ORAL HISTORY INTERVIEWS

STANLEY HIGHTOWER

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STATUS OF INTERVIEWS:
OPEN FOR RESEARCH

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The transcriber and editor also have removed some extraneous words such as false starts and repetitions without indicating their removal. The meaning of the interview has not been changed by this editing.

While we attempt to conform to most standard academic rules of usage (see *The Chicago Manual of Style*), we do not conform to those standards in this interview for individual's titles which then would only be capitalized in the text when they are specifically used as a title connected to a name, e.g., "Secretary of the Interior Gale Norton" as opposed to "Gale Norton, the secretary of the interior;" or "Commissioner John Keys" as opposed to "the commissioner, who was John Keys at the time." The convention in the Federal government is to capitalize titles always. Likewise formal titles of acts and offices are capitalized but abbreviated usages are not, e.g., Division of Planning as opposed to "planning;" the Reclamation

Projects Authorization and Adjustment Act of 1992, as opposed to "the 1992 act."

The convention with acronyms is that if they are pronounced as a word then they are treated as if they are a word. If they are spelled out by the speaker then they have a hyphen between each letter. An example is the Agency for International Development's acronym: said as a word, it appears as AID but spelled out it appears as A-I-D; another example is the acronym for State Historic Preservation Officer: SHPO when said as a word, but S-H-P-O when spelled out.

Introduction

In 1988, Reclamation began to create a history program. While headquartered in Denver, the history program was developed as a bureau-wide program.

One component of Reclamation's history program is its oral history activity. The primary objectives of Reclamation's oral history activities are: preservation of historical data not normally available through Reclamation records (supplementing already available data on the whole range of Reclamation's history); making the preserved data available to researchers inside and outside Reclamation.

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www.usbr.gov/history

Oral History Interviews
Stanley Hightower

Storey: This is Brit Storey, senior historian of the Bureau of Reclamation interviewing Stanley J. Hightower on January 23, 2002 [2003] in Building 67 at the Denver Federal Center. This is tape one.

Mr. Hightower would you tell me please where you were born, and raised, and educated, how you ended up at the Bureau of Reclamation?

Early Life

Hightower: Well, I was born in a small town in Kansas and was raised in another town, of a population of 200, in October 1937, so I'm 65. And, as you might expect in a small town of 200 you participate in all the sports, as you grow up, because they need you for the team. I was valedictorian of my class, went to Kansas State and got a degree in mechanical engineering, graduated in 1960. I took Air Force R-O-T-C and went into the Air Force as a Lieutenant.

I was stationed for three years at Vandenberg Air Force Base and served as the

Chief of the Mechanical Design, Mechanical Design section there, supervising civil service engineers. We worked on the design of mechanical systems to support the large rocket and launch facilities at Vandenberg Air Force Base, where they tested all the large intercontinental ballistic missiles. After working there, and being discharged in 1963, I went to work for what is now Lockheed Martin, here in Denver, and worked there for thirteen years as a specialist in propulsion and heat transfer, working on various space exploration programs such as the Titan, the Gemini, Apollo, Sky Lab and the Space Shuttle programs. As far as awards there, I guess I won't go into that, unless you're interested in that?

Storey: I'm interested in all of it.

Work in the Aerospace Industry

Hightower: Okay, during that time I was chosen as Engineer of the Year, one of the years I worked out there, and as a result, I got an invitation by NASA [National Aeronautics & Space Administration] to witness the launch of the Apollo 11, which is the first moon landing. I attended a reception where I was privileged to meet all the astronauts, as well as

Charles Lindbergh and Werhner Von Braun.

During that time, that I worked at Martin, I was in charge of a group that was responsible for the flight control of the Sky Lab, once it was launched. And, we had a real problem when they launched it in that a large portion of the outside skin fell off, ripped it off during launch, or it was ripped off during launch. And I was put in charge of the emergency team that designed and built several solar shields. That took us about ten days to put together a team to design and build those, and ten days later they launched the astronauts and they were able to get them out there and shade the outside surface, and they could get the temperatures down to 70º F after they had been running about 200º F there in their living quarters.

Began with Reclamation in the Mechanical Branch

My career with Reclamation began in 1976. I hired into the Mechanical Branch, in the Technical Engineering Analysis section under Fred Ruud and Tom Logan, who was the unit head I worked for. I was hired to perform technical analysis of the solar and wind power systems to provide electrical power in combination with Reclamation's

hydroelectric system, because the nation was right in the middle of a severe energy crisis at the time.

Solar Energy Team

We at that time formed a team that was headed up by Ed Tomsic, who was the deputy under Jim Brown, who was the Chief of the Design Division. We called this team, or Ed Tomsic called this team, the Solar Energy Team. And it was put together at the request of the Commissioner[1] at that time to take a look at how the Bureau of Reclamation might be able to use its hydroelectric system in combination with solar and wind power systems to increase the total amount of the electrical energy that could be generated in the United States, since they were so short on energy at that time. The members of that team consisted of John Skuderna, Hank Falvey, Clem Todd, Ed Tomsic and myself. There may have been another member or two, but I

1. The Commissioner of the Bureau of Reclamation at that time was R. Keith Higginson, who served as Commissioner from 1977 to 1981. Mr. Higginson also participated in Reclamation's oral history program. See R. Keith Higginson, *Oral History Interviews*, Transcript of tape-recorded Bureau of Reclamation Oral History Interview conducted by Brit Allan Storey, senior historian, Bureau of Reclamation, March 22, 1995, and April 19, 1995 in Boise, Idaho, www.usbr.gov/history/oralhist.html.

can't think–I'd have to check my records.

The purpose of the team was to take a look at the various technologies that were available that could potentially be used to increase the amount of energy being generated. And, as a result, I was asked by the team to perform some preliminary studies to take a look at the state-of-the-art of these new technologies as well as the economics of generating power from these systems to see how much we might have to increase the rates that we charged our users.

As a result, I published the first report that showed the comparisons of large wind turbines, as well as what we called Solar Central Receiver Power Systems, which were huge mirrors that reflected the sun's rays up to a boiler that was on the top of a huge tower, to boil the water and generate steam and thereby generate electrical power that way, and tie it in with the hydroelectric system down in the Southwest, which included Hoover Dam, and the other hydroelectric facilities down in that area.

Genesis of the Wind Power Project

The other portion of the study, I took a

look at building huge wind turbines that were about the size of a football field from tip to tip, 300 feet, to generate 2 ½ and 4 megawatts each. And, again, tie those huge wind turbines in with the hydroelectric system in the Colorado River Storage Project, which included Flaming Gorge and Glen Canyon [dams], and several other hydroelectric systems. I had just started on that report when the Teton Dam failure occurred.[2] And, with all the investigations and so forth, there was a move afoot at that time to potentially disband the Bureau of Reclamation. So there started to become support, significant support on the part of the Commissioner's Office, as well as some of the regional offices to try to get into some new technologies that could potentially be a more promising future for the Bureau of Reclamation.

In the course of making a presentation to the Lower Regional, Lower Missouri Regional Office, on the result of my studies, a person by

2. Teton Dam was planned as the major feature of the Teton Basin Project in eastern Idaho. On June 5, 1976, shortly after construction was completed, the dam suffered a catastrophic failure, causing over billion dollars worth of property damage and 11 casualties. For more information, see Andrew H. Gahan and William D. Rowley, *The Bureau of Reclamation: From Developing to Managing Water, 1945-2000*, Volume 2 (Denver: Bureau of Reclamation, United States Department of the Interior, 2012), 820-832.

the name of Abner Watts attended my presentation. He was the head of the Power Division in the Lower Missouri Region. And he was just a few years from retirement and saw that it was what appeared to be a real promising technology, or set of technologies, solar and wind power technologies, to use the hydroelectric systems.

So, he got very enthused about it and asked if I would mind if he teamed with me and we would put together a technical paper to present at various locations including the Commissioner's Office and various regional offices, proposing that they get behind the idea of using wind, huge wind turbines in combination with hydroelectric system.[3] And, he performed the various economic studies, and I performed, put together a computer program that would calculate the way that the wind turbines could be used to integrate into the hydro system.

Theory Behind the Wind Power Project

And that whenever the wind would

3. Stanley J. Hightower and Abner W. Watts, *A Proposed Conceptual Plan for Integration of Wind Turbine Generators with a Hydroelectric System* (Denver: U.S. Department of the Interior, Bureau of Reclamation, Lower Missouri Region, 1977).

blow, it would generate electrical power from the huge wind turbines and there would be a like amount of water that could be held behind the dams, to be stored behind the dams, during that time, that didn't have to be used for hydro power. And so that when the wind quit blowing you'd have an extra amount of water that would available behind the dam to generate electrical power so your lights wouldn't go out when the winds quit blowing.

This was a concept that Ed Watts and I came up with, but we had to go through and get the wind data at a typical site. So we checked with the Department of Energy and got some detailed wind data, that was available. I guess actually the data was available through the National Atmospheric–through NOAA [National Oceanic & Atmospheric Administration], and it was hourly data. So we could calculate the wind power that could be generated each hour of the day for a typical year, and, to determine how this would have, how much of an impact this would have on the hydro system by changing the flows, you know, each hour of the day that way. And so, we used all that data, put it in this technical report and then also in a technical paper that we presented at a large wind turbine conference in Washington,

D-C.

Developing Wind Power Project

As a result of that, there was an interest in Congress that we pursue it further. And one of the local power agencies that the Bureau of Reclamation marketed its power through asked us to make a presentation to various senators and Congress, senators and congressmen, in Washington, D.C. So, we went back and gave a presentation in one of the congressional hearing rooms the Dirksen, in the Dirksen Building. And, as a result of that, there was, let's see, about, I think it was $2 or $3 million that was written into–let's see, no it was more like $4 million. I think it was around $4 million that was written into our budget to build and test two large wind turbines for a pilot project at Medicine Bow, Wyoming.

Originally we had planned to only build one wind turbine and test it. And, with the $4 million we went out with a Request for Proposals. Boeing Company was the lowest bid. There were two bidders. I'm sorry. Let me back up. There were two bids, one from Boeing Company and one from Hamilton Standard at Windsor Locks, Connecticut.

Boeing at the Seattle. Hamilton Standard won the contract, they had the lowest bid and best technical proposal. And, it turned out that they only bid, I think it was $2 million, and we had $4 million available to us. Department of Energy came to us and said that they had invested a significant amount of money with Boeing Company to develop the Mod-2 Wind Turbine, which was a two-megawatt wind turbine. The Hamilton Standard was a 4 ½-megawatt wind turbine.

Interagency Agreements

Boeing unit was 300 feet in diameter. The Hamilton Standard was 257 feet in diameter, single blade. As a result of the Department of Energy showing an interest in us to also testing the Boeing unit, they offered to pay for half of the price of the Boeing unit. So, they, they paid, I think it was $2 million, or $1 million for half the price of their $2 million machine. So, at that time I had been meeting with not only the Department of Energy people, but also the NASA people, at the Cleveland offices, who were responsible for the research that was being done on these huge wind turbines. And so I was well acquainted with their capabilities and the tremendous amount of studies and testing that

they had done.

And so, I recommended that the Bureau of Reclamation enter into an interagency agreement with NASA to assist us in issuing requests for the Request for Proposals and the award of the contract. I guess, backing up, that actually occurred before we issued the Request for Proposals and before we actually made the award. I had them enter into that agreement with NASA. Because of the fact now that we also were going to be building a Department of Energy machine, the Boeing unit, we also entered into an agreement with the Department of Energy as well, which required a significant amount of contract-agreement type work, as well.

Pilot Project

One of the things that we were proposing, Ed Watts and I, in that earlier report and study and technical paper that we wrote, was that if they did go ahead and build a pilot project as we proposed, that they should build and test it for a year or two. And if it succeeded in accomplishing what we had anticipated, we were proposing that they build a 100-megawatt project that would have consisted of about fifty wind turbines that

would be built there at Medicine Bow, Wyoming.[4]

At the same time, I told them that you needed to budget a significant amount of money into the pilot project so that, since it was a new technology. It was my experience in the space program that you always had to budget a sufficient amount of money in the pilot project to allow yourself to run tests until something failed, fix the problem, test it until something else failed, fix that problem, and keep working on the design. Because there's always unforseen problems that you run into, that you can't anticipate when you first build a new technology. And in this manner, you can assure yourself that you'll end up then with a good machine that'll be reliable, and then you can go ahead and pursue the 100-megawatt project that we proposed.

Unfortunately I wasn't able to talk the various people in the budget area into acquiring that additional money. They had apparently been so used to using old technologies, hydroturbines that had been

4. For more information on the Wind Power Project, see James Bailey, "The Medicine Bow Wind Energy Project," Denver, Bureau of Reclamation History Program, 2014, www.usbr.gov/history/projhist.html.

designed and built back in the Hoover [Dam] days. And the next dam was essentially a carbon copy, for all intents, with a few changes. And, so, there really weren't too many unforseen problems that turned up, and so they didn't buy into my recommendations.

Dedication Ceremony

We had a big dedication ceremony, when the two wind turbines were built. They were approximately two miles apart. The Commissioner and all the politicians and everybody imaginable attended. I should mention that Joe Hall[5] was the Regional Director of the Lower Missouri Regional Office, and he was very supportive of building and testing these wind turbines at Medicine Bow, because he thought it would really be a shot in the arm for that Lower Missouri Regional Office. The, as a result of the

5. Joe D. Hall was Regional Director of the Lower Missouri Region during testing of the Wind Power Project and later went on to become the Deputy Commissioner from 1987 to 1993. During that time, he briefly served as Acting Commissioner in 1989. Mr. Hall also participated in Reclamation's oral history program. See Joe Hall, *Oral History Interview,* Transcript of tape-recorded Bureau of Reclamation Oral History Interviews, conducted by Brit Allan Storey, senior historian, Bureau of Reclamation, in Denver, Colorado, edited by Brit Allan Storey, further edited and desktop published by Andrew H. Gahan, 2015, www.usbr.gov/history/oralhist.html.

various people that attended, and so forth, we got a lot of publicity, and there were various people in the Commissioner's Office, as well as in the Assistant Secretary's Office that–I can't think of his name. He became the Governor of New Mexico?

Storey: Richardson?

Hightower: No.

Storey: Lujan?

Testing Smaller Wind Power Projects

Hightower: No. (Storey: Uhm.) Boy, I can't think of it. He was the Assistant Secretary. I'll think of it later. But as a part of the wind turbine testing that we got involved in, we also were requested by some people at various other regional offices to test smaller wind turbines that could potentially be used to provide power for some of their remote sites. One of the installations was a 25-kilowatt system that had a blade diameter of about thirty feet. We tested that at Medicine Bow, as well, and then built and operated it for quite a while at a site that was at Lake Meredith, north of Amarillo, Texas. We built two more of those, one of which was at a site down next to Lubbock,

Texas, at a water project there. The one north of Amarillo was at a water project that the Bureau of Reclamation had.[6] Another small wind turbine that we built was located at a Job Corp Center north of Salt Lake City.

Storey: Oh. Ogden?

Hightower: At Og–near Ogden, Utah.

Storey: Weber Basin?

Hightower: Weber Basin, right.[7] And that was really a neat project. The students there helped install it, and operate it, and take all sorts of data. As a result of that wind turbine being built, we had a big dedication ceremony, and this Assistant Secretary that was there–hmm. I still can't think of his name. He gave a

6. The Reclamation project referred to is the Canadian River Project in northwest Texas. The project provides municipal and industrial water for 11 communities within the project area, including Lubbock and Amarillo, Texas. For more information, see Eric A. Stene. "Canadian River Project," Denver: Bureau of Reclamation History Program, 1995, www.usbr.gov/history/projhist.html.

7. The Weber Basin Project, in northwestern Utah provides supplemental irrigation and municipal and industrial water. It delivers roughly 165,000 acre feet of irrigation and 50,000 acre feet of M&I water to farmers and communities along the west slope of the Wasatch Mountains. For more information, see Christopher J. McCune, "Weber Basin Project," Denver: Bureau of Reclamation History Program, 2001, www.usbr.gov/history/projhist.html.

speech, and I gave a speech, and we got quite well acquainted. And about a month or two later I got a phone call from him, Gary–I think his first name was Gary.

Storey: There was a Gary Stephenson.

Hightower: No. That's not it.

Storey: Wrong governor. (Laughter) Different state probably too.

Hightower: I'll think of it. Anyway, he called me and he said that he was over in Spain and the people in Spain were asking if there was somebody in the Bureau of Reclamation–they had heard of all the things that we were doing on wind power and then testing these huge wind turbines. And so, they wanted to know if somebody from the Bureau of Reclamation could come over and help them start up a wind turbine project there.

Exploring Wind Power Possibilities Abroad

So, he called me and asked me if I'd be willing to come over there. And I said, "Yeah. I would. And incidently, there had been a number of other countries that had sent their wind turbine experts to the Bureau of

Reclamation to take a look at our large wind turbines that we were operating, and would it be alright if I went to these various countries that had invited me to come over to see some of their wind turbines so that I could learn from some of their testing, and so forth?" And he said, "Yes. That would be okay."

And so I went ahead and arranged it so that I'd go to the Spanish meeting, which was held actually in the Canary Islands, which is on the north edge of Africa. And [I] flew in there, and there were representatives from all the various countries all over the world that were involved in wind power at that time. And we all gave presentations of various technical papers, giving the status of our program, and then how we might be able to help them. I went from there then to Germany, and went to see the huge wind turbines they were testing there near–hmm, don't remember the name of the city, but it's probably immaterial. It was in north, northern Germany. And then went from there to Denmark, to look at their large wind turbine projects. On to Sweden, which I had gotten well acquainted with the Swedish engineers because they had been over here to a number of different meetings and they had a significant amount of hydroelectric power

systems that they were tying, planning on tying their wind turbines in as well.

So, their projects were very similar to what Ed Watts and I were proposing. And [I] flew over to their test facilities, well first went over on a ship to their ones in, they were testing, that were sister machines to our 4 ½-megawatt wind turbine. They had almost an identical machine there. And, it was at Malmo, Sweden, in the southern part. And then I flew up to Stockholm and went across to Gulland, the island, where they were testing two more huge wind turbines. Flew back and went to Holland and I looked at their wind turbines that they were testing. Then on over to England and on up into Scotland, and went to some islands off the coast of Scotland, where they were testing their huge wind turbines. Got all this technical information, brought it back, and incorporated it into our testing, and the various studies that we were doing.

Progress of the Pilot Program

They tested our wind turbines, I don't recall. I'd have to look at my notes. It seems like somewhere around two to three years. The first wind turbine started to have a

problem in the Mod-2 wind turbines that D-O-E [Department of Energy] was testing in California. They developed some cracks, where some technicians had drilled some holes that were too close to each other, which just structurally you just don't do, but they did it by mistake. And, we took a look at our wind turbine and sure enough, ours was developing cracks in the same general area.

So, they went in and repaired those, and, let's see . . . I'm trying to think . . . then it developed some other problems, but I forget exactly what they were. I'd have to look at my notes. But, again, like I said, since they didn't incorporate enough of a budget to fix even the minor problems–I mean these are the types of problems that you'd run into in any technology, if you drilled the holes in the wrong place. It had nothing at all to do with the fact it was a wind turbine.

But, because of the lack of budget and the lack of interest on the part of the Regional Director that would happen to be there at that time, (Laugh) he chose to shut the wind turbine down and not request any sufficient funds for the testing of the Boeing Mod-2. He, against my objections, put it up for sale to anyone that would want to bid on it, including

the junk dealers, and one of the junk dealers got it and ended up putting dynamite on it around the base of it and blew it up. And, so that was the end of the Boeing Mod-2.

Project Support Waned

It was a shame because it looked like that with just a little more funding that they could have fixed the problem and continued testing, as I said earlier, and potentially resolved the problem and that wind turbine still could have been running, possibly. The Hamilton Standard unit, the 4 ½-megawatt unit, continued to run for another year and a half after that. Then there was a bolt that vibrated loose out of the inside of the electrical generator, which was an off-the-shelf electrical generator, it had nothing at all to do with the fact it was on a wind turbine. Fell into the windings of the generator, bunged them up, and so they had to shut it down.

Again, at the same time, they had very little support in the Regional Office. The Regional Director had no interest in it. And this time, they did listen to me. They issued a Request for Proposals, and put a stipulation in it that whoever bought it had to put it back into operation, and continue to test it, rather

than tearing it down, because of all the adverse publicity they got out of tearing the other one down. The wind turbine was put up for bids, and the highest bidder was Bill–I can't think of his last name, that was our site engineer for the Bureau of Reclamation, that had just recently retired. And, his heart was in, so much in trying to make sure the technology was given a fair test that he bought it using his own funding, and ended up repairing the generator himself, because he had repaired similar generators on hydroelectric systems. He was an electrical engineer. Bill Steele was his name.

Storey: With an "e" on the end?

Hightower: Yeah. He worked his heart out up there, at the top of this 250-some-foot tower, and working on that generator with block and tackle and so forth, and got it all fixed, put it back into operation, and signed a contract with the power company. And, I think he went into partnership with another fellow from Hamilton Standard, which is the company that originally built it, and they also still had an interest in building more wind turbines. So this fellow decided to go into operation, or into partnership with him. And, they ran it for, I think at least two years, maybe longer,

and were able to get more than their investment out of it.

Design Issues

Unfortunately, as time went on, one of the things that was in the design was that the blade was on what they called a "teetered bearing." So that as the wind turbine rotated they would teeter like a teeter-totter and the upper portion of the blade would move more than the lower portion because the higher wind speeds at those huge heights were stronger. And, so by setting up a teetered hub like that, you wouldn't have to design it . . .

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BEGIN SIDE 2, TAPE 1. JANUARY 23, 2003.

Storey: And you have to design it to take those levels, same levels of stress?

Hightower: Right. (Storey: Uh huh.) So it if were a rigid hub well, you know, it would have to take a lot more stress. (Storey: Yeah.) It would have to bend with that change in wind speed as it rotated. Is it running?

Storey: Yes.

Hightower: So, that hub had some stops on it that, as it teetered it would bounce against those stops. And as time went on, those stops wore out, and so he had to shut the machine down. And, I kind of forget, but I think I recall that he did repair those and put it back into operation. But, again, you know, that was part of the design, you know, that, there were some unforseen problems which could have been fixed and they could have continued to run probably for quite a few years. I don't think that he actually adequately fixed that.

And, as a result, operating it another several months or a year it ended up throwing a blade. And I guess actually, it actually hit the tower, because of that teeter-stop problem, and he shut it down. And so he had to take it out of operation at that time. I don't recall what happened to the wind turbine after that. I kind of lost track. I don't know whether it was–I think it's probably, eventually, been taken down.

Wind Project Publicity

One of the things I forgot to mention, that during that time that we were running both wind turbines, there was a significant amount of publicity all over the world as to

what the Bureau of Reclamation was doing. And, like I mentioned earlier, we had visitors from all those various foreign countries, that I visited, to take a look at what we were doing, to help them out. And one of the group of visitors that I chaperoned up there, and took on a tour, was a group from Australia that produced the show *Beyond 2000* that's on the Public Broadcasting Company T-V program that maybe you might have seen. What's the, I forget the name of the, it's not *Beyond 2000*, that's their specific program. But there's another educational program, at least on P-B-S [Public Broadcasting System].

And so they came out to film our project and as a result it was put on the Public Broadcasting System and was shown here a number of times in the Denver area. I've got a copy of that tape here if you want to (Storey: Hmm. Interesting) take a look at it, where they interviewed me. And it was well done. I guess, other than that, I can't think of anything else.

Wind Turbines Looked to be Cost-Effective

We continued to run studies on wind turbines and it still looked to be a cost-effective technology for the Bureau of

Reclamation to use. And [it] could potentially integrate well over 100 megawatts into the Central, or the C-R-S-P [Colorado River Storage Project] system, without, you know, impacting environmentally, the flows beyond what was acceptable in the flows out of the dams.

Solar Energy Studies

The other studies that we did, like I mentioned, was on, were on Solar Central Receiver studies in combination with the Department of Energy. They funded us a significant amount of funding to do detailed studies of a similar nature of a 100-megawatt Solar Central Receiver power plant that would have been built at Yuma, Arizona. And we were to tie it in with the hydro facilities at Hoover Dam. We met with the various customers that we sold power to, power coming out of Hoover Dam, and they seemed interested in supporting us in getting the funding to build a huge solar power plant.

As I mentioned, this uses these huge billboard-size mirrors, sets of mirrors, that reflects the sun's heat. And it took something like two or three thousand of those in a large area to reflect the sun's heat. They track the

sun, and concentrated the sun's heat on the top of this tower, in a boiler. Again, those appeared to be promising. And, as time went on, it seemed obvious, in the eyes of the people at the Bureau of Reclamation, the Denver Office as well as the Commissioner's Office, that we needed actually a separate office to coordinate all the studies that were going on, using solar and wind power.

And so, this Solar Energy Team, that I mentioned earlier, recommended that a separate office be set up in the Research Division. That office was set up and I applied for the job and was hired to be the chief of that office in the Research Division. It was called the Advanced Applications Office. Actually, my title was the Coordinator of Advanced Energy Applications for the Research Division. Later on that was changed to the Chief of the Special Technologies Group. The first office was set up in 1979, and then it, the second office was set up in 1981.

Special Technologies Group

As a result of that office being set up, we branched out, and were requested to do technical studies of other solar technologies that could potentially be used by the various

regional and project offices, to not only provide power but also to provide fresh water. One of the areas was using solar photovoltaic systems,[8] solar cells, similar to what you sometimes have on watches and calculators. We had already been using some of these solar photovoltaic systems for monitoring wind, potential wind turbine sites.

The Department of Energy had a significant amount of money, in their program, to try to talk various federal agencies into using various solar and wind power technologies. We submitted a proposal and received a significant amount of money from the Department of Energy to install solar photovoltaic systems throughout the Bureau of Reclamation. The first systems were used for, like I mentioned before, for monitoring a number of potential wind turbine sites scattered all over the western United States,

8. A solar photovoltaic system is a power system designed to supply usable solar power by means of photovoltaics. "A photovoltaic cell (PV cell) is a specialized semiconductor diode that converts visible light into direct current (DC). Some PV cells can also convert infrared (IR) or ultraviolet (UV) radiation into DC electricity. Photovoltaic cells are an integral part of solar-electric energy systems, which are becoming increasingly important as alternative sources of utility power." See "Photovoltaic Cells (PV Cells)," http://whatis.techtarget.com/definition/photovoltaic-cell-PV-Cell. (Accessed 2/2016).

probably around twenty or thirty different sites up in the mountains, and out in remote areas.

Utilizing Solar Energy Technology

These systems looked a lot like a Mars Lander, that had a small solar photovoltaic panel on it (Storey: Uh huh.) that generated the power for the station. And the station had instrumentation for measuring wind speed and direction and temperature, humidity, rainfall, all the various perameters that the meteorological people were interested in, and which we were interested in for determining whether the sites would make good wind turbine sites if we potentially were going to build a 100-megawatt wind turbine site, or project, at each of these sites. The advantage of these systems was that you could install them in real remote sites up in the mountains, and you could cloud seed in a particular area, and have the various remote weather stations scattered around through the mountains. So you could determine whether you actually made it rain or snow in the area that you had planned to when you cloud seeded. It took all the data and transmitted it to a satellite that was in orbit, then retransmitted that data back down to our ground station that was just outside of the Building 67 here.

One of the sidelights, that was kind of funny, when I was telling the people at that meeting there in the Canary Islands about these systems, where we could transmit this data up to a satellite and back down to our ground station. Someone spoke up in Spanish and said something and everyone laughed and I didn't understand what they said. So later at a banquet I asked someone, "What in the world was that, that that person said that was so funny in Spanish?" And he said, "Well, when you pointed up in the air and said that you transmitted that data to a satellite in orbit, he said 'Just like Superman.'" (Laughter) I didn't suppose anyone in Spain or anyone else overseas had ever heard of Superman. But, that was some of the first applications we used solar photovoltaics.

Applying Solar Technology on Reclamation Projects

And then after discussing how well these systems worked, and how reliable they were, with all the different regional and project offices, we had a number of other applications that came about. We received funding, again, through a proposal to the Department of Energy to install a five-kilowatt system, which is a system that consisted of huge solar arrays about the size of two huge billboards. (Storey:

Uh huh.) And, these were installed on top of Harquahala Mountain, and provided the power for the Central Arizona's Granite Reef Aqueduct Project. They had a repeater station on the top of a mountain that they needed to provide some power for communications, and so we had that built and installed to provide power for them. It was a microwave repeater station, there on Harquahala Mountain.

Another application was that we installed a smaller solar photovoltaic system that was installed down in the South, Southwest, well the Canadian River Project. And that was installed to provide power for a cathodic corrosion protection system on a pipeline system, which was out in the middle of nowhere. It turns out it doesn't take a whole lot of power to provide the cathodic protection system that you need to keep a pipeline from corroding.

We also built and tested a concentrator photovoltaic array for the Closed Basin Water Pumping System near San Luis Valley,[9] in San

9. "In 1972, Congress authorized construction of the Closed Basin Project which spans 195 square miles of the sump of the closed basin from east of Alamosa to four miles south of Moffat. The purpose of the project is to salvage unconfined groundwater from the sump area (continued...)

Luis Valley in southern California. This is a large . . .

Storey: You mean in southern Colorado?

Hightower: Yeah, I said California? (Laugh) I meant southern Colorado. Yeah. This was a 7 ½-kilowatt photovoltaic system, that provided power for a ten-horsepower pump. And it provided power for one of the wells that was in that area. There's a number of wells in that area where they pump the water out of the wells that provide water into the Rio Grande.

Another solar photovoltaic system that we installed was for the Twin Lakes Project,

9. (...continued)
that historically was lost to evaporation and evapotranspiration.
"The value of the Closed Basin Project to the San Luis Valley is simple. It helps Colorado to meet commitments to New Mexico and Texas under the Rio Grande Compact of 1939. For every acre-foot of water produced by the Closed Basin Project, irrigators in the San Luis Valley get to keep an acre-foot of water for irrigation. Because Colorado receives credit for Closed Basin Project water, less curtailment is required for irrigators who have water rights on the Rio Grande or Conejos rivers.
"The water has also helped the United States meet its commitment under a 1906 treaty with Mexico. Lawsuits have been filed against the United States and the state of Colorado in the past over downstream water shortages." See Rio Grande Watershed Conservation and Education Initiative, "The Closed Basin Project," http://rgwcei.org/16-news/79-ken-beck.html. (Access 2/2016).

where they were monitoring the limnological, living organisms, and temperature, and weather data there on Twin Lakes to determine what the environmental impact was of the pump storage project that they had, that they just built at the Twin Lakes site.[10]

Another photovoltaic system that was built that provided power at a remote site was for Dam Safety. This was in partnership with Lynn Carpenter. These systems were set up so that you could measure any disturbances, ever so slight, that could potentially predict that there might be an earthquake and cause over-topping of the dam. These are installed around the perimeter of the dam. They were installed at several other locations, Crystal

10. Twin Lakes is a major feature of the Fryingpan-Arkansas Project, which is a transmountain diversion development to provide supplemental irrigation and M&I water from Colorado's West Slope to farms and communities in the Arkansas River Valley. For more information, see Jedidiah S. Rogers, "Fryingpan-Arkansas Project," Denver: Bureau of Reclamation History Program, 2006, www.usbr.gov/history/projhist.html.

Dam,[11] Calamus Dam,[12] and several others.

There were just quite a few different applications that the various project people wanted to use solar photovoltaics, that we assisted them in getting the funding from the Department of Energy. One of the other projects was we built a solar photovoltaic system on the roof of Building 56, about the size of a billboard, which is still located there, and that is used to test various desalting systems. The first one we built and tested was an electrodialysis desalting system, which appears to be probably one of the more cost-effective ways of providing desalting for remote sites. As a result of that particular testing and report that was written, by Larry Haughseth and Roy Eisenhower, we received funding to build and test a similar system for the Navajo Tribe down near Gallup, New

11. Crystal Dam is a feature of the Wayne Aspinall Unit of the Colorado River Storage Project (CRSP) to provide hydroelectric power along a 40-mile stretch of the Gunnison River in Colorado. For more information, see Zachary Redmond, "Wayne Aspinall Unit: Colorado River Storage Project," Denver: Bureau of Reclamation History Program, 2000, www.usbr.gov/history/projhist.html.

12. Calamas Dam, know called Virginia Smith Dam, is a feature of the North Loup Division in central Nebraska. For more information, see, Kevin E. Rucker, "North Loup Division: Pick-Sloan Missouri Basin Program," Denver: Bureau of Reclamation History Program, www.usbr.gov/history/projhist.html.

Mexico. And, this was built and tested for several years down there.

Solar Heating Systems

Another area that the Department of Energy showed an interest in supporting the Bureau of Reclamation was the installation of solar heating systems, in testing those. And so we went into partnership with several different project offices and built solar heating systems at the visitor's centers at Glen Canyon Dam and the Shasta Visitor's Center. And also another one was built at Flaming Gorge [Dam]. Bob Zelenka was in charge of that series of projects. Harry Remmers was the Assistant Coordinator that worked in my group, responsible for all the solar power type work that I had going on in my group. Dick Gebart, after we got started, for several years, became the Assistant Coordinator for the wind power work that I had going on in my group. The weather modification type probe stations, Dean Newkirk was responsible for that, that particular effort. Steve Hebert [spelling?] was responsible for the limnological monitoring station at Twin Lakes. And, Lynn Carpenter was responsible for the Dam Safety work, using solar photovoltaics.

Solar Pond Technology

Another technology that showed a significant amount of promise was the solar pond technology. This was a technology that was developed over in Israel. They built and tested a power system that took advantage of the salt water that you have available to you, in that case, there at the Dead Sea. In our case, we had a group that was interested in, not only interested was highly involved in desalting research here in the United States, and had done work for the Office of Saline Water and Office of Water Research and Technology over a number of years, and helped develop the reverse osmosis technologies and other desalting technologies.

Solar Technology for Desalting Units

And one of the biggest problems in trying to make a system of that sort cost-effective is trying to decide what you can do or what, how to dispose of the salt brines, or concentrated salt water, that you get out of a desalting system once you've desalted the water. And this is particularly a problem at inland sites, and where you'd have to pump it significant distance to the sea coast, or you'd have to build evaporation ponds to get rid of

it. So we took a look at the possibility of using this solar pond technology to get an additional beneficial use out of the salt brines, and at the same time have a useful application for the salt brines, and help pay for the overall desalting project in the process.

The way the technology works is if you take fresh water and put it on top of a layer of concentrated brine, the fresh water will float on top of it. And then, secondly, if you put a layer in between the fresh water and the salt brine, that's what we call a gradient layer, where it gradually increases, or decreases in salinity as you come up to the surface. You can have a perfectly stable layer there that can be approximately three to four feet thick that'll be about like three to four feet of insulation. And, so as a result, the Israelis found from their testing, that if the water's sufficiently clear, the sun's heat will go all the way down to the bottom of the pond into that salt brine layer and it gets hotter and hotter and it will actually boil. Unless you do something with that hot water, because of that thick layer of insulation water that you've got, that we call a gradient layer there in the middle, that it'll just continue to get hotter. And, so they developed a technique where you could pump that hot water through a heat exchanger and boil

Freon.

Generating Power with Solar Pond Technology

And, it's kind of like running your refrigerator backwards. When the Freon boils, you can take that and run it through a turbine and then connect that turbine to an electrical generator and generate power. Take the heat out of the water in the process and then put it back into that lower storage layer again until it absorbs heat again. And so, they were testing a, I believe it was about a two-megawatt system there on the Dead Sea, and they were successful in doing that. And so we asked them to come over and talk to us about their technology, which they did, were willing to share their knowledge on the technology.

So, we requested funding through our research program and got sufficient funding to build and test a small system of this nature at a site that the University of Texas at El Paso, UTEP, had proposed that we build and test a system there. It was located at a Mexican food canning company that already had a pond that was available, that they no longer needed, because it was originally built for fire protection and now that they had the city water line out to their plant they no longer needed

the pond. And, they also needed process heat for their canning process, so they were willing to go into partnership with us to build and test such a system, in partnership with the University of Texas at El Paso.

So, we issued a Request for Proposals and the company in Israel that built the power system in Israel bid on the job, and [they] were awarded the contract to build a 100-kilowatt power system so that we could test it at that site. We went ahead and built the solar pond and showed that it was feasible to get temperatures high enough to run such a power system. In the meantime, the Israeli company was building the power system, and I went over to Israel then and held a design review on their system, and we made sure that their interfaces would match with our power system that we had as well as the cooling tower that we needed at the site, all the size of the flanges and piping and so forth, and the electrical interfaces would match.

We entered into a cooperative agreement with the El Paso Power Company to buy any excess power that the canning company couldn't use. And they also, in this agreement, told us what we needed to install in order to make the power system compatible

with their power system. And so, we incorporated all that into the system as well. The system was built and shipped over to the United States, and shipped in by rail up the site. It's a real large system, that was built, and installed, and tested for a number of years, and the power system is still running as far as I know. (Laugh) They periodically have to clean it and make, you know, slight adjustments to it, but it's been an extremely reliable system.

This type of a system was proposed to be built at the Salton Sea, at one time, by the Department of Energy and the Bureau of Reclamation. This didn't materialize. We still feel like that it's a good technology that could be used in combination with desalting systems to dispose of the concentrated salt water that you get out of inland desalting systems.

Solar Ponds and Desalting Systems

The way that type of system would operate is that, or that we envision, and we actually had one of the graduate students at UTEP run a study, and it appeared that this could potentially be done this way. But, we were proposing that you would first build a

small desalting plant and then a small solar pond system that would accept the salt brines from the desalting plant. And then as you continued to generate more and more salt water and generated more and more power, that you would build another solar pond and generate more and more power. And you would sell not only the power, but you also would sell the fresh water.

And you would continue to do that, building more and more desalting systems, more and more solar pond systems as you generated more and more salt brines to the point where you now had the desalting system paid off from selling the fresh water and for selling the, you know–like in thirty years you could pay off the desalting system as well as the power system. And now you no longer needed to build any more solar ponds to take care of the excess brines, but you continued to have a revenue stream now, that was coming in from your paid-off project that you could pay then to build a pipeline and get rid of the water in other ways, or build evaporation ponds to get rid of your salt brines in other ways. But you would now have a revenue stream that you could do that. And this was studied where it looked like you could phase it so that you could have a revenue stream that

would pay off the project in that manner.

Like I said, I think that type, or that system is still running. If not, it was probably shut down because of funding problems and not because of any technical problems, because it's such a reliable system. It's very similar to a refrigerator, and we all know that refrigerator systems are very reliable.

Reclamation's Wind Power Program Helped to Spur Private Development

Let's see. I guess probably the next area you'd be interested in is that, as time went on there became less and less interest on the part of the Bureau of Reclamation, as well as the Department of Energy, to continue to pursue these technologies, and particularly the large systems. A lot of the private companies and private utilities now are building a significant number of the smaller wind turbines. They're scattered all over California by the thousands, and Nebraska, Minnesota, the Dakota's, back East, and the Northeast, and in a lot of other places they're building smaller wind turbines. Public Service Company of Colorado is building their own projects all around Colorado, southeastern Colorado, as well as northeastern Colorado, and all over up in

Wyoming, a number of wind turbines.

Again, smaller ones are being built, but fairly significant sizes of projects, you know, in the 50 to 100-megawatt sizes of total projects. Fifty to 100 wind turbines in each project or more. But the Bureau of Reclamation started, and other federal agencies, have since lost interest in pursuing these technologies, and rightfully so. I suppose, in some instances, because our main interest was to build these projects to help commercialize the technologies and thereby the costs would decrease where others could afford to buy them.

And so, we were successful, I think, in doing that so it wasn't a complete waste of time and effort and money on the part of the Bureau of Reclamation. They served, I think, and extremely important purpose in doing what we did. At the time that Ed Watts and I were proposing these projects, a lot of people looked at us like, "Are really serious?" You know, they didn't really think we were serious about proposing 100-megawatt projects. In fact, as a sidelight, there were some people that had to laugh when they introduced us, when we gave presentations at different locations all throughout the West. When we

were introduced as Hightower and Watts and our project became known as the Hightower and Watts Project. And, the reason it was so funny is we were proposing to build these tall wind turbines on high . . .

END SIDE 2, TAPE 1. JANUARY 23, 2003.
BEGIN SIDE 1, TAPE 2. JANUARY 23, 2003.

Storey: Tape two. An interview by Brit Storey with Stan Hightower on January 23, 2003. Generating all these Hightower and Watts was . . .?

Hightower: And Watts was the partner that I had that was working with me. And of course, we were going to sell that power and that's why Watts was applicable as a name. Several people told me years later that they really didn't believe that was our names even. They thought, they didn't believe we were proposing wind turbines to generate that much power, and also they didn't believe that that was our names.

To carry it another step further, as I mentioned, when I helped organize that interagency agreement with NASA to help us in issuing requests for bids and so forth and with the technical reviews and so forth, the project manager they assigned to work with

us, his name was Vern, Vern Wires. (Laughter) So that carried it another step further.

Storey: NASA's guy?

Analysis and Water Treatment Section

Hightower: Right. (Laughter) So there were a number of interesting developments there. As I said, a lot of people really didn't think we were serious about building such huge wind turbines. As I started to mention, when it appeared that the Bureau of Reclamation no longer had as much interest in pursuing solar and wind turbine technologies, to the level that they had originally planned, and there was a move to have a reduction in force and so forth. I was asked to be the head of the Analysis and Water Treatment Section, which is the section that I mentioned earlier that is responsible for all of the desalting research that's being accomplished by the Bureau of Reclamation. This started a number of years ago, quite a few years ago, like I said with the Office of Water Research and Technology and the Office of Saline Water, which actually were, were offices in Washington, D-C that reported directly to the Secretary of Interior.

And, this particular group that I was asked to head up now, provided a lot of technical studies and testing in support of that group in Washington, D-C. Because of the shortage of water in the western United States and the various things that were going on over in the Middle East, this particular group, this section, the Analysis and Water Treatment Section, took on a new level of importance. And so there started to become a, quite an interest in the Commissioner's Office and other various offices around the western United States for the Bureau of Reclamation to get even more involved in doing desalting research.

Research to Provide More Fresh Water

And, various lobbying agencies and so forth wrote into the Bureau of Reclamation's budget that we be given a significant amount of money to issue Requests for Proposals and award significant, a significant amount of money to universities and private companies that had an interest in trying to reduce the cost and improve the performance of the various desalting technologies that were available to this group of interested parties, that wanted to provide more fresh water to the western United States.

And, so, we issued a Request for Proposals and awarded a significant amount of contracts to do research in these areas, to improve the reverse osmosis systems and innovative systems of all sorts, as well as thermal-types of desalting systems, and so forth. Also as a result of the Bureau of Reclamation being highly involved in desalting and being seen as the federal government's primary desalting research agency, we were asked to provide technical support and all sorts of other assistance to those countries in the Middle East, like Saudi Arabia, and uhm . . .

Desalting Systems and the Middle East

As a result of that Kevin Price and I, and Lisa Henthorne [spelling?], were asked to travel to the Middle East and assist with the survey that they needed to do as a part of the Middle East peace process to determine what the current technical capabilities are of the various nations there in the Middle East. And how possibly we might go about assisting them in setting up a Middle East desalting research center in the country of Oman. And assist them in issuing Requests for Proposals to award contracts to various technical entities in Palestinian West Bank, Jordan, Israel, Saudi

Arabia, all the various countries and across North Africa, as well as the Middle East to promote peace in the Middle East. And with the idea ultimately having joint research projects between these various entities in these countries and ultimately funding desalting projects to provide fresh water to these countries. Because that was one of the common needs in all the countries there, including Israel.

And, it was looking like that a significant amount of progress was being made in that area. I assigned Kevin Price to head up that area, and he attended a large number of meetings at various, at high levels in all those various countries to help promote that type of a program. Unfortunately, after two or three years of significant amount of progress, this faction that started the Infatada there in the Palestinian West Bank, had no interest in peace. And as a result, with all the killings and so forth, most of that effort that was underway has pretty much come to a screeching halt. They still have a few meetings once in a great while. Kevin Price, he's now the head of the, of the . . . section that is still involved in that somewhat. I guess that's all I can think of, right now. I know that covers a lot of ground (Laughter) in a short

time.(Laughter)

Storey: Yeah, we did cover quite a bit of ground. Well, let's go back and start over. (Laughter)

Hightower: Can I take a restroom break? (Laughter)

Storey: Sure. (Paused; tape turned off.)

Storey: There we go.

Hightower: I forgot to mention another significant amount of effort that the desalting group is involved in is in building and testing desalting systems in our laboratories, as well as out at project sites ourselves. So it's not all done by contract as I might have alluded to in the earlier discussion. To get more detail on the past history of the Bureau of Reclamation's desalting effort, I'd recommend you talk to Ed Backstrom for the past history, as well as Kevin Price, who's currently the group manager of that group right now.

Storey: Uh huh.

Enjoyed Working on Multiple Teams

Hightower: A couple other areas that you might be interested in is, as I mentioned in this article

that was written. When I retired, I really enjoyed working with various, on various teams, serving on various teams that were trying to make Reclamation a better agency and ensure that it continued to play an important role in the future. And, as a result, I was selected for numerous special assignments, like the Reclamation's Solar Energy Team, that I mentioned.

Another team that was put together to do a series of comparison studies of the Reclamation and private sector engineering charges to show that our charges weren't out of, engineering charges weren't out of line with what was currently being charged by the private sector in the consulting area and design areas. A project management team was put together also that I served on, to take a look at the design team management concept. This was an area that I'd been pushing on ever since I came to the Bureau of Reclamation.

Re-Evaluating Project Manager Concept

Because the way that the aerospace industry does all of its work is that they assign project managers to each project and they're responsible for the entire effort. They organize the team, hire the people, or put them

all in one location to get the job done and make sure they have adequate budget and keep control of the costs and so forth so that the entire effort from beginning to end is accomplished successfully.

The way the Bureau of Reclamation was organized when I first came here was that there'd be a huge project that would come into the Design Division. And the Chief of Design Division was the project manager for every project that came in. And, it was just like, you know, there was a million dollars was put in his hands and somebody went through with a bunch of cheese knives and each branch decided that they needed a little bit of the funding to do their effort. And there really wasn't a project manager, per se, you know, that just, you know, was responsible for that specific project in total, on a daily basis, that you could go to. You always had to go through the top guy all the time. And, this was really, I would think overwhelming to the Chief of Design Division to try to be the project manager, you know, for a 105 different projects that might potentially be going on in the division.

So, as a result, I think it was finally recognized, at that time...I kind of forget, I

think it was Darrell Webber[13] that was the ACER [Assistant Commissioner Engineering and Research] there at that time, and asked that we take a look at changing the way that the projects were managed. I'm trying to think, Neal Parrett was on that team, Bill Anderson, and . . . I forget who the other's were. But as a result of that effort, the whole organization in the Engineering Research Center was changed so that there was essentially a project manager that was put in charge of each project, with a separate budget, and one or two people from each of the design branches that that project manager thought that they needed to support the project. And they weren't put on the project unless they felt like they were really needed.

Re-Thinking Reclamation's Role

Another team that I served on was a team that studied the possible privatization of

13. Darrell Webber briefly served as Regional Director of the Southwest Region in 1982 before becoming the Assistant Commissioner Engineering and Research (ACER) from 1982 to 1993. Mr. Webber also participated in Reclamation's oral history program. See Darrell Webber, *Oral History Interview*, Transcript of tape-recorded Bureau of Reclamation Oral History Interviews conducted by Brit Allan Storey, senior historian, Bureau of Reclamation, Denver, Colorado in 1993, edited and desk-top published by Andrew H. Gahan, 2012, www.usbr.gov/history/oralhist.html.

Reclamation. That was an effort that was afoot by the administration, I think when [Ronald] Reagan was president, to try to disband a lot of the government agencies. And, the Commissioner's Office asked us to take a look at that possibility. It turns out that there is an organization that's been privatized, that's somewhat similar to the Bureau of Reclamation, in Australia. It's called the Snowy Mountain Commission,[14] or something like that. And, it was originally set up to build all the hydroelectric and water facilities in Australia. And, once all the projects were built, they turned it into, I guess I should say a pseudo-private government entity, kind of like T-V-A [Tennessee Valley Authority]. And, that was one of the options that we looked at, was to set it up as a pseudo-government

14. "SMEC has operated for more than 40 years, although not in its current form. SMEC's origins date back to the Snowy Mountains Scheme–Australia's largest infrastructure project. The scheme was a massive multi-purpose project undertaken between 1949 and 1974, which involved hydropower, roads and bridges.
"In 1967, the Snowy Mountains Scheme was rated one of civil engineering's 'Wonders of the Modern World'. As the scheme neared completion, the Australian Government passed an Act of Parliament which recognised SMEC as an agency of the Commonwealth Government. SMEC was established on 24 June 1970." See, SMEC, "Company History," http://www.smec.com/about-smec/company-history. (Accessed 2/2016).

agency like that.

Another was to take a look at the possibility of making it into a completely private organization, where there would be stock in the company, if you will, or corporation, that would be issued. Some of which would be issued to employees of the Bureau of Reclamation so they could participate in the ownership of the . . . or corporation. There was some other possibilities that we also looked at.

Computer Aided Drafting Team

Another team I served on was the computer-aided drafting team. There was a real problem in that the Bureau of Reclamation, the Engineering Research Center, had spent a lot of money to develop its own drafting computer program. It was a monstrosity, but did a lot of things. And it served its purpose, back in the days when there wasn't such a computer-aided drafting system available. But as time went on, the private industry people developed Auto-Cad System and several other different types of systems. And our regional and project offices picked up on that right away, because it was more advanced and easier to run, smaller

systems, and so forth.

And, so they'd send their drawings into the Engineering Research Center, preliminary drawings. And Engineering Research Center had to run these digitized data through a system that converted it over to the type of digitized data that the Engineering Research Center computer program could decipher. Some of which it never did decipher, and it lost a lot of this data. And, it was really an unwieldy sort of thing to try to convert and reconvert back to their systems. And, since the regional and project offices were so frustrated in trying to deal with Engineering Research Center, they ask that a team be put together to take a look at converting the Engineering Research Center system to something that was more compatible, or maybe going ahead and using their Auto-Cad systems that all those guys used.

And, so I was asked to head up that team and I could bring anybody into that team that I wanted to. So I brought in all the young men that were experts on their drafting systems, computer-aided drafting systems, and the various regional and project offices to serve on my team. (laugh) And, I didn't have a vested interest in it at all. All I was interested in

doing was try to make the various organizations cooperate better, including our own internal organization here. And, as a result of that, the conclusion of our team was that the Engineering Research Center should convert to the same systems that their regional and project offices were using.

There also was a Futures Team, that Darrell Webber put together. And I served on that team to take a look at what the Bureau of Reclamation could do to try to increase its work effort.

Establishing Billable Rates for the TSC

And then there was another team that was put together to establish what the billable rates should be, based upon the various skill levels here at the T-S-C [Technology Service Center]: to come up with a technique of billing the amount of charges against the hours that were used, to design and do studies and so forth on various projects, to essentially use the same type of systems that all the private engineering firms use when they bill their customers. And, I served on that team and wrote a report, and that technique's currently being used.

I guess that's it. I can't think of anything else. (Laugh)

Storey: Good. Good. Well, you know we're, now we're about seven minutes when we, I was, from when I was planning to quit.

Hightower: Okay.

Storey: So, let's do a few things at the beginning.

Hightower: Okay.

Storey: And then, I think, when we get to your Air Force experience, we'll stop and save that for the next time. Would you mind telling me what town in Kansas you were born and raised in? Towns, I should say.

Growing Up in Kansas

Hightower: I actually was born in a small town by the name of Centralia, Kansas, which is the hometown of John Riggins, who was a running back for the Washington Redskins, who you might recall. (Laugh)

Storey: And I believe, there's a college there, isn't there?

Hightower: No.

Storey: No?

Hightower: That's...

Storey: I'm thinking of somewhere else.

Hightower: That's in Missouri. Centralia, Missouri.

Storey: Okay.

Hightower: I only lived there probably two or three years and then we moved to Bern, Kansas, which is about fifteen miles away. That's a Swiss community. B-E-R-N.

Storey: Uh huh.

Hightower: As I mentioned that town was only about 200 population. It's in northeastern Kansas, about eighty miles north of Topeka. Close to the Nebraska line.

Storey: Now, dual, a two-pronged question. Why K-S-U [Kansas State University]? And why were you interested in mechanical engineering?

Developed an Interest in Engineering

Hightower: (Laugh) Well, that's a good question because I worked most of the, my years in high school for a self-made inventor (Laugh) that was the town electrician. And [he] also did all the maintenance on a small power line, that where the power was generated by diesel generators in a nearby town. And so, we did all the maintenance on the power poles and cross arms and all that sort of thing. And, when he needed to come up with an auger to put in power poles, he invented an auger system that fit on the back of a Caterpillar that had a derrick on it and so forth, and we drilled holes with it. He invented a lot of other things and I just took an interest in, you know, mechanical engineering as a result because it looked like the same sort of thing that I enjoyed doing there. I also liked to draw. In fact, I do watercolor painting as a hobby now.

Storey: Uh huh.

Hightower: And, so as a result I thought I would like to be a draftsman or a designer, you know.

Storey: Yeah.

Attending Kansas State University

Hightower: And so, when I went to K-State. Well, that's

why I went to K-State, because K-State had a reputation for the best engineering school. In fact, my brother's the Assistant Dean of Engineering there, has been for a number of years. And so, I went to K-State and soon found that it's a world of difference from being the valedictorian of . . . of a class of eighteen in a small town. I about flunked out the first year I was there. I didn't have any chemistry or physics, or mechanical drawing. But, as a result of working night and day to try to pass, I managed to make it through the first year. And then, from then on I was able to do okay.

Gained Experience through Summer Work

The summers I worked in Chicago as a draftsman for International Harvester. I sent about, you know, fifty applications to companies all over the United States for summer jobs, and that's who hired me. The first summer I worked on design of engines, and drafting, and, you know, making blueprints and that sort of thing for engines for farm tractors. And, the second summer I worked in the, and third summer, I worked in their transmissions design area. And I soon found out that I didn't really like to draw quite as well as I thought I did. It got to be pretty

boring to do that everyday, I thought. (Laughter)

Storey: Uh huh.

Hightower: And so, the next summer I applied and I got a job as a computer programmer for a company called Collins Radio Company. It was in Dallas, Texas. And, worked there developing computer programs for various types of electrical and mechanical designs.

Then, I applied and got a job, I was scheduled to go into the Air Force, because I had a commission to the Air Force after going through Air Force Cadets, there at K-State. And, I wanted to be a pilot, actually. And, my eyes went bad my senior year so I wasn't able to continue along that line. And, so I, they wanted to make me a navigator and I told them, "Well, that looked like a lot of work and not as much fun." So I said, "How about making me an engineer?" And that's how I happened to be assigned to Vandenberg Air Force Base, which was the best thing that happened to me actually, or I never would have gotten into the space program which is really (Storey: Uh huh.) a tremendous experience.

What I started to say was, I applied and got a job with R-C-A, at Camden, New Jersey, and worked in their rotation program. They knew I was going into the Air Force, but they were willing to put me through a training program and spend one or two months at each one of their technologies to decide which area I'd be most interested in working in, once I got discharged. So I worked a month or two in their division that did radio and television design. And, that was back in the days when they came out with the first pocket radios, and so I worked on the tuning mechanism for the, for one of their first pocket radios. And, then they assigned me to work on computers, big mainframe computers in downtown Camden, New Jersey. Worked on that for a month or two, and then worked on their BMEWS system, which was a huge radar installation along the northern part of Canada and Alaska, as an early warning system.

Storey: How do you spell that?

Hightower: They called it BMEWS. B-M-E-W-S. I don't know what that (Storey: Uh huh.) stands for, stood for [Ballistic Missile Early Warning System]. But, it was an early warning system in case Russia should start shooting (Storey: Yeah.) missiles at us. And, so they needed

somebody that had background in heat transfer to help design some of their big feed horns that they had on those radar systems. And then they assigned me to work in their record and tape division in Indianapolis. (Laugh) I worked there for a year, or a month or two. And that was just when they were just first coming out with video tape. Up until that time it was just audio tape and they needed higher quality tape for the video systems. And, so that's what I was assigned to work on.

And then I was called to active duty by the Air Force and went into the Air Force. The first assignment was at Wright-Patterson Air Force Base at Dayton, Ohio. And they sent me to, I think, about four months of training for the base engineering type work. You know, so you could become acquainted with the ways that the Air Force uses as far as their budgeting (Storey: Okay) and scheduling and so forth.

Storey: Before we go . . . let's do that next time.

Hightower: Okay.

Storey: Tell me about heat transfer.

Heat Transfer Studies

Hightower: Okay.

Storey: You studied that at K-S-U?

Hightower: K-S-U, yeah.

Storey: Tell me more about that. How did you get interested in that particular aspect of it.

Hightower: (Laughter) Well, it turns out that, you know, when you take mechanical engineering you have all sorts of different areas that you can specialize in. And, thermodynamics and heat transfer is kind of the mainstay of mechanical engineering. If you want to design car engines or whatever, you got to, you have to be concerned about whether you can get rid of the heat, you know, so it'll run without overheating and so forth. It's just, you know, one of the things that I took an interest in along the line, I guess.

But, the way it developed, though, you know sometimes things happen that you really don't have any control over (Laughter) too much, because people ask you, you know, "Will you actually do this type of work for us?" You know, and since I was assigned to work in that group and that's all they did (Laughter) you know. I did the work they

assigned to me. And, then I had that background at R-C-A, and so when I went into the Air Force at Vandenberg Air Force Base, then, you know, they put me in charge of the Mechanical Branch that had, you know, a couple GS-13s and a couple of GS-12s in that branch. And, I was a young graduate straight out of school and I was their supervisor. (Laugh) And they'd been there for years.

Storey: Uh huh.

Hightower: And they were responsible for providing heating and air conditioning for these big rocket boosters, you know, that were being launched out there. And, you had to do heat transfer studies, you know, to support that effort, typically.

Storey: Good.

Hightower: To size these systems. And then, I interviewed for the job at Martin Company and it was kind of the same way. They saw that I had that previous experience, so that's what they, they gave me the job offer to work in that area.

Storey: Good. Well, let's stop for today. We're just slightly over time.

Hightower: Okay.

Storey: I'd like to ask you whether it's alright for information on these tapes, and the resulting transcripts, to be used by researchers.

Hightower: Sure.

Storey: Good. Thank you.

END SIDE 1, TAPE 2. JANUARY 23, 2003.
END OF INTERVIEW.