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ORAL HISTORY TRANSCRIPT

ARCHIE R. BECKETT
INTERVIEWED BY JENNIFER ROSS-NAZZAL
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ROSS-NAZZAL: Today is January 21, 2003: This oral history with Archie Beckett is being conducted in Las Cruces, New Mexico, for the NASA Johnson Space Center Oral History Project. The interviewer is Jennifer Ross-Nazzal, assisted by Rebecca Wright and Sandra Johnson.

Thank you for joining us this morning, Mr. Beckett.

BECKETT: Thank you. I'm glad to be here.

ROSS-NAZZAL: It's a real pleasure to finally meet you.

BECKETT: Well, great.

ROSS-NAZZAL: What I would like to begin with is your interest in engineering. Growing up, was there any indication that you wanted to be an engineer? Were there any specific events or people that may have sparked this interest?

BECKETT: Well, I'm a native of the area, and I was born right next to the railroad station, the Santa Fe, and any new kid wants to be an engineer, and the kind that I'm talking about is the one that leans out the window, with the striped hat and the striped overalls, and blows a whistle and blows steam on you as we were playing along the tracks. So I always wanted to be an engineer. That was my first impression. But I really didn't know what type of engineers there were until

about the time I reached high school age. Then I became very interested in all types of engineering. I took the courses that I thought would help me whenever I got to be of college age.

I joined the Navy [near] the end of World War II, and I took a lot of electronics courses, became an electronic technician in radar. So I thought, well, when I go back to school—I went back to school on the G.I. Bill, I thought, well, I'll major in electrical engineering, but it really didn't take me long to find out that I was more interested in mechanical engineering than the type of problems that [electrical] engineering dealt with.

The reason I think I was impressed with mechanical engineers was because my dad was a mechanic and a machinist, and he was a shop foreman where he was over all the trades of welding and brazing and that type [of] thing. I was always attracted to the shop. I also had an uncle who was a self-taught engineer or master mechanic, I think they called them in those days, and he worked on dams, large dams.

He worked on the Don Martin Dam down in Mexico, and also Elephant Butte is where my family was rooted. Up in Fort Peck Dam in Montana, and also El Vado Dam in northern New Mexico. So I was quite interested in heavy construction, particularly in dams of concrete, Earth filled, and also structural steel. So that's how I got the interest in mechanical engineering.

ROSS-NAZZAL: You actually graduated in 1951 here at New Mexico State [University, Las Cruces, New Mexico].

BECKETT: Correct.

ROSS-NAZZAL: And you took a job with Phillips 66 [Company]. Can you tell us about your career with Phillips 66?

BECKETT: Yes. I had a good career with Phillips. The fact is, if I had been single, I'd probably

still be working for them. But in 1951, I went to Phillips in Borger, Texas. It was a town that had black smoke and everything. If you've ever been in West Texas and the carbon black plants, [and] you'd have a white dog, the dog would come out black after it'd been [outside] for a little bit. You'd hang your clothes up on the clothesline, and [they] would end up being gray.

But I went to work for Phillips as a design engineer. I spent eight years total with Phillips, and five of those were as a design engineer in all kinds of environments—plants, that dealt with chemicals, and also the normal oil- and gas-related plants. I spent two and a half years in Bartlesville [Oklahoma], and there's where I got a wide experience in structural steel and concrete of large facilities, a lot of piping, a lot of pressure vessels, and it sure paid off later on when I went to work for NASA, because that's exactly what I got into. And in particular, there was one plant that I worked at where they made nitric acid, and they used hydrogen in the making of ammonia. So I had some previous experience with hydrogen and nitrous oxide.

It was entirely different [from] the way NASA treated [hydrogen and nitrous oxide], but at least it gave me a chance to know the nomenclature and everything else. That's part of the difficulty of [a] job, is just getting on board as far as knowing the language. So, Phillips' training did me [lots of] good.

The last two years I was with Phillips, I was in market development, and that was an entirely different field than what I was trained for, but it was very good from the fact that you got around people who had innovative ideas. They were forceful, they wanted to make money, and so that was a good experience for me also. At least it trained [me] how to deal with people whose ideas might not be the same as [mine], widely different.

So was there a part of that question that I didn't answer?

ROSS-NAZZAL: No, I think you touched on everything.

BECKETT: Okay.

ROSS-NAZZAL: In 1959, you actually came back to Las Cruces, and you began working at the White Sands Missile Range [White Sands, New Mexico]. How did that opportunity come about?

BECKETT: As I said a little bit earlier, if I'd been single, I would have probably still been working for them. The last two years, I was in market development for Phillips, thermoplastic-type materials, and it covered the eleven western states. Every month I had to make a swing around all of the eleven western states, and while it was very enjoyable, it took you away from your family and your home, so when you came home, you had screen doors to repair and that type thing, so it got a little old.

So after two years of that, I decided that wasn't for me [or] my family. I had four children, and my wife was actually raising the children; I thought I needed to help, so I told her I was going to quit. I could've stayed with Phillips, but anytime that you ask for a transfer or you ask for a demotion, so to speak, well, you're probably in hot water. So I went ahead and said, "I'm going to quit and go back home," and I did.

I called and found out what kind of opportunities were available and was told that they were in a down RIF or reduction in force is what we call it, but I came anyway and interviewed, and here's how things can happen so unusual that you're not prepared for. I went to college here, had met a girl. She wasn't anything other than a friend, but she was working for personnel at WSMR [White Sands Missile Range]. I went in. They told me, "We're reducing our force and so there's nothing available."

So I was about ready to leave, and this girl came and said, "Archie! What are you doing here?"

So I told her that I was looking for a job. She says, "Well, you come on back."

Well, in a matter of two hours, I had two offers, two jobs. So I went ahead and accepted. In two weeks I was back. I came back home. So it was a real lucky thing.

ROSS-NAZZAL: You actually ended up working for the Television Division. What were some of your duties there?

BECKETT: I was the only mechanical engineer in the Television Division, fortunately. So they gave you all the jobs that had to do with anything that dealt mechanically, and they had a lot of little jobs that had been on the shelf for a long time, but most of the jobs were related to putting a television camera on a pan and tilt unit, one that would go a full 90 degrees this way [gestures], and then go 360 degrees horizontally. So they would place these cameras in a vital location to monitor their systems, missile systems activities, and also the launches and that type thing. So that was primarily what I did.

There [were] two actual activities that were very interesting. One was for Fort Churchill [Canada] up in the Arctic Circle. They had a problem with their TV camera frosting over the window in their observation room, and also it would either frost over or condensate would form on the inside. But anyway, it would make it cloudy, and you couldn't see through it. So they asked if someone down here could possibly design a new system for them. So I designed a double-walled Plexiglas bubble. I designed the fixture itself, contracted, went out and had the bubble made, and installed a partition at the bottom with a desiccant in it and a circulating fan so that it would maintain it dry on the inside, and the double wall wouldn't allow enough heat to go out and melt the outside snow and ice so that you eliminated the ice on the outside. And from what I hear—I didn't get a chance to go up and install it, but from what I hear, it worked very, very well. I don't know if it's still there, because it's been forty-five years or so, I imagine they've changed. But that was one interesting project.

Another was, I don't know if you've ever seen the Cape [Canaveral, Florida], how they track the vehicle firings. Here at White Sands [Test Facility, Las Cruces, New Mexico], we always called an activity a firing. Down there, I know they're launches. Only one turned out to

be a firing.

The one real good improvement was that they would get a theodolite and then a person would look through it, and he'd try to keep the missile in view, and he'd try to keep the crosshairs of the theodolite right on the missile so that whenever they reduced the data they could get the positions.

Well, they wanted to do it electronically or automatically, and since I've been a radar tech [technologist], I knew a little bit about the electronics parts, and then we used selsyn motors or induction-type motors that will slow down or speed up, depending on the voltage you give them. And what they would do is they would have the camera right on the missile, and when [it would] take off, it would integrate the distance between where the image was and the center line of the apparatus, and it would take that difference, convert it to a voltage, and then turn it into a control or a command to the selsyn motors to slow down or speed up, and that way very rapidly it would position and reposition the pan and tilt unit to follow the missile and try to keep it on the hairline. So that was a big advance.

On that, they gave us local people, me as the mechanical man and others of an electronic nature, the task of making a breadboard to see if this concept would work. At the same time, they went out and contracted two electronic firms. I remember one of them being RCA [Radio Corporation of America], and I don't know who the other one was. Might have been Bell [Aero Systems Company]. But they contracted them to come up with the same concept. Well, they gave them ninety days to come up with it to see if it would work, and we finished ours about thirty days before they did, and it worked great. So I was quite proud of those two things in the Television Division.

ROSS-NAZZAL: Then you moved and became a climatic engineer?

BECKETT: Yes.

ROSS-NAZZAL: And began working on the Nike Hercules missile?

BECKETT: Well, I had very little to do with Nike Hercules. Really, again, I was in a support function. What we would do is we would provide support to any systems engineer or project engineer out there that needed us to do something to condition their system so that they could monitor it under a wide range of climatic environments, minus 65 degrees Fahrenheit to 140, sand and dust, wind, snow, sleet, rain, high temperatures, low temperatures. So those type of environments were available, and we had large chambers there in White Sands Missile Range that we could put a part of the system or a whole system in the chambers, or we could take portable shrouds out to the actual site where they had the missiles up on top of a mountain or down in a valley, and condition their equipment in these large, huge Quonset-type huts. So that was my job. And on Nike Hercules, most of that testing was done before I came back. I came back in '59, and I think most of that was done in '57, '58, but it carried over into '59. So I was familiar with the systems, but I actually had nothing to do with the missile systems themselves.

