportunity to work for a utility, having studied electrical engineering for three years, was a golden opportunity in 1936 because the Depression was really still on. And so they all got together and convinced the Dean of Men that I should be allowed to take the final examinations at night privately, and they volunteered their time to come and conduct those examinations. Otherwise, I wouldn't have graduated.

TC: Let's talk about the frequency change and some of its background. It stems from the purchase of the L. A. Gas and Electric system in the city. Is that correct?

HK: No, that was part of it but the decision was based upon the construction of Hoover Dam. The decision had to be made whether to build Hoover for fifty or sixty cycles and the Department decided that sixty cycles was the way to go because that was the frequency that was being adopted almost nationwide.

TC: Yes.

HK: Our early fifty-cycle system was satisfactory, but to continue to expand at fifty cycles didn't seem prudent. Also, it was the intent to take over the sixty-cycle system of the Los Angeles Gas and Electric Company. So those two things together made the decision.

TC: What were the technical implications of this?

HK: Well, it was an enormous undertaking, really. All of the meters in the city had to be removed from the houses and businesses, brought into shops, overhauled, relagged, retested and reinstalled. So there were meter shops set up in various parts of the city. I started in San Pedro and worked in the shop repairing these meters which were then sent into the testing room and relagged and tested.

TC: What did the repairs consist of?

HK: Repairs were really just an overhaul, to clean the parts and put in new jewels on the rotating shafts and the disks. And the real problem was to get them relagged or readjusted to operate correctly at sixty cycles.

TC: At sixty cycles, okay.

HK: And that required some rather technical involvement for the larger meters, the big three-phase meters that served large amounts of power to industrial and commercial facilities. The great bulk of the meter work, however, was residential meters, which were very simple. There was quite a variety, each somewhat different, so it involved training to understand how each manufacturer had designed and built these meters, and we had classes at night to learn those fine points.

Then the motor drives throughout the city, in most cases, had to be changed out in some fashion. The facility being driven sometimes was not affected materially by a change in speed, but other devices had to continue to be driven at the same speed on sixty cycles that they had been driven at fifty. And this was accomplished by sometimes changing pulleys and belts, sometimes by rewinding the motors.

And so, after I had spent about six months on meter work, I got an assignment at a building at 800 North Spring Street where the motor work was to be done. I was in charge of the graveyard shift of a little testing laboratory set up to test each motor as it came in to determine its characteristics at fifty cycles. And then the design engineers would redesign that motor for operation at sixty, the shop would rewind the motor, and then I would test it at sixty cycles to see if we had accomplished the objective.

There were all manner of strange devices that came in. There were motor generator sets that supplied power for the arc lights and movie theaters that were very critical. Some of the folks on the frequency change had to come up with rather novel solutions to the charistic curves that these machines would operate through, and they developed what was called a pole-notching process in which the magnetic poles in the generators were notched to produce a different magnetic reaction. Many problems took quite a bit of effort to solve, but almost everything in the city had to be adjusted in some fashion. Electric clocks were handled by trading. Depots were set up and people who had an electric clock could bring it in and receive a new one. Those were not worth fixing or generally not possible to fix them, actually.

TC: And this was all done at Department expense. Is that right?

HK: Yes, right.

TC: So that was rather an expensive undertaking to change, but I suppose it was . . .

HK: That's true. And then there was considerable work done in our hydroelectric plants up in San Francisquito Canyon. I'm not familiar with precisely what was done but those machines had to generate at sixty cycles after the change. They'd been designed for fifty-cycle operation, so this involved changes both mechanically and electrically in those facilities.

TC: This was done at Department expense, but did that entail any kind of, you know, assessment or bond issue or anything like that, that you recall?

HK: I don't recall. Just how that was financed, I don't know.

TC: Okay, so how long did that whole process take?

HK: A little over a year. It went rather smoothly.

TC: Done in pretty short order.

HK: Yes.

TC: So that would have been, say, 1937 or 1938?

HK: Yes.

TC: And you stuck with the frequency change until it was . . .

HK: Until it was essentially completed. Then I was laid off for lack of work. And I was off for about three months before I passed a civil service examination for powerhouse and station operator and came back to work.

TC: And where were you assigned after that?

HK: My first assignment was Receiving Station B on Central Avenue. That's the location of the termination of the original Boulder Transmission Lines. So that was kind of an interesting place to be at that time.

TC: Yes. What were your duties there?

HK: I was a roving operator, making inspections of various station equipment, recording instrument readings at various times during the shift and I was a subordinate operator, taking direction from the chief operator on the shift.

TC: Who was the chief operator then? Do you remember that? Do you recall?

HK: Who it was? No, I don't. I worked also at Station A at 1630 North Main Street. It was a receiving station and the chief operator there was named Jim Griffiths and his assistant was named Shelburg.

TC: At the receiving stations, just to get the technical part down, that's where the high voltage comes in and then is it cut down at that point?

HK: Yes. The receiving stations are the termination of the transmission lines bringing power into the city and they are linked together with a high voltage loop transmission system, in which various high voltages were used. Most of the system in those days was at 138,000 volts linking the receiving stations together. Transmission lines came in at various other voltages: 115,000 volts from San Francisquito Hydro; 287,500 volts from Boulder Dam, and then from the receiving stations sub-transmission at 33,000 volts which later was elevated to 34,500 volts. These sub-transmission voltages linked the receiving station to a group of distributing stations and then each distributing station radiated to the city at 4,800 volts, which was the voltage on the lines going down the streets and alleys from which pole top transformers and underground transformers distributed the lower voltages to homes and businesses.

TC: At the time when you were working at Receiving Stations A and B, how many receiving stations were there in all? I know they've added to them.

HK: I think that there were only four when I began: A was at 1630 North Main Street; B was on Central Avenue; C was in Wilmington; and D was out in the Fairfax District.

TC: Oh, okay. Yes, in fact, I know where that is, at Fairfax and Venice, or something like that.

HK: Yes, in that region.

TC: And nothing in the San Fernando Valley at that point?

HK: No. As a matter of fact, when I later became a junior electrical engineer working in the drafting room, we were working on the design of Station D, the expansion of Station D, and it was believed at that time that that was the last receiving station. (laughter)

TC: Little did they know.

HK: Little.

TC: After this period of working in the receiving stations, is that when you went off to the Owens Valley?

HK: Yes. I went to Owens Valley in January of 1938.

TC: What were your duties there?

HK: A powerhouse operator.

TC: Powerhouse operator.

HK: I was assigned to Big Pine Power Plant which was a small hydroelectric facility on Big Pine Creek. At that time, it was shut down and on stand-by duty and so there were only two of us assigned to that plant. One or the other of us had to be present, twenty-four hours a day, so that if the plant was needed on-line, we could quickly start it and bring it up to speed and put it on-line. And the rest of the time we were doing maintenance work, taking care of the plant itself, the intake facilities up on the stream, the surge chamber and the flow line. We did everything. In those days, union rules hadn't appeared on the scene and today powerhouse operators are not used in that fashion. But it was a wonderful experience.

TC: Yes, I can imagine.

HK: Because everything that needed doing, except something really major, we handled ourselves. We also grew flowers. We had a beautiful garden surrounding the power plant. But there were other aspects of that experience that you won't find in today's world either. The manager of the hydroelectric system was a man named Ruble and Mr. Ruble was rather tightfisted with the budget, so it was very difficult to get money for anything and to get equipment unless we absolutely had to have it. One of the things that hadn't been done was to provide adequate housing up there. So, when I arrived at Big Pine, I was given a one-room cabin, twelve by fourteen feet, with no running water, no bathroom, nothing except a shell, and I thought that was the most wonderful place on earth. I had a cabin on a trout stream and set about fitting that cabin out to make it liveable, built in paneling, clothes closet, sink, drain board, bought a Sears and Roebuck wood range to cook on, a small apartment house refrigerator, I mounted my gun rack with my firearms, my fishing rod. I bought a used leather chair from a secondhand store in Bishop, [California], and in pretty short order I had a very liveable cabin.

TC: I can imagine, yes.

HK: For the first few weeks, it was necessary to walk a block to find the bathroom at the powerhouse until we could build an outdoor privy; and bathing required the use of an old washtub, just like the early pioneers. In the summer months, I had a shower head mounted on the power pole that fed power to the cabin, surrounded by a growth of willows to make some privacy. But that was quite an experience. And for the first year, I was there alone except for an Irish Setter hunting dog that was given to me by the superintendent on the system, who was then John McCullough.

TAPE NUMBER: 1, Side B

November 1, 1989

HK: Another operator was sent to live with me in this one-room cabin. So, at that point, I built a davenport-double bunk combination out of some old steel cots that the Department had up there, so that we could have a place to sit during the daytime and a double bunk to sleep in at night. And we shared that cabin then for two years, two men. And one winter, my Irish Setter had eight pups.

TC: Oh, no.

HK: It was too cold for the puppies to be out in that weather, so we had two men and nine dogs in a one-room cabin. (chuckling)

TC: Well, it made for warmth, I guess. What was the name of your partner there?

HK: Walt Barry.

TC: Did he stay on with the Department, too?

HK: He did. He stayed on until he retired. Walt is ten years older than I am, which makes him today eighty-five. This summer on our vacation trip, we stopped through Boise, Idaho, where Walt and Teddy now live and Walt is in great shape, planning to go cross-country skiing this year.

TC: The system up there in the Owens Valley, the hydro system, consisted of the plant that you worked out of. That was, obviously, like an auxiliary plant?

HK: Well, the power plant had been built in 1927 by the Water System rather than the Power System for the purpose of pumping ground water from Owens Valley which, as you know, is a very controversial subject today.

TC: Yes.

HK: Haiwee Power Plant at the southern end of the system, Division Creek Power Plant, Cottonwood Power Plant, those . . . I think Cottonwood and Division Creek had been built back in the days of construction of the [Los Angeles] Aqueduct.

TC: Yes, I think so.

HK: Very, very early.

TC: Yes.

HK: And then I don't recall what year Haiwee was built, but it was built at the outlet of the Haiwee Reservoir. And that system, then, was an isolated system with a 34,500 volt transmission system and served only the Owens Valley, and not all of that, because the Southern Sierras Power Company--which later became the California Electric Power Company, which was later purchased by Southern California Edison--was functioning. And they had power plants on Bishop Creek. There were six on Bishop Creek, some in the Owens River Gorge, others on up in the June Lake area. And, incidentally, it's quite a fascinating part of history and I don't have details too well in mind, but some of the earliest work on high voltage transmission in this country was done in that region. The power plants on Bishop Creek, small hydroelectric plants, were built to serve the gold fields in Nevada and Tonopah and the town of Goldfield.

And after they had operated for some time, the company wanted to build a transmission line to San Bernardino from Bishop. Electrical engineering wisdom at that time was skeptical of the ability to build a line that would function at that distance, so the double-circuit transmission line from Bishop Creek to the Nevada gold fields became a test facility to demonstrate the ability to do this. What they did was to connect the two lines together in the gold fields and transmit power from Bishop Creek to the gold fields and back to Bishop, to demonstrate that this would work. And that justified the construction of the line to San Bernardino, which, I believe, at the time, was one of the longest lines in the world.

TC: Oh, that must have gone over some pretty high country there.

HK: No, not particularly. The Owens Valley is at an elevation of about 4,000 feet.

TC: So they sent it down the valley.

HK: Down the valley.

TC: Oh, I see. And then across the desert to San Bernardino.

HK: Yes, right, right.

TC: How did you get along with the inhabitants of the valley?

HK: Oh, quite well. It was a little bit difficult initially to be accepted because, in those days, some of the early day warriors were still there, the people who had dynamited the aqueduct. And, in fact, they had blown up the penstock on the Big Pine Power Plant, among other things.

TC: Had they?

HK: During the wars that took place.

TC: Yes. That would have been in the late twenties. Is that correct?

HK: Yes, the plant was built in 1927, so it had to be the late twenties or early thirties. I'm not sure exactly when that happened but it was before I got there. But there were some young schoolteachers just out of college teaching in the Big Pine school system and we were accepted socially. I joined the Masonic Lodge in Big Pine and acquired a great many fine friends through that association. And because we were isolated, particularly in winter, our social life was the high point of our existence. We didn't have television, we didn't have very many things to do, except for the hunting and fishing and ice skating and skiing.

TC: Could you pick up radio up there, at that time?

HK: Yes, we had good radio, but only at night. As soon as the sun came up, the radio transmission died.

TC: So the social activity was mainly lodge meetings, for instance?

HK: Those and a dance in the town hall most every Saturday night, old time dances, which were much more fun than what people do today. The communities were not too far apart, so people traveled back and forth between Lone Pine, Independence, Big

Pine and Bishop. Those were the four major towns and they were linked together. There were other types of social gatherings, church socials and barbecues and one thing and another, and the people really enjoyed each other. Everyone knew everyone and knew pretty much everyone's business. Some people resented that small town type of existence. I loved it. I thought it was just wonderful, to associate with those people.

TC: So you went hunting and fishing. Did you get to do much hiking, for instance, up to Mount Whitney or some of the other peaks?

HK: Oh, yes. One of the things that helped in that regard was the way that we worked. We worked ten days on and four days off, rather than five and two, so it was very nice to be able to throw a pack on my back and go back into the Sierras for four days. And we had, oh, at least a dozen lakes up the Big Pine chain, the lowest of which was at 10,000 feet elevation. At the time the power plant was built, Second Lake was chosen as a regulating reservoir to smooth out the flow of water. And the way it was done was to drill a tunnel from the upper edge of First Lake, the lowest lake. They drilled a tunnel underneath the bottom of Second Lake, installed a gate in the tunnel, set a charge of dynamite at the end of the tunnel, and blew the bottom of Second Lake out. And from that point on, then, the water that came from Second Lake came through the tunnel. So, by pulling that lake down through the winter, it provided a reservoir to catch the snow run-off the following spring and avoid the waste of water. The power plant could only use so much water and, if the flows were higher than that, it was by-passed and ran on down the stream without gaining that energy. So one of my jobs was to regulate the gate on Second Lake. And the Water Department had built a cabin between the two lakes, a little tiny, corrugated steel cabin, primarily for use by the snow surveyors who would go in throughout the winter and measure the depth of snow. And the cabin was stocked with things to eat and bunks. I would be given a horse and two days to go in and regulate the gate, and I'd get two days of the finest trout fishing in the world and get paid for it.

TC: And for some reason, you returned to Los Angeles. I can't quite understand that. (chuckling)

HK: Well, I couldn't either. (laughter) As a matter of fact, that's an interesting part of the story, too. Because after three years up there, I was so thoroughly taken with that valley that I didn't really want to come back to the city. But I had passed my junior electrical engineer civil service examination and I thought I ought to get on with my career, if I was ever going to, and so I made the shift. But when I returned to the city, I was very unhappy that I left that wonderful valley up there, and I made the decision that I would abandon an engineering career and go back to the valley. So I called my old boss and told him that I would like to come back, and if he was agreeable I would try to arrange it, arrange a transfer back up there. No, I guess I wrote a letter to my old boss and told him that I was going to try to make this arrangement. And that same day, I got a letter from President Franklin Roosevelt inviting me to join his Army, and so I sent off another letter advising my old boss to disregard the first letter, that I was going to be busy for awhile.

I went into the Army, and during my service in the Army my father died, which left my mother dependent on me. I couldn't support her on $21 a month, so I was released from the Army. This was the period before the war.

TC: Yes.

HK: And then the war broke out and I joined the Navy, the Seabees [Construction Battalion]. And when I got back from the service the world had changed, and so I gave up the idea of going back to the Owens Valley and continued with my engineering career.

TC: The Big Pine plant, I just wanted to get the location. If you're driving through Big Pine going north, would it be towards the . . .

HK: To the west.

TC: It would be towards the west, towards the mountains.

HK: About three miles out of town, yes, right at the base of the mountains. And then about three miles up the stream is the intake. And from the intake, there's a flow line that moves almost horizontally for about a mile and one-half with about a sixteen foot drop and then a surge chamber. And then from that point, a steel penstock comes down the steep part of the mountain to the power plant.

TC: I see. That power was generally distributed in the Owens Valley? Is that right?

HK: It was at that time. It wasn't until the Gorge power plants were built that the 230,000 volt transmission line for the Gorge plants made it possible to move that excess energy into the city.

TC: So that the power that was sold up there was sold by the Department?

HK: That's right. And the load was small enough, which was the reason that Big Pine, for example, was not operating appreciably when I was sent up there. There wasn't enough load to utilize its energy.

TC: I see, yes.

HK: And when the Water System began to build Long Valley Dam for Crowley Lake, then we put the plant on the line to provide power for the electric shovels that were used in construction of the dam.

TC: So, in 1940, just prior to the period of getting drafted, in the valley, was it your decision to just pack up and leave or did you see a job bid back in the city that you wanted to go for? And, if so, what was that job?

HK: Yes. I had passed my junior electrical engineer examination and was offered a job in the power drafting room.

TC: Oh, so they offered you a job back in the city.

HK: Right.

TC: I see. When you enlisted, or when you were drafted, where did you do your basic training?

HK: At Fort Ord [located in northern California].

TC: And you were in for how long?

HK: Just three months.

TC: Three months, then you came out. And you were in the Seabees then after that.

HK: Yes.

TC: Was that an enlistment?

HK: Yes, I volunteered for the Seabees. I needed a berth thatwould pay sufficient money to support my mother and I couldn't go to Officers Training School because that involved several months of low pay. And I got a berth as a Chief Electrican's Mate in the Seabees, which paid $99 a month, and that solved the world's financial problems.

TC: Where were you stationed in the Seabees?

HK: In New Caledonia for the bulk of the period.

TC: Where did you do basic training for that?

HK: Basic training hadn't been invented for the Seabees. I went o boot camp in Newport, Rhode Island.

TC: Oh, that's where I hail from.

HK: Oh, is that so?

TC: Yes.

HK: Well, we were there for a few weeks and then we went to Quonset Point, [Rhode Island].

TC: Yes, I know it well.

HK: There was to be a training program technically there, but the Navy hadn't figured out much about that, so we really didn't have a training program.

TC: This was still in 1941 then?

HK: It was March of 1942. The war broke out in December of 1941 and I joined in March of 1942. I'm not sure just when I left home because, after joining, there was a brief period before I was given my orders to go to Newport. From there we went to Camp Allen, [Norfolk, Virginia] which again was a matter of putting in some time--this was in the Norfolk, Virgini, area--and then came out to [Port] Hueneme, which was to become the Seabee base. And we were the first outfit into Hueneme, arrived in the middle of the night in a foot of dust, and had quite a bit to do with getting that base set up so that at least people could sleep in the quonset huts. We had to eat at a Coast Guard station because our facility just hadn't been built. But shortly after we arrived at Hueneme, we were sent to San Francisco and embarked in small contingents from there. I was in the Third Battalion and it was divided up into four separate groups. One went to Fiji, one to Vella Lavella. Our group went to New Caledonia where we were stationed on a small island off of the mainland called Ile Nou. It lay across the bay and formed the harbor of Noumea, which is the capital of New Caledon.

TC: What were you constructing there?

HK: Well, what had happened was that the small island, which we were to construct a naval base on, had been supplied with electricity from the mainland. And one of the first ships into the harbor dragged its anchor and tore out the submarine cable that supplied the island. So there was an island without a power system. And there was no way to repair the cable, no facilities with which to do it, no cable. Supplies were in extremely short condition in those days. The Japanese were still coming south. No one really expected us to get home again because the Japanese intent was to take New Zealand and Australia, and New Caledonia was going to become the American base with which to stop that drive. And failure to stop it was viewed as setting the war back several years, so it was very important, but we had nothing much with which to work.

Well, our people went about building all sorts of facilities. We built a ship repair facility, a seaplane base, an aircraft engine overhaul base, a submarine detection loop. The RAAF [Royal Australian Air Force] had a small base on the island, the Army had an Army aircraft unit and there were a few native French soldiers on the island, but it was pretty grim.

Our commanding officer hadn't understood his obligations in taking a contingent to the South Pacific. He assumed that everything would be provided by somebody and he made no preparations for the trip. We arrived on our island in our dress shoes with our sea bags, 160 rifles, no ammunition, and 10,000 paper cups, and that is all we had. We stole a steel door off of a French prison to build our first cookstove. We borrowed food from the Army. We later got some tents from the Army. We made stakes out of brush that we cut and pounded into the ground with rocks, and we bootstrapped ourselves into an organization that could begin to work. And then we began to build these facilities as the materials came out. But all this time there was no electricity and electricity was going to be needed to run these facilities.

Well, before the war, the Japanese had been operating an iron mine at a place called Goro on the mainland on the far side of New Caledonia. And when the war broke out, they packed up and left. They left everything intact because they felt that they would be back in operation again. So the Army heard about this facility and went around to see what they could scavenge from it and found the power plant that powered a conveyor belt that had been used to carry iron ore from the mountain down to a deep water harbor, directly into the ships. This was not big in terms of electrical capacity, but for people with few hand tools and not much else, it was a pretty big piece of machinery.

Well, the Army assigned a group of GIs to dismantle this power plant and take it around to the capital of Noumea. First, they decided they'd fire it up and see if it would work. The generator pit was full of water, they bailed the water out, they started the plant up and brought up voltage and, of course, burned out about seven or eight coils on the bottom of the generator. It was a 3,300 volt winding. They didn't dry it out, so they burned out the bottom coils. And then the GIs, with their wrenches, took everything apart that could be taken apart, and loaded the bits and pieces onto a barge. And the barge was pretty heavily loaded and the last piece to go on was the generator rotor, which weighed seven and one-half tons. And when they put the rotor on the barge, the barge sank in thirty feet of water with all of this equipment.

So they got a diver down and brought the rotor back up with a crane and they lost some of the equipment and eventually hauled what they had salvaged around to the capital city of Noumea and put all of these bits and pieces in an old French warehouse and abandoned the project. They found outthat this was a sixty-cycle machine and Noumea was a fifty-cycle system, and that was too much for them and they just abandoned the whole project.

Well, the Navy heard about this Army power plant and decided the thing to do was to build the power plant on the Island, Ile Nou. So my partner and I were assigned to do that job, which was the most interesting experience, I think, of my whole life. We had to survey the pieces in order to design a foundation, for example. We would measure the distance from a shiny place on a crankshaft to the edge of a bearing, and from there down to the bedplate, and from there to a bolt hole location. There were no drawings.

TC: Because it wasn't constructed and you had to imagine what this would be?

HK: Exactly. No drawings. Now the diesel was Seltzer, Swiss Seltzer. The generator was built by Fuzi-Denke Seizo K K, whatever that means, and that was about the only English on the nameplates. The rest was in Japanese but the numbers were in the Arabic system so that we could fathom what most of them meant.

But the design was rather difficult because we had no drawings and we had to measure everything. The crankshaft weighed three tons. The pistons weighed 500 pounds apiece. The generator rotor weighed seven and one-half tons. The generator stator weighed three tons. So we set about designing for this before we got mostof the pieces across the bay. Some we couldn't handle.

We didn't have anything heavy enough to lift the rotor, for example, but we went ahead with the power plant anyhow and designed a foundation, poured it, and built the plant, the Building, and began to assemble what we could. Well, we knew we would have to have a hoist inside the building and we went out to a ship that had been torpedoed and had come to rest on a reef some ten miles out at sea and cut out an I-beam which had two hoists on it, from the engine room of this old ship. We mounted the I-beam and the two hoists in the power plant. The larger one was a ton and one-half hoist, the smaller one was a one-ton hoist. And we reached the point where we really had to have that rotor. We had assembled the base of the diesel engine. We hadn't put the cylinders on yet, but we had to move that rotor across the engine and drop it into position in the generator pit before we could continue with the engine.

About that time, the Marines had arrived with a barrage balloon outfit and I happened to see them one day placing a gun with a tractor crane. I asked what capacity that crane had and it was adequate. And I asked the captain who was in charge of this thing if they had one over on the mainland. He said, "We sure do." And we had helped the Marines a great deal because we had a shop at the power plant and they had needed our facilities periodically. We had worked very closely with them and they were happy to reciprocate. So the captain gave me a letter to take over to the mainland.

I found a tractor crane supporting a boat out over the shore where the Marines were painting the bottom of the boat. He opened the letter and instructed his group to swing that boat back in the water, wet paint and all. The tractor crane went down to the warehouse, picked up the rotor, and brought it throught the streets of Noumea like a watch fob swinging on the end put it on a barge, brought it across the bay, picked it up ane and hauled it down to our power plant some mile and one-half away on a dirt road, and dumped it in our doorway. Well, there we were now with a one and one-half ton hoist, and that was the maximum we had with which to lift a seven and one-half ton rotor. To make a long story short, we picked up the three-ton stator and suspended it in the air over the generator pit, picked up the seven and one-half ton rotor, merged the two in the air and lowered them together into the generator pit.

TAPE NUMBER: 2, Side A

November 1, 1989

HK: Well, we proceeded then with the completion of the power plant and the need for power was getting so critical that for the last few weeks we worked twenty hours a day.

TC: And this was a gas-powered plant?

HK: No, it was diesel, a diesel engine driven power plant. We had had a submarine tender make new coils for the bottom of the generator and we installed those. We were concerned because we knew the stator had soaked in salt water for some thirty hours. We tried to dry it out with Coleman lanterns and other heat sources, but we didn't have much faith in our ability to dry out that winding. So, on the afternoon of Christmas Eve, in 1942, we reached the point where we could start the diesel engine.

Now, to continue to run the engine, it was necessary to circulate cooling water from the bay. We had built a heat exchanger in the bay. We were set up to pump water through the engine but we had no electricity to run the pump. And so we had a head tank with 1,000 gallons of water and we figured we could get maybe five minutes of operation out of that tank of water to test the engine.

We also had to have a means of starting the engine, which normally started from air pressure from an air bottle. So we filled the air bottle with carbon dioxide, which was the only gas we could get our hands on, got enough pressure into the bottle to turn the engine over, started the water flowing, brought the engine up to speed, turned on the compressor, and built up air pressure in the bottle so that we would have another start available, and ran the engine for about five minutes and shut it down. That was Christmas Eve, 1942 .

We went back to camp, had a shower and a good dinner, and I told my partner that I wasn't going to be happy until I could build voltage up on that machine. So we got the crew and we went back down and put another 1,000 gallons in the tank and fired up the engines. I got up to 2,000 volts and the bottom coils burned out again. So there we were.

Christmas morning, we tore those coils out. We reconnected the windings to ignore them. We just couldn't wait to try to form new coils. And we knew then that we would have to dry that machine out internally, so I made a deal with the RAAF which had a small radio transmitter station on the island, a ten-kilowatt generator, a gasoline driven generator. It was operating the only communication we had from the island. They agreed to shut that station down for two days, and send power back over the power lines so we could operate the circulating water pump. Then we short-circuited the generator windings and phantom loaded it, building up just enough voltage to maintain full load current through the windings for a couple of days to heat it internally and dry it out.

And on the afternoon, then, of December 27, we fired that machine up and put some load on it. It operated maybe two hours and one of the pistons seized. We put the crew on the jacking bar and hand-cranked the lubrication system and kept the rotor slowly turning and cranking oil into the lubrication system until we cooled that engine out, dismantled the cylinder, pulled the pistons, polished out the liner which, fortunately, was possible because the nearest one was Switzerland. If we hadn't been able to fix that cylinder liner, we would have been dead. And that night we fired up that generator and my partner and I got a jeep and we drove around the island watching the machines humming, the shops turning.

Pan Am had been operating what's called NATS, Naval Air Transport System. They were about a mile from our plant. They had been using a bucket brigade to put gasoline in the airplanes that they were flying, because they had no way to pump gasoline. And that was something to behold: a group of natives handing odd-sized buckets of gasoline from hand to hand to fill an airplane.

We operated then for three months, not even stopping to change oil, and then continued to operate until it was time to come home and turned the plant over to a base maintenance unit that came out to operate the bases that we had built.

TC: Were you there for the duration of the war?

HK: No, I came home in June of 1944. We went down June 8, 1942 and came back June 7, 1944. We were there two years. But we had operated the plant for roughly a year and one-half after we built it.

TC: Were you ever able to modify what you had built or expand on it?

HK: Yes. And, you know, we did a lot of rather weird things. We were thieves, the Seabees. We were the best of thieves. We stole almost everything we got our hands on. And one of the things we stole was a small generating unit--two of them, as a matter of fact. We hauled the first one away ourselves off the dock and then the second one, we just changed the tags and had it delivered to us. And we built one of these into our power plant as an auxiliary unit and the other one we put at Pan Am's dock to operate their communications system, because they had so much air traffic and their communications were extremely vital to the war effort. And they needed an auxiliary generator there in case the power plant went down.

When we put in the auxiliary generator at the power plant, it was a small seventy-five-kilowatt diesel unit--a skid job that we took off the skids and hauled inside--we needed a means of balancing the load between the new unit and the larger one, and we needed a wattmeter for that purpose and we didn't have any wattmeter. So we took two Japanese watt-hour meters, house meters, if you will, with the rotating disks?

TC: Yes.

HK: We mounted one disk above the other on a common shaft so that we now had a poly-phase meter. We loaded the disk with a spring out of a broken wristwatch, so that instead of rotating it would simply move proportionately to the load. We calibrated it with a curved scale, using an instrument that had been traded to us from a naval minesweeper. The minesweeper had an electrical instrument, an electrical analyzer--alternating current instrument--that they had no use for. We had helped them with some of their problems so they gave us this rather beautiful instrument that had been sent to them. We then calibrated the meter (we had attached paper clips to the disk to swing around the curved scale) and we had a poly-phase indicating wattmeter. And I can show you a picture of that. In fact, I can show you pictures of the whole power plant.

TC: I'd like to see them.

HK: We had substations where we would mount these Japanese transformers, pole mounted transformers, of various loads, and we had no high voltage fuses, so we made them out of bamboo with hair wire inside to provide some degree of protection.

Oh, the stories could go on for hours about our experiences there. But to sum it all up, it was a marvelous experience because you couldn't pick up the phone and call GE [General Electric], you couldn't look in a reference manual, you couldn't get information from anywhere. You simply had to figure out how to do everything you did and it was a tremendous experience for all of us.

TC: And it took tremendous ingenuity, too. Remarkable. That's probably what won the war to begin with, that sort of resourcefulness.

HK: There was a great deal of that that showed in all of our people and the others we worked with down there, and under adverse circumstances, people do bring out capabilities.

TC: You were discharged then in 1944 as just a . . .

HK: No. I remained in California at Camp Parks, which was the Seabee base in northern California near Livermore.

TC: Yes.

HK: I was put in charge of electrical design for the base up there and spent the year there and was discharged then on September 19, 1945. I had one month of freedom and was married on October 19, 1945.

TC: Oh, had you met your wife during the war?

HK: Yes, in Oakland.

TC: So you returned, then, to the Department of Water and Power?

HK: Yes.

TC: I figure since we're on the second tape, maybe we can just get into this post-war period for a few minutes anyway. Were you given the job back that you had been in when you enlisted? That job was frozen, is that how it worked?

HK: Oh, well, of course, I was on leave of absence.

TC: Yes.

HK: . . . from a position as an electrical draftsman. When I came back to the States, examinations were given for the position of electrical engineering associate. So it was permitted that I could take this examination in the Navy. Two of us, two Department employees, Ken Withey and I, spent one Saturday under the supervision of a naval officer on the base taking the written examination. And since we couldn't be present for the oral part of the examination, this was handled by interviews with former supervisors. And so, we both wound up on civil service lists. However, there were no positions being filled at the time that I came back, so I continued to work as a junior electrical engineer, my original rating, which has been more recently converted to electrical engineering assistant, I believe it's called now.

However, the supervisor in the drafting room, H. C. Simons, assigned me as a checker, which position was normally filled by an electrical engineering associate. And he told me, "I can appoint you, I can give you an electrical engineering associate position if you want it, it pays more money but I'd advise you not to take it. I'd advise you to wait for a call from the Design Section. And so I did that and I worked as a checker for roughly a year and then got a call in the Station Design Section.

TC: What did a checker do?

HK: Checkers checked the work of the draftsmen. They went over the drawings and found the errors and marked up the prints for correction, and it was sort of a final check before the drawings went out into the field for construction.

TC: One thing I wanted to get at, of course, this took place at the time you were away, but you may have become aware of it afterward. In 1943, the two Bureaus were consolidated.

HK: Yes.

TC: Prior to that, they had worked independently? Is that how it was set up?

HK: Well, my own experience didn't relate to that area, except that we were aware that we were two different Bureaus and there were many Water people in Owens Valley when I was up there. I was working for the Power System, which had taken over the Big Pine Power Plant, which had originally belonged to the Water System and so forth. We were simply aware of the fact that there had been this consolidation, but I had no personal experience with it.

TC: The other thing I wanted to get at was the stature of Ezra Scattergood and your experience with him. I know he died in 1947. I suppose as a junior engineer, you wouldn't have had much contact with him at all.

HK: No, I did not.

TC: But as far as a figurehead, how did you see Ezra Scattergood?

HK: Well, he was, in our view, of course, a very famous high-level man, but I had no personal contact with him at all.

TC: He had close connections in Washington, I know, with the Roosevelt administration and some of the departments that would have some kind of jurisdiction over him. The Bureau of Reclamation, for example. Did that mean that there was more of a Democratic Party influence in the Department at that time, or was it a non-partisan situation?

HK: I was not aware of any political dealings at that time. In later years, I had a better understanding of these sorts of things. But I think, primarily, Scattergood's influence in Washington had to do with the Hoover Project, because it was the Department's willingness to take a major share of that generation, which made it possible to finance the job and build it. And lacking that, I doubt if it would have been built. So I know something of what's involved in trying to come to agreement on a project of that magnitude from my later experiences, and I'm sure that Mr. Scattergood played an extremely important role in that project.

TAPE NUMBER: 3, Side A

November 8, 1989

TC: When we left off last time, we were speaking about your post-war return to the Department of Water and Power and your work as a checker and your subsequent move to the Station Design Section.

HK: Yes, Station Design Section.

TC: And that is in . . .

HK: Power Design and Construction.

TC: And so you made that move somewhere around, say, 1947 or 1948? Is that correct?

HK: No. You see, I returned from the war in 1945 and roughly a year later, after working as a checker for about a year, I moved to the Station Design Section as a design engineer.

TC: So that would have been circa 1946, or so?

HK: Yes.

TC: What were your duties there in that position?

HK: I was assigned to what was then called Receiving Stations and Generating Plants, a group in the Station Design Section. And at the time we were doing some finishing up work on Receiving Station D, design of switchracks, control facilities and so forth, and I was in what was called an equipment group.

The section was divided up into . . . Well, to begin with, there were a number of different organizations within the Station Design Section. One was limited to distributing stations, for example. I was in an organization that dealt with receiving stations and generating plants. And after a few miscellaneous assignments, I was assigned to take apart a frequency changer at Receiving Station C in Wilmington and split it into two pieces, move half of it to Receiving Station D, and install them both as synchronous condensers. These are essentially synchronous motors running idle and they provide voltage control for the system. The frequency changer had been installed at C in connection with the transition from fifty to sixty cycles. The city was not cut over all at once, and the frequency changer permitted a sudden shift, if you will, in a section of the city. Then the next frequency . . . Well, it wasn't a frequency changer, it was a purchased synchronous condenser. It went in at Receiving Station F on the east side of the system. And what I did was to supervise the physical design of facilities for these kinds of installations.

Others were writing specifications, doing wiring design, and my specialty was equipment layout, if you will, and contract administration for the equipment that was purchased for this work.

TC: How did that work? Did that go out to bid or were you allowed to just go to the vendors?

HK: Everything essentially went to bid, yes.

TC: Now the private companies don't have to do that. Is that correct?

HK: No, they don't. But the city is limited to small amounts of equipment that can be purchased without competitive bidding. Almost everything is supplied through competitive bidding.

TC: So was that a fair system? Do you think it operated as it should have? I suppose it was instituted in order to create a fairness or instituted to avoid any kind of favoritism?

HK: That's correct. And by and large, it worked well. There were problems associated with competitive bidding, in that the legal requirements sometimes made it difficult for the engineers to exercise sound judgment in the award. If, in the engineer's opinion, a manufacturer's product was unsatisfactory for the particular application, he would have to prove that pretty solidly or the Legal Division would object to the recommendation for award. And we did have some problems in that area because it was an important role to exercise judgment about the availability of equipment.

For example, in complex machinery it was very common to indicate equipment manufactured by a particular manufacturer or equal. That was a kind of a broad-based way of specifying what was wanted, rather than trying to write volumes and volumes and volumes of specific details about a piece of equipment. And then when the bids came in, the issue always arose as to whether this was equivalent to the item specified. And if, in the judgment of the engineer, it wasn't, sometimes the manufacturers with the lower bids would object and the matter would go before the Board of Water and Power Commissioners and sometimes there was quite a little trouble.

TC: At this time, had equipment become generally standardized? Were there any innovations happening? I know that earlier on when the Power System was being set up--this would have been in the teens--so much of the equipment that was being bought and installed was brand-new stuff, as far as inventions went. I suppose that bigger capacity type of equipment was being constantly developed by that late 1940s period.

HK: Yes.

TC: Was it still a period of innovation there?

HK: Oh, yes, yes. Improvements, things were growing larger with consequent problems. Trying to obtain equipment that would fit into smaller spaces was a problem, particularly in the congested areas of the city. The transition from stations involving many acres in which to lay out a plant, and in more congested areas where equipment had to be pretty tight, the use of innovative designs was underway, and it continued then for many, many years.

TC: In my reading of this period, I've come across the term "economies of scale" a lot, and I wondered if we could define that in terms of what was happening. I suppose that has more to do with the steam generation or the generating plants themselves.

HK: Yes, it does.

TC: Be they steam or hydro or nuclear. If I'm correct, it means that economies are achieved by bigness, by size, right?

HK: That's true. If you go back in history a little bit, from about 1935 until, oh, the late sixties, there had been a continuous decline in rates for electricity in the Los Angeles system. There were many rate reductions and these were coming about somewhat due to the economy of scale, in which ever larger equipment produced lower cost generation--it was largely in the field of generation--and the industry generally was going this route. It was not possible to go too large all at once. It was a function of the size of the system. Because, you see, in the early days of electrical generation in this country, most systems were isolated, operating independently. And there again the economy of scale becomes an important matter.

For example, one of the things required in supplying a system reliably is reserve, that is, some back-up generation, back-up transmission lines--in the event of a failure of a piece of equipment. And so, quite obviously, if you have a single generator supplying a system and it fails, the entire system is down. If you put in two generators and one fails, you're down to half capacity. If you want reserve for that system, then you have to have a third half-size generator. And if you have 100 generators and one fails, it's a rather minuscule loss, and so there's not very much reserve required.

So this was happening to individual utility systems and, as a result, interconnections were arranged.

These interconnections initially were on a rather small scale, between utilities which were immediately contiguous: Los Angeles and the Edison Company, Los Angeles and Pasadena, Glendale, Burbank. There were interconnections for a variety of reasons, but one of those was shared capacity, shared reserves. And so, as the systems grew larger and larger, the size of the equipment that could go in--in view of the fact that you're looking at a system of several ownerships but still a single physical system operating in synchronism--that combined system, through the interconnection process, could tolerate a larger generator. And if it could, there was economy of scale to be achieved.

Now what really made the grand change, the upsurge in this economy of scale, was the advent of extra-high voltage transmission. Now, this made possible mine-mouth generating plants of considerable size, in which there would be cooperative development among several utilities, each taking power from that plant. And by virtue of the fact that they were, they were interconnected. So now we had regional interconnections, and these regional interconnections then led to some severe problems--cascading failures--the Great Northeast Blackout, as an example.

TC: Yes.

HK: These posed many, many problems. These interconnections became possible due to the advent of extra-high voltage transmission.

TC: Well, that would have been in the fifties then, or late fifties?

HK: Sixties primarily.

TC: The sixties primarily, okay.

HK: Yes.

TC: And just while we're on that subject, I'd like to continue a little bit on that. When you say extra-high voltage, how much was the high voltage boosted to make it extra-high voltage?

HK: Well, in general, high voltage was limited to about 230,000 volts. And the Boulder Transmission Lines from Hoover Dam to Los Angeles, at 287,500 volts, those lines were the highest voltage, longest lines in the world for some seventeen years. And then industry began to go higher at 345kv, 345,000 volts, 500,000, 765,000; and then when we built the DC [Direct Current] Intertie, it operated at 800,000 volts initially, and now is operating at 1,000,000 volts between poles. It's insulated for half of that because the midpoint is at ground potential. The DC system has a voltage above and below the ground point, so the two poles are a million volts apart, but each of them is only a half a million volts with respect to ground.

TC: That's an incredible jump when you think of the time frame there. Was anybody in the mid-fifties saying, "Oh, yeah, in twenty years we'll be having this million volt possibility"?

HK: No. Well, I suppose there were visionaries who anticipated this, but most of this growth was a step-by-step process and it overshot in terms of generation. We built generators that were too big and the industry had to back off in later years because the problems of trying to achieve the economy of scale got us into some generating sizes that were too big. And the loss of those machines resulted in all sorts of problems.

TC: Would that have been in the steam plants in the Los Angeles basin?

HK: Yes. For example, there was a steam plant generating unit built elsewhere with 1300 megawatts on a single shaft, which is about the same size as all seventeen generating units at Hoover Dam.

Now there you can see a picture of the economy of scale, in terms of looking at Hoover and looking at this single installation. But when you lost that machine, you lost 1300 megawatts, and the higher temperatures and pressures were pushing the limits of metallurgy and so problems developed.

TC: Well, where was that unit that you just mentioned?

HK: I don't recall where that was installed. It wasn't anywhere in the west.

TC: Oh, I see.

HK: It was an eastern machine.

TC: Oh, I see, okay.

HK: But the industry, having overshot, backed down where the maximum size units now being put in is on the order of 800 megawatts.

TC: Well, going back to your step-wise progression in the Department after moving to the Design Section. Who did you report to, first of all? I want to get some names.

HK: Initially I reported to Ernest W. Werk, and he in turn reported to Oscar Sidenfadden who was a senior engineer in charge of our Subsection, who reported to J. P. Stratford who was head of the Station Design Section.

TC: And you stayed in that position for how long?

HK: Until 1954. And then I was promoted to electrical engineer and became a group supervisor.

TC: And what group was that?

HK: It was the generating plants design group, and it consisted of about six or eight people doing the same sort of thing I had been doing for the previous several years--people I'd been working with. It was sort of a minor reorganization, in which we were growing and getting more work and specializing a little more.

TC: I see. Specializing in what way?

HK: Well, for example, Receiving Stations and Generating Plants were separated.

TC: Okay. Before that they had been lumped together.

HK: Yes, right.

TC: Would that have been because, you know, they're sort of on each end of a process, so that was from generator to receiving station?

HK: It just was viewed, I think, as a more manageable organizational arrangement to specialize a little bit. I had a great many different kinds of assignments in both Generating Plants and Receiving Stations in the years when I was an electrical engineering associate design engineer, and my promotion to engineer level came about when this reorganization occurred and specializing, separating groups of people.

TC: Yes.

HK: We still had a separation also of the specification group writing specs and the wiring people, and this has continued to change over time. The organizational names are different, the civil service titles are different, and things change more or less continuously.

TC: So this was still within Power Design and Construction?

HK: Yes.

TC: In the mid-fifties, the Valley Steam Plant was put into operation in about . . . I have a date somewhere. It was about . . .

HK: Nineteen fifty-six or nineteen fifty-seven. Yes, I spent seven years of my life working on the electrical design of Valley Steam Plant.

TC: In 1957, you got it, yes.

HK: It had been planned to go at Seal Beach. The equipment had been purchased for installation at the old Seal Beach site of the Los Angeles Gas and Electric Company, a plant which we acquired in 1937 and which was subsequently torn down. And there was a dispute with the Seal Beach people and other political people over taxation, which led to the decision to put the plant in the San Fernando Valley.

TC: I didn't know that. That's interesting.

HK: That was one of the major concerns. The other one was that the growth of the San Fernando Valley called for generation in that area, and there's been a great deal of growth out there so it was a good move.

TC: Well, did the proximity of the Seal Beach area to the ocean for cooling water . . .

HK: That's right.

TC: That must have created a problem, in terms of planning for the Valley.

HK: Yes, it was necessary to go to cooling towers in the Valley, which involved considerable consumption of fresh water for cooling the machines.

TC: And was that aqueduct water?

HK: Well, it's a mixture. The Water System acquires water from many sources, some of it from the aqueduct. There's water that is pumped out of the underground basin in the San Fernando Valley, and just how it's mixed and where I'm not too sure.

TC: That cooling water is recycled, though? Isn't that the case?

HK: Yes, but it cools by evaporation. There's two things basically that happen. To begin with, you have a condenser in a steam generating unit, and as the steam exits the machine it passes over tubes which are full of cool water, which condenses the steam and pulls a vacuum on the tail end of the turbine and increases the efficiency of generation. The water which is flowing through those tubes, of which there are many hundreds, is recirculated through the cooling towers where two types of cooling occur. The water is distributed at the top of the tower. A fan is blowing air vertically upward, and there is an exchange of heat between the cool air and the falling water, as well as the cooling due to evaporation. The water winds up in the sump in the bottom of the tower and is pumped back to the condenser.

But in the process, of course, the salinity of the fluid increases and it's necessary then to "blow down," as we call it, to discharge that water periodically and add additional fresh water to keep the chemical content under control. Otherwise, you get plating inside the condenser tubes and all manner of problems. So there's a good deal of chemical treatment, as well as the necessity to throw away a lot of fluid, to keep the chemical balance proper.

TC: Now, compared to the seacoast plants, you have just a continuing flow of water coming in and out. Is that correct?

HK: Yes, the Seal Beach plant is located adjacent to an estuary, tidal basin, the terminus of the San Gabriel River, and the intake was then fairly close to the plant and the discharge some distance at sea. In the case of other steam plants like Scattergood, you lay two lines out to sea, one considerably farther than the other so that the intake and discharge are separated to avoid recirculation.

TC: I had read--and this was in Department pamphlets describing the Valley Steam Plant as it was getting ready to be put into operation--that there were certain innovations in that plant, one of which was that it was an open-air plant as opposed to plants [that] have to be enclosed in some way because of weather. Out here that wasn't necessary. Was that an innovation or was that sort of a publicity statement?

HK: No, it was really an innovation. It saved a considerable amount of money over an enclosed plant, both in the cost of the structure that would have housed the machine and with the auxiliaries associated with an enclosure. There was, of course, a great deal of enclosed area under the generator deck, which gave protection against the weather for that equipment. The boiler had a bit of outdoor equipment scattered at the various levels up and down the structure, but none of those was in any kind of a severe problem. Of course, our weather here made this possible.

There are many areas where it's not appropriate. When we built Scattergood, for example--that's an indoor plant--

and the proximity to the ocean there indicated that that should be indoor. The handling of major equipment during an overhaul is a major consideration there, using a big gantry crane at the Valley Steam Plant against a bridge crane that you see in an enclosed plant. But the overhaul has to be protected from the weather and so we built a portable building of steel, to be assembled on the deck during an overhaul operation at Valley.

TC: Oh, very interesting.

HK: So it could be worked on inside in that.

TC: And this was part of the original plant then, to be able to do this and have this ready.

HK: Yes, right.

TC: How often do the overhauls take place? One of my questions about the problems in steam plant generation was that equipment upkeep and overhaul must be a consideration.

HK: Well, usually, a turbine is torn down after one year for inspection because of the guarantee. The generator windings may be coming loose and need rewedging, the turbine may have developed some problems and so an inspection is desirable. As to actually reworking much of the machine, I've lost track of the time that is normally used now. I think in the days when I was there it was probably a five-year period, but I'm not even sure about that.

TC: You were there on-site as it was being built and put into operation, and even afterwards? You said you were there seven years or so.

HK: No, I spent seven years on the design. There was a great deal of planning for the plant before construction started.

TC: Oh, yes.

HK: And the writing of specifications was underway. The coordination of design for that project brought into being a coordinating committee, so that the several sections involved could work together.

TC: Yes.

HK: That produced quite a few difficulties. The Steam Design Section, by and large, had the lead on the plant, but people in other sections that were designing the structure--the piping and so forth--all of this had to be coordinated with the electrical installation, so that you didn't have conflict of equipment, and trying to achieve some economy and layout arrangement without adversely affecting each of the specialized areas.

The exchange of information with respect to specifications is important. For example, when you write a specification for a turbine generator, mechanical people are concerned primarily with the turbine, the electrical people with the generator, there's a great deal of auxiliary equipment, the pumps are each driven by a motor, controls are both mechanical and electrical so that a kind of cooperative effort was underway for quite a while before ground was broken.

TC: Oh, I see.

HK: Scheduling was a major problem for a project of that magnitude because things had to be ordered in such a fashion that equipment would arrive and be in place before other facilities could be set. Foundations had to precede equipment arrivals and so forth. There was an order which we now refer to as "a critical path schedule," in which various things have to go first. And this works its way back into the writing of specifications--the time for bidding, the award of the contract, the design of the foundations and other structures that will accommodate this equipment--and so there was a great deal of that kind of work before construction started, although we did not complete the design before construction started. We got a head start and stayed ahead of it, so to speak.

TAPE NUMBER: 3, Side B

November 8, 1989

TC: Who was in charge of this coordinating committee? Who would be the chairman?

HK: The chairman during most of that period was a senior mechanical engineer named Al French. That changed from time to time over the years, but most of those years it was Al French in that role.

TC: This is slightly off the specific topic of steam plant design and construction, but there were other management committees, I understand. You know, if you look at the organization chart, you can see the various breakdowns in the divisions. But there were also committees that would meet. That wouldn't necessarily show up on that chart, different kinds of management committees. Were you involved in any of those?

HK: Yes. I was chairman of the Electrical Design Committee within my own section, in which we attempted to coordinate the equipment layout with the wiring design specification work and so forth. The coordinating committee was made up primarily of senior engineers in various specialties. There were three senior engineers in the Steam Design Section, again, specializing in piping or equipment, whatever. There were civil engineers from a new section that was created along about that time to handle the civil engineering aspects of Design and Construction's work. That came into being, I think, during the early stages of the Valley Steam Plant Project. Those were the major committees I was associated with in those days. And we were more or less feeling our way. This was the first major steam plant project that I had anything to do with. The Harbor Steam Plant had been constructed. It had been started prior to the war and was more or less put on hold through the war.

TC: Put on hold, yes.

HK: I did work a little bit on some of the modifications when I came back from the service, so that experience the Department had been through.

TC: Looking at it with a long view, you see a trend of the Department relying largely on hydro up until, say, sometime in the mid-forties, and then you have the slow but deliberate change to steam as the major power source for the city.

HK: Yes.

TC: That was obviously a conscious decision, I know, but there must have been some kinds of considerations that influenced that decision. For instance, somebody must have seen at some point that the amount of hydro was limited.

HK: That's right.

TC: Where did that come from? Was that in a planning group or was that coming from the top level, from [Charles] Garman or from [William S.] Peterson?

HK: Well, later on, in about 1963, I became senior engineer in charge of the Operating Engineering Section in the Operating

Division. That organization had been previously known as Research and Records and had served in a staff capacity to top management in some of these planning areas, to assist management to make that kind of decision. I wasn't involved in that in the earlier years, but I got a little better insight later on when I got into that.

TC: Yes.

HK: And so, basically, there were planning people--generation planning people, I guess you might call them--in the Operating Division advising top management on the need for such things. The Department's organization, of course, was much smaller in those days and there was less need for large staffs and so forth.

TC: Yes.

HK: But to make a long story short, the Department had contracted for an enormous share of Hoover, far more than really could be foreseen at the time. And that willingness to contract for that huge amount of power was the only thing really that made the project possible. So, over time, that hydro capability was used up and the time came when it wasn't going to be able to meet the growing load, and there were few other sources of hydro available. The vast hydro resources of the Pacific Northwest couldn't be tapped because we hadn't gotten into the era of extra-high voltage transmission yet. So it was necessary to go to steam generation.

TC: Well, the Owens River Gorge Project was begun, I guess, around 1949. And those plants would have become operational, I suppose, some five years later or so. Now, was that considered just a back-up sort of deal?

HK: No. It became possible to develop the Gorge when Long Valley Reservoir was built. The Long Valley Dam and Crowley Lake provided the necessary storage on the Owens River.

TC: Yes.

HK: It would have been a run of the river operation without the lake.

TC: Run of the river being that whatever the river was doing, whether it was high or low, that would be the . . .

HK: That's correct. You see, the Water System wanted that lake for water storage. Power System wanted the opportunity to generate. Quite a little time went by before the power plants were put in and this was largely decided by the price of oil. When oil was selling for $2 a barrel, you couldn't afford to build those hydro plants. The other thing was that there was no transmission line, so the project would involve three power plants of 37,500 kilowatts each, plus a 230,000 volt transmission line to Los Angeles, to make it possible. And it waited until oil prices got up to, oh, I don't know, $2.50 or maybe $3 and then it became economical.

And it also required the Pleasant Valley Reservoir, downstream of the last power plant, as a re-regulating reservoir, to smooth out the flow of the Owens River below that point. And this was one of the things I worked on in the Station Design Section, too. And we had a mechanical design section in the Station Design Section which handled the hydro mechanical work. So we had association with those people, as well as the Steam Design Section that was totally separate from Station Design that handled the mechanical work for the steam plants.

TC: That's interesting.

HK: It was called the Steam Design Section and it was essentially an all-mechanical organization.

TC: The two basic problems in steam generation that I was able in my thinking about this to locate were air pollution and fuel supply. And, of course, those two things are related. I don't know if they're two separate power problems, but I know that by the early sixties that what is now the Air Quality Management District [AQMD], which then was called the Air Pollution Control District, was fairly concerned about what was happening with air quality in the Basin and was watching the steam plants pretty regularly. At some point, Rule 62.1 was established, 1964 maybe, and that pretty much dictated what kinds of fuel you were going to be using in these plants. Could you explain some of the politics of air pollution?

HK: Yes. Of course, power plants do pollute. The oil, fortunately, that we were able to use here is low-sulphur oil, so it has much less of a problem than the high-sulphur fuels that are burned in the east. Nevertheless, there's considerable amount of pollution. And pollution control equipment was not generally developed in the early days of power generation. This came along after the pollution crisis evolved, and so a great many things were being done to fight smog. The proliferation of steam plants in the Basin was rapid. I believe I worked on some seventeen different units in the Basin in the time that I was involved in the electrical design of generating plants.

I'm not too familiar with the technology because this was a mechanical specialty, but there were two basic elements in this pollution: the unsaturated hydrocarbons and the nitrogen oxides. And all sorts of things were going on in the industry to diminish the effect of these. One of the things was to reduce the temperature of combustion inside the boiler, and this was accomplished by what was called off-stoichiometric firing. In other words, you backed off from the most efficient way of producing heat for generation in order to lower the temperature of combustion, to cause the combustion of the fuel to take place in a little different pattern within the boiler. These boilers are huge furnaces with water walls, stretching the flame out so that the combustion didn't occur quite as suddenly at such a high temperature. It had a lot to do with reducing the nitrogen oxides, which hadn't really been discovered in the early days of pollution control. We went through this with automobiles, you may recall. We put a variety of different devices on automobiles.

TC: Yes, right.

HK: We discovered that some of the early efforts to reduce the unsaturated hydrocarbons actually increased the nitrogen oxide problem, which turned out to be a worse problem than the initial problem. So there was a great learning curve.

TC: Oh, yes.

HK: The Department was faced with this problem: always the utilities are being besieged to retrofit, which is a frightfully expensive thing to do, and the older a plant gets, the less economic it is. So, in the case of Scattergood [Unit] 3, that is where the issue really was joined with the air pollution people. They laid down rules which limited the power plant to gas-firing. And then there was a crisis in fuel supply and there wasn't any gas, and so our newest and largest and most efficient generating unit sat idle for many, many long months because of the law. The law, or the rules and regulations promulgated, would not even permit the installation of oil-burning equipment. I think that has been subsequently corrected since I retired, that they are in a position to burn oil if they have to. We prefer to burn gas.

But one of the major problems with fuels was the unavailability of a firm supply of gas. There was lots of gas in Texas. The Department and the Edison Company joined forces to build a private supply line. It was referred to as the "enchilada inch" because it was going to come through Mexico.

TC: That's the Gulf-Pacific Pipeline, right?

HK: Yes, and it would have provided a firm supply of gas for a considerable period of time. But the Southern California Gas Company argued before the Federal Power Commission that it was essential for them to supply all the gas in this area, which they promised they would be able to do forever and weren't able to. What they really wanted was a constant load on their system, in which the domestic uses of gas in the wintertime would use their capacity.

They would force the industrial users to turn to alternate fuels. And then in the summertime when there wasn't any particular load in domestic heating, they would sell vast amounts of gas to electric utilities and other industrial users. And that was ideal from the standpoint of the gas company: a constant load, compared to a load shape in which you have to put in facilities for peak supply and then back off to a low commodity sale through much of the year. So we were forced then to burn oil whenever the gas company ordered us off the system.

In order to burn oil, we had to contract for it and the law required that if gas was available, we had to burn it. And you never could figure what the weather was going to be. When I was in the Operating Engineering Section in the early sixties, that was quite an experience: contracting for oil to be delivered in convoys of trucks and by rail and whatnot into our somewhat limited storage. We would contract and the trucks would stream in to fill our storage. We would burn it rapidly and suddenly the weather would turn warm and the Air Pollution Control people would require us to burn gas and we couldn't burn the oil and we had no place to store it. We had to abrogate contracts and it was a frightful thing.

The alternative to that was to build immense storage, which is extremely expensive, and maintain very large stocks of fuel in storage, which again that inventory is very expensive. So the economics of power generation were tremendously affected by these air pollution problems.

TC: The Air Pollution Control Board, is that a state body or is it a county . . . ?

HK: No, it's regional.

TC: It's regional.

HK: Regional. It was largely county in those days.

TC: But it gets its authority from the county organization, the Board of Supervisors?

HK: Yes, it did then, and I think largely now. But I don't know what the involvement of the state is at this point.

TC: Oh, okay.

HK: But it was a county-wide affair in those days and its present complexion is more regional than just Los Angeles County.

TC: When was this group formed? Do you have any recollection of that?

HK: No, I don't.

TC: So the Gulf-Pacific matter dragged on for some years?

HK: Yes.

TC: And the final ruling was in favor of the Southern California Gas Company.

HK: That's correct.

TC: Another point on electrical generation in this period was the transition from overhead lines to underground lines.

HK: Yes.

TC: I know there was a special section that was involved in that. Was that Design and Construction? Was it a Division within Design and Construction?

HK: Yes. I can't remember now whether underground was a separate section or part of the Transmission Section, but there was an organization of underground people who where putting in cable and this goes back quite a long ways. We had a great deal of underground transmission looping the receiving stations together at 138,000 volts.

TC: So that even early in the fifties, say, you would have had some undergrounding in operation?

HK: Yes. And then the radial supply from the receiving stations to the distributing stations was largely underground at 34,500 volts.

TC: In your designing work, did you have to think in terms of, well, what is above ground now will be underground at a certain point, as far as transmission goes? Did that impact your design thinking?

HK: Well, I wasn't involved in that in those early days. Later on when I had the System Development Division, we were concerned with planning for those facilities.

TC: Yes.

HK: But the trend was rapidly moving toward underground. As the city expanded, the opportunity to build overhead was diminishing rapidly. There were a few places where you could put in an overhead transmission line but not many.

TC: That must have been a tremendously expensive proposition.

HK: Yes, it was. And I don't recall any numbers to quantify that but, yes, it's expensive, and maintenance can be a severe problem when one of those cables fails.

TC: Yes, I suppose you wouldn't actually know where it failed, if it were cut or something.

HK: Well, the point was that the failure was underground in a conduit somewhere between two manholes. And the problem of removing and repairing such a cable was far greater than working on overhead structures. But the work was done well and I don't think there was a great deal of a problem.

TC: Part of the rationale for going underground was aesthetic, that too many lines overhead didn't look as good as no lines overhead.

HK: That's right.

TC: And I guess there were some beautification people that were promoting this. But it's interesting that the Department did take it up and say, "Yes, you're right. Let's do this."

HK: Yes.

TC: We were talking about the Valley Plant. The next plant after that, was Haynes?

HK: Scattergood.

TC: Oh, Scattergood was after that, okay. And were you involved in the design for Scattergood?

HK: Yes, right.

TC: Scattergood was planned to be bigger than the Valley Plant, is that right? I think what went into operation was smaller, but it was . . .

HK: Well, of course, those plans changed. I don't recall that it was planned to be bigger than Valley, no.

TC: No?

HK: We did expand it to the third unit some years after the initial two were built, but Valley Steam Plant was built with a view to four units from the start. The first two turbine generators were supplied by Westinghouse and the second two by General Electric. And the boilers were by different manufacturers, so they were somewhat separate projects. But the whole installation of four units was contemplated from the start.

With Scattergood, my recollection was that additional units were thought of as maybe coming along later, but it was not so much of a design layout for four units or three units. In the beginning it was two units.

TC: It was two units. And then Haynes was begun sometime in the early sixties. Is that correct?

HK: I can't recall now exactly what the dates were, but as a follow-on to Scattergood. Haynes, of course, was six units and that was where we put in our first foreign turbine generators, supplied by Brown Boveri [Electric Inc.] of Switzerland.

TC: What was the response among the American suppliers for going out of country for that?

HK: Well, they, of course, were quite upset. But what we had really done, the specifications for those first generators--units one and two at Haynes--had been written in such a way that foreign bidders could not bid. And when the bids came in for those first units, the prices were outrageous. There were three suppliers: General Electric, Westinghouse and Allis Chalmers. And because of the high prices, top management decided to cancel the bids and re-advertise, and the specifications were rewritten to permit foreign bidders. I was involved in that effort from the start. There were consultants who, I think at the behest of some of the American manufacturers, were strongly advising Department management to avoid the foreign bidders. And we examined their arguments and discounted them and I think we wound up with some very fine equipment.

We had received some foreign equipment, of course, prior to that, but those were the first generators. The generation transformers at Scattergood were furnished by English Electric and we had lots of problems with those. But the generators, I think, broke the door down that had prevented foreign generation in this country. That was the first invasion of large foreign turbine generator manufacturers in this country.

TC: After Haynes went up and became fully operational, was the whole steam generation program cut then? Did somebody say, "Okay, we have enough of this. We shouldn't be doing this anymore"?

HK: Well, it was after Haynes that we went back to Scattergood with a third unit. But that was the end of the line.

TC: Well, how did the nuclear plans enter into this whole thing?

HK: Well, of course, the Department was interested in nuclear generation as soon as it became a viable option, and there was opposition right from the start. The initial effort was a site in Corral Canyon near Malibu. Other sites were looked at, too, but there was opposition from environmental people and political people. And despite best efforts, we never managed to build one.

TC: Did you have much interplay with the Nuclear Study Group or the Nuclear Projects Office as it came about?

HK: Well, in those days, I was not involved when the Malibu effort was underway, for example. Later on, I became quite involved in such efforts.

TC: Okay. Well, maybe we could hold off on that. That would be Bolsa Island [Nuclear Power and Desalination Project]? Is that it?

HK: I was heavily involved in that, yes.

TC: Maybe we can hold off on that, to finish up this discussion of the steam plant period. You know, so many of these things that are developing are all happening at the same time. It's very difficult. It's simultaneous.

HK: That's right.

TC: Now, by about 1960 or so, the [Pacific] Intertie question is beginning.

TAPE NUMBER: 4, Side A

November 8, 1989

TC: We were just talking about how, in discussing some of these matters, that so many things are happening simultaneously that we're necessarily simplifying, and it didn't quite happen as simply as that. In that early sixties, the Department is starting to connect with other utilities in the area to develop certain projects or to establish goals, say, to help in planning for the region. One of these groups was WEST Associates.

HK: Yes.

TC: I'd like to talk about the founding of that group and what the Department's role in that group was and what your own association with that group was.

HK: Okay. Well, to go back a little bit, I had been appointed as senior electrical engineer in charge of generating plants design in about 1962. In 1963, I made a lateral transfer as senior engineer in charge of the Operating Engineering Section in the Operating Division.

TC: Okay.

HK: And from that organization I moved to the level of principal engineer in charge of the Overhead Section in about 1965. In about 1967, then, the System Development Division was established and I was appointed as head of that Division. Now, while these were separate operations, the activities that

I got into in the Operating Engineering Section were sort of continued as a collateral duty and interest throughout most of the next decade. And so this is all a little bit woven together.

TC: Yes.

HK: But to get back to the beginnings of the Intertie consideration . . . As I mentioned, the advent of extra-high voltage transmission was making these power plants possible: mine-mouth power plants at remote distances. We were going off in all directions at once, with a view to establishing these resources. One basic area was the Pacific Southwest where the coal resources were located; the other was the Pacific Northwest where vast hydro potential existed.

Well, early in the sixties, the federal government began to take a considerable interest in building extra-high voltage transmission lines from the Pacific Northwest. And to justify that, it was going to be necessary to increase generation in the Columbia [River] Basin. Now the geography of the Columbia Basin was such that all of the firm generation that could be installed had been, essentially, installed. There was not sufficient storage in the United States possible to justify much of an increase in generation, and so a treaty was negotiated between the United States and Canada, under which Canada was to build three dams on the Columbia in Canada. Let's see, Duncan, Micah, and what was the other one? Arrow, I guess. In any case, there were three Canadian dams:

Duncan, Micah, and Arrow. And the United States was to build the Libby Dam on the Kootenai River in Montana, which is a tributary to the Columbia.

TC: Yes.

HK: So, in return for Canada building this additional storage, which was about 15,000,000 acre feet, the United States added another five at Libby for an increase of about 20,000,000 acre feet, which more than doubled the storage on the Columbia. And that justified the installation of a considerable increase in generation, which was done, and the Canadians then acquired a right--a Canadian entitlement--to that generation, by virtue of having built these dams. Now this was all part of a big picture in which the federal government, absent efforts by the private utilities, was going to build this generation whether anyone liked it or not. And so the private utilities in the western United States, seeing the handwriting on the wall, came up with the Pacific Intertie extra-high voltage 500,000 volt AC [alternating current] transmission and the Department opted to develop an interest in direct current [DC] transmission. And so the DC line was built from The Dalles, Oregon, to San Fernando Valley at Sylmar, with the Bonneville Power Administration building the northern leg from The Dalles down to the Nevada-Oregon border, and the Department building the remainder, in order to bring this additional generation down.

There were two kinds of power to be developed, some firm and some dump energy, surplus energy. There was a great deal of such energy possible, and it was purchased at an extremely attractive price--2 mills/kilowatt-hour, for example, was the figure I recall. When you look at today's rates, it was almost zero.

TC: Yes.

HK: And if I remember correctly, during one very wet winter, there was enough energy brought down at that rate to pay for the whole installation of the DC intertie.

TC: No kidding.

HK: In one season.

TC: I didn't know that.

HK: Now the Department had less than a half interest in the line. Southern California Edison and San Diego Gas and Electric had an interest in the line. The municipalities of Burbank, Glendale and Pasadena, likewise. And I forget how the numbers divided up, but the Department managed and built the southern section of the line.

TC: Well, that's one thing I wanted to find out about. Did the Department go it alone on that? Or did the Department come forward and say, "Yes, we have the wherewithal, the resources and the brains to do this, so we will do this"? Did Edison want to get in and say, "Well, how about some of our engineers being involved in this"?

HK: Well, Edison was involved in building the 500,000 volt AC lines. So the Pacific Intertie consisted initially of these two 500,000 volt AC circuits and the 800,000 volt DC circuit. And each entity had enough to do.

TC: Okay.

HK: PG and E [Pacific Gas and Electric] was building part of it and the people up in Oregon, Pacific Power and Light, I believe, and others up and down the west coast. That was a cooperative effort between a number of utilities on the AC system. And Edison, as I say, bought into a share of the DC line. But we handled that and purchased the terminal equipment from ASEA of Sweden and did the design work and the construction work as far as the border.

TC: What was the logic behind direct current?

HK: Well, it was a new technology that had been developed, really, for the first time in any huge development. Smaller developments had been made. But there are a number of advantages to a direct current line. One is the charging current associated with an alternating current line is not present with a direct current line. For example, if I remember correctly, if you energized the Boulder Transmission Lines at Hoover [Dam] without the other end being closed into the Los Angeles system load, that the line would draw something like 86,000 kva, as a condenser, a charging current.

TC: I see.

HK: This high inductive reactance and capacitive reactance was such that these lines had that kind of problem. The corona losses, voltage for voltage, are higher because you have in an alternating current system a root mean square voltage, which is what we refer to, but you also have a peak voltage in the sine wave of voltage that is considerably higher than that. And there are other aspects to it that get quite technical, but you eliminate the charging current. You also are free of the problems that alternating current systems get into, in which electricity follows its own lead and goes where it wants to go, depending upon the impedance of the interconnected network. With a direct current line, you can control point to point transmission precisely, by turning a small dial, and that was a major factor. What happens in large interconnected AC systems was becoming a major problem, later resulting in the Northeast blackout and so forth.

Well, that effort then got underway to bring that resource south. Simultaneously, the coal resources in the Pacific Southwest were being investigated as a source of generation, now that voltages were high enough to go after it. And this is where WEST was formed. WEST stood for Western Energy Supply and Transmission Associates and it was made up of, oh, some thirteen, I think, utilities in the nine-state area of the Southwest. I was assigned then, through my job in the Operating Engineering Section of the Operating Division as a member of the Engineering and Planning Committee of WEST.

And the utilities were joining together to see how this could be put together and suddenly discovered that they were about to be in violation of the antitrust laws of the United States.

TC: Oh, really!

HK: For joint planning. And so the original scheme for doing this had to be dropped, since this would have been a violation of federal law. And what was substituted for this effort was just cooperative planning, rather than joint planning. There's an important difference.

TC: There's a difference there, yes.

HK: And out of that effort came the Mojave Project, with joint participation by several utilities, and planning then for the other projects that were in the works. There were a number of projects that were being studied, some of which were built.

TC: Well, who was it that said, "Whoa, we can't do this in this way. Let's back off and be merely a sort of a planning, cooperative group, as opposed to a joint projects group"?

HK: I don't know whether it was a threat from the federal government or whether the attorneys for the participating entities concluded that we'd best not go that route. I don't know, but it was clearly changed for that reason.

TC: So the projects that got going, as a result, each one was under the auspices of one of the utilities? Is that how it worked?

HK: Yes. For example, Edison headed up the Mojave Project, with participation by a number of utilities.

TC: Let's talk about the Mojave Project for a minute. Where is that located?

HK: Bullhead City, Arizona.

TC: So that's just below the Davis Dam?

HK: I think that's right, yes.

TC: Across from Laughlin, Nevada.

HK: Right, that's correct. And that involved bringing coal from Black Mesa, Arizona, in a 270 mile long slurry pipeline, which was something that had been done once or twice elsewhere, but not to the extent that this line was built for. This was a coal-water mixture. The coal is ground up, mixed with water and pumped.

TC: And then it's removed from the water, dried out and . . .

HK: It's put into a centrifuge, dried out, and then fired into the boiler as pulverized coal.

TC: Is that more efficient than carting the coal in in coal cars?

HK: Oh, yes. The reasons being that you have an expensive capital expenditure to build the facility, but you've nailed the costs down. You have a long-term coal supply contract, you have an investment in the facilities, and that's it. When you contract with the railroads for transmission, if there is a rail line, you have no control over the future cost of transportation and the railroads have a terrible reputation in upping the price at every opportunity. They seem to have considerable influence with the Interstate Commerce Commission, which exercises control over these rates. And there are some horror stories associated with rail transportation that led the industry to try to avoid that kind of a problem. Also, it would have been necessary to build considerable rail for that project.

TC: Well, what did the meetings of WEST Associates consist of? Would the various representatives just sit and outline different projects and then work assignments would be handed out as far as: "Well, this is what we need on this particular project. You guys do it."

HK: Of course, there were several committees associated with these organizations. My experience was with the Engineering and Planning Committee. We got our directions from a higher level committee--I forget the name of it--probably a coordinating committee of higher level people who were meeting to discuss policy, to determine what effort would be made. There were studies of the transmission network and how the interconnections were to be handled, and this is what led to the determination that WEST just couldn't handle this. That's why WSCC [Western Systems Coordinating Council] was formed.

TC: Oh, I see.

HK: Now, I've lost track of today's numbers but there are basically three electric systems in North America: the western area, which consists of about thirteen or fourteen states and British Columbia; Texas, which was isolated in those days from everybody and maybe still is--I've lost track; and the eastern United States and some provinces on the eastern side of Canada. Those are three physical electric systems. And as these interconnections began to develop, they became coordinated operating systems, and it was necessary for the managements of those entities to work together to solve these many problems. And we were creating new problems all the time as the system grew.

TC: Such as?

HK: Well, to avoid these huge cascading failures, such as the Great Northeast Blackout, there were technological problems of, well, just that: cascading failures.

TC: What are cascading failures?

HK: It's a domino effect.

I'll give you an example. After the direct current transmission line had been in service for some time, our people were washing insulators out at Sylmar and flashed over the DC line. The line tripped, of course, and Pacific Intertie the load it had been carrying immediately shifted to the two AC lines. The two Pacific Intertie AC lines couldn't handle it and tripped out. And all of that power being generated in the Pacific Northwest tried to go around the eastern side of what we call "the doughnut," which is a circular transmission system some 3,000 miles in circumference, and we knocked Salt Lake City and Denver off the line.

TC: Wow.

HK: We never lost a watt in Los Angeles, but we caused the problem. It was this kind of thing. So we developed a system to trip generation simultaneously with the loss of two parallel sections of the AC intertie. Arrangements were in effect, at least were at that time. Of course, I've been retired for fifteen years and I don't know exactly what the situation is now, but we set up a system in which we would trip a comparable amount of generation simultaneously with the loss of any two parallel sections of that line to avoid this cascading effect.

TC: The Northeast blackout now, that was about 1965 or 1967?

HK: Yes, it's along in there. I can't recall the date.

TC: Yes, I don't know the exact date. But that was a matter of one system going off and then switching that load over to another and that not being able to take care of it. I can remember the night it happened.

HK: Yes. You have a situation also that is somewhat comparable to a mechanical failure. If you have, for example, two electrical machines tied together with a very slender steel shaft--this is a hypothetical situation.

TC: Yes.

HK: Two generators being driven by independent prime movers, and they're carrying load in some fashion, not necessarily the same amount, there becomes a twist in this shaft that's tying them together. One is being slowed down by the load imposed on it. The prime mover is trying to speed it up to maintain the standard speed and a disturbance of some sort happens and these two machines begin to rock. And if they rock far enough, that slender shaft will buckle.

TC: Yes.

HK: Now this same thing happens electrically. And the stability of the system, the limits of stability are such that, if you begin to rock the system, because of things happening between the Northwest and the Southwest with these interconnecting transmission lines, they may tear apart, and then everything collapses. We tried, for example, after the interconnections had been pretty well developed on both sides of the Rockies, to tie the east-west ties together. They weren't heavy enough to do it and they would tear apart, with some pretty severe problems periodically, and we finally opened those ties. Whether they've ever been closed in the intervening years, I don't know. We could not tie the east to the west and hold it without much more transmission than existed there at that time.

There is a thing called a swing that happens. Going back to the mechanical analogy, there would be a rocking, an oscillation in speed. Well, this rocking back and forth through transmission lines involves surges of current. And if you reach a certain point, then you trip the systems apart. Well, this rocking can be triggered by a small event that's maybe pretty subtle, but it is kind of a harmonic problem and it can grow as well. So we would see the start of swings that might take a half hour to go in one direction and another half hour to come back--that slow--but increasing in magnitude, and watch that develop to the point where the increasing swing currents would tear the system apart. Well, we had to address those kinds of problems and so forth. That came quite a bit later.

But to go back then to the work of WEST, it became evident that it would be necessary to involve all of the entities in the western United States because we were interconnected, and so the Western Systems Coordinating Council was formed. I was a charter member of the Planning Coordination Committee of that organization and served as its chairman one year. And there were a great many other committees. I can't recall all of the task forces that were established, but groups of people working on specialized problems gathered together with representatives from all the major utilities in the west to work together.

TC: This sort of development would certainly seem to negate any sort of public-private antagonism that might have existed at one point.

HK: It helped. Basically, it solved that problem. Suddenly, these faceless corporate entities that had been antagonists turned out to be made up of human beings with wives and children and vacations and . . .

TC: And you spoke the same language.

HK: That's right. We had mutual problems and we became fast friends and the old public-private power war that had existed in earlier times just disappeared. And then, by virtue of the establishment of WSCC, the need for Regional Electric Reliability Councils was recognized throughout the country. And the man who was Chief Electrical Engineer at the time, Floyd Goss, set off to help organize other regional reliability councils throughout the country. Initially, there were a dozen, and they were later redefined and wound up so there were nine, total, including WSCC.

TC: So these were independent entities. These were not Federal Power Commission bodies or something.

HK: That's right. There were federal people aboard, because of the power interest, like the Tennessee Valley Authority, but the regional reliability councils were established on a regional basis because of the entities that existed in that region, as we were in the west in the Western Systems Coordinating Council. And almost immediately it was recognized that there needed to be a coordination between these nine regional councils. So the National Electric Reliability Council was formed. It's now called the North American Electric Reliability Council. And, again, a committee structure was established, with representatives from these regional councils working together. And by virtue of being chairman of the Planning Coordination Committee of WSCC, I was assigned to the Technical Advisory Committee of the

National Council, and began to work then with people from all over the United States and Canada. That was a marvelous experience. I think that was really the highlight of my career, the association with those people. They were very fine, high level people, excellent technical people, good managers, and we did a tremendous service, really, for the people of this country.

TC: I'd say. Now we're talking now about the late sixties, I would think.

HK: Yes.

TC: Okay. I just wanted to pin a date on it because we are going back and forth a bit, which is natural. Where was WEST Associates headquartered? Did they have a regular office?

HK: I don't think they had a headquarters.

TC: Okay.

HK: No.

TC: So it would just be a meeting of groups.

HK: Right.

TC: And is that the same thing with WSCC?

HK: Yes. Now, later on, WSCC did establish a headquarters. And the reason that came about was evolution, I suppose. The chairman of the Planning Coordination Committee was required to furnish a secretary for the committee, for the year he was in office. And I had a young transmission engineer in my division named Dennis Eyre who I assigned as secretary to the Planning Coordination Committee.

TAPE NUMBER: 4, Side B

November 8, 1989

HK: It was decided by the top management of the organization to establish a permanent headquarters in Salt Lake City. Dennis Eyre was selected as the engineer to manage that office and he's still there.

TC: He's still there.

HK: A very fine man, very capable. And he has a staff of, I don't know, he had seven or eight people, the last I heard, in which assistance to other groups, other committees, task forces and so forth, is rendered. It's located at the University there in Salt Lake City, where they have the major computer effort for the system as a whole.

You see, one of the things that became obvious in the early stages of these organizations was that no one entity could make a major decision that didn't affect everybody else. Whether it was a generating plant or a transmission line, its installation was going to change the complexion of the interconnected systems. Therefore, we began a process of voluntarily submitting our plans to the organization, to be studied, and we simulated the operation of the system with the planned facilities, to see what was going to happen, and then we negotiated to alter those plans to solve problems.

There was also established an Operating Committee of WSCC, that was the other major committee, to coordinate the operations of these systems and to come up with the rules and regulations and standards with respect to reserves and procedures. We set up things like a program for dumping load in a crisis, to keep the system from falling apart, and we did that automatically by frequency control. When the frequency reached a certain level, certain loads would be dumped. And these were all worked out through the Operating Committee.

We in the planning end of the business were studying the consequences of our planning. And in many cases, these cooperative efforts led to a vast reduction in the amount of generation and transmission to be built, because we could see the possibilities of cooperating in the exchange of energy, to reduce the reserve requirements on each of the individual systems and so forth.

TC: Well, how did the Southern California Public Power Association enter into this? Or was this a later entity that maybe is not relevant to what we're talking about here?

HK: Well, that came largely after I was through with this work.

TC: Okay, so that's more recent.

HK: And I'm not too familiar with how it was established.

TC: Okay.

HK: This is [Art] Devine's organization?

TC: Who's that now?

HK: Art Devine, who heads this organization presently.

TC: Oh, okay. I knew of its existence and was under the impression that it may have come up along the same time. But if it didn't, we don't have to . . .

HK: Well, it was, of course, limited to public entities and it was a cooperative effort on transmission. For example, it handled the transmission for the Intermountain Power Project.

TC: Yes, okay.

HK: It really grew out of what we did in putting Intermountain together. And that's another story.

TC: Yes. Okay, well, that might be a good point to end this session on because I think next time we can . . . We touched on the origins and the formation of System Development [Division] and that's a topic that I really want to explore: how it was brought together and how it drew from other functions, from other units, and I want to talk some about that.

HK: Yes.

TC: And then your own role in heading that up. And maybe we can also fill in some of the chronology, as far as position steps that you took.

HK: Okay.

TC: We did jump over some of that, so why don't we take that on next time.

TAPE NUMBER: 5, Side A

November 22, 1989

TC: Last time, we left it that we would talk about the origins of the System Development Division and we had ranged a little bit in our conversation. I wanted to focus on that today, but I think there's a step before that, which is the period when you were head of Overhead Distribution in Power Operation and Maintenance. And I'd like to talk about what your duties were there. That's where Bolsa Island comes in. Is that correct?

HK: Well, it was kind of a strange mix of things because of my particular background. I had some collateral duties that had nothing to do with my position as engineer of Overhead Distribution.

TC: Oh, okay.

HK: I had come up largely through Design and Construction. I had spent a year and a half, approximately, in the Operating Engineering Section as senior engineer in charge, and it was there that the earliest stages of the Bolsa Island Project began. So, when I moved into a position as engineer of Overhead Distribution, this was a result of a promotion to principal engineer, into a field with which I was totally unfamiliar. And yet, because of my prior involvement in planning matters, through Operating Engineering and my Design and Construction experience, I was assigned a number of things to do that had little to do with Overhead Distribution.

TC: Oh, I see. Okay. Well, what were your particular duties in Overhead Distribution? First, we can kind of settle that and then talk about some of the collateral activities.

HK: All right. Well, the Overhead Distribution Section at that time--and there's been a reorganization since. Now there is a Distribution Division, in which Overhead and Underground are combined. But at that time, Overhead was separate. It covered all of the overhead facilities in the city of Los Angeles and these were handled out of ten overhead districts at various locations in the city. Each of those districts was managed by a superintendent and there were, as I recall, something like 1160 employees in that Overhead Section at the time. There was a general superintendent named Danny Greenwood, in overall charge of those ten districts. I was given administrative direction of that organization and, to the extent that I actually got involved in what the districts did, worked through Danny Greenwood.

TC: I see.

HK: I had one engineering assistant who shared an office next to mine, who devoted full-time to investigating claims made against the Department, because of the activities of the linemen and their related people, the tree trimmers and so forth.

TC: Would these claims be accident claims or property destruction claims or something?

HK: Primarily property destruction claims.

TC: Oh, so they were claims from the public against the Department?

HK: That's right. And some of those were rather interesting. For example, periodically, a transformer would fail and maybe impose high voltage on a certain segment of the district in which the transformer was located--one of the pole-top distribution transformers--and our people would go out immediately and repair or replace damaged equipment. And the word would get around the neighborhood that the Department was buying new toasters and new television sets and so forth, and the claims would come in from people who had not been on the circuits that were involved, so those had to be investigated. Our line trucks were heavy. They would occasionally pull in on a private driveway and crack some concrete and we would have to make restitution. Sometimes we would pull in on a driveway and we would get a claim for broken concrete, and the investigators would find grass growing up through the cracks which couldn't possibly have sprouted within the few days involved.

TC: Oh, yes.

HK: And that sort of thing, so that there was always the necessity to weigh what was happening.

TC: And handle it diplomatically, I'm sure.

HK: That's right. When we trimmed trees, for example, our immediate problem was to keep the trees away from the power lines. We did not trim for service conductors that fed the individual houses or buildings, but the primaries, the 4800-volt circuits. We trimmed trees for that. But if you trim a tree simply to clear it from those lines, you have an odd-shaped tree, so we went a step further and shaped the tree, which was the proper thing to do. And that resulted often in claims for over-trimming by people who didn't really understand that we'd been providing them a service and, particularly, if the tree happened to bear avocadoes or some such fruit.

TC: (chuckling) What was the relation between the Overhead Section and the Underground [Section]? Did you have to coordinate things? I know that for a period much of what was overhead was put underground, but I suppose there's always something that remains overhead, like some of the high-tension wires, obviously.

HK: Yes, there is a combination of things. Very often there's an underground feed from an overhead circuit, for example, and so the work was coordinated by the two sections. There was an effort made while I was engineer of Overhead Distribution to coordinate, to combine, these two sections at that time, and there was strong opposition from the union to doing that because they envisioned a reduction of staff and opportunity, which would have occurred, of course. And it later happened but it did not happen during my tenure because of that opposition.

TC: That would have been 1964 or so?

HK: No, that was about 1967, as I recall.

TC: And just for the record, that's the IBEW, the International Brotherhood of Electrical Workers.

HK: Yes. Local 18, I believe.

TC: I suppose originally they represented linemen, for the most part.

HK: Yes.

TC: But since then they've got a pretty good chunk of representation there.

HK: That's correct.

TC: Including some clerical and, obviously not management, but people other than electrical workers.

HK: That's true.

TC: Were you ever involved in any of the other aspects of labor relations? This might be off the point, but while we're on it . . .

HK: Well, yes. In this respect, that I had come from a career in engineering and suddenly to be associated with this large contingent of craftsmen was a totally new experience to me. Some of these were pretty rough people and handling them was totally different than managing an engineering organization, for example, different from my experiences in associating with other utilities and so forth, and there were problems that required . . . Well, they required considerable discipline, disciplinary action, which was totally foreign to my experience, but it had to be done.

Within a week of my appointment to that position, I had to suspend a line foreman for failure to follow proper safety procedures, for example. His crew was replacing poles on Western Avenue and the rules provided that an old pole that was about to be removed had to be tested with a steel spike, in order to see if it was rotten inside before men went up. In this case, a new pole had been set and the linemen were working the top of the old pole to transfer the conductors to the new pole, and those conductors were the only things holding that pole up because it was rotten inside and had not been tested. And when the last conductor was removed, the pole and the two men atop the pole went down into the middle of Western Avenue with serious injuries. Well, we didn't have too many of these kinds of accidents, but that was a pretty serious one, and it happened, as I say, within a week of my appointment to that job.

I became very much interested in the rather poor safety record that Overhead Distribution had and spent quite a little time in trying to do something about that. We had periodically a dinner meeting for the superintendents of the districts, in the evening, where we would discuss various problems relating to overhead distribution. My contributions to those meetings had largely to do with an analysis of accidents and safety practices and encouragement and the establishment of some new rules to try to avoid accidents. For example, in my field visits, I would note that the crews would go to work around an old pole which was covered with weeds and broken bottles and whatever might be in the neighborhood, and that these things were ripe for accidents. It's so easy to step into a hole that one can't see because the ground isn't clear, and maybe stumble and let go of a line that's holding an important piece of equipment, that sort of thing. And that a few minutes invested in cleaning up the work site would be very worthwhile. There were a number of other things that I observed. I can't recall much in the way of detail now.

TC: Well, would the union men oppose that sort of thing because it wouldn't be in their job description?

HK: Oh, no. No, there was great compliance and a considerable improvement in the safety record of the Overhead Distribution Section.

TC: Yes, it would be to their benefit to have a better program.

HK: That's correct. One of the elements there had to do with the more seriously injured people with their . . . What is this area of insurance? Workmans compensation?

TC: Yes.

HK: These people had cases before workmans compensation boards and frequently made claims against the Department, which had to be adjudicated, and I got involved in some of those. There were some questions that would arise as to malingering and that kind of thing: people who had been off on disability for some time but were working in another job and appeared quite capable of doing their regular duties who weren't willing to come back to work. There were also cases where a provision had been made for people to come back to work for the Department in a job other than their original line work, for example, in some other area of the Department, which they could handle even though physically impaired. This was a good program. So I got into an awful lot of that kind of policy question and I was the liaison between top management and those people in my section, so that there was a considerable amount of go-between.

One of the more interesting things that came out of that, from a morale standpoint, happened somewhat by accident. The general superintendent felt that I should visit each of the ten districts as soon as was reasonably possible, meet the people, and let them meet me, since I had been involved in some of the more interesting and exciting things going on in planning prior to taking this position.

I spoke at the first of these meetings, which was called a tailgate meeting, held at 7:30 in the morning before the crews go into the field. They would gather all the people in the district together at district headquarters for a very brief meeting and comments by the general superintendent, opportunity for questions and answers and so forth, and they took advantage of these meetings to introduce me and to ask me to say a few words. And at the first meeting, I spoke about what was going on in the Department, its far-flung activities in connection with planning for the future of the Power System.

The reaction was rather striking. These people had not really had that kind of information delivered before, they didn't feel like they were part of the Department, and the reaction was amazing. The general superintendent was ecstatic about the feedback that he got after that first meeting, and he said, "I want you to do that at every one of these meetings," which I then did. And as that program proceeded, then the morale took a jump, and I think that turned out to have been a very good contribution to that work and to those people.

TC: In these districts, the district headquarters, were they located close or adjacent to, say, receiving stations or distribution stations or were they just a separate kind of thing?

HK: They were just separately located in appropriate divisions or geographical areas of the city. I don't recall.

TC: Were they Department-owned buildings?

HK: Yes, they were.

TC: One point occurs to me on labor relations. It seems there were a couple of strikes that the IBEW called, and I don't have this nailed down as far as when. I know that at one time during the war there was one. You wouldn't have been there at the time . . .

HK: Yes, there was a strike during the war and I read about it in a Navy news bulletin in the South Pacific, and I recall how I felt about that.

TC: How did you feel about that?

HK: I was pretty upset, with the war going on and, at that time, the Japanese were still coming south and we didn't expect to get home. And here I had been so proud of my Department and I knew of its contributions to the war effort in supplying electricity to the industries of the southern California area and so forth, and suddenly this strike happened. I wasn't acquainted with the details; I still do not know precisely what precipitated it, but I felt pretty uncomfortable with that.

TC: I know that during the war most unions took a no-strike pledge for the duration of the war, so it's kind of odd that that occurred. And I believe also that federal troops came in to oversee operations for a day or so and then it was resolved.

HK: I believe that was so.

TC: In later years, were there any kinds of serious labor disturbances like that?

HK: Yes, there were. There was a strike, and I can't recall precisely when that occurred. It was prior to my period of service in the Overhead Distribution Section, but there was a strike which resulted in an agreement between top management and the union, which established what were later considered to be outrageous pay scales for linemen. And it threw the entire industry in the western United States out of kilter because of the strong effort that had been maintained throughout a number of years to keep these craft salaries on some reasonable level, with respect to each other.

TC: Yes.

HK: And this strike resulted in scales that tilted everything in that general field, in the utility field. The other utilities never forgave the Department for that, for example.

TC: Because those union locals would want a "me too" kind of contract.

HK: Exactly, right.

TC: Did that reach some point of equalization afterward, or is it still somewhat skewed?

HK: I can't tell you. At the time I retired I don't think we had reached equilibrium yet, but I'm not sure of that. I got off into other work and lost track.

TC: Well, now, your work in Overhead, was that part of the origins, the thinking behind System Development? Or was that something separate? I'm just wondering, I'm just looking for a bridge here to talk either about Bolsa Island or about System Development. (chuckling)

HK: (chuckling) Okay. Basically, planning for the Department had been done in different Divisions. There were three main areas of planning in the Power System: Transmission planning had been handled in Design and Construction in the Transmission Section; generation planning had been handled by Operating

Engineering, which formerly was known as Research and Records; and hydroelectric considerations and some of the civil engineering planning was done in Power Executive [Office], by a very small group in Power Executive. The work had not been too well coordinated in the earlier days. Of course, the Department was growing rapidly as the system grew and there were reorganization efforts going on within most of the organizational structures.

The man who did most to establish the System Development Division was Floyd Goss, who was in charge of the Power System at that time. He had been Engineer of Operations prior to becoming Assistant Chief Electrical Engineer and then moved on to become Chief Electrical Engineer in charge of the Power System.

TC: He had had quite a history with the Department, too. I believe he came in during the thirties. Is that correct?

HK: Yes. He had been a young engineer during the construction of the Boulder Transmission Lines, for example, and he had considerable experience in distribution and transmission work and had gone through a number of positions in the Operating Division. It was Mr. Goss who invited me to transfer laterally from a position as senior engineer in charge of electrical design in the Design and Construction Division to head up the Operating Engineering Section in the Operating Division. This was a lateral transfer rather than a promotion.

And there I became involved in some of the planning activity going on, in which that section was involved, including the Intertie and the Suppliers' Contracts and negotiations with the state, some of the Castaic planning and so forth. And after I moved on to the overhead distribution work, some of the things I had been involved in I continued to be active in, even though I was in another Section, which wasn't too difficult because I could spare the time. The overhead operation was largely a craft operation and didn't require all of my time. Floyd Goss then concluded that all of the planning activity should be consolidated into a new division so that it could report directly to top management and coordinate their various planning activities. So he established that Division and appointed me as its initial Division Head.

TC: Well, just going back a bit on that. You broke it down that planning took place in three different areas.

HK: Yes.

TC: And the coordination wasn't always as good as it could have been. Now, the group in Power Executive, would that have been the Chief Engineer and several people around him that would be in on planning, in terms of the long range?

HK: I wasn't too familiar with what was going on there personally. Phil Hoffman, who later was one of the initial engineers in System Development, had been the hydroelectric planner. He worked largely with Bradley Cozzens at the time he was

Assistant Chief Electrical Engineer. I think Larry [Laurence] Schneider was in that office for some time, in connection with the very earliest investigations of coal in the southwestern United States.

TC: Would that have been the Power Resources [Office]? I'm trying to think now. Was that Design and Construction? That was a separate office of itself.

HK: Yes, it was Power Resources in Power Executive.

TC: And I'm trying to get the . . . I'm visualizing the organization chart and, if I remember correctly, that was a separate sort of office.

HK: Very small in Power Executive, yes.

TC: Yes, okay. So, in this consolidation, then did you take certain personnel from these other areas?

HK: Yes, that's right.

TC: Who would that have been initially, in the first phase?

HK: Well, Pete [Peter G.] Lowery was my assistant and he headed up the generation planning portion of System Development. Christian H. Prior handled Transmission Planning. There were two senior engineers, one dealing primarily with generation planning and one dealing with transmission planning, with some subsection organization. We were small at that time and we probably had no more than sixty people or so during the time I had the System Development Division. It's quite a bit larger now.

TC: And that was about five years. Is that right?

HK: Yes, that's right. I think it was seven and one-half years that I was with System Development.

TC: Was it a fairly smooth transition from this, you know, more of a segmented planning to a consolidated planning?

HK: Yes, it went very smoothly. We were small enough that we worked rather well together. Some of the people involved in these specialized activities became familiar with the activities of other planning people, and the thinking began to merge rather well, in taking a proper look at planning in general.

Basically, there were several types of planning and, yet, they had to be integrated. For example, we had one group of half a dozen people whose sole duty was to forecast the changing load patterns in the city. They studied demographics, they studied the saturation of appliances.

TAPE NUMBER: 5, Side B

November 22, 1989

TC: Load patterns?

HK: Yes, there were lots of things happening. For example, air conditioning had become a significant load. And as air conditioning comes on, it comes on differently in different sections of the city: much more rapidly in the San Fernando Valley than in the coastal areas and San Pedro, for example.

TC: Because it gets so hot out there.

HK: Yes, much more need for it. And in any area that is going to see the growth of air conditioning, there is going to become a saturation also. So you see rather steep rises in electrical consumption for certain appliances and you know also that they're going to eventually saturate and create what's called an "S Curve," a rather rapid rise in use and then a bending over of the curve and then a flattening out of that curve.

There were studies of the consumption in single family homes versus apartments. There were studies of the effect of freeway construction, where after a freeway was constructed there tends to be a commercial development on either side of the freeway; which is backed up by apartment house construction, which is then backed up by the original single family dwelling areas--this kind of thing. Of course, the patterns have changed with time and I've lost track pretty much of what's happening, but these were the kinds of things which were going on, which then made it possible to attempt to forecast what the future load was going to be and where it was going to be. And having come to some conclusions about those things, it gave a clue as to where a new receiving station might be built in a desirable location, and new distributing stations might be located in relation to that receiving station. And, of course, the receiving station is the focal point for transmission lines coming from outside the city. It was obvious at that point in time that our future generation was going to come from outside the city, since we had installed essentially all of the in-basin steam that we were going to install.

TC: Yes.

HK: And population studies were, of course, involved in that kind of analysis, also. The city was constricted to its some 464 square miles--whatever it was at that time--surrounded by other communities which were no longer annexing to the city because they no longer needed to because they could get water from the Metropolitan Water District.

TC: That's true.

HK: These kinds of studies then determined the needs from a transmission and generation standpoint. Then, in the Generation Section under Pete Lowery, who was a mathematician of some note . . . The economics of generation planning are rather complex: the way in which generating units participate in meeting the load, the economics of various alternatives, the joint projects that we were getting into in those days, as compared to wholly owned separate plants.

Now, back in the very early days of Power System operations in the utility business, it was commonplace for a utility to install a new generating unit, which would be its largest and most efficient unit in most cases, and load it up to the hilt, and then bring up the older units and leave off the oldest ones when all were not needed. That was not the most economical way to run a power system.

TC: Yes.

HK: The proper way to do that was to look at which generating unit in the system could meet the next kilowatt hour most efficiently, most economically. And so Pete had been doing studies in Operating Engineering for some years and issuing instructions to the dispatchers on how to load the system. And he had been involved in the work which was then later done by the Design and Construction Division to install equipment in both the dispatch headquarters and the generating stations, which were programmed--computers--to economically load the system. So it became an automatic function, as against going by written materials which he had been sending to the dispatch headquarters.

TC: So the whole computerization of that aspect came out of the System Development office.

HK: It had come largely out of Operating Engineering and became part of System Development's activity. So generation planning, combined with transmission planning, basically, was the whole ball of wax.

TC: Yes. I had a couple of questions. Just going back a bit, we were talking about annexation. Now, at some point, that stopped, you said, because it wasn't necessary for some communities to become part of Los Angeles because of the Metropolitan Water District. Was the initial impulse towards annexation, that the city had water and . . . ?

HK: That's right. The city had water and the surrounding communities, as they developed and grew, annexed . . . those areas annexed to the city to get water because the city served water in the city of Los Angeles.

TC: Was that a mutual sort of thing, that the people in those communities would say, "Well, because we're growing, we have these needs. Let's become Los Angeles, as opposed to being . . ."

HK: Well, I think it was a two-way street. I think Los Angeles was desirous of growing. And developers of that day . . . it was a different pattern of development, of course, but the people who were building new areas, new housing and so forth... If you're going to go into county land adjacent to the City of Los Angeles and build houses, you had to have water. And so, just how those deals were cut, I'm not sure.

But the basic growth of the city was largely for the purpose of getting water.

TC: Yes. But yet, Santa Monica and Beverly Hills stayed separate? I guess Burbank did, too.

HK: Yes, Burbank, Glendale, Pasadena, likewise. Pasadena had access to water, some of which it still has of a local nature. Most of it, of course, is purchased from the Metropolitan Water District, but still considerable local water. And then Los Angeles had local water, as it does now. I think that the Los Angeles River, which is an underground river, supplies something on the order of 300,000 people yet today.

TC: Yes. What relation did System Development have with General Sales [Division], for instance. Did you coordinate? You know, "This is our information on where it's all going to go and perhaps you can use this in your . . ."

HK: No, we didn't really have any coordination with General Sales. General Sales were the people who were in contact with our larger customers, primarily.

TC: Oh.

HK: A business would start up and would need to be contacted by the Department with respect to what they intended to do. Their coordination was more with Design and Construction, which eventually resulted in the installation of a customer station or the expansion of the distribution system in some fashion to supply that customer.

TC: I see. I asked because there seems to be a relation between this load forecasting and load building. For a long time, there was a load building effort.

HK: Load building was their forte. That was really a political activity, encouraging people to use more electricity. It's quite different today.

TC: Yes. Well, that's one thing I wanted to get at. At some point, that shifted to conservation and using less electricity, which the Department got into.

HK: Right.

TC: I suppose that's towards the mid-seventies, so it's probably out of the time frame that we're talking about.

HK: Yes.

TC: Well, in those stages, say, the early stage of the planning activity that was going on in System Development, what was seen to be the way to go? Was it this mixed approach that is taking place now?

HK: Yes, it was a mixed bag. And I recall Floyd Goss describing it one time and referring to one of these vaudeville shows put on by Chinese acrobats, in which they put a dozen stakes on the stage with the spinning plates. And as the plates are starting to run down, the acrobat runs back and forth and speeds each one up, until he's in a frenzy trying to keep them all going.

TC: (chuckling) Right. That's a great image, yes.

HK: Well, this was pretty much what happens in System Development, or it happened at that time. You never knew what was going to go and what was going to fail. I remember stating publicly on one or more occasions that I had an unbroken record of failure. We had tried so hard, so many times, to develop generation for various places, and this was the era in which we ran into opposition from almost every quarter. Regardless of what we tried to do, there was somebody there to oppose us, the Sierra Club, politicians of various sorts, both in and out of the city. And what we did was to cooperate with others in trying to develop joint projects in planning various ways in which we could meet our future needs and keeping all of those options alive. We always had a plan, but that plan changed frequently, and we didn't know which of our many options might come to fruition.

TC: So it wasn't a "plan writ in stone." It was kept open-ended, flexible.

HK: That's right. It had to be.

TC: Yes.

HK: You couldn't count on success in any particular endeavor. And this had to do with transmission line planning as well, because they were getting increasingly difficult to arrange.

TC: So the failures or, as you say, the plans that never got put into construction and operation, there were others besides nuclear plans?

HK: Oh, yes.

TC: Such as?

HK: We investigated a number of sites for coal. There were, as you know, a number of sites attempted for nuclear, which were frustrated.

TC: How about upgrading of hydro? Was that a possibility?

HK: Yes, and we did that. We upgraded the San Francisquito hydro. It had been built for fifty cycles when the system was first constructed back in 1917, I think, when the first one went on-line. So, in those later years, San Francisquito was improved. Most of that was done after I retired, though it was in the mill.

We were looking for innovative ways to add generation and some of these were ridiculously frustrating. I recall one of the things that we learned about in System Development was the existence of the Great Lakes Carbon Company down in the harbor area. Great Lakes Carbon manufactured carbon products in a process that involved an enormous use of heat, and its stack temperature was very, very high, which led to unacceptable levels of nitrogen oxides. High temperature combustion seemed to be the main culprit in producing that area of smog. Well, they were cited by the Air Quality Management District for failure to meet the standards and were ordered to reduce their stack temperatures. So we investigated and found that we could install a fifty-megawatt generating plant using the waste heat going up the stack in their manufacturing process, which would have two major advantages. One, it would reduce the stack temperature, and thereby solve the bulk of the air pollution problem. Secondly, it would generate fifty megawatts of electricity without the use of additional fuel, which also adds measurably to improving the environment.

But we had the problem of reaching an agreement with these people. We had to be satisfied that they would remain in business for a protracted period before we could afford to invest in constructing a power plant, and there were other areas of the agreement that required considerable solution. At the time I retired, an agreement had not been reached; I don't believe it ever has been. And the last I heard, sometime after I retired, was that the powers that be had insisted on the expenditure of, I think, $167,000 to perform an environmental impact study on this project, which on its face could do nothing but improve the environment. And this kind of frustration . . .

TC: Well, that's what I was going to ask about. You must have had to develop a frame of mind that didn't allow you to become, say, embittered or just immobilized because of frustration.

HK: That's right.

TC: There must have been a sort of sense of humor and esprit de corps that was maintained.

HK: We investigated the geothermal potential at Coso Hot Springs, which is now under more active investigation. That's on the naval property out at China Lake.

TC: That's right. Okay, yes.

HK: We were not able to reach agreement with the Navy on this development because they wished to consider this as an experimental project, subject to testing over a protracted period. We couldn't afford to invest in a power plant that was going to be down half the time making tests.

TC: There seems to be these "catch-22s" throughout.

HK: Yes.

TC: How about out in Barstow? There was a solar plant and I believe it's been constructed and in operation. Is that part of . . .

HK: Solar One. The Department contributed to that. That was largely after I retired.

TC: Oh, okay.

HK: The Department had a small percentage interest in that project. It was a contribution in aid of the study. Quite a bit of work has been done out there near Daggett, a little farther out than Barstow. [Southern California] Edison headed that project up, along with the federal government and others.

TC: I see.

HK: And quite a lot of information was developed for solar development. There are several different types of solar energy collectors out there. I visited the site, representing the Navajos, in some of my consulting work in more recent times, and it's quite an installation.

TC: So it's up and running?

HK: Oh, yes.

TC: And generating electricity?

HK: Yes.

TC: What's its capacity?

HK: I don't recall those numbers.

TC: It's nothing along the order of what a steam plant or a coal plant or a nuclear plant has?

HK: No, it's relatively small in that sense. And, of course, it's a specialized area of generation, in which you generate when the sun shines and you don't when it doesn't, and so you store heat for the period, through the rest of the day when the sun is not shining, and it's rather expensive. It becomes economic, like so many things that are touted as economic, when there are subsidies and tax credits. But on its face, it doesn't compete.

TC: Oh, that's interesting.

HK: There comes a time when other alternatives cost more, that these types of technologies eventually become an economic choice. But in today's world, they haven't reached that point.

TC: Yes.

HK: They also put in out there a coal gasification project, which is quite an interesting facility also, as a means of dealing with the impurities of coal before it's burned in the power plant. It works quite well, but it's expensive.

TC: So the gas is extracted and then used to fire the . . .

HK: Yes. The idea is to remove sulphur from the coal prior to combustion.

TC: Who owns that project?

HK: Edison.

TC: Edison has done that?

HK: Well, I think that EPRI [Electric Power Research Institute] contributed to it and the federal government . . . I'm not too sure about all of those who participated in it, but Edison is heading it up and operating it.

TC: Well, let's talk a bit about Bolsa [Bolsa Island Nuclear Power and Desalination Plant] now, because this seems to overlap and you said it was a collateral sort of activity, prior to System Development. It was 1966 that the Department got involved in Bolsa. Is that correct?

HK: Yes. I think that's right.

TC: But the idea was not the Department's baby, as I understand it. Was it a government plan to begin with?

HK: Yes. The original idea . . . I don't know which agency actually suggested it initially, but the initial effort was between the Metropolitan Water District, the Office of Saline Water of the Department of the Interior, and the Atomic Energy Commission. Those three entities concluded that this project should be developed. One of the reasons for it was to establish a yardstick with which to measure water importation projects, such things as bringing Columbia [River] water down to southern California. Ralph M. Parsons had even done a study to bring the Yukon [River water] down here. Now, when you talk in terms of big water transfer projects, in order to justify those, you need to know what the cost would be of doing it some other way.

TC: Yes.

HK: And nuclear desalting was one of the considerations. Well, the initial idea was to put in a reactor, a desalting facility, and that there would be some by-product electric power to be disposed of. And so the three entities that initiated this project contacted the three major utilities in southern California to study how to utilize the power, the by-product power.

Jim Drake of Edison, Harold Arfman of San Diego Gas and Electric and I were the three engineers appointed to represent the utilities in this study. So we began to work with the other entities on that study. And we electric utility people concluded that if we were going to go to the expense of building an artificial island off the California coast and all of the costs that go into a nuclear facility, that it shouldn't be limited to one reactor and a desalting plant with a little by-product power. The thing to do would be to put in a larger installation with a significantly larger amount of electric power. We proposed this through our respective managements to the other partners and formed the effort to do just that.

That concept was to build two large nuclear reactors which would each drive a large turbine generator. These two reactors would be connected by a header, which would be T-tapped to feed a smaller back pressure turbine which, instead of being a condensing turbine, would exhaust its heat directly into a desalting facility. Flash distillation it was called. And it would be located on an artificial island off of Huntington Beach about a mile. It would generate 1800 megawatts of electric power and, I think, 150 million gallons of fresh water per day.

This water, being the equivalent of triple-distilled water, would be so pure that it would not be possible to put it into the existing distribution system, because the affinity of that water for concrete, for cement, would eat the pipes up, the concrete pipes. So there was to be built a thirty-mile long pipeline from this desalting plant up to what was called the Diemer Filtration Plant on the Metropolitan Water District System, some thirty miles inland from that site, where that water would be blended. This would be a plastic-lined pipe to carry the distilled water to the Diemer Plant, where it would be mixed with Colorado River water. And the resultant product then would be a much improved water, having much lower total dissolved solids than the Colorado River water, and put into the distribution system.

We proceeded then with a rather intensive conceptual design effort. Bechtel Corporation was hired to do this and we were involved in contract negotiations for quite some period, with respect to how we were to participate in building this project, financing it, the utilization of power, et cetera.

TC: So were contracts actually negotiated?

HK: Oh, yes. And this was one of the earlier cooperative development contracts. And when you consider that we had two private power utilities, a public power utility, a public water district, and two federal agencies involved, each with its specialized requirements and concerns, that that negotiation was a most difficult one. But we did put the agreements together.

TC: Now, who did you work with from the Department in these negotiation sessions? Did you have a team?

HK: Joe [Joseph F.] Bosio and I handled the contract negotiations. Joe was an attorney for the Department. He is now retired and living in Solana Beach. And Joe and I represented Los Angeles through those negotiations. Each of the others, of course, had their staff people, too.

TC: Yes.

HK: Mainly, it was an engineer and an attorney for each entity, and we put the agreements together in pretty good shape. When we got the conceptual design completed, as I recall, the estimated cost was about $444 million for the project. Then the federal people, either on their own initiative or because of pressure from other agencies, began to insist upon enhancing the project in one way or another, and the cost began to climb. And the last straw was when the federal government dictated that if we were to build an artificial island with a nuclear facility on it, it would have to withstand a fifty-foot tsunami, which is an earthquake generated wave of considerable size.

TAPE NUMBER: 6, Side A

November 22, 1989

TC: Why don't we discuss that 700-plus million dollar figure?

HK: Well, the original estimate when we completed the conceptual design was around $444 million. And by the time we got through with all of the enhancements to the project that were required, the estimated cost, as I recall, was $765 million. And the top management people of each of the entities involved met and agreed to abandon the project.

TC: What enhancements do you need to withstand such a tidal wave? Is it a wall or something, like a seawall?

HK: In order to raise the island high enough, since it is built like a pyramid, so to speak, from the ocean floor, in order to get the tip of the iceberg raised, you spread it enormously on the ocean floor. The island became frightfully large.

TC: Initially, it was forty acres, or so, of island. Is that true?

HK: Something on that order. I can't recall the numbers now, but it was a very sizeable island. And of course, it had tremendous advantages, in that it was in the middle of its cooling water supply for the turbine generators.

TC: Yes. Had that been considered before, prior to this project, setting a nuclear plant in the ocean like that or on an island, other than, of course, Three Mile Island?

HK: I don't recall that it had been considered before in that sense. There hadn't been too much done in seawater distillation. Israel was doing some, as I recall, and there was a little technology available but not very much.

TC: Well, it seems like such a good idea. It involves . . . Okay, you're offshore, so you don't have a local population to worry about. You're producing this wonderful water resource, and you're producing electricity. It seems like it had everything going for it.

HK: Yes.

TC: But it was the escalating costs that killed it.

HK: That's what killed it then. It would have been killed from other sources, if it were revived today. And I have heard rumors that Metropolitan Water District would like to take another look at it again. Today, its proximity to a major population center would probably rule it out in that location.

TC: Well, how far offshore was it?

HK: It was only to be a mile.

TC: A mile. Well, that's still . . .

HK: You see, San Onofre is what? Five miles from the nearby city of San Clemente?

TC: Yes.

HK: That is cited by opponents as being too close to a population center. It's arguable, of course. Its location in the ocean seemed to me at the time to be an ideal way to handle a nuclear development of that kind, both from a cooling water standpoint and to isolate it from close proximity. One of the things, if you find a site anywhere in the country which is away from a population center, you can't guarantee that it's going to remain that far isolated for very long, the way the country is developing.

TC: That's true, yes.

HK: But with an artificial island, you pretty well have the immediate area under control. The adjacent mainland area is another story.

TC: Did you work at all with the Nuclear Projects Office on this? Or had it not gotten to that point where they would be brought in?

HK: Well, it really hadn't reached that point yet. They were involved to some degree, of course, in considering the nuclear aspects.

TC: Like reactor design and that sort of thing?

HK: Yes. And, actually, we bought equipment for that project before we abandoned it.

TC: Oh.

HK: There was a rather interesting chain of events there, too. The Department had ordered foreign equipment from Brown Boveri which, as I mentioned earlier, was the first major generation equipment in the United States from a foreign supplier. The Southern California Edison Company was opposed, basically, to accepting foreign equipment. But when the bids came in for the generators, the turbine generators for Bolsa Island, the prices were so drastically different between American suppliers and foreign suppliers, that Edison couldn't insist upon American equipment. One of the things we had agreed to was that we would put in identical units, for purposes of minimizing spare parts, for example, and other items of operating coordination. And so an agreement was reached then to go with English Electric.

When we abandoned the project, then the Department of Water and Power cancelled its contract with English Electric, but Edison did not. It kept that contract alive with a view to modifying it for another site, which it did, and those are the units that are now at San Onofre, the two 1100-megawatt units at San Onofre, the two large ones. They were only 800-megawatts when they were at Bolsa, but their steam conditions and all the other factors were modified, too. But it was that original Bolsa contract that provided the machines for San Onofre.

TC: What is involved in cancelling a contract like that? Is it payment in full and they keep the equipment?

HK: Well, nothing had been manufactured.

TC: Nothing had been? Oh.

HK: And I don't recall what the financial considerations were in our cancellation, whether it amounted to anything or not. I think Edison's purpose in keeping the contract open was because they had a good bid price, rather than that they would have suffered any significant loss if they cancelled. They needed more generation and they intended to go somewhere with it, but I know nothing about the detailed negotiations between Edison and English Electric.

TC: Right. Again, this is probably not within your jurisdiction but you would have been aware of it. How was it that San Onofre was constructed and put into operation in the first place, given what was happening with the other nuclear projects in the area--not just the Department of Water and Power's projects but other projects, too? You know, in northern California the opposition was there and there was opposition in southern California. How did Edison get around that?

HK: With great difficulty. It was not a smooth project. We fought the battle at Malibu and lost. They fought the battle at San Onofre and won. It was a very difficult and expensive, trying experience for them, but they persevered. It was a good site and they got that first unit in. It was a smaller unit, 490 megawatts, as I recall, the small first unit. And having once established that site, then these English Electric machines went in as the two larger units. Edison had put in the smaller unit, and I don't recall what period that went in exactly, but having once gotten that site established, then it was much easier to add two more units at that site.

TC: Yes.

HK: And of course, we were shooting for ocean cooling. That was our desire, to avoid the use of fresh water for cooling. And there was enormous opposition to a siting along any part of the California coast where there was a population of any size or where recreation was happening to any degree. You see, San Onofre is on a federal reservation and that is probably the most important element in their successful siting there.

TC: Yes, because, as you say, San Clemente is, what, five miles up the coast?

HK: Yes.

TC: And then [Camp] Pendleton was down the coast.

HK: It's really on Pendleton.

TC: It's on Pendleton. Let me see, maybe we could finish off this side with some discussion of the Suppliers' Contract and Castaic. That was a different operation, obviously, but was System Development involved in planning for that? Castaic was a State Water Resources project. Is that correct?

HK: Yes.

TC: The idea was to use the water that was pumped into the Pyramid Reservoir from the California Aqueduct. Is that correct?

HK: Yes.

TC: When did this whole idea come into existence, as far as you can recall?

HK: Well, when the state aqueduct was developed--and, of course, this goes back a very long time to Governor Edmund G. Brown [Sr.] [who] was probably the father of that whole project--it seemed like it took fifteen years or so to finally get that approved and underway. The State Department of Water

Resources planned the aqueduct to operate through a series of small pumping plants down through the San Joaquin Valley to the Edmonston Pumping Plant, which is on the base of the Tehachapis [Mountain Range], to raise that water up over the Tehachapis, rather than come through in a tunnel because of the San Andreas Fault. It was concluded that an earthquake might sever that aqueduct and stop that entire supply permanently, if not for a protracted period. In any event, the decision was made to come over the hill instead of through it. And so the Edmonston Pumping Plant was planned at the time to be the largest pumping plant in the world, I believe. It raises the water which comes down through the San Joaquin Valley some 1900 feet. It then goes through a small tunnel into Quail Lake, a small lake, and from there it was to come down into Castaic [Power Plant] to be distributed on through their system.

Well, Bradley Cozzens first noticed this plan of the state, which included at that time a small energy recovery power plant which would have been capable of about 140 megawatts, generating around the clock on a relatively uniform flow of the state aqueduct. This was one branch of the aqueduct. There's another branch that goes around through the desert.

TC: Yes. This is the west branch.

HK: And Bradley assigned Phil Hoffman to have a look at this project. This was before System Development was established and Phil was working in Power Executive [Office] in this Power Resources Group. Phil conceived the pumped storage project that resulted in the construction of Pyramid Reservoir as the upper reservoir--Castaic is the lower--with a 1250 megawatt capacity rather than 140.

TC: Oh.

HK: As I recall, Castaic has somewhere between 305,000 and 350,000 acre feet and Pyramid about 180,000, on that order.

TC: Yes.

HK: And between the two, there is a tunnel seven miles long with a difference in elevation of 1050 feet. The state had in its original planning included Pyramid as an interim reservoir before this tunnel was constructed. They would bring the water down into Pyramid through an open conduit and then tunnel down to Castaic with a small tunnel. I don't recall what size it would have been, but it was relatively small. And so Phil's concept was to enlarge that tunnel in order to handle the large pumped storage project.

And this is what was done. The tunnel is thirty feet in diameter and seven and one-half miles long. And when that plant operates at full capacity, if I recall correctly, there is a flow of 1800 cubic feet per second of water coming through that project. Well, then on a weekly cycle, the water was to be pumped back to Pyramid. Some 10,000 acre feet of space in Pyramid was reserved for the purpose of pumped storage, the idea being to pump back on weekends and at night in order to reuse the water on-peak during the weekdays. So you had the combination of the flow-through water, which would go on down, and the pump-back water.

The original concept was, of course, to coordinate this with the Malibu Nuclear Plant, because nuclear plants are highly capital intensive--high construction cost but very low energy cost. So here was the ideal combination: low cost energy for pump-back. Also, if you install a nuclear plant at very high costs, you want the highest possible load factor on that plant. And this would enable you to generate on-peak electricity for the system and off-peak for pumping. It's a beautiful fit.

TC: Yes.

HK: So the state then needed a power supply for its pumps. There are several small pumping plants along the aqueduct in the San Joaquin Valley. One of the more visible is Windgap Plant. If you're traveling I-5 [Interstate 5], you see it off to the left as you go north. To the west of the Bakersfield area, you see the penstocks rising up to a cut in the hills.

TC: Yes.

HK: Basically, the aqueduct is a long lake. It has very little drop in each section. Because when the flow is stopped, you do not wish to spill, so you have a very long lake and you pump water out of one end of it and raise it up and put it into another very long lake, and so forth in a series of stages, until they reach the Edmonston Plant where it went up 1900 feet.

TC: Yes.

HK: Well, to meet the needs of those pumping plants, including Edmonston, the state was going to require a considerable amount of electricity. At that time, the Director of Water Resources was William G. Warne and Mr. Warne was quite a shrewd negotiator. We were in negotiations for quite some time on how that power was to be provided. The utilities, PG and E [Pacific Gas and Electric], [Southern California] Edison, San Diego [Gas and Electric] and the Department, entered into the Suppliers' Contract negotiations. And whenever those negotiations got into difficulty, Mr. Warne would hold a press conference and discuss the nuclear plant he intended to build in the Tehachapis. It was going to be a breeder reactor, a seed and blanket breeder reactor, and there would be much publicity about this nuclear plant which would supply the power for the pumping of the California Aqueduct. And then the negotiations would improve and eventually . . .

TC: So he used it as sort of a threat or a stick.

HK: Exactly. Primarily, the private utilities, principally PG and E and Edison, did not want the state to get into the power business. The Department politically was somewhat neutral on that issue. It didn't make much difference to the Department whether the state was in the power business or not, but to PG and E and Edison, this indicated a threat comparable perhaps to TVA [Tennessee Valley Authority] in the east and the growth of a power system. And, of course, the state was also going to get into hydro generation and so all sorts of negotiations were going on, under which the utilities were going to buy from the state and sell to the state. In connection with the Castaic contract then, which the Department negotiated, the Department paid for enlarging the tunnel to thirty feet in diameter and paid for the construction of the Castaic Power Plant. And the agreement provided that the state would get all of the energy that it would have gotten with its Energy Recovery Plant, as though it had built it, but that power would be supplied from the Department, whether from steam or whatever, in a contract that had many mutual benefits. And it turned out well. Castaic is a good project, providing peaking energy, some of which has been sold to others in intervening years and it has been a great help to southern California.

TAPE NUMBER: 7, Side A

January 22, 1990

TC: Just before we get into continuing our discussion on some of the power projects of the sixties and the seventies that you were involved in, I wanted to begin with sort of a context question. In my research, I came across an article in Business Week for November of 1969 that talks about the "power crisis" of the period. We did talk some about the development of the Electric Reliability Councils that you were involved in, and I thought that maybe we could talk more about what was happening industry-wide in this period that would bring about such an alarming type of article as this Business Week article. They bandy the term "power crisis" around. I'm wondering was there, in fact, a power crisis at that period?

HK: Well, there was in a number of respects. One, of course, is reminiscent of what happened to AT&T [American Telephone and Telegraph] a few days ago when their whole system practically failed.

TC: Oh, yes.

HK: The electric industry in the Northeast blackout reached a point where this cascading failure problem was spreading and was considered very serious. As I've mentioned before, this led to the formation of the Regional Reliability Councils and the National [Electric Reliability] Council and the studies that were made.

One of the things that was going on, as a result of the development of extra-high voltage transmission and the interconnections that that made possible, were the very large power plants which could then be constructed, which called for as much economy of scale as could be developed. And one of the things that makes that possible is a very large generating unit. As these units got larger and larger, problems developed as a result of size, and the industry overshot.

As I mentioned earlier, one steam turbine generator was built at a rating of 1300 megawatts, which is about the same size as all seventeen Boulder Dam generators put together. It became necessary to resort to cooling the rotors with water. If you can imagine the complexity and the technology involved in attempting to pass cooling water through a rotor weighing a great many tons, rotating at 3,600 revolutions a minute, these were some of the things that happened.

One of the major problems that developed primarily with General Electric machines was that the increasing diameter of these rotors lead to a brittle fracture problem. One of the General Electric machines exploded on test in Schenectady, [New York]; and there were some other failures that I can't recall in detail, but the industry was very concerned.

The Department had four of these units, two at Valley Steam Plant and two at Scattergood, which were suspect from the standpoint of brittle fracture. As a result, it was necessary to establish a pre-warming program for those rotors, when the units were being brought up from cold standby, to operate them at increasing temperatures at a very low speed for a number of hours to warm the metal, so that when they were brought up to speed, we could forestall a mechanical explosion.

There was an engineer working for Westinghouse who was in the forefront of this industry effort to solve this problem named Laffoon. Mr. Laffoon was the person I think most responsible for solving this problem. He discovered that these brittle fractures were the result of entrapped hydrogen. When the generator rotor ingot was poured, hydrogen was included in small void spaces in the ingot as it cooled. These were determined to contain hydrogen at 12,000 atmospheres of pressure. These voids being very sharp-edged spaces, led to crack propagation.

There had been a number of brittle fracture problems in industry, generally, in pipelines and in ships during World War II. Some of the Liberty Ships, which were welded rather than riveted together, steamed up into the Arctic, and instead of the plates shifting on the rivets, taking care of the stress resulting from ice water on the outside and a hot steam boiler on the inside, some of those ships simply cracked in half and sank. Pipelines that would have a notch somewhere, under proper conditions, would split and a crack would propagate for a couple of miles in just a matter of seconds.

So this was an area that was affecting the industry. Westinghouse didn't have the problem because it kept its rotors at a smaller diameter. General Electric overshot in size. In some of the units the shaft of a rotor was always bored in order to determine if there were any irregularities in the center. That's where most of the problems would develop. And then they would examine those rotors with a borescope to see if there were any rough edges and smooth those out, if possible. On one occasion, General Electric over-bored a rotor, trying to get rid of all of these irregularities in the center of the forging and overdid the job, and that rotor failed, also. As a result, the industry pulled back to units of about 800 megawatts in size, 850 or thereabouts, and has remained at that level as a sort of a rule of thumb maximum size since that time.

Brown Boveri, which supplied some of the Department's units, had a novel solution to the problem--probably not so much a solution to the problem as part of their basic technology. They cast forgings in three pieces for these huge generators that they were building, and that enabled them to forge a much smaller piece of metal. These three forgings then were assembled on a bolt which became the shaft and the bearings were, in effect, nuts holding those three forgings. Or, the journals, that were to ride in the bearings were also nuts on the shaft that held these three forgings together. So those three forgings were always in compression, whereas a single-piece rotor is in tension on half of its rotation and in compression on the other half which, as you can imagine, is putting an enormous stress on the rotor at 3600 rpm.

Now that was typical of some of the problems. There were many others that were found. There were insulation problems. I recall that at Scattergood during the first year inspection, we found the windings pretty badly loose in one of the machines after a year's operation.

We purchased generation transformers for Scattergood from English Electric. They were using a design which was questionable in our minds. It was a very large transformer, a three-phase transformer, large enough to take the full output of the generating unit, as I recall, on the order of 200,000 kva. These units were built in England and shipped to the United States. And it was our custom in those days, on receiving major equipment of that kind, to have it delivered to our shops at North Main Street for inspection before installation. English Electric objected to having their transformer untanked and stated that the guarantee would be void if these units were untanked. So we said, "All right, it's your responsibility. You install the transformer."

So their erection engineer, overseeing the work done by our crews, was on the job when the units were put in place. And when the cover plates were removed from the tank in order to install the bushings, the erection engineer found all manner of trash that had been left in at the factory inside those transformers and then requested us to please take the transformers to our shop and untank them. When we did, we found lathe turnings and metal bits and pieces. We had to build an oven for drying that core after it had been washed with transil oil. It was an extensive job to attempt to clean up those windings, which was not successful because you couldn't get into all of the fine hiding places in those windings. As a result, the transformers failed in service, and that became a very serious matter because we couldn't use the unit. We did cobble up a bank of transformers from receiving stations, which enabled us to operate at reduced capacity until the transformer could be shipped back to England and rewound. And we went through this two or three times. It practically ruined the business for English Electric in this country. I'm sure it damaged their reputation very seriously.

Other utilities were having problems of this same kind, largely, I think, because of the extrapolation of size. Meanwhile, efforts were underway to get into the nuclear field and we're all familiar with what happened there: opposition by political people and environmentalists and others.

TC: Well, let's talk a bit about that. We talked before about your involvement with Bolsa Island. Following Bolsa Island was the San Joaquin Project.

HK: Yes.

TC: I thought maybe we could get into some description of that. But there was another project just prior to San Joaquin which was quickly scrapped in favor of San Joaquin. That was the Porterville Project.

HK: Porterville, yes.

TC: Were you involved in that one?

HK: Yes. At Porterville, we stopped that project because of the geologic investigation which found displacement in the earth. And although our consultants in the geology field felt that the displacements had occurred on the order of a half a million years earlier, they were unable to prove it with conventional means. And that was a requirement of the Atomic Energy Commission in those days, that the site not have had a displacement within something on the order of a half a million years.

So we abandoned that site and looked for another one, which we found in the San Joaquin Valley. If I remember correctly, that valley is filled with some 11,000 feet of sediment at its deepest point. It was once an inland sea and the material in the valley had washed down from the mountains during the mountain building process and thereafter and laid down in layers.

So the problem here was a little different for geologic investigation. Whereas at Porterville we had cut trenches in order to examine the walls, in the San Joaquin area which was near Wasco, about thirty miles northwest of Bakersfield, we drilled holes and removed core samples from vertical holes spaced over a large area surrounding the site. By measuring the layers of various kinds of material in those cores that were brought up and catalogued, it was possible to determine the slope of these layers and whether there were any irregularities. And none were found.

One of the things that was discovered, and I can't recall at what depth, was what was called the Brunhaas-Monteyama Interface, or some such expression as that that the geologists use. It was a place where the earth's magnetic field had reversed. The explanation was that as these layers came down in that body of water many, many long years ago, that the magnetic particles tended to orient themselves with the earth's magnetic field as they settled to the bottom, and then gradually they were trapped in that position, so that they constituted a magnet. So, when the earth's magnetic field reversed, the particles settling after that were found to lie in an opposite direction. And that boundary, the Brunhaas-Monteyama Boundary, was believed by geologists to be something on the order of 700,000 years ago that this reversal occurred. So that established sufficient proof, from a geologic standpoint, that the site was valid. There had been no displacement. It was a good site.

There was concern, of course, as there was everywhere on nuclear development. And Eugen Koffman and I and some of our people made numerous trips to speak to the general public up there and to the elected officials in a number of public relations efforts. We had hit upon a scheme to use agricultural drainage water for cooling, which would have provided a service to the valley since the water table was rising, the salinity was increasing, and the people in Kern County were facing a difficult problem as to what to do with that drainage. You may have read in more recent years about the problems at Kesterson Wildlife Refuge where drainage from the Westlands farming area contained an abundance of selenium and the result was deformed waterfowl and so forth.

TC: Oh, yes.

HK: Agriculturally, there are serious problems with increasing salinity. When the roots of citrus trees and other crops reach that level where they're into some of these saline waters, the crops die or are damaged. One of the problems was what is called perched water. This occurs where there is an impervious clay layer some distance underground, through which water that is placed on the land, either through irrigation or rain, doesn't go on down but is trapped by this boundary, this impervious clay layer. And, therefore, you have an increasing salinity problem in a relatively thin layer of the earth's surface at that point. And if you penetrate it, then you release this saline water down into aquifers, which may be important from the standpoint of water supply--serious problems.

When the state aqueduct was designed, the concept was to build the San Joaquin Drain, running in a counter-direction to the aqueduct. As the fresh water came south, the drainage water would go north and dump into San Francisco Bay. The environmentalists in the Bay region were opposed to the construction of the San Joaquin Drain because it would contain pesticides and other toxic materials and no one knew for sure just what. So, as a result, the drain has never been built. Portions of it, I believe, were built, but the drain as such was never constructed, and so these problems were rather severe.

We would have evaporated an enormous amount of that water, using it for cooling, and then stored the solids in a lined dump in a canyon somewhere, where it couldn't seep into the groundwater. And for the life of the plant, we could have disposed of the solids in that water and it would have improved agriculture. At the same time, it would not have been a consumptive use of fresh water. So it had a lot of appeal, from that standpoint, to people who understood this. But trying to reach the general public with something that complicated was not too successful.

TC: Well, who then formed the opposition to this, other than maybe there was an element in the general public that, because they didn't understand it, were opposed to it? But there must have been a more active opposition group.

HK: Yes. And, unfortunately, Mayor [of Los Angeles, California] [Thomas] Bradley had appointed to the Board of Water and Power Commissioners people who were opposed to nuclear power. I think that probably was the most significant cause of the failure of that project. We had done our work well. We had spent a considerable amount of money on geology, approved the site, we had written specifications and taken bids for the nuclear reactors. We were proceeding under federal guidelines which required that a conceptual design be developed around the equipment intended to be installed for the environmental study and statement. The California Environmental Quality Act, on the other hand, required that an environmental impact statement be written before any significant action was taken. We had reached the point where we had analyzed the bids and we were ready to award the contracts for the nuclear reactors and the other major equipment, following federal guidelines. And the Attorney General of the State of California, Evelle [J.] Younger, threatened the Department with an Attorney General's suit under the California Environmental Quality Act. And the Board, some of the members of which were opposed to nuclear energy in the first place, decided to abandon the project.

Now, putting this together had been an enormous undertaking. Because of its size and location and because of what had become standard practice in the industry, it was developed as a cooperative development by the major utilities in California. Our partners in this effort included Pacific Gas and Electric, San Diego Gas and Electric, Southern California Edison Company, Burbank, Glendale, Pasadena, Riverside, Anaheim. And the Department, having the lead role in developing this project, really suffered the most when it failed. The others had come along, the agreements had been developed, and we were proceeding in good form when the Attorney General threat of a lawsuit killed the project.

TC: So you didn't particularly see opposition coming up from the Bakersfield area or Wasco or that locale. It was more the upper levels of state administration that were involved in the opposition.

HK: Yes. There was opposition, of course. There had been . . . Always in these situations, the activist groups managed to stir up a lot of ill feeling amongst the general population, being badly informed by negative press. It is very interesting to me: the hypocrisy that exists in the media. For example, I was on the public relations trail a great many times making presentations to people. I became involved in debates with environmentalists, sometimes on television. And questions would be raised and answers given, sound answers, and yet, at the next meeting, these same people would be there raising these same questions, which had been well-answered previously. And the media took great delight in quoting what these people had to say, most of whom had no expertise whatsoever. Their only expertise was in the field of

activism. And if there was an expert who said something, then that became quoted over and over and over again, whether it had been laid to rest or not, and there were always a few people who had professional titles who were on the other side of the picture. The general public didn't seem to see how this was tilted.

TC: You must have run up against people like John Gofman.

HK: Oh, yes. The failure of the San Joaquin Project led me to early retirement. I had put so much personal effort into organizing that project, setting up meeting after meeting to bring that partnership together, and putting so much effort into the other aspects of developing the project, that when it failed I didn't have the heart to continue. I had been with the Department for just under forty years. I was pretty tired. I had had a number of disappointments in efforts to secure future generation for the Department, and I concluded the time had come to leave. As a result, Bob [Robert V.] Phillips [General Manager of LADWP] and I both retired the same day, officially.

TC: Now, when you were involved in this San Joaquin activity, this spanned the period when you were head of System Development and when you became Assistant Chief Electrical Engineer. Is that correct?

HK: Yes.

TC: What were the steps involved? What was the situation by which you were chosen to become Assistant Chief?

HK: Well, that was a civil service examination, and a replacement for someone who retired ahead of me.

TC: Who would that have been?

HK: Let's see, I guess this was at the point where Burton Currie was retiring as Chief Electrical Engineer and Jim [James L.] Mulloy was going to move into his position.

TC: Oh, okay.

HK: Bill [William A.] Sells was holding a position as Assistant Chief Electrical Engineer. There were two Assistant Chief Electrical Engineers in the system at that time and so I replaced Jim Mulloy as he moved into the Chief Electrical Engineer position.

TC: So part of your function as Assistant Chief would be to involve yourself very publicly this way with something like San Joaquin?

HK: Yes. The division of responsibility between the two assistant chiefs gave me my old System Development Division, the Design and Construction Division, the Power Executive people who were making rate studies and a few other things; whereas, Bill Sells had the Operating Division and General Plant [Division]. That was the basic split of responsibility.

TC: Okay.

HK: So that when I moved over from System Development, there was a continuation of things I'd been doing for seven or more years in System Development. Through that role, because of its association with the external affairs of the Power System. . .

TAPE NUMBER: 7, Side B

January 22, 1990

HK: The duties I had been performing, with respect to the National Electric Reliability Council and the Western Systems Coordinating Council, I turned over largely to Charlie [Charles] Erickson at the time that I was promoted to Assistant Chief. One of these was the Intermountain effort [Intermountain Power Project] that I had been involved in. And Charlie replaced me on the board of directors of that project at that time. But he was then reporting to me, so that these were sort of adjustment arrangements to spread the work.

TC: Yes, I see.

HK: I dropped all of my activity with the National Electric Reliability Council, which had involved membership on a number of committees. But having dropped out, a crisis developed in the industry over what was then called the National Grid. There was a political effort to take over all of the transmission in the United States, the major transmission, by the federal government. And so the National Council requested me to return to that effort and I was made Chairman of the National Electric Reliability Council Committee on the National Grid. And that was a very interesting experience.

TC: Well, what's the background on that? Is that the bill that Lee Metcalf [D-MT] was pushing? This would have been about

1974, and within that bill there was some kind of proposal for establishing a national grid corporation, which would be federal funding for new capacity.

HK: Yes. I can't recall the fine details of Metcalf's activities, but he was in the forefront of that movement, and there were others whose names I don't recall. The Ford Foundation got involved and funded a study by a consulting firm in Schenectady, which was the focus of our committee's efforts at the time. This study was to be used to try to convince Congress of the necessity to establish a National Grid. This committee was made up of some of the industry's top people and it was a real pleasure to work with them on this effort.

TC: So you were able to block this movement towards establishing a National Grid then?

HK: Well, we helped in doing that by preparing a report which dealt with the facts of life concerning the National Grid from our industry viewpoint. There was a lot of support from the public power side for a National Grid because of the failure of these entities to obtain wheeling rights on privately owned transmission. This has been a problem ever since interconnections began to occur and it's still a problem, becoming less so as time goes on. We can get into that a little bit later.

TC: Okay, sure.

HK: At the time, we found it very difficult to imagine a system that would be torn to pieces in this fashion. I've thought about this so many times in connection with Judge Green's decision that destroyed the communications system in this country and broke up AT&T and the chaos that has resulted from that. I shouldn't say we forestalled that, but we helped by convincing members of Congress of the lack of wisdom in this approach.

One of the things that wasn't well understood, and it's still a matter of debate: What is the capacity of a transmission line? If a line is built for reliability, or some portion of it is dedicated to reliability--which was an important concern--then if it is loaded up fully it ceases to serve its purpose during a breakdown in the overall system. If you don't have unloaded transmission, it's like not having unloaded generation to respond to a failure. Some lines were built primarily for reliability. And immediately, there were those who wanted to load them up with economy energy purchases and with, even worse, firm energy contracts that would utilize all of their physical capability to move power.

From an industry standpoint, what criteria would manage this system, if it were to become a National Grid, was frightening. There were all sorts of schemes in the works in those days: the concept of "G and T", as it was called, "Generation and Transmission", being divorced from the distribution systems of utilities, there were so many concepts being floated and proposals being made for reorganizing the nation's electric systems. And some of these are coming to pass. The Public Service Company of New Mexico has made a serious effort to isolate its generation and transmission from its distribution, in terms of the corporate structure and the control of that structure by regulatory agencies. This is still a cauldron and no one is too sure where it's going to go.

The recent mergers that have become publicized emphasize this kind of thing. As a result of merger efforts, there is increasing support for wheeling, by law, mandatory wheeling.

TC: Can you just quickly define wheeling?

HK: Wheeling is selling transmission capability to people who don't have it: Small municipalities who wish to purchase power across the grid, if you will, and are unable to make contracts with the large utilities that own those transmission lines, who say that they have no capacity in those lines. This is back to the question of how much capacity does a transmission line have?

One of the facets of this can be seen in the operation of a large area transmission system. For example, when the Pacific Intertie was built, we wound up with a massive transmission capability up and down the Pacific coast, from the Pacific Northwest to the Southwest. There was a less dense system of transmission around the eastern side of the western United States, down through Montana, Idaho, Utah, Arizona, New Mexico area--lower voltages, smaller lines, not too much capability. And yet, if we were to negotiate, as we once did, a contract to purchase some power from, say, Idaho, and had a contract path worked out around the eastern side of this system, the power chose to go where the impedance was lowest, and that was down the Pacific Intertie.

TC: Yes.

HK: So here we have an alternating current network belonging to Edison and PG and E, bringing power south from the Pacific Northwest. And while we have a contract path that could theoretically bring power from Idaho down through New Mexico and Arizona and across to Los Angeles, it wouldn't go that way. Therefore, if it happened, it came down over transmission lines other people were trying to use, people who owned it, and we had to back off of contracts that technically we were entitled to make; because this is an industry problem and by cooperative effort we had to avoid that kind of a problem.

So the problems that entities like Anaheim and Riverside had with Southern California Edison Company, in attempting to buy economy energy, low-cost power, new resources, and bring it in over Edison transmission lines, resulted in years and years and years of litigation as to whether there was, in fact, transmission capacity available. Now, there's no need to go into any of those fine details, but this has been a widespread problem for many, many long years.

Quite recently there was a merger under which Pacific Power and Light acquired the Utah power system, Utah Power and

Light. And in securing approval for that merger, the Federal Energy Regulatory Commission, which replaces the old Federal Power Commission, stipulated for a period of some five years the rules and regulations under which wheeling must be made available when it can be demonstrated that transmission capacity exists. Now there is an effort on the part of Pacific Power and Light to also acquire Arizona Public Service Company. That merger may well take place. And again the wheeling issue is going to be before the Federal Energy Regulatory Commission.

Gradually, it's becoming more standard to permit wheeling and to require it by law for entities that do not have it. Historically, there have been a great many abuses where a municipality, for example, establishes a municipal power system but has no generation of its own. It is an isolated, captive customer of a private utility. And although there may be resources elsewhere that could be purchased for economy's sake, there's no way to get it in unless transmission can be purchased to go with it.

TC: Yes.

HK: Now Riverside and Anaheim won a number of lawsuits against Southern California Edison. Among the results of that type of thing were the sale of some of San Onofre nuclear capability to those entities. So these were some of the major problems going on. You see, this was all part and parcel of this new situation, in which the advent of extra-high voltage transmission made these interconnections possible, made large mine-mouth power plants possible, led to the economy of scale and overshooting of size, and created the opportunity for the smaller entities to demand wheeling.

TC: I see.

HK: So there was much chaos as a result of that.

TC: Could you always count on the California congressional delegation to support your position or the position of the utilities out here in general?

HK: No, we could not. This was more or less on an ad hoc individual basis, as to whether we got support or not, and what was going on at the time politically. In general, I never felt that we had adequate support. The Hualapai Project is an example. Did we discuss Hualapai?

TC: We haven't discussed Hualapai, no. Go ahead.

HK: Well, that was a fascinating experience. The Hualapai Indian Reservation is in the vicinity of Bridge Canyon on the Colorado River. We had made studies many years earlier of a possible second development between Glen Canyon and Hoover [Dams]. While I was in System Development, my hydroelectric engineer Phil Hoffman, who was the father of the Castaic Project and had conceived of that--his specialty was pumped storage generation--he conceived the idea of building pumped storage on the Colorado [River] at Bridge Canyon on the Hualapai Indian Reservation.

At one point early in the investigation, I took a group of some seven people from the Department and one from the Colorado River Commission, in company with people from the United States Bureau of Reclamation, headquartered in Boulder City, on an expedition to the site to examine it. We took along with us Raymond Hill, who was a noted consultant in dam construction. The concept that Phil Hoffman came up with and which we felt was viable was a dam similar to Hoover with an enormous after-bay below it that would hold 40,000 acre feet of Colorado River water, with the pump-back capability similar to the Castaic Project, such that we could install 5,000 megawatts of hydrogeneration on the river. It would have had the energy capability comparable to Hoover, but many times its capacity. Hoover has roughly 1300 megawatt capability. I think it's been increased since the renegotiation of the original 50 year contracts.

TC: Since the renegotiation, yes.

HK: But at the time it was about 1300 megawatts and we could see the possibility of 5,000 megawatts. So we organized meetings in the Department offices and invited power people from most of the power utility entities in the Pacific Southwest and made presentations of our concept to these and to the Bureau of Reclamation, which was cooperating with us in this preliminary investigation.

Well, this site is below the Grand Canyon National Monument and, of course, there has been opposition to dams on the river for quite some time, primarily by river rafters and naturalists and environmentalists of one sort and another, and so the opposition began to develop before we got very far. Nevertheless, our Chief Electrical Engineer Floyd Goss, with the support of the utilities in the Pacific Southwest did make a presentation to committees of Congress for this development. And what he was proposing was that the Bureau of Reclamation be authorized to study, and hopefully build this project, in which all of these major utilities would cooperate. We had this emerging coal generation in the Pacific Southwest which would provide low cost energy for pump-back, and it would have given us an enormous amount of peaking capability on the river.

Well, one of the views of the Bureau of Reclamation was that should this project be built, it would provide considerable income for the federal government through the Bureau of Reclamation, and that much of that money could be ear-marked in a study of water importation into the arid Southwest. We had done some preliminary work in looking to the Columbia River as a source of additional water. One very fine concept was to tap the Snake River before it got into the Columbia.

TC: The Snake River, yes.

HK: Bring it down across Nevada, dump it into the Colorado, and run it through the existing power plants where it would generate more power than would be required to pump it out of the Snake. That was a major project. [Ralph] Parsons had studied bringing the Yukon down here for the United States. The idea, however, of tapping the Columbia didn't appeal to [Henry] Scoop Jackson [D-WA] in the Pacific Northwest. And so, when this matter came before Congress, the political people went to work on it and, before they were through, they passed a resolution forbidding the Bureau of Reclamation from even studying such a project as Hualapai for ten years. And during that ten-year period, they extended the boundaries of the Grand Canyon National Monument to include the site, and that was the end of the Hualapai Project.

TC: If I remember correctly, there were people shouting about flooding the Grand Canyon? Was that part of the Hualapai?

HK: Yes. It wouldn't have flooded the Grand Canyon. But it would have flooded a significant stretch of river below the Grand Canyon, that's true. The Hualapai Indians were eager for this project. It would have provided them with a lake similar to Lake Powell, on which they could develop all manner of commercial enterprise.

TC: Sure, recreational activities.

HK: Boating, recreational facilities. They were eager to have it built and very disappointed when it failed.

TC: This is what year? What time span are we talking about here?

HK: I can't recall the exact date.

TC: Is it into the seventies, though?

HK: No, I think this mostly occurred starting about 1967, if I remember correctly.

TC: Okay.

HK: It may be a little bit after that, but in the very early seventies probably.

TC: Okay. Well, I'd like to shift now and talk about Intermountain Power Project.

HK: Okay.

TC: If I could establish a date for the beginning of that, how did that begin to emerge in the Department as a possible project?

HK: Well, it was quite an interesting coincidence. There were in Utah some twenty-six small municipalities and other entities which had distribution systems and were purchasing power from Utah Power and Light for part of their needs and which had contracts with the federal government for upper Colorado River Storage Project power, known as CRSP. These twenty-six entities got together and formed the Intermountain Consumer Power Association for the purpose of joint purchase of power for their members. This was agreeable to the federal government under these arrangements, so that they were paying for capacity on the basis of the combined peak of those twenty-six entities, rather than the separate peaks. And since their peaks occurred at different times of day and different periods generally, the combined peak is significantly lower than the sum of the individual peaks. And as a result, they were enabled to earn the differential in cost of capacity, and the money was earmarked under their agreement to study future power supply for their members.

They viewed this to mean coal-fired generation, and so they began to look for sites for a coal-fired power plant. They filed on some 50,000 acre feet of water on one of the streams in Utah. They drilled a deep well into the Navajo sandstone and tested it to see how much water it might be able to produce for cooling water. When they had gotten that far, they decided to invite others to join with them in this effort, because they knew they couldn't, among themselves, develop a major coal project. They had heading up this organization an engineer named Joe [Joseph C.] Fackrell who was a member of the APPA [American Public Power Association] Power Supply Planning Committee, of which I was also a member. We had a meeting scheduled in Washington, D.C. of that APPA committee. And prior to the meeting, Joe Fackrell sent letters to all of the members, at least in the west, inviting us to stay after the APPA committee meeting to discuss possible power generation in the west.

There were only two of us who stayed; one was Gordon Hoyt, General Manager of the Anaheim System, and I was the other one. We met with Joe Fackrell and some of his people and we listened to what they had in mind, what they had done, what they thought--and this was midwinter and I can't recall which year--but we agreed that when the snow cleared we would meet them in Salt Lake [City, Utah] and have a look at what they had done. So Gordon Hoyt and Everett Ross who headed the Riverside system, and Alan Watts who was City Attorney for the City of Anaheim, and I met in Salt Lake City with the Intermountain Consumer Power Association people and went back into the wilds in four-wheel drive vehicles to see the site, to see the test well, to study and discuss this possible power development.

We were impressed favorably with this concept and so we organized a meeting in Salt Lake of essentially all of the power people in the Southwestern United States who might have a possible interest in joining and made a presentation. And there was sufficient support amongst those people to undertake the project. So Los Angeles was named as project manager. We formed a board of directors and I was a member of that board for a few years, until I moved on up to Assistant Chief position and turned it over to Charlie Erickson.

And we set up an arrangement, under which this project could be financed by bonds backed by power sales contracts, which would have several advantages for the Department, one of which would be that we would not exceed our bonding limitation--our bonding covenants--by not issuing our own bonds. We would simply sign a long-term contract for the power and that would enable the organization that we established to issue bonds and finance the project.

Now, the site that we selected was called the Salt Wash site, and the federal government opposed building at that site because it was too close to Capitol Reef National Park. I think it was something like twenty-five miles from Capitol Reef. So time went on and little progress was made. Studies, however, proceeded, including studies on a more appropriate format for undertaking the project, which required some changes in the law in Utah. And at the time I retired, this had not been accomplished. The federal government, in rejecting the Salt Wash site, had offered to aid the organization in trying to find a suitable site, and did so. And so the plant was never built at the original site. It wasn't built using the original water supply that was contemplated, but it was built and has been quite successful.

TAPE NUMBER: 8, Side A

January 29, 1990

TC: I just wanted to finish up on the Intermountain Power Project discussion with a technical question. What was the role of DC transmission in that?

HK: It had to do with the distance of Intermountain to southern California. Direct current transmission is only economical in very long distance transmission because of the high cost of the terminals. Although, in some cases, back to back DC terminals have been installed on power systems at some places in the world because of the advantage of being able to control the flow of power directly, not letting it become subject to the natural laws under which alternating current systems operate. But by and large, you must have a fairly long transmission link to justify direct current.

TC: So are all of the transmission links for Intermountain to all the other entities all a direct current deal?

HK: No, there are some alternating current lines to other locations interconnecting Intermountain with the western systems grid, but the lines to southern California are direct current.

TC: Maybe one more question on that, not on DC but on the entity that governs Intermountain Power Project. The original group was called the Intermountain Consumer Power Association. Is that it?

HK: Well, the Intermountain Consumer Power Association, ICPA, was this group I made reference to last week of some twenty-six small Utah utilities.

TC: Right. And emerging from that was the Intermountain Power Agency, the IPA?

HK: That's right. This group ICPA, as I mentioned earlier, undertook this project as a means of future power supply for their group and realized that they couldn't build it on their own and invited other participants. That's how the Intermountain Project was formed.

There was a considerable amount of work done to change the laws in Utah and to reconstruct the financial arrangements, which we had come up with initially, by the first board of directors, to make it possible to finance the project by issuing bonds backed by long-term power sales contracts from each of the participants. And this was a highly technical legal approach which was carried out after I retired.

TC: Well, let's move now to the Navajo Project. Was that happening simultaneously to Intermountain, or just prior to Intermountain?

HK: No, it was quite a bit before the Intermountain Project.

TC: Okay. I think it was in 1969 that the Board of Water and Power Commissioners okayed the project, but it must have been in the works prior to 1969 then.

HK: Yes. I can't recall the exact date, but it was sometime between 1967 and 1969 that this project was undertaken, yes.

TC: Well, what was your initial participation in it?

HK: Well, at the outset of the project, the Salt River Project organized a meeting in Tempe, Arizona, which was attended by the [United States] Secretary of the Interior, Stuart Udall and representatives of almost all of the power interests in the Pacific Southwest, to discuss the possibility of building coal-fired generation at one or more of three sites: one was Kaiparowits, which Edison was pushing very hard; one was additional units at Four Corners, which was already functioning as a generating site; and the third was the Navajo site near Page, Arizona.

Out of that meeting came a decision to study this project and a number of committees were formed. There was a Coordinating Committee consisting of high-level management people from each of the entities. There was a Principles of Participation Committee, of which I was a member, to go into the details of organizing such a project. There was a Loads and Resources Committee, which I was also on, for the purpose of studying who needed what and in what time frame, amongst the possible participants. There was a Transmission Committee, there was a Generation Committee, Socioeconomic Problems Committee, and in all there were some ten committees formed, staffed by people from most of the prospective participants. And that work proceeded.

On the Loads and Resources Committee, we discovered after taking a poll that there was a need for two plants rather than one. There was a very large request for power and then there was considerable debate and study over where the two plants would be built. Edison still favored Kaiparowits, but the group as a whole favored one at Four Corners and one at Page. And that was the ultimate decision, to do those two plants. And then somewhat down the line, Edison pulled out of the project, leaving the final six participants who eventually built the project, and that was done at the Page site.

TC: Well, things like the socioeconomic problems, for instance, would that be to deal with or anticipate some of the things that would come up in the boomtowns that develop around these kinds of plants?

HK: Yes. And primarily it was aimed at providing assistance to the Navajos, both in terms of the mining that would be involved on Black Mesa, construction of the power plant, the use of water in the area, the disruption of the communities, the need for schooling, transportation, housing, employment, all of these factors were studied.

TC: A tall order, yes.

HK: I did not serve on that committee and I don't recall too much about the deliberations, but the project did undertake very significant socioeconomic support for the community out there.

TC: And the Navajos were all very much behind this project, I would guess.

HK: Yes, they were indeed. Of course, there's always, in any group of people, a difference of opinion and mixed views. There were some who opposed the project, and I presume that those were primarily the ones whose lives were going to be disrupted by the immediate proximity of project facilities to their homes and occupations and so forth.

One of the things that was involved is that the Navajos are primarily sheepherders. They are allotted grazing land by the Tribal Council. These lands are owned by the federal government in fee and held in trust for the Navajo Indians and controlled by the Tribe. The Tribal Council then was responsible for allocating grazing lands to individual families. And to the extent, for example, that the strip mining operations on Black Mesa would displace a grazing area and a hogan or other home, it was up to the Tribal Council to pay for relocating that family to some other place, building a new home and providing additional facilities. So the project was required, of course, to compensate the Tribal Council for those expenses. And so there was some opposition politically among various self-appointed protectors of the Navajo people to argue that not enough was being done for the Indians.

There were also people on the other side of the issue who felt that no one should do anything on the reservation, in order that the nature of their culture would continue unchanged forever. Of course, their culture was largely poverty. So here was a clash of ideas between people who felt that nothing should be done and people who felt that everything should be done, and the project made a very serious attempt to do what seemed best in the circumstances.

TC: What is the percentage of ownership that the Department has in that project?

HK: The Department, if I recall correctly, has a 21.2 percent interest in the project. The largest interest is held by the [United States] Bureau of Reclamation, the federal government, some 24 and a fraction percent, to obtain power with which to pump the Central Arizona Project.

TC: I think that covers the project side of your career, but I wanted to talk about some other things, like general relations that Department management and senior engineering staff had with different levels of government, say, starting with the Board of Water and Power Commissioners. Last time, you mentioned that at one point in the course of the San Joaquin Project [Mayor] Bradley appointed some anti-nuclear people to the Board.

HK: Yes.

TC: And that helped to quash that project. Other than that, were your relations or the relations of senior management at the Department pretty good with the Board, in terms of the Board deferring to what engineering management would suggest?

HK: No, the relationship was not very good, and for reasons somewhat similar to those that we faced on the San Joaquin

Nuclear Project, although Navajo was earlier. I believe I mentioned to you in an earlier discussion the problems we had with getting contracts approved.

TC: No, I don't recall that. Please go over that.

HK: The Principles of Participation Committee of the Navajo Project met long and hard to work out how to combine these six entities into a partnership arrangement legally not a partnership, nor a joint venture, but a cooperative undertaking. You can understand that with private utilities, publicly owned utilities, and the federal government all involved in such a venture jointly, it is a very difficult problem to come to agreement on how things should be done.

There were private agendas amongst the participants. There were strongly held views of how things should be done. For example, the Arizona Public Service Company wanted to own all of the transmission in the State of Arizona. The Department was unwilling to do that because we were able to own transmission financed with tax-free financing. It was considerably cheaper for us. We wished to own our own transmission lines, at least in partnership with others. And it took some two years before that particular issue finally was resolved because of very, very strongly held views of this kind.

So the Principles of Participation Committee did a great deal of work to come up with a conceptual design of not only the project, physically, from an engineering standpoint, but for the relationships of the parties. And when it had proceeded to a point where the Coordinating Committee was satisfied with this effort in this fashion, we changed the Principles of Participation Committee to the Legal and Negotiating Committee and began to negotiate a definitive contract to cover all of these arrangements.

The result of that work, which took a very long time, was an omnibus contract covering all aspects of the project for a period of fifty years. The design, construction, the operation, the ownership, et cetera, were all contained in this one single contract. And in due course of time, that agreement was executed by all concerned. Execution by the Department required approval by the City Council, by ordinance, and by the Mayor, and this was obtained.

Included in that omnibus agreement was an agreement to proceed forthwith to negotiate individual definitive contracts, covering each of the specialized areas. For example, a separate contract for operation, one for design, one for generation, one for land ownership. There were something on the order of a dozen separate, definitive contracts, which were drafted. And the basic approach taken by the Legal and Negotiating Committee was to depart from the principles laid down in the omnibus Participation Agreement, only by total mutual consent. If we could not improve upon what had been included in the contract that had been executed, we would stay with the principles set forth there. We departed, by mutual agreement, on many facets as we got into the fine details of these individual contracts.

And in due course of time, those drafts were all completed and executed by all of the other members of the project, with the exception of the City of Los Angeles. They were forwarded to the City Council, and at that point, Mr. Bradley, then a Councilman, took up what he viewed to be the environmental problems of the project and introduced into the City Council what became known as the Bradley Resolution.

It dealt with a great many environmental matters. It dealt with a great many important agreements that had been hammered out in blood between these six participants over a long period of time. And basically, what it required was that the City of Los Angeles, the Department of Water and Power, go back to the other five partners and convince them that the overall agreement had to be totally renegotiated.

At that point, I went to the General Manager, Bob [Robert V.] Phillips, and told him that I was prepared to resign, to take early retirement, but I would not go to that group of people and request them to change the agreements that had been put together with such great effort. I did agree to take this information to the partners and to make them aware of what was being requested by the Los Angeles City Council, which I did, and the result was as anticipated.

The general feeling amongst the partners was that the City should be excluded from the project so that it could proceed. Meanwhile, the project was under construction under the terms of this single omnibus Participation Agreement. So the approach taken by our top management, which was a wise one, was to attempt to educate the members of the City Council to the facts of life, with respect to this project: its importance and the reasons why the provisions of the agreement were as they were.

In order to do this, a series of field trips were arranged to take the City Council members to the project, see it firsthand, take them to Black Mesa, see the mining operations which were going on there for the Mojave Project, which would be similar to what we had contemplated for Navajo.

Over a period of approximately a year, a sufficient number of City Councilmen were convinced of the wisdom of this project, so that when these agreements were again submitted to them, they were approved by ordinance. But by that time, Mr. Bradley had become mayor, and when the ordinance reached his desk he vetoed it. And those agreements had not been executed at the time I retired. These two projects, San Joaquin and Navajo, were both in serious trouble from the standpoint of political problems.

Ultimately, of course, the energy crisis occurred and it became apparent that the Navajo Project was an extremely important part of the power supply for the city of Los Angeles. And then Mr. Bradley approved these contracts and they were placed in effect. But had they not been approved, that project could have and would have proceeded for fifty years under the terms of that single, omnibus document.

TC: Amazing. Prior to that period of both San Joaquin and Navajo, were relations with your Board and the City Council pretty smooth, would you say?

HK: Yes, I think so. And this didn't apply to all of the members of either body. The members of the Water and Power Commission were very serious-minded, sincere people, with divergent views about what was appropriate for the Department in those days. And the City Councilmen, by and large, are much more political people and were concerned more with politics than what was good for the Department of Water and Power. That's my view. So problems arose, just because of the nature of politics. It was very difficult to communicate the things which we considered to be important to people who were faced with getting reelected.

The matter of rate increases, for example. The decision of the City Council on a number of occasions to insist that the rates be disproportionately applied to commercial and manufacturing/industrial users, as against the general population, were political reasons, contrary to good management practice in which rates should be set on the basis of cost of service. And that same process was taking place elsewhere in the state, in which the state Public Utilities Commission was permitting a similar type of thing to occur with respect to the other major utilities in the state. And those pigeons have come home to roost now.

In this present era, self-generation is very popular. Co-generation is very popular. Large industrial users are finding that they can install generating equipment of their own and generate power cheaper than the rates being charged by other utilities, which then results, if you follow this scenario to its end, in increases rather then decreases in residential rates. If a very large industrial customer, for example, on the Pacific Gas and Electric system finds that it can generate power more cheaply with a generating plant that it builds and operates and owns itself, then that load is removed from the system and the revenue is removed from the system. It is necessary then that the remaining customers meet the revenue requirements of that system, and so the rates go up instead of down. It is a boomerang that hit a lot of utilities in the head because of the political actions of regulatory bodies. And we had our share of this kind of problem, too.

TC: You mentioned the Public Utilities Commission, and I have a note that has to do with the California State Energy Commission. That would be a different body, I take it?

HK: Yes, it is a separate body, the Energy Commission.

TC: But it was around 1978, which would have been after your retirement, the early years of your retirement, that the Energy Commission directed utilities to examine the idea of

smaller plants. And this gets back to something we were talking about last week, which was the sort of over-building and the economies of scale which got to a certain plateau and started to create problems.

HK: Well, that wasn't the primary reason for the Energy Commission's actions. This grew out of what was referred to as PURPA, the Public Utilities Regulatory Policies Act of 1978, which was a law passed by congress mandating that the public utilities in this country, the privately owned ones, which didn't apply to the City of Los Angeles by law, but the privately owned utilities were required by law to purchase power that would be generated by small power producers. The state regulatory bodies were directed to implement this law and were able individually to come up with the specific approaches requiring this to be done in each of the several states. And this is what caused the State Energy Commission and the other regulatory bodies to move in that direction. The result of that was a great growth of small power producers with hydro, wind, co-generation, et cetera.

TC: I see.

HK: Which happened. And as a result of that, the very large amount of such generation, which the utilities were required to purchase, reached the point just a few years ago where the regulatory bodies were very concerned that if the utilities were required to continue to purchase all of this small generation, that it would render some of the existing utility plants idle. And, to a degree, that's happened.

TAPE NUMBER: 8, Side B

January 29, 1990

TC: If you're at Mojave [CA] and you take Route 58 towards Tehachapi . . .

HK: Yes.

TC: There's a huge rim of windmills up there. And then, down by Palm Springs there's another huge windmill farm.

HK: Yes.

TC: And then up in the north, driving towards San Francisco, you come upon another. Is this part of that movement?

HK: That's right. You see, one of the things that happened was that the financial people saw the advantages of getting into this business for tax benefits. So, while some of the generation that was developed during this period was very sound from an engineering standpoint--co-generation and small hydro--a great deal of it was also very unwise, because there were many installations which would not have been economic on their own and were economic only because of the huge tax advantages mandated under the law.

TC: I see.

HK: So the wind business, for example, was never justified from an engineering standpoint.

TC: Who owns those wind farms?

HK: Well, they're owned, I presume, by limited partnerships for the most part; and, largely, the investment came from people with other income, against which they needed tax credits. So wealthy attorneys and doctors and other people who had sums of money to invest were able, through the tax credit arrangements, to reduce taxes on their other income by investing in these devices.

To give you an example, the prices during the energy crisis reached extremely high levels, and the law required that this energy be bought at what was known as avoided cost. Now, to explain that, if the San Diego Gas and Electric Company, in operating its system, was required to put on some of its older units, burning OPEC [Organization of Petroleum Exporting Countries] oil at very high prices, the incremental cost of that little piece of generation would be avoided cost on the system. In other words, the least efficient and highest cost generation on the system set the price for purchased energy.

And the theory had a ring of reason to it, in which it was argued that if a windmill can back down one of these old units, such that it burns less OPEC oil and replaces that generation in that fashion, then it's reasonable to pay that small power producer the amount of money it would have cost to do it with the old generation. The trouble with that theory was the nature of the economics of power systems. I can recall that there was something on the order of thirty years on the Department system in which the rates continued to come down as the economy of scale improved and other efficiencies improved.

And we were always looking at lower cost generation being added to the system, lower and lower and lower. The result was we had over a long period of time a very low imbedded cost of generation. That's true of the other utilities, PG and E and Edison. Plants built way back in the early days at low cost were part of their system, so in pricing power generated by those facilities, the imbedded system cost was what the regulatory bodies were looking at in order to determine an appropriate rate to approve.

And now, suddenly, we come into an era where all generation that's being added is at the highest incremental cost--the other end of the spectrum completely. If you think about it, if you proceed down that line very long, you wind up with a system that is made up of extremely high cost generation. As the older units are retired and they are taken out of rate base, you're gradually moving toward a system, all of which has been built and added at the highest incremental cost. This is of crisis proportions.

The regulators weren't able to see that, for some strange reason, until the pigeons began to come home to roost and the California Energy Commission and the Public Utilities Commission, working together, finally saw the light: That if the utilities were required to continue to purchase on long-term contracts, these kinds of developments, that it would render valuable equipment idle and would shift the cost to the domestic rate payers in an unreasonable fashion. And as a result, the rules that were laid down beginning in 1978 were modified severely.

For example, in the early days of this program, long-term contracts, among others were mandated. There were about four different types of contracts, depending upon the nature of these generating units. Small power producers could enter into a contract to supply what is referred to as "as available energy" or "as available capacity," which meant that when they ran, they ran, and when they didn't, they didn't, and you got paid if they did. On the other hand, some of these generating units had firm capacity capability and the prices for firm capacity were significant. If the utility could rely on that generation, it could avoid building new generation. Whereas, with "as available" energy, like that provided by a windmill, you couldn't rely on it, so you still had to build the generation even if you didn't run it for the energy. So we had quite a mix in these basic four types of agreements in the state, and it was eventually necessary to cancel the long-term agreement requirement.

To give you an example, among the consulting work which I did following retirement, one project I was associated with was for the Santa Fe Irrigation District and the San Dieguito Irrigation District, located in Rancho Santa Fe in southern California, in which I handled the negotiations with San Diego

Gas and Electric for power from a small hydro plant. That plant uses water from the second San Diego Aqueduct, which supplies some of the water to that area; and the energy had been wasted all these years as the water was taken from that aqueduct under high pressure and the head was broken through just the series of valves into their system. We installed a small generating unit of about 1500 kilowatts, which functions very well.

Under the terms of the contract, which were mandated at the time, we negotiated an Agreement under which the Districts would receive on the order of seven cents per kilowatt hour, beginning when the plant went on-line, and continuing for a period of ten years with a built-in escalation, such that the price would reach about fourteen cents per kilowatt hour at the end of that ten-year period. The contract then would shift to another basis for establishing the price, but by that time, the investment would have been recovered.

And then the bubble burst. San Diego Gas and Electric is now paying less than three cents per kilowatt hour for the same kind of generation. But they're locked into a contract that's going to escalate clear to fourteen cents before any adjustment is made. This is a typical example of what happened because the political people placed themselves in charge of something they didn't know too much about. Their motives were good, their understanding was poor.

TC: You were involved in several other hydro projects during your retirement.

HK: Yes. Shortly after I retired, William R. Gianelli, who had been Director of the State Department of Water Resources, was acting as a consultant to the Turlock [CA] Irrigation District. And the district came up with some power contracting problems. Bill suggested they invite Bob Phillips, who had just retired from the Department, to assist. When Bob talked with them, he learned that this was a power matter rather than water, and Bob's background was water. He suggested me, and as a result of that contact, I wound up consulting for the Turlock Irrigation District for some seven years.

The initial work had to do with some very interesting and complex contracting problems between Turlock and the City of San Francisco and the Pacific Gas and Electric Company, involving the Hetch Hetchy system, which is one of the most complicated power contracting arrangements one could imagine. We worked out most of those problems in a cooperative effort between the Turlock Irrigation District, the Modesto Irrigation District, and the city and PG and E. And having become familiar with the Turlock system, it occurred to me that there was an enormous capability for hydrogeneration in their canal system.

Turlock is the oldest Irrigation District in the State of California, the first one approved, and it's over 100 years old at this point. They distribute about two-thirds of the water of the Tuolumne River, which comes out of Yosemite National Park, and Modesto Irrigation District distributes the other third. Of course, there's a portion of that which goes to the City of San Francisco. That's the major water supply for the City of San Francisco. But from an irrigation standpoint, the two Districts distribute all of the irrigation water in the San Joaquin Valley.

So I suggested that the District hire Phil Hoffman--who had been a hydroelectric engineer in System Development and, as I mentioned earlier, was the father of the Castaic Project and who had conceived the Hualapai Project--to survey their system for its potential, which was done. A number of sites appeared to be economic and we undertook then to build small hydro projects.

Now, the Turlock Irrigation District has its own power system and there are some adjacent irrigation districts which do not. They are only irrigation. South San Joaquin and Oakdale, for example, do not have power systems, but they have power potentials in their systems. And so, through arrangements with these other Districts, we eventually built nine small generating units on these several canal systems. The first one that went into service on the Turlock system was at the outlet of Turlock Lake. And the water had been released from that lake through valves dissipating the energy for some sixty-seven years. When that small power plant went into service, it began to save 20,000 barrels of oil a year. That one installation was a very significant small hydro development.

TC: Oh, I'd say.

HK: This was the kind of thing which was in the minds of the people who wrote PURPA to get this kind of generation underway, to avoid the use of fossil fuels and so forth. They were sound projects and they have done a magnificent job.

TC: Well, who owns those plants? Does the Irrigation District own it?

HK: Yes.

TC: Who services that area anyway?

HK: Well, PG and E serves the general area. The Turlock area is served by the Turlock Electrical System and Modesto serves its system, but the surrounding areas are largely served by Pacific Gas and Electric.

And there is an interesting experience, with respect to PURPA. Initially, we were going to utilize all of this power on the Turlock system. And by doing so, we would reduce the amount of power, which had to be purchased from the City of San Francisco, which in turn purchased it from PG and E, to the extent that it couldn't be supplied out of the Hetch Hetchy system. And we had this program underway when PURPA came along. We were well underway with part of these projects. It became apparent that, rather than back down the purchases from PG and E by the amount of generation, it would be better to sell the output of these small plants to PG and E at avoided cost and continue to buy from PG and E at the contract levels. The result was a windfall for the Turlock Irrigation District and a shortfall for PG and E. And this is a demonstration of what was wrong with the law.

TC: Yes, I see. That's interesting. Well, I think that covers my very specific questions on projects and on the various steps in your career. But I did have a summation sort of question, which has to do with the needs of the utilities in this area to balance their own plants with the needs of the environment. In my reading and research, I do find that early on the utilities--at least the Department of Water and Power--was interested and concerned with environmental matters. You know, early on, with the Department's attempts to cap or scrub the steam plant stacks, say, in the early fifties, this concern was already evident. But in the public view of the situation, you see utilities on the march and the environmentalists gathering together to halt this march, which is ruining, in their view, the environment. How do you see the balance being struck between utility needs and environmentalists' concerns?

HK: Well, it has been a war. The power people, utility people generally, are environmentally minded. They're also practical engineers. And therein is the trouble. The general public is continually bombarded by activists who are not expert enough to say what the facts of life are. They're extremists.

They speak in terms of ideas rather than numbers. And it's very easy to do that. You can build a bridge to the moon, if you have enough money, but there never will be enough money.

Whereas the utilities got the reputation of being anti-environment, this wasn't true. The utilities were anti-extremists. The utilities were faced with the problem of meeting the future load of their service areas, and this requires a great deal of long-term planning, particularly during those periods when opposition doubled the lead time on major project development. It siphoned off the energy of the people trying to do the job, who had to spend a great deal of time before commissions and regulatory bodies trying to justify what they were trying to do. They were being attacked, and this left its emotional scars on the good people who were trying hard. And what they were trying to do was to meet the needs of these same people. And you would run into people, for example, who would be so concerned about air pollution problems that they would propose in public, on speaking tours, that we start cooking with wood instead of electricity; not realizing, of course, what this would do to the forests of this country--totally insane ideas. And, yet, these kinds of things catch on with the general public, which doesn't often analyze things too clearly.

TC: It's a romanticism for an earlier time, I think, that takes hold.

HK: That's right. And there's an example of something that did happen. During the energy crisis, so much wood got burned in Oregon that they produced an air pollution problem up there far beyond what we had in southern California and they had to back off of it.

TC: Yes.

HK: The other thing, one of the greatest and most important efforts is the supply of water to the people. You must have water. You can get along without electric power, but you can't get along without water. And water in the west is in very finite supply. So one of our major objectives in those early days in the Power System was to build nuclear on the seacoast, to use ocean water for cooling in order to eliminate the need for using fresh water for cooling.

I made a study . . . It wasn't really my study. I gathered information from other studies for the purpose of addressing the Colorado River Association some years back in a meeting in Las Vegas, [Nevada], of the projected needs for fresh water for all purposes in the western United States. And I found that if all the contemplated coal-fired power plants were built and all of the shale oil developments were developed that people had in mind to meet the projected future needs, that it would use more water than was available.

To me, this was a very solid demonstration of the need for nuclear power on the seacoast. But nuclear power has developed opponents who worry about radiation. There are those who also worry about the affect of warm water in the ocean on sea life, although if one goes near the outlet of San Onofre or Encina Power Plants along southern California, that's where you tend to find the most fish.

TC: Yes.

HK: But I'm not a naturalist and I can't speak with any authority on how the overall ecosystem is affected. I suppose there is some environmental damage from using ocean water for cooling, but the ocean is pretty vast. When you think in terms of the whole environment, there are other areas that are more important. And so you have to make a choice. If you're going to save enough fresh water for the general public, you have to take a certain course of action to do it.

I mentioned, with respect to San Joaquin, that we had come up with the idea of using agricultural drainage water, which was a problem area. We were striving frequently to do that. I'll give you another example. There was a coal-fired power plant which never got built, which was going to be sponsored by the Nevada Power Company. We worked very closely with Nevada on this project. It would have been built about thirty miles northeast of Las Vegas. We were going to utilize the sewage effluent from the city of Las Vegas for cooling. The Bureau of Reclamation had been demanding for years that Las Vegas clean up the Las Vegas Wash, because this water, after going through a sewage treatment plant, rolled down the Las Vegas Wash into Lake Mead. This had been a dry wash, historically, and had grown into a small river because of the size of Las Vegas.

This water was not very good. The treatment was low-level and the water coming into Lake Mead was not really acceptable for the standards established by the government for fresh water, and so Las Vegas was ordered to do something about it. Well, it was a very costly thing to do and they didn't want to do it. So when we put this conceptual design together for a 2,000 megawatt power plant, with a view to utilizing that water for cooling, it suddenly became the most valuable water in the state of Nevada, and entities that had some ownership interest in it immediately wanted to obtain a very large price for it. It was laughable.

We came up with a system to finance the project. It was a very unique approach. We were going to take about 85 percent of all the power to the City of Los Angeles, initially, and the Nevada Power Company, with its service area mainly the Las Vegas area, would receive about 15 percent of the power. As their load grew, they would buy back at depreciated book value sufficient capacity from that project to meet their future needs. And so, over a long period of time, they would eventually take back the entire project.

The financing arrangement was sound, but in order to proceed with it, it was necessary to get clearance from the IRS [Internal Revenue Service] which turned it down on the grounds that a private utility would benefit from the use of tax-free financing supplied by the City of Los Angeles. And although the equity had been carefully worked out, such that there was no detriment to the citizens of the United States in this project at all, that project failed. And it was a good one. We had a coal supply and cooling water lined up.

TC: What was the name of that project?

HK: It was the Harry Allen Project and was to be located in Arrow Canyon. I worked on that project three times. First, John Gibbs, the Vice President of the Nevada Power Company and I put the concept together and developed it. And when the IRS killed it, it remained dead for quite a long time. Later on, it was resurrected when PG and E and Edison got into an arrangement with the Nevada Power Company to develop it and PG and E offered a portion of their share to the Turlock Irrigation District. I wound up working on the project again. And then there was a third sporadic effort to put it back together after that arrangement failed, and the project was never built. But it was a good project.

TAPE NUMBER: 9, Side A

January 29, 1990

TC: We were talking a little bit ago about the nuclear situation. What is your assessment of that? Do you see nuclear making a comeback and finally being established as a component of the Department or any other utility or power system?

HK: Yes, but it will be a very long time from now, in my view. The reason is that the general public has to see the light with respect to power supply for the future. And you have to think in terms of the very long-term future because we are growing. The population of the world is growing, the population of this country is growing. It seems such a short time ago that we had a population of 200 million people in the United States. I read just a few days ago that we're at 250 million now. And to think that in part of my lifetime we've added 50 million people is frightful.

TC: Yes.

HK: We've also added 10 million to the 20 million we had in California just a few years back. We have forces going in opposite directions, in which higher efficiency of appliances is being achieved but more things are being added. And the net result is a growth, although at the moment small, in requirements for energy.

Historically, in most utilities since the dawn of our industry, until a few years ago, we were growing at about 7 percent a year, which doubles the size of the power system each ten years. Presently, the power systems of the country are growing somewhere between 2 and 3 percent a year, a significant comedown. Part of this is due to the elasticity of demand, affected by price. With the energy crisis, the high cost of fuel, the high capital costs of modern equipment and so forth, energy costs more and is going to cost more. As a result, a product that was so economic and so cheap a few years back now is a matter of significant cost, and people are more conservation-conscious in using it, both industrially and in the homes.

On the other hand, we have more and more and more electronic gadgets at our disposal, and that program is going to continue, I think, for a long, long time. And we have more people. Industry is making increasingly larger uses of electricity. Electricity has the potential for solving a great many of the environmental problems, depending upon the source of generation. If, for example, we do get into the nuclear era on a very large scale, we can back down from the burning of fossil fuel, which has tremendous benefits for mankind since we reduce air pollution considerably, and we conserve these fossil fuels for more important purposes. They are in very finite supply, and when they're gone, they're gone.

There are some of those resources for which there are very few substitutes, and we have to think in terms of those.

For example, lubricating oil. What will this society do when there is no material available with which to make lubricating oil? You may have nuclear power to run vast machines and no oil to lubricate it. This kind of concept needs to be faced, and it's a slow process of educating people to see the long-term consequences of the present program. So, one day, they will see the light and they will realize that whereas fossil fuels are in finite supply, there is an almost unlimited source of uranium and various other fissionable materials which could be utilized. Just, for example, if we were to develop the breeder reactor, we could probably survive on the tailings of uranium already mined for many decades. It's that kind of energy. And these fissionable materials are materials for which there is no other use, as compared to the fossil fuels, for which there are so many, many uses.

So I see it coming, but it will be slow to come. And it's going to have to come in this fashion, and I think these moves are well underway already. We're going to have to establish a standardized design for a nuclear plant which is accepted and will be repeated precisely as the last previous one. The custom design of a new nuclear plant requires such an enormous waste of regulatory time and effort. The process of getting permits is so drawn out, it is such a highly capital-intensive undertaking that utilities can't afford to invest the huge amounts of money, for which there will be no return for ten or fifteen years. It's just not economic to go that route. One of the reasons nuclear power is so expensive now is because of that enormous lead time. Whereas Japan has a lead time of about six years, we . . . Well, if you take Diablo [Canyon Nuclear Power Plant], what, fifteen, twenty years, practically, before we got it on-line and any significant use out of it.

TC: Yes.

HK: The other thing is the political arena, in which the regulators haven't got the foresight to do long-range planning, but they assume the role of playing God with respect to after-the-fact decisions. And so a utility or a utility group that, with the best efforts they can muster, forecast the future needs of their utility systems, for reasons well beyond their control, wind up with a generating plant which is in excess of actual needs, ten or fifteen years down the line, and are faced with regulators who say, "We will not allow you to put that unit into rate base. Your stockholders will have to pay for it." This is destroying the utilities in this country.

There are problems in Arizona and New Mexico presently because the third unit of the Palo Verde Nuclear Plant has not been allowed into rate base for the Public Service Company of New Mexico. One of its coal-fired plants, the San Juan Unit 4, has not been allowed into rate base. And the Public Utilities Commission tells the utility, "You can't sell that unit to anybody and you can't get paid for having built it."

And this problem is what led to the effort to build the power plant which I worked on with the Navajos, the Dine' Power Plant. It was to be a 2000 megawatt coal fueled generating unit in New Mexico. And it was to have been an entrepreneurial project, not built by a utility for its own service, but built by a group of people for the purpose of selling it to whoever needed power. This had an interesting genesis.

The Public Service Company of New Mexico had intended many long years ago to build a power plant for its system at a time when load growth indicated that it would be desirable to do so, and had never been able to pull it off. They decided to make a try for it about six years ago, and they knew that they would need resources from the Navajo Indians if they were to proceed with this project. They also found that they weren't going to be able to buy these resources from the Navajos, and so they formed an agreement between the General Electric Company, Public Service Company of New Mexico, the Bechtel Power Corporation and the Navajos, to undertake a joint project as an entrepreneurial project. This would have the advantage of providing a future power supply for utilities who were too frightened to invest in one for themselves because of the way in which the regulators have been acting. An additional partner was added, Combustion Engineering, and we made quite a lengthy study and produced a conceptual design. The Navajos had acquired rights to the coal lands that were going to be developed to power this facility. And they owned, of course, the land which would be required for right of way for power lines and other facets of the project. Along with the conceptual design of the power plant, we made market surveys, visited the utilities in the Pacific Southwest, as far east as Texas and mostly in California, and eventually concluded that there was not sufficient market at this time to proceed with the project, and it was dropped.

Simultaneously, the Thousand Springs Project in Nevada, by another consortium, has been under study and is still proposed as a viable project of this type: an entrepreneurial project with no utility service area of its own. I think that this is viewed as one of the only viable ways for the future, unless the regulators can be brought to understand that all the utility people can do is use their best judgment in planning for the future because of the long lead time. Certain decisions have simply got to be made and they've got to be honored, and they're not being honored today.

TC: Who becomes a regulator?

HK: Well, the Public Utilities Commission in the state of California is a regulator.

TC: Yes, but as a person, an individual, where do regulators come from?

HK: They're appointed by the governor with the consent of the legislature, this kind of thing. I suppose it's different in each state. But most people appointed to commissions are political people. They are appointed for political reasons.

It's my feeling that a significant segment of the political world is not of the statesman category. It is so bad, in fact, that I think the time has come perhaps to change the basic doctrine and say that, so far as that group of people is concerned, they are guilty until proven innocent. That's a very cynical attitude, but I'm afraid it's shared by a large segment of the population today.

And for people who have gone through a career in the utility business or something similar, over a very long period of time, this feeling of cynicism runs very deep. It's been frustrating. In the early days, it was the most enjoyable work. There was a tremendous satisfaction in doing a job that contributed to the well-being of the general population. And, suddenly, that general population became a critic and an enemy spurred on by activists who were incompetent and lacked knowledge and were self-appointed saviors. And it's a shame because, for people to do a good job, that feeling of support is necessary.

TC: Well, there was no change in this sort of atmosphere, say, when [Ronald] Reagan was governor? I know that one of his great campaign promises was to reduce government and to cut back on some of this regulatory madness, if you will.

HK: Well, there again, the objective was good; the process was poor. A good example was an article by Supervisor Edelman in yesterday's [Los Angeles] Times on what happened to radio in this community. As a result of getting the government off our backs during the Reagan years, the Federal Communications Commission abandoned all of the rules which had been set in place over many years to provide some balance in broadcasting, because the air waves do belong to all the people. And as a result, the air waves are now managed by people whose only purpose in life is making lots of money. And as a result, although last week we got one new classical music station, we lost KFAC several months ago and we were down to just one classical music station in this large metropolitan area. And that is a frightful thing. And quite aside from classical, there's an enormous amount of marvelous music that you never ever will hear on radio. There is nothing but rock on radio because that is what the pollsters tell the owners is where the listeners are, and so that's where the money is. You know, the lack of regulation is a very sad thing in many areas, and that's simply an example.

TC: I see. So it's a balance sort of thing, where some regulations that have been imposed were imposed for good reasons, and to pull them is not necessarily wise.

HK: That's correct. Regulation was introduced to deal with natural monopolies. It still has a strong place where those exist. And to abandon regulation in a monopoly situation is fundamentally wrong.

TC: Well, I've covered in these many interviews everything that I wanted to find out about. And I'm wondering if there's anything that I haven't covered that you wanted to comment on?

HK: I don't think so.

TC: I want to thank you for these sessions. It's been wonderfully informative.

HK: Well, I'm glad to have been of some help.

TC: I've really learned a great deal.

HK: Well, I appreciate your coming here.

END OF INTERVIEW