You mentioned a system that actually was one of the busiest out there at White Sands. Every week or every other week, depending on their schedule, they would fire four times in one day, and that's almost unheard of as to actually take a system and fire it four times [within a day] during development tests and qualification tests. But that Highway 70 going from Las Cruces [New Mexico] to Alamogordo [New Mexico] was pretty well sewed up, because even though it might have been fairly reliable, they thought, the contractor thought it was very reliable, the government people didn't think it was quite so reliable, but because they had a lot of vibration problems, they would have missile parts scattered all over the range, even though they never initiated a destruct system. Each missile [had] a destruct system so that when it goes up and something goes wrong, the test conductor just goes ahead and pushes a button and it blows it up or it cuts off the power anyway.

Well, with the Nike Hercules, they had problems in their wings. They had primer cords that would go out to the various points in the missile and to the engine itself, and the vibration would break the primer cord so that no longer did you have command of the various functions. And when they would try to detonate it, nothing would happen, and sometimes that thing would just keep going, and it might get up so fast it would just take a nose down. So you never really knew where the missiles were or where all the parts were. That particular system turned out to be a very good system, but it had lots of problems. But I wasn't responsible for the system at all.

ROSS-NAZZAL: In '64, you actually transferred from the Army facility over to White Sands Test Facility.

BECKETT: Correct.

ROSS-NAZZAL: Can you tell us how that opportunity came about?

BECKETT: Well, that is a long story that I probably can't make very short, but I'll try.

ROSS-NAZZAL: That's all right. We'd like to hear your story.

BECKETT: I was aware that the White Sands Test Facility or the Propulsion Systems Development Facility was being built on the west side of the Organ Mountains, but I've never really had a lot of interest in becoming a NASA employee at that time. Sputnik came up in '57 when I was out in California. But it just didn't catch my imagination at that point in time.

However, when I was a climatic engineer, a fellow by the name of Howard Feindel, he got acquainted with me, and he was the one that would come in and request services for conditioning the Little Joe before its launch activities. So I got pretty well acquainted with him

and started talking about NASA, and he was just really gung-ho on NASA activities. Each week or each day, in fact, he would come to our [scheduling] meetings. And our [scheduling] meetings [were] supposed to be over at two o'clock or two-thirty. And any input after two-thirty, according to the colonel, was taboo. So if you went to the meeting and you didn't know your requirements, particularly on a Friday, you just didn't get anything [done]. You didn't get the service. So Howard, he was a real nice guy. He would come, and he wouldn't say much except, "Well, we want this. We want this. And no, we don't want any work over the weekend."

So we'd break up and go back to our offices, and invariably at three thirty or four o'clock—and four o'clock was the quitting time for the whole missile range—at about that time he would call and say, "Hey, we just [got] some new requirements. We have to condition [some equipment] down to minus 65 for the whole weekend." Well, that would start a reaction, and it'd get back to the colonel, and he would say, "No, no, we're not going to do it." He was a pretty hard-nosed guy, but he was aware of the commander-in-chief's, [President John F. Kennedy], dictate that we reach the Moon at the end of the sixties. So we always supported. We always supported, even though it was tough to tell people right at five minutes till four that "Hey, you have to come back and work tomorrow," and that type thing.

But I got real enthused about NASA from his conversations, so I decided to fill out an application, and found out there was an opening. It was as the head of the Mechanical Systems Branch, [I] filled out the application, talked to B. R. [Billy] Gantz, and lo and behold, a week or so later he [called] me up and said I was hired, or I would be hired. I went in and signed the papers and came right on over. I was real enthused.

ROSS-NAZZAL: What were some of your duties as the head of ground support equipment in the Mechanical Systems Branch?

BECKETT: We had a saying [in our group] that "if it isn't instrumental, if it isn't electrical, then it's ours," if it wasn't a test article. We had nothing to do with the test articles themselves. But we had everything in the test areas. We had all the facilities, roads and grounds, the buildings, test stands, firing systems, the ground support equipment, which meant the conditioning equipment where you would circulate [propellants]. You would temperature-condition it. You would pressurize it either on a standby or pad pressure to keep the moisture out of the propellants, and then when time came, you would transfer it.

You'd work with the engine test conductors. You'd load the vehicle at what pressures they wanted, what rates. Then you would unload it, retank it when the test was over, if there was any propellants left. So we were involved in just about everything.

In addition to that, the Mechanical Branch had responsibility for a lot of laboratory functions. The laboratory was something that had just been completed. We had a chemistry lab and a photography lab and a metallurgy lab and that type thing. And anything that was mechanical, like mechanical calibration of gauges, we were responsible for going into the labs and overseeing that activity also.

ROSS-NAZZAL: Sounds like you had your hands in just about every cookie jar.

BECKETT: I thought that I had a tremendous job.

ROSS-NAZZAL: Can you tell us what the work atmosphere was like out at White Sands Test Facility and compare it with working out at the White Sands Missile Range?

BECKETT: Yes. This was gung-ho, very enthusiastic. Everybody thought that they were going to be an astronaut. When they first went to work, they didn't know what was going to be the final results of their activity. But everybody, regardless of who they were, whether they were a

manager or head of a system, or the laborers, or a carpenter, even, they would come out and what they did was important because they knew that we had a deadline [to make]. Even though it was 1964, and that deadline was five or six years away, it was almost like it was at the end of the year vision. You could just foresee what we were going to do in the next five years or the next two years or however long it was until they actually landed on the Moon. So it was a very, very exciting time.

ROSS-NAZZAL: Were there any differences in terms of the work atmosphere at White Sands Missile Range, working on a military facility versus working for a civilian agency?

BECKETT: Oh yes. In fact, that's a very good point. I hadn't even thought of it. The management was entirely different because at White Sands Missile Range it was very bureaucratic. "We're the Army, and this is the Department of Defense," and they sort of dictated the schedules and everything else. Even though it was their system, the Army was pretty rigid in their management. The labor force was civilian, civil service engineers, managers, or laborers. Even those people that worked on the television systems themselves, the operators and that type thing, they were civil servants. So they weren't a contractor. It was all Army or civil service supporting a contractor who would come in with his equipment and his people. They were the ones that would do the operation, but all their support was done by civil service people, whereas at White Sands Test Facility, the R&D [Research and Development] contractors had their systems, and they were responsible for them, but their support was provided by another contractor, called an M&O contractor, maintenance and operations contractor, and NASA was merely the overseer. However, we were always, always heavily involved in the technical portions, not necessarily the management of the workers, but we were heavily involved in the technical direction.

So it was quite a bit of a different atmosphere, White Sands Missile Range being

bureaucratic and much slower to get a job done, where White Sands Test Facility was smaller and eager, and whenever we got a task, we really jumped in there and got the job done in a hurry. I'm not saying that White Sands Missile Range was wrong. They were just of a different environment. We thought our job was urgent, and they thought theirs was deliberate, and they wanted to be time-consuming to get a job perfected, where I think we wanted perfection, too. But we wanted to get a job done and move on to the next thing, because we knew that we didn't have a lot of time. So it's an entirely different atmosphere.

ROSS-NAZZAL: You mentioned just briefly that you worked with contractors. Can you talk about your work with the Apollo contractors?

BECKETT: Oh, sure, sure. I worked very closely with all contractors. The R&D contractors that were responsible for the command and service module, which was North American Aviation [Inc.] or North American Aircraft. I don't remember the exact title. And also we worked with GAEC, Grumman Aircraft Electronics Corporation. I don't remember what the exact title is, but I worked very closely with them. There was about 350 North American people, about 400 or 450 Grumman people.

We became like companions, really. We socialized a lot with one another. We worked with each other. At first, it was kind of tough for them to accept our meddling or our overseeing job tasks. We felt we were responsible for the total system and the site, so we weren't going to let anything happen that was going to jeopardize the site, where they wanted to progress, because they were under an incentive-type program, and the faster they progressed, of course, the more money they made. So it was hard for them to get used to NASA being involved in their knickers, so to speak.

But as time went by and we grew to trust each other and respect the other's position, we became very, very good friends. In fact, I think the Grumman people coming to Las Cruces,

New Mexico, was probably one of the best things that ever happened to the town. The women, particularly, were very aggressive and wanted, demanded codfish or certain services that they could get back in New York that they couldn't get here. And they just kept demanding it and said, "Well, you order it," and pretty soon the merchants knew that that was good income for them, so they started providing better services.

All in all, I was very impressed with the contractors that came here and settled here. And later on, when we reduced in force, and some of them were required to leave, they hated to go back to where they were from, because they'd gotten out here and gotten a new experience, found out that they liked the desert, the good, wonderful climate, the lower cost. And they, of course, were under higher wage here because they got a certain percentage—they had different rates, but some got 10 percent more plus a bonus, and so they had like maybe 15 percent increase just to come to New Mexico, and it's probably 15 percent or more cheaper, so they were really happy to be here, and they hated to leave.

After they did leave, many of them came back right away. Some of them took several years to come back. But even today, I go meet with about eighteen to twenty people on a weekly basis for coffee, and what we do is we sit and tell the same stories over and over again. But at least we meet, and that's a combination of Aerojet [General Corporation] people, Grumman people, Zia [Corporation] people, NASA people, North American, the whole works. LTV [Aerospace Corporation]. So there was six or seven contractors here that a lot of people are still remaining that came back. Well, some of them quit their job and stayed, even initially, became farmers.

ROSS-NAZZAL: Became farmers, really? That's a change from being an engineer.

You mentioned an interesting point. You mentioned that the women of Grumman, they wanted certain types of meat or different types of services than Las Cruces was able to provide. What do you think the impact of the White Sands Test Facility was on the area, on Las Cruces in

particular?

BECKETT: Great. Great. Las Cruces—and I've studied it a lot, and I was observant enough to know that Las Cruces has grown by plateaus. In the thirties, when people were going from Arkansas and Oklahoma and Kansas, Texas, over to California, this was practically the only road that was the warm route. If you went farther north, through Albuquerque [New Mexico] or up through Wyoming, it was a pretty difficult winter. So they took the southern route, and they had a lot of problems coming across the mountains. They had problems going over a viaduct that we had across our railroad track. They would come in their Model Ts, about to break down, and sometimes they couldn't go forward, so they'd turn around and back over. They had more power going backwards than they did forwards. We had a lot of people that just stopped because it was a farming community. They liked the farming community because most of them were farmers anyway, and they stayed here.

So in the thirties, it grew probably 25 percent of what the population was. Maybe the population was 8,000, and they grew up to 10,000. At that time it was probably only about 6,000, and they grew to about 8,000, so that's a 33 percent increase in that decade. Well, the next decade was after the war when all the servicemen came back, and White Sands Missile Range started in 1945, and it jumped up from 10,000 to 12,500 and stayed along that era. So it just jumped this way [gestures].

Grumman and the space program coming here, started a whole new subdivision, Telshor. Up until then, practically everything was down in the valley, because there you could plant things, and they would grow with very little water, because there was water only ten feet deep, and you could actually stick a hand pump down if you wanted to, or if you drove a well, just get down fifteen or twenty feet, and you could get water, or you could irrigate out of the irrigation ditches. So there wasn't very much on the upper highlands or sand hills, and Grumman started that division. They went in there, and they wanted nice houses. A contractor had just developed

an area overlooking the valley right next to the hospital, and the people came by droves, and a very nice subdivision came out of that, and Grumman was primarily responsible for it.

Back to the original question, what was it? I got involved.

ROSS-NAZZAL: Just the impact of the test facility on Las Cruces, in general. You mentioned the subdivision.

BECKETT: Housing. They bought good houses. They increased the demand for good service in the foods. You know, laundries, cleaners. Every business in Las Cruces benefited by the NASA program coming into here.

ROSS-NAZZAL: Tell us what the facility was like in '64. What buildings were there? Was the Army Corps of Engineers still building part of the facility?

BECKETT: Yes, they were. The facility, whenever I came in May of 1964, was probably about 50 percent complete. The facility, on paper, consisted of a 700 Area down to the 100 Area. One, two, three, four, five, six, seven. And they were all designated different isolated areas. One was the water wells and the water distribution system.

The 100 Area was the administrative area as well as the cafeteria and warehouses. The 200 Area was the laboratories and their immediate area. The 300 Area was the test area for North American Aviation. The 400 Area was the test area for Grumman and the LM [Lunar Module] system, and something I'll get into later, and that's the steam jenny, and that was my sweetheart. That was in the 400 Area. The 500 Area was our remote storage areas and also the gaseous, [and] liquid storage areas, like liquid nitrogen, gaseous nitrogen. … [The 600 area was the water systems.] The 700 Area was a small, remote, way out of the way, test area for anything that we had to do that was dangerous, we wanted to get it as far away from the rest of

the facility. So that was what it was in 1964.

The 400 Area [had hardly] been started, and it was more or less the big system that made this site unique. The whole facility was estimated to cost $25 million, which is a lot of money for this area. But it was about half completed when I got here.

ROSS-NAZZAL: Were there any services available for contractors or employees at the time?

BECKETT: The cafeteria. The only services that were available to—I don't think there were any services available to any contractor that wasn't already under contract for the Apollo Program. We didn't have any reimbursable projects. [If] our contractor says, "Hey, I want something [else] tested," [we couldn't have] under any conditions. We had our mission, and that what's what we were working on.

ROSS-NAZZAL: I'd like for you to talk about White Sands Test Facility and its relationship with the Johnson Space Center, which was then called the Manned Spacecraft Center [Houston, Texas]. What was the relationship like when you first joined the test facility?

BECKETT: You must've been talking to people about the three-headed monster. [Laughs]

ROSS-NAZZAL: I've heard about that, yes.

BECKETT: It was really four-headed, I think. But what I think you're referring to was the three different groups or the three different organizations that White Sands Test Facility offices had to report to. I know they had an ASPO [Apollo Spacecraft Program] Office at—they had representatives out at White Sands. The admin [administrative] people, the MSC [Manned Spacecraft Center] admin people had Ken [Kenneth R.] Haynes, who you're going to talk to

today, and the other functions reporting to them, and then the engineering office down there under [Aleck C.] Bond and Guy [Joseph G.] Thibodaux, they had the Propulsion Systems Branch or Engineering Branch report to them. So I think that's the thing that everybody's always referring to as the three-headed monster.

That didn't cause me a problem, because I was new and I really didn't care about the administrative problems and the reporting problems. All I wanted to do was get involved, learn my system, because I was brand new at it, so I could develop confidence in a system when it became required that we support [a] test. So that didn't bother me so much. What bothered me more than anything was the Corps of Engineers. They were still building at the same time that we were trying to assume the facilities to maintain and operate them, and they wouldn't turn them loose as far as being [completed] or the legal part, but yet we were sort of expected to go in and maintain them.

Like I say, the cafeteria, the cafeteria was complete, and we were the ones that had to be sure that they had hot water. Whenever they had a problem in the cafeteria, our branch would go in and take care of it, clean out the sewer or whatever it was. But yet it wasn't ours, so that was what I call the four-headed monster, is the Corps of Engineers.

ROSS-NAZZAL: Were there any people in particular that you worked with, with the Corps of Engineers out at White Sands Test Facility?

BECKETT: Oh yes. The fact is, most of them ended up in my branch. Gene [L. Eugene] Lundgren, Bill [William M.] Schroeder, Charlie [Charles H.] Provine, I think Warner, a guy by the name of Fred [Frederick W.] Warner. They all worked for NASA. Well, they worked for the Corps of Engineers over at Roswell [New Mexico]. And then when the Corps of Engineers came over to do the job west of the mountains, they came with them, but they went ahead and went to work for NASA, but they were with the Corps. It was kind of confusing because here

they were NASA employees, and they were actually overseeing the construction for the Corps. And then as soon as they would turn them over to the facilities, the guy that was responsible for that system in the Corps, he was NASA, he would transfer over to my branch. So it was a little bit of a problem.

When they finally completed the system, that is when they went in and formed another branch, the Facilities Branch.

ROSS-NAZZAL: When was the facility finally complete? When were you rid of this four-headed monster that you talk about?

BECKETT: I would guess 1966, maybe [latter part of] '65. As I said before we started, I can remember most of the things that happened. I just can't remember when they happened.

ROSS-NAZZAL: Oh, certainly. Certainly. We all have that problem.

BECKETT: So it was probably '65 or possibly early '66, but probably '65.

ROSS-NAZZAL: Describe for us the Army's relationship with the White Sands Test Facility during the Apollo Program. Did they provide any administrative support, for instance, for the program?

BECKETT: For other groups, they may have provided more than they did the Mechanical Systems Branch. From the Mechanical Systems Branch's viewpoint or standpoint, we were practically independent. We didn't require support from WSMR, although eventually or through the years—I don't remember it being right at first, but through the years we probably both supported each other, and the fact is, if you needed a crane, a heavy crane, we had one, but if we

needed two to, say, lift some of our altitude chambers, we would borrow a crane temporarily for three days or something. And likewise, we would send equipment over to them whenever they needed it. So we supported one another.

They didn't do any paperwork functions for us. We were entirely independent that way. They would clean the highway when it snowed. It doesn't happen very often, but the mountain pass gets snowed in, and sometimes down to where the NASA facility was, so we relied on them to keep our roads clear. But other than that, we were pretty independent.

ROSS-NAZZAL: Was the relationship between the Army and the test facility positive at that time?

BECKETT: Yes, I think it was always positive. Might not have been between the general and the manager, but as far as the people, the working people, most of them came from White Sands Missile Range, so there was a good relationship.

ROSS-NAZZAL: You mentioned that you provided support for the Apollo Program. Can you talk about the support that you specifically provided for this program, to land a man on the Moon? I know that you won, for instance, an award for testing the Apollo Program propulsion systems, but you mentioned that you primarily worked on support.

BECKETT: Support, correct. Every function we were involved in, so we worked with each of the test stand personnel, the test conductors there. We approved the paper. Sometimes we generated the paper to get a job done to, say, condition the propellant. It was all our equipment that had nothing to do with the test stand, and they would just tell us, "We want the propellant's condition to a certain temperature." Then we would write the paper, work with the M&O contractor. We would do the work. Then whenever it was ready, we would say, "Hey, we're ready," and then the interface would be closed, and then we would start working directly with the test conductors.

But primarily we are in a support function, and we supported every activity out there as far as welding jobs. If something would break down, we would weld it up for them. If they had a bad mix of propellants, we would detank it, put it in a disposal area, get rid of it for them. So we were in all activities. We were in charge of the test stands and blockhouses. So anything that had to be done in the blockhouse, we were in charge of seeing whatever repair was needed or correction. We were responsible for the tunnels that went from the blockhouse down to the test stands. If something was wrong there, the engineering group would be responsible for that, and if it was mechanical, I was responsible. If it was electrical, then the Electrical Branch would be responsible and so forth. Just direct support.

ROSS-NAZZAL: What impact did the Apollo 1 fire have on the White Sands Test Facility?

BECKETT: Vast impact. Huge. I was the one that was chosen to go from White Sands Test Facility down to the Cape and be one of the investigators on that. I can't remember the fellow's name, it's terrible that I can't, but we went down and went around, took tours of all the facilities. We read the reports of what had happened. We came across a lot of the grisly details of the fire started, the screams, and they couldn't get out, the mistake of having the door reversed. The door was installed to allow good sealing pressure. In space, it would've been 5 psia [pounds per square inch absolute] pressure inside the command module, and it would make the seals better because outside it had an outside vacuum so that the pressure aided you in sealing the door. But in the situation that developed, it's just like an auditorium. If you have a door open inward and everybody's trying to get out, it's just a bad, bad situation. That's one of the things that we certainly recommended that they turn around and redesign the door. Still have a good seal, but have it so that the thing would fly open. As soon as you built pressure inside, you could just push on it and it would come on open.

I'm the one fellow that had kids at that time that were of the age where they needed their

best possible toys, and a toy that I designed for them is, I had a light pole that was up about 35 feet there in my back yard. I lived sort of in the country. And I put a ladder up to it and a platform and had a pole with a guy wire going from there to a point all the way across my property. I had two acres. They assembled some pulleys and made a device so that all they [had to do was hang on] a T-bar, which I didn't recommend they do, [or] they could sit on it. They just constantly played with that escape system.

Well, when we got down [to the Cape], and there was no escape system there at the 465-foot level of the launch tower where they were conducting this test; my recommendation [was to install an egress cable] and it was incorporated—I don't know if I'm the one that sold the committee on it, but it was agreed that we needed an egress from up at the level where the command and service module was, and after it was all over, they installed [an] egress cable. They had [a] special fitting, I think, on their suits, where they'd come out, and just latch onto it, and they'd come down that egress cable. It was practically like a freefall. As soon as you got onto it, [there] was enough slack that they almost dropped vertically until it tightened the wire, and then they would go out horizontally [a] quarter of a mile or [so]. I don't remember what the distance was, but they got away from the tower.

And the fellows that came out here for an RCS [Reaction Control System] firing later on, I was talking to them about that egress system, and [one] said, "Oh, my gosh. I've ridden that once." He said, "I'll go to the Moon, but I'll never ride that thing again." [Laughter] And that kind of amused me that here they were willing to risk their lives and go to the Moon on a long mission, being away from Earth, and then yet they weren't going to ride that thing again, because I guess it was scary.

So it had a tremendous impact on us. The fact is, it increased our workload probably another 15 percent or so, because that's how we got funds to build—and my group built it—the 800 Test Area, where we remotely controlled the loading and the operations of the materials test program. We had the little test chambers with little shelves in it, and we would put [in] the

material that we wanted to test, and then we would place [the test chamber] in our eight-by-eight concrete test cells. We would connect up all the piping and then remotely put in the propellants, the [fuel and] oxidizer, with the incompatible materials, and then monitor it. It had TV cameras, and we'd monitor that.

We had instrumentation that would give us the increases in the temperature and pressure so we could see what was happening. The fire was the main cause for us having that kind of a facility. It turned out that we ended up doing practically all the materials testing for the whole agency. So it had a big impact on White Sands.

ROSS-NAZZAL: Talk first, if you would, about building that 800 test area. Did that begin before the fire, or was that a result of the fire that you started building that area?

BECKETT: I think it was absolutely a result of the fire. I mentioned earlier the 700 Area, and we had been doing the test out there. What we would do is we had sandbags, we had barricades that we would have windows that we could look through and see what happened. But we were naive, I guess. We didn't think that NASA would buy bad materials for us to test that would explode right in front of you. We were pretty new at the program, and what we would do is we would take these little fixtures that had shelves in them, put the material in, and then go down to the remote storage areas. We even approved the paper to fill them, and then take them to the test area to store them. Of course, when you write it, initially you think it's going to last ten or fifteen minutes, and you'd fill the thing and get in your vehicle, drive over and set the tray down behind this wall. Then whenever you came up in the future, [you] would be on the outside of your big barricade. It would be here [gestures], and you'd come in and look through Plexiglas panels and multiple windows, so it couldn't come directly at you, and we thought that was safe, but it didn't turn out to be that way.

One of them, the fellows loaded—this is one of those situations I said I didn't want to get

involved in too much, but they loaded one of the little chambers, then they stopped to take a smoke break, and they were sitting on the [tailgate] of the pickup with the system here [gestures], and it exploded, and it injured one of the guys very badly.

So even though we'd been doing that type of work, we didn't have the impetus to really get after it, and I think that MSC-Houston is the one that got behind it after the fire. They said, "Hey, we've got to have a remote location where we're going to test these materials," and I think that's when they selected White Sands Test Facility, to have the huge modern test facility.

ROSS-NAZZAL: How long did it take to build the test area?

BECKETT: Our branch was responsible for it. We were the ones that designed all the test cells, and we designed the test cells first, and I would say that probably took six months. Then immediately upon the completion of that, we started testing remotely, and the fact is, from another building about 100 yards away, and that wasn't very convenient, so we got additional funds to build a building right up next to the test cells. So that took, by the time we went through contracts, it probably took a total of a year and a half to finalize it. But we got the test cells themselves where we could still do the remote testing, I would say within six months.

ROSS-NAZZAL: I've read that the White Sands Test Facility has actually tested 90 percent of everything that flew in Apollo and Space Shuttle.

BECKETT: I think that it was easily that much. Maybe 95. I don't know.

ROSS-NAZZAL: Pretty impressive record.

BECKETT: They did a good job for them, I think. I think White Sands did a good job for MSC in

that area.

ROSS-NAZZAL: You mentioned, just a few minutes ago, issues about safety. Could you talk about the safety program at White Sands Test Facility during the Apollo Program?

BECKETT: Sure. The contractors had a safety program, and each one of them, the M&O plus R&D, and NASA had the safety program at MSC that we tried to adopt and tried to follow. I think that everybody was intelligent enough in the safety area that they made people aware of the hazards, that we had a number of hazardous situations here, and you had to be cautious, so they taught awareness very well.

However, things do happen. [A] guy can get careless. For instance, sometimes if a fellow would, instead of following procedure exactly, he would think that he had done it so many times that it became routine that he would call maybe out of sequence. He wouldn't be looking at the paper directly, and maybe he'd open a valve before he closed another one, and the engine would fire. Well, if someone was near the engine, he'd get burned. He could easily have been killed. So those type of things happened.

One fellow was pumping a liquid—I can't remember whether it was oil or something in the maintenance area, and they had a little pump that you could attach a compressed air bottle to it or use nitrogen. An inert gas is a pressure, and you'd connect to that and open the valve, and the thing would sit there and pump like these pneumatic tire tools. It would sit there and pump, and no problem. But this one guy, he connected up the procedure, said, "Connect up air source." Well, he grabbed an oxygen bottle, and that's an air source, and he didn't pay any attention. It was a green bottle instead of the normal color. All he knew was it was there, so he grabbed the air bottle and connected it up, and then hit that grease-lined piston and everything else with high-pressured gaseous oxygen, and the whole program is what oxygen will do to it. And boy, that thing just blew up in nothing flat. He almost lost a hand. So those type things we could've

avoided. With just a little bit more awareness, we would've avoided it, but you just can't train everybody.

They trained us in SCAPE [(Self-Contained Atmospheric Protective Ensemble) suits, which is an environmental protective suit]. Anytime that anyone had to go up to the test area and had to provide services in the test area, he had to go through SCAPE suit operations. That looked like an astronaut suit, much heavier and much more cumbersome, and you had a big air bottle behind your back, and so you couldn't do a whole lot of work. But you could go out and inspect something and see where the leak was, and then later on detank, depressurize, and then go out in splash suits, which are much lighter, and do the work. But I think we had a pretty good system. [However], you had people that hadn't been in that type of an environment before, and they got a little careless.

You know, usually safety is measured in numbers of man-hours lost or loss of life or loss of equipment. If you have a pretty good record in that line, like when I worked for Phillips, if you had two million man-hours without a lost time accident, you were doing great. But when you have 28,000 employees, it doesn't take long to make two million man-hours. So you could go a month and you'd have a record of lots of man-hours not lost due to an accident. Well, out [here], you didn't have that many people, so you couldn't base your reputation on, "Man, we've had a thousand man-hours without lost time." It's just a different way of measuring it. A large company, you usually use numbers of deaths or numbers of lost man-hours due to an accident as a criteria, where out here, it just shouldn't have been that way at all.

I think that if they had had more what the industry calls toolbox sessions, I think that we would've had a little bit better record. And those toolbox sessions is where they go over this same type of a job where they show what type of equipment needs to be used, how that equipment is used, what you do do and what you don't do, and it's more on a personal basis, small group on a specific task, and I think our record would have been better if we would have had a little bit more detailed safety program rather than just a lot of billboards and safety counts,

and "the future is yours," or whatever they usually say.

ROSS-NAZZAL: Did the safety program change at all as a result of the Apollo 1 fire? Were there more hands-on exercises, for instance?

BECKETT: I think there was more awareness, that, hey, we can be hurt. I really don't know how to answer to that question. I don't recall any significant change other than the memory of what had happened, and people were conscious of that, so therefore, I think it went over some into their work, but I don't remember any particular big change in safety direction that resulted.

You know, there's an interesting thing about that Apollo fire and also about the *Challenger*. When the *Challenger* happened, it was a very, very devastating thing to the nation and as well as to us. But the day after the *Challenger*, there was a train wreck. There was a derailment of a train up in the northeast part of the country and it made headlines for one day, "Twenty people killed. Train derailed." And yet the next day they had the debris cleaned up, they had the tracks repaired, and were back to full service. They had 100 percent service restored, where after the *Challenger*, it almost shut us down for a year. You know, the public would've been in outrage if we had just said, "Oh, well, let's go ahead and plan the next launch." I don't think the public would've stood for it. And certainly, NASA management didn't want to do it.

But I don't understand the difference between you taking an old system that people are used to and have been traveling for years and years, you have a tremendous accident, and yet it's wiped out the next day. "Oh, those poor people." But they really don't do anything about it, where NASA was forced to go over and over—they knew what the problem was on *Challenger*, but they had to go over and over and over again to try to get it repaired.

Well, I've rambled on about that.

ROSS-NAZZAL: No, that's interesting. When we talk about *Challenger,* I'd like you to talk about that a little more.

You mentioned that White Sands actually was almost shut down in ['86] for about a year. In '68, Martin [L.] Raines actually informed George [M.] Low that they should begin a phase-out of the contractors here at White Sands Test Facility. How did this impact morale at the test facility when they heard about this memo that went out?

BECKETT: Well, of course, it was devastating to the employees. They had had such a good program going. They were enthused. They wanted to be at the site. Sometimes we worked twenty hours a day out there. It was strictly because, well, it was because we were required to get a job done. But we did it happily. We did it, grateful that we had a good job and grateful that we were doing something for the nation. And whenever all of a sudden—they knew that in 1969 or 1970, that was the end of it, but yet that was always three years away or two years away, and when it got closer and closer, they realized that, man, they were going to be out of a job. They might have a job, but they were going to get transferred back home or to a new location, maybe to go to Houston or down to the Cape, which they weren't aware of. They liked it here. They had children in high school and so forth, and they just hated to move.

Then there were others that would go back to farming, local people here that grew up here. Their background was farming, and they went to school, maybe took engineering like I did. And so they said, "Well, I've still got that forty acres out there. I can go back and farm it." It wasn't a good future to look forward to. They hated it to happen, but it was inevitable. They knew it, so it was going to happen.

ROSS-NAZZAL: Did this in any way impact the facility's operations?

BECKETT: Probably. It probably did. I wasn't aware of it at the time that we slowed down

because of the news, but really, it gave more work to the people that were going to be there, and the ones that knew they were actually leaving or going to leave, it may have affected them. They may've started coasting. But the ones that didn't plan on leaving, they probably had to work harder. Whenever they interviewed me and asked me would I be willing to go to JSC-Houston, I said, "Absolutely not." I can't remember who my interviewer was, but he said, "You mean to tell me that you'd quit NASA rather than go on to Houston?"

And I said, "Absolutely." I said, "I've got children here in school, and I'm not going to uproot them and take them there. I know I can get by. I can probably go back to White Sands Missile Range. I don't know that I can, but I probably can. If not, I'll do one of my dreams. I'll start building houses, because Cruces is growing." So eventually, that's what I did anyway. It certainly impacted some people. Other people took it as an expected thing.

ROSS-NAZZAL: You remained on, and you actually served as the technical manager for the LTV contract. What were some of your duties as the technical manager?

BECKETT: Different. Being a technical manager, it's like playing a game of "I Spy." Even though you want to do the right thing, the atmosphere is such that, hey, I'm looking over your shoulder, and if I see anything wrong, you're going to get penalized. You just can't keep away from it. Maybe other people that have a different attitude than I do, maybe they can handle it better, but I always felt that I was selling people short from one side or the other. It was an incentive-type contract, and so therefore, the higher the grade, the more the contractor got. So that's what he was after, was a high grade.

The NASA people wanted a good job done, and they felt that reporting an activity would correct whatever they saw. If too many guys were huddled around the [water] cooler, then they would report that type of thing. Well, it can be a significant thing, but generally, it's nitpicking when you get to that level. If it's something real serious, then it was more worthy of passing on.

But when you had maybe ten complaints a month from an individual—maybe he would be seeing the same people spending too much time around the water fountain or in another guy's office where he didn't belong. And you constantly got that kind of input. It was reported all the time.

We had meetings as required to get all the inputs from the various people, and what I had was, I had a number of specific people picked to give me inputs from different areas and different disciplines, and we would meet, we would exchange ideas, exchange inputs. Then we would evaluate them and assign a grade, a grade that we thought would be fair and accurate. However, a lot of times the contractor didn't think it was fair and accurate at all, but that was part of life. But I felt that it was too much of overseeing in that type contract. I really didn't relish the idea.

The thing that's interesting about me being named the technical manager is that I don't ever remember losing my other duties. I think one of your questions is going to be reorganization. There were a lot of changes in organization all the time that we were out there, and nothing ever seemed to be official that, hey, you'd lose these duties and you assume these. It just seemed like every time you were given a new title, it was just, well, "You'll continue to doing what you're doing, except you'll also be doing this." So I never did consider that I was just a technical manager. I thought I was still the head of the ground support equipment, and I felt I was still head of the Mechanical Systems Branch. But I could be mistaken. I might have just thought I was head of the systems.

ROSS-NAZZAL: It makes sense that you're wearing two caps at once.

Well, in 1970, we read that they were going to officially close White Sands Test Facility. What were your thoughts at the time, when you heard that?

BECKETT: Well, I thought it was a mistake. I thought it would've been a mistake. We felt pretty

good about ourselves. We felt that we could do a job better than anybody else with fewer people. We were at a remote location where we could do a lot of hazardous jobs that they couldn't do at other places.

For instance, at JSC they had a thermochemical test unit, which was sort of a pilot test for things like we were doing at White Sands. Whenever they had an oxidizer spill down there, and they had a big—I'll call it a big blank red cloud, BFRC, it became a real serious situation down there. Well, we could have that at White Sands and not even notice it. The wind was primarily in one direction, and the facility was built that way so that that would be dispersed without incident. It wouldn't get back to the admin areas. So we knew we had a good facility remotely located to do the type of work that we were doing, and everyone here thought, "How could they possibly close us?" And I think it would've been a very, very bad mistake to have closed us at that point in time. We've done a lot of services for them since.

ROSS-NAZZAL: Do you remember about how many people were working at White Sands in 1970?

BECKETT: In 1970, no, I probably can't give you a real accurate number, but I would say that it was probably half of what we'd had before, and I think we had sixteen, eighteen hundred back when we started, so I would guess somewhere around a thousand, maybe eight hundred. Eight hundred to a thousand would be my guess. The contractor generally had four hundred people. NASA had a hundred and fifty probably at that time. That's five hundred. The cafeteria people. I don't know. Maybe seven [hundred] to a thousand.

ROSS-NAZZAL: You mentioned that you continued your duties as head of the Mechanical and Facilities Branch. Are there any specific programs or incidents or events that stick out in your mind during the 1970s that you worked on?

BECKETT: Well, the ADL [Apollo Design Limits] program, I think, is the one that came around in '69. When they started phasing out the contractors, I think North American left about the last part of 1966 or 1967. Their job was essentially complete. They were quite a bit ahead of Grumman because they had a contract longer. They finished their facilities first, so they were able to move in the heavyweight rigs and spacecraft #1, do all the functional testing a lot sooner [before] they even finished the 400 Area. So they were out first, then Grumman went out, probably in '69; at that same time, I don't know if it came up from White Sands Test Facility from the test that we had run or from the reports that they sent to JSC-Houston, [but] someone came up with, "Hey, we need to expand or increase our Apollo design limits test." They [called] it an ADL Program. And that was one of the things that was being done whenever I was the so-called tech [technical] manager.

It was kind of an interesting program. They had small tankage and short lines compared to the usual spacecraft configuration, but they tried to submit those Apollo engines to every conceivable off-design condition that there was. One in particular was almost outrageous. They had these small tanks with stainless steel coils through [them], and one of the tests was to run steam through [one] coil, while the other one they ran liquid nitrogen through. So here you had steam going through one tank and liquid nitrogen going through the coil in the other. You had boiling propellant in one and frozen propellant in the other. At least you had icy propellant. Then you would fire the engine. We never could make that engine fail. It always ran. It might not have been according to specifications, but it didn't fail. So that was a good program, because White Sands Test Facility engineers thought of every conceivable possibility that could happen and say, "Hey, let's test it." So they did. So that was one of the programs.

The Viking 2, I think, was another one that was done. It's where they simulated the Viking surface. They got a special dirt, [from a spectral] analysis, I guess, of Mars [that] showed that it had certain compounds, and they mixed up a special soil, trucked it in, put it in the bottom

of one of our [extended vacuum] chambers, and had a rail that they descended [with] the engine [firing] at the rate that they expected to land on Mars, to see what the effects of the dust was. So that was another program that they did that I think was very beneficial. I'm sure it paid off when they did land on Mars. They probably found a few things that we didn't know, but that was very beneficial.

During that period of time, we tried to do a lot of catch-up, particularly in the Mechanical Systems Branch. For years we were supporting all the time and didn't have time to correct drawings. We would just add mods [modifications] to the drawings, an addendum to it, and we never had time to go back and actually update the drawings. So we did a lot of updated drawings. We did a lot of checking of relief valves on pressure vessels. We did a lot of testing of the walls of the pressure vessels to try to find spots where there was corrosion. So we were pretty active.

The water systems, I don't know if you've ever been around a water system where it almost smells like a sewer and yet it's pure water, I mean clean water. Where that comes from is the iron ferrites that develop, and right on the bottom of the line will be just like you took a saw and ran a saw right down the bottom of the inside of the pipe, because it corrodes [in a fine line] at the bottom. That's where all the contaminants, the products of corrosion are, and it just got deeper and deeper, and eventually it'll start dripping through, because it gets [so] thin-walled in that particular area. So there was a lot of that going on. In all of our valve pits, we had to go in and replace a lot of the lines and valves, too, because they wear out. So we had a lot of maintenance activity during that period.

ROSS-NAZZAL: It sounds like there was a good deal of downtime so that you could do this maintenance.

BECKETT: Yes. Well, it was always a job, all the way through the program, it was always a task

to schedule your maintenance along with your R&D test. If you had a test scheduled for tomorrow at ten o'clock and then they postponed it into the time that you had allotted for doing maintenance work, then, of course, you would slide your maintenance work. But it was always a challenge to get both of them done, your test work plus your maintenance work, because they were always in conflict with one another.

ROSS-NAZZAL: In '76, you actually became the Space Shuttle site activation manager.

BECKETT: Yes.

ROSS-NAZZAL: What changes did you have to make to the facility so that you could begin testing of the OMS [Orbital Maneuvering System] and the RCS systems?

BECKETT: Well, first they had to change the propellant. They had used Aerozine 50, and then the new propellant was monomethyl hydrazine, so that was the first change. We knew that had to happen, and as a result, we had to get either get rid of the other propellant and clean it, and fill it full of the new one, or else we had to have a different tankage. So you had to start with a new source there, and then all piping, whether it was [oxidizer] or fuel, and the interface, when it came from the storage areas into the test stand area, all that had to be modified because it was an entirely different configuration. The Shuttle was an entirely different configuration than either the CSM [Command and Service] modules or both the LM ascent and descent modules. So the work was extensive inside the test chambers.

The altitude simulation system, when we started, only had thirteen minutes run capability, so during the Shuttle, if they wanted to run up to, say, an hour or so, we had to change the control circuitry and instrumentation so that we could operate off of one module on our steam generator, rather than all three.

The steam generator was composed of three rocket engines. The X-12s, I think was the name of it. What's the experimental plane? I think it was the X-12. All it was was modified injectors, and they fired the LOX [Liquid Oxygen] isopropyl alcohol mixture in [a spark plug] igniter, and it went down through a five-foot path, a cylinder, to produce 540 pounds per second of steam. There was a lot of power there. At the same time as we got combustion, we started trying to quench it to turn it into steam, so it was a real complicated situation. But we had to design it so that we could only use one module rather than the three that we'd previously used on the Apollo, and that was quite a change.

We had to use different size ejectors that create the vacuum on the altitude cans where you could test an engine. We had to have smaller ejectors rather than the big nine-foot ejectors. It came back down to a smaller size. So, you had to make the marriage fit. You had to make the facility that was designed for a 20,000-pound-thrust engine in one area, accommodate one that was only half that size. So it was about 10,000.

Let's see. Other changes. Of course, instrumentation. And in [the] blockhouses, we had to change the control panels entirely. The control panels that we'd used in Apollo [were] done by Grumman or North American, and here we had a different contractor, and we just completely redesigned all the consoles. We were busy.

ROSS-NAZZAL: It sounds like it. And did you still continue to work as head of the Mechanical and Facilities Branch? Were you still wearing both hats at the same time?

BECKETT: Boy, as far as I'm concerned, that never left me, but evidently, it had to, because I think if I broke away from the Mechanical Systems Branch, it was in 1976, from 1976 to 1978, because the manager had asked me in 1976, "Would you take the site activation manager for Shuttle?"

And I said, "Well, are you going to change my job description?"

He said, "Yes."

So evidently, they did, and I probably got away from it. I was so close to the systems and the facility, that I don't recall ever being away from it. I was head of what we called a "steam team," and that was, to me, my most cherished title, from all the time that I worked at White Sands. Whenever they addressed me as "Here comes the head of the 'steam team,'" well, boy, my chest swelled, and I was really proud of that, because that is what made that site unique, is to have a steam generator and its altitude system to work to the point where you could actually have a live firing of an engine, flying down into a diffuser that actually helped in the pumping, too, so that you had an atmosphere that was about 95 percent effective of true outer space.

So it was quite an accomplishment. It was a very complex, intriguing system. I think if you'd taken a vote, anybody would say the most complicated system, the most intriguing, the most unreliable is that steam generator, and they made a special team of us to work that until we got it so that it would support the mission.

Myself and Rudy [Rudolph G.] Gerdin were out of the Mechanical Systems Branch. Grady [E.] McCright and Don [Donald R.] Visness were out of the Electrical Branch. George [P.] Demchok and Rene De La Fuente were out of the Instrumentation Branch. Then we had two test conductors from Zia, the M&O contractor, and about six personnel that operated the consoles and so forth on the "steam team." But I'll tell you, we were a real organized bunch, and we really were proud of what we were doing, because it was different than all the rest of the site at that time.

Now, that was particularly true in '66, the latter part of '66 until 1968; when we really got into the testing, where we ran the fire-in-the-hole test, where they had a Mylar diaphragm across the diffuser, and it was wired so that whenever the engine would start, the Mylar diaphragm milliseconds later would be ruptured to simulate the ascent stage, taking off from the descent stage during an abort, or on the Moon's surface. The ascent stage was sitting right down on the descent stage, and they were worried about back pressure, that when that ascent engine

would fire, when it's hitting against something, what's the effect of the back pressure, and that's what we were trying to simulate. So it was all part of a real good program on our part. We were very proud that we were able to do those type of things.

I can't remember what the original question was.

ROSS-NAZZAL: No, no, you've answered all of my questions very well. …

Did the Space Shuttle Program have any other impact on White Sands Test Facility in terms of its mission or its goals or the facilities besides those which you've described?

BECKETT: Is the question did the original design have to be changed? Is that what your question is?

ROSS-NAZZAL: Did the facilities change besides the various descriptions that you gave—the propellants, the blockhouses? Were there any other facility changes or was there a change in terms of the mission?

BECKETT: Not that I recall. I'm sure that the technology had advanced some that they used different and more data points, but from the facilities standpoint of tankage and that, we had larger tanks than required, but yet you could still use them. We had larger pipes than were required, so we could still use that. So the only changes were downsizing to meet the specific size engine, so I don't think the mission of the site changed at all. We were able to fit it in very well, and I think that's one of the reasons why we were chosen. We were remote. This had to be done in a remote area, and we had people that were experienced in the type of propellants that were being used, so I think it was a very wise choice for JSC to pick us.

ROSS-NAZZAL: As the site activation manager, did you have anything to do with the

development of Northrup Strip [White Sands Missile Range]?

BECKETT: No. Some of the people that worked for me would arrange for a crane to go over and do some work, or a road grader, to develop that Northrup Strip. After a rain, in particular, they would actually grade the thing off, roll it, and it would be just like concrete. Very good landing strip. But Al [Alexander S.] Paczynski was the one that was primarily—he was out of the Propulsion Branch, and he was the one that was in charge of the operation over there. However, "Ski" [Carl F.] Radwanski, who worked for me, did a lot of work for him, you know, like on a loan basis. We didn't trade or loan, but Al would say, "Hey, we need a grader over. Will you do this and do that?" We said, "Sure." So my people would go get the job done for them. Again, we were strictly the support. We were the flunkies.

ROSS-NAZZAL: I wasn't sure about that, so I thought I would ask. This is probably a good time for us to take a quick break to change out our tape.

BECKETT: Sure.

[Tape change]

ROSS-NAZZAL: I'd like to finish talking about the seventies. During the 1970s, NASA really had to make do with fewer dollars. The Apollo Program was over, and the country was undergoing immense inflation. What impact did that have on the White Sands Test Facilities and its capabilities?

BECKETT: Well, we already were pretty lean. We were already on a starvation diet, so, in my opinion, things didn't change a whole lot because we were used to working with the limited

numbers and limited funds. We didn't always have a whole bunch of funds anyway, even in the good times, because most of the stuff we got was for a building that they recognized needed to be done. So our funds were pretty well consumed, I thought, by just management and the equipment that was required; the appropriations they gave to the contractor [was] probably [made] a long time before the need arrived to spend that money, but I didn't notice a whole lot of difference between, say, '68 and the seventies.

We were on the downhill side. We were still busy with all the functions I mentioned before—recalibrations, checking the relief valves, and checking wall thickness and corrosion, repairing the water systems. So we'd been doing as much of that as we possibly could with the funds that were available. And just because we didn't have program funds, we had our bare dollars, and that kept us busy. So from my standpoint, we weren't hurting too bad. We could keep the people that we had busy, and that was good.

ROSS-NAZZAL: In '78, there actually was a reduction in force out of White Sands Test Facility. Was there any indication that this might happen?

BECKETT: I'm sure there was. I retired in 1978, and I wasn't aware that they did have a reduction in force. Your e-mail kind of surprised me that there was a reduction in force. I wasn't aware of it. I'm sure that the people that were there—I don't know when it happened. Do you know what time of the year it happened?

ROSS-NAZZAL: No, I don't. I just was looking through some personnel records, and they mentioned RIFs. So I thought, "Oh, that's curious."

BECKETT: Well, I was the site activation manager at that time, and when July 1st came, that was the end of my site activation role, and for the next two or three weeks, I was just trying to clean

up all the loose ends that I had on Mechanical Systems Branch going all the way back, and drawings and notes and everything else.

By the way, I don't know how far you're going to carry this investigation in or accumulation of data, but we kept a daily record of everything that happened on that shift. When we worked a twenty-four-hour shift, all the guys that reported on different shifts would have our manual for our Mechanical Systems Branch, and every day in the time that something happened, that would be entered. And I assume that information is still available. However, when you talk to Ken Haynes, you might see what they did with that, because a lot of times they would label it, put it in boxes and put it in a warehouse, and that might be where it is, but there is a lot of information available on the activity on a day-to-day basis, hour-to-hour basis.

ROSS-NAZZAL: Well, that would be great for a historian wanting to know more about the facility. Why did you choose to retire from NASA at that point?

BECKETT: It was an opportunity that—I would've enjoyed staying. I enjoyed my job, so there wasn't anything wrong with me continuing. However, the building business had been great in Las Cruces. Las Cruces was growing. I was a native. I knew a lot of the bankers. I knew a lot of the people. And I thought, "Well, this is a good time for me to—." Since they had written a job description for me, and as soon as that job was over, and I'd foreseen this two years in advance, that I could walk out the gate because the responsibility for NASA was to provide me with a similar or an equal job, and if I didn't take it, well, I was free to go. They were going to have to release me. So I thought, well, this would be a good time to get out and do something else that I've wanted to do, and that was to do construction.

Solar was real big in 1973. There was an energy crisis, and all over the nation people were going to solar panels for hot water. They were going to solar panels to heat their houses. They were going to special orientation of the house to have the sunlight come in and hit the tile

floor and warm up during the day, and then radiate the heat out at night. There are all kinds of concepts on new construction. I thought, well, gee, I was sort of the forerunner in NASA at the White Sands Test Facility on solar energy savings, so I thought, "Well, I really got a place in construction where I can apply that." So when I saw the opportunity, I thought, "Well, I'll just become a home builder."

So when I did retire, that is when the economy got to the point where interest rates went up to 18 percent. You know, now they're down to 6 and 7. Well, I just got in at the wrong time. I built about five houses and some swimming pools and some solar collectors, a different type than on the market, like greenhouses. So it was a very satisfying time. But labor was such that they weren't trained well enough to suit me. They exasperated me. Whenever I would line up a special job for some of the guys on weekends because they wanted more money, and then [they] wouldn't show up, I'm the one that had to be putting up the sheetrock. I'm the one that had to do the taping. I'm the one that had to do the painting and all that, because I'd scheduled Saturday and Sunday to do this work for some people that were my personal friends, and my labor didn't show up. I said, "The heck with this." So that's whenever the opportunity came to become a consultant for NASA contractors.

But I retired because I felt I needed a change. I saw an opportunity. The opportunity didn't work out as well as I had hoped, although I did make money. People didn't really swing to solar like I thought they would, and so my dream of becoming a solar expert in the Southwest fizzled out, and I went back to work for the site.

ROSS-NAZZAL: That's unfortunate. You mentioned something that I thought was interesting, that you were a leader out at White Sands for the solar energy savings. Can you talk a little bit about your role at White Sands Test Facility in pursuing this?

BECKETT: Anything that came through after I became the facilities and mechanical systems,

when they combined them, I took over—in '73, they had edicts that you would not allow the temperature in the buildings to be higher than 68 degrees Fahrenheit in the wintertime and not be any cooler than, I think it was 82, unless it was done naturally. But you didn't go in and have the air conditioners running and bring it down to 72, like everybody wants to be. The temperature might have been 76. I think the comfort zone is from 68 in the wintertime to 76 in the summertime, according to the ASRHE. That's the American Society of Refrigeration and Heating Engineers. They have established that as a criteria that most people are comfortable in that temperature range.

So when JSC-Houston says, "You will follow the national guidelines," then my job was to see that that was put into procedures. When we built those buildings out there, we had them east and west, and they put in a metal screen between two pieces of glass. You could still see through it, because there was a slight angle which would catch the sun and heat that up and be like a radiator. Well, it just so happened that they were too much. It would get too hot. Everybody usually wants a desk by the window. Nobody wanted it next to our windows, because it was like a radiator, winter and the summer.

So there were other things, though, that we had to do to try to improve the quality of life as far as temperature was concerned. We had a few places that we made into outside eating—instead of eating in the cafeteria, they'd get their lunch and go outside and sit on a bench, that type thing, where they could bask in the sun.

But there were a lot of just general things on solar energy that I had to study to find out what the requirements were. I became interested—I took a course in solar energy out at the college, New Mexico State. I had a son working at Los Alamos [National Laboratory, New Mexico], University of California, and they had a program where they were studying solar energy, how to live subterranean, in caves, how to have heavy masses to catch the sunlight, and then reradiate. They told you about the smokestack phenomenon, where cold air would come into the—if you have a house, you should have your openings in your house as low as possible,

and then have your exits as high as possible so that natural convection would bring in the cooler air. It would come through your house and would rise and would exit at the top. So by a natural system, you would have good circulation. And that's what I was trying to put into my houses, those type of concepts.

There's a lot to be learned in solar energy. Some day they'll have it so that people will accept it. They'll be willing to draw a shade at night. They'll be willing to get up in the morning and open it in a certain position. But right now they won't do it. Right now they want the thing to be automatic.

ROSS-NAZZAL: You mentioned that you actually returned back to White Sands Test Facility because of the housing problem here in Las Cruces. What were some of your duties as an engineering consultant?

BECKETT: The first one was doing all the concrete work and the structural steel work, the tankage and piping for the high-energy laser program over at White Sands Missile Range. Lockheed [Aircraft Corporation] was our contractor at NASA, and they were also selected for jobs on White Sands Missile Range, and so Lockheed just took it over, I think with NASA's approval. "Can we go over and be the contractor at the high-energy level laser program?"

NASA agreed, and I was sent over there to do the actual design of all the concrete and the structural steel that TRW [Inc.] hadn't done up to that time. TRW was the prime contractor for Test Cell 1 at the laser site, and that only carried a certain distance, and then I had to add all the helium tankage, liquid nitrogen, liquid oxygen, all the stuff that we'd been working with for years, and I think that's why Lockheed was selected, because we'd been working at White Sands Test Facility with more of those dangerous and exotic liquids than what White Sands Missile Range had done. So we were sort of a natural.

And not only that first job, but all the jobs that followed. One of the reasons they would

always call me, and I was thankful for, was because I'd been through it before. I'd been through that before. And they'd say, "Well, that's why we want you."

"Well, why don't you go out and get a kid with a computer. He'll do you a faster job, and maybe a better job."

They said, "No, we'll stick with the old-timers."

So a lot of it was just repetition from one job to the next. That was the first job over there. Then later on we got jobs like the water systems. Every few years you have to change out all the corrosion problems, the lines, the valves. PVC [Poly Vinyl Chloride] became a problem for a while. When they started switching over to PVC for water lines, they [were] great [when] you let them cure long enough. Maybe you are familiar with PVC. [When you have a problem] and a plumber comes in, he fastens [the PVC with] that glue and gets up and says, "Well, that's $100," and he leaves. He said, "Go ahead and use your system."

Well, you shouldn't go ahead and use your system [right away]; particularly on jobs where you have tanks up 500 feet higher, maybe. And the hydraulic pressure, you open a valve and then close it. Boy, when that water's coming down and all of a sudden you close [the valve], you have a tremendous hydraulic spike, and it'll just blow those PVC pieces apart, because even though the PVC is strong enough itself, the joints aren't until that solvent is able to seal and solidify and cure for at least twenty-four hours or maybe forty-eight hours. But people don't treat it that way. Normally, you can get by with it, because usually you'll have a regulator or something that won't allow your pressure in your house to get above sixty-five pounds or eighty pounds. Well, when you have a source up there that could get you up to two hundred pounds and you don't have a regulator, it's kind of hazardous.

We ran into a lot of troubles with underground piping that way because we didn't know [about the curing times]. They'd go in and repair the lines, cement it together, backfill it. Then all of a sudden we would have a problem. Water would come seeping out of the ground or we couldn't get the water pressure in our areas because lines had blown apart.

Those are some of the jobs. My last job that I was out there on was the design and fabrication of two mol sieves units that went down to the Cape. At the Cape, they would order the propellants to the latest spec [specification] and try to get the best quality of material in. And it might be great when it came to the Cape, and they would put it in their storage tanks, and it would sit there for quite a while, and it would have a pad on it, a pad pressure [of] maybe twenty pounds or fifty pounds, and that should've been enough to keep moisture from coming in and getting into the system and backflowing, counterflowing to the normal flow. The propellant would be so hydroscopic, it would build up in water content. I guess people there, some of them may have understood it, but a lot of people didn't, said "How can that be?" But it does happen. Even though you have a higher upstream pressure, moisture will migrate against the pressure differential.

So it was a problem because they would [fill] the vehicle, maybe there'd be delays, maybe sometimes for quite a long period of time. Well, that oxidizer would get more and more moisture in it, and once it gets moisture, it turns to nitric acid, and then the corrosion rate goes exponentially. It really travels in a hurry. And I think that's one of the problems that they had on a lot of the RCS engines in outer space, where the Russians wouldn't even come on board because we had so many leaking RCS engines where the brown clouds kept coming out, that BFRC.

Whenever the propellant gets moisture, it just gets bad and becomes very corrosive. So they wanted to make sure that they had the best quality propellant at launch time. So this unit that I designed, I did two of them; they had the capability of putting them at their storage areas or right next to the vehicle where they could circulate this oxidizer [right up until launch]. What it was doing was like a water softener or deionizer, [it] has a gelatin-type material inside that has holes or cavities in it that are large enough for a molecule of water to go in, but not large enough for a molecule of oxidizer to go in. So the water would be trapped in this material. If you got moisture in there, the water would come along, and all of a sudden there'd be a cavity and the

water would go into it, and the oxidizer couldn't. So it'd be like a water softener where the propellant would keep getting cleaner and cleaner and cleaner, and then eventually it would detank, get rid of the oxidizer, dry out your gelatin and then be back in service again. It would operate like a water softener, except what it was doing was taking water out. So that's what we'd built and sent down to Cape Kennedy [Florida], and as far as I know, they're using them.

An interesting thing is following specs, you know, NASA's great for specifications, and one of these requirements was to build this thing so that it would be able to withstand a hurricane. There's a not a whole lot of data available except, I think, in one of the standards it says to design for 150-mile-a-hour winds. So that's what I did. I designed it for 150-mile-an-hour winds. Well, it came out like a tank. The design came out like a tank, and we built it like a tank, very, very strong, where it would take 150-mile-an-hour wind with the bolts the sizes that I used to go into their concrete pads down there. Well, after they got it down there, they said, "My god, that thing is huge. That thing is like a tank."

We said, "Well, the reason is, because you wanted it built for 150-mile-an-hour wind."

They said, "Oh, no." See, these are different people than what wrote the specs. And the ones that we'd talk to were the ones that wrote the specs, and that's why we built it that way. But whenever you start talking to the people that operate it on a day-to-day basis, they said, "Oh, no." They said, "If a hurricane comes up, we have plenty of warning. We'll take it into the hangar. Or what we'll do is we'll get a couple of tankers, semis, and we'll park one on each side of the other."

Well, that tanker wouldn't withstand 150-mile-an-hour wind. It would probably do part of the damage. But when you're talking to the people that are going to use it, and they see something so monstrous in size, they didn't want it. They wanted something lightweight and everything else. But you talk to different people, and you sure can get a different requirement. But that was my last job.

ROSS-NAZZAL: Sounds like a fun job. You had mentioned previously that the *Challenger* accident almost shut down the site for about a year, and I'm wondering if you could talk a little bit more about the impact of the *Challenger* accident on that test facility. Did White Sands Test Facility, for instance, participate in the investigation?

BECKETT: Of course, I was gone by then. I was on contract to do certain jobs off and on, and I really don't see how the impact of the [*Challenger*] would affect them since, I think, basically pretty early they knew what was wrong. There was hot gases going across the thermoplastic material [which] charred them—normally in warm weather, they would have the seals, and they had a number of them, and the hot gases only penetrated so far, and they never caused a failure, but I guess when they got down to 28 degrees or whatever the temperature was, the seals contracted enough to open the passageway more for the hot gases to get back [deeper than ever before] in nineteen seconds or whatever it was, [and] completely burn through.

I think they knew enough to not really change the requirements of White Sands, but since I wasn't a big part of the communications, and I was just strictly stuck over here somewhere doing a design job, I didn't realize that. I know it was a very sad thing to lose seven great people, but I don't remember any particular impact.

ROSS-NAZZAL: Okay. I thought I would ask since you were out there working with some of the contractors, in case you had some information for us.

BECKETT: An interesting thing happened that's sad about the Apollo-204 fire, the three astronauts that were killed there were also out at White Sands Test Facility to witness, monitor the firing of the first RCS engine, the thousand-pounders. You know, the RCS engines had four different categories, to my knowledge. They had thousand-pounders, they had a hundred-pounders, they had twenty-five-pounders, and they had ten-pounders. At the time, all we had

were the thousand-pounders, and [Roger B.] Chaffee, in particular, I remember, they wanted to get out as close to the test stand as possible so they could hear it and see it. In the blockhouse, all you could do is look out a window, and everybody was crowded around it, and they didn't feel they could get as good a view, and that was a no-no, to let people outside the blockhouse. For one thing, flying debris, if an explosion happened, but also sound. But because they were astronauts, just like in the fire, they got special favors. They got special materials put in there. Well, out here they got [a] special privilege to go out and witness the [firing of a thruster engine].

Well, as soon as that happened, everybody else wanted to go out, too: I was one of them. I wanted to go out, too, be with the astronauts. I wanted to hear what the thing sounded like out in true person. So we went out, and when they fired that thing, we were expecting it, and I was standing right behind Roger Chaffee, and when that thing went off, he must've jumped a foot and a half. He was really startled, as well as I was. I think I knew more what to expect, because we'd been through so many other type engine tests, and I knew it was going to be a long, hard bang, but I guess that was his first experience with one of those type things, and he was really unnerved.

Afterwards, he said, "My god, we're only going to be that far from that," the wall of the command module. And those three guys that night, they went out and partied and so forth, and that was all the conversation was about, "Boy, that thing is loud. That's going to burst your eardrums, and you won't be able to concentrate when you fire those RCS engines to change your attitude," and so forth.

Do you know, lo and behold, there was another problem came out there, and I don't know if it was originally intended, but where they tested these twenty-five-pounders and ten-pounders, in thousands of firings, they would fire and sit there [demonstrates] where they could actually inch—it was probably always in the design, but it became much more prevalent in their usage. I think, from then on, instead of using the big surges like that for their reaction control system to change their attitude up or down or sideways, they started using these little bitty

thrusters. To me, that was an interesting concept, because what they originally intended for them to use, the astronauts became very concerned about, and they probably had a lot of input into some of our testing out here on the smaller RCS engines, to get away from that.

ROSS-NAZZAL: That's an interesting story.

BECKETT: Well, it was interesting to meet those guys. And then later on, to have what happened happen. I thought about that many times.

ROSS-NAZZAL: I just have a couple more general questions about White Sands for you. While you were working out at the test facility, you worked under a number of different NASA managers, and I was wondering if you could comment about their management styles and working with them during the Apollo Program and the Space Shuttle Program.

BECKETT: Well, I knew all of them. The first two I really didn't know well enough because I was new, and I didn't have that much contact with them to be able to comment. Wes [Wesley] Messing was head of Administration, and I saw him. He was over in one building, we were in another, and I really didn't have any contact with him. He was the one that Ken Haynes reported to.

Let's see. Messing. Paul [E.] Purser. Messing was the first manager, and Paul Purser was the one that replaced him, because of this three-headed monster or four-headed monster. When Paul Purser came out, he got everybody on the same wavelength and got all the people reporting to him, and then he reported to JSC-Houston. Again, he wasn't here long enough for me to really be able to understand his technique or his management philosophy. He seemed like a real nice guy, and that's about all the contact I had with him.

The guy that replaced him, Martin Raines, he was an ex-military man, and he's probably

the one that I had the most interface with as far as duration. He let you know what he wanted. He was very direct, and I think he was very honest, but his being direct is the thing that impressed me more than anything else. He had someone work for him that I reported to, so I didn't have contact with him on an everyday basis, but I'd been around him a lot, and anytime that he found something that he didn't like, he would get to the bottom of it, and generally he wouldn't necessarily go through your supervisor. If it was serious enough for him to get interested, it was serious enough for him to talk to you directly. So I was on the carpet more than once.

And I'll just name a few that I had. The others that I worked with, and some of them as a consultant, I knew them all well. I think they all did their job well. They didn't have the same status in my mind as Martin Raines did, because Martin was an older, distinguished guy, white-haired like I am now, but back then he was very white-headed, very mature-acting, very polished, and his military background, I'm sure, gave him these qualities. But every time that I got into trouble, he had me in his office. And sometimes it was on the good side, not necessarily the bad side.

But one night—and we'd been working many, many hours, practically around the clock. Sometimes we'd put in twenty hours, sometimes sixteen, but usually always twelve hours a day. Put that time in, just had time to go home, eat, and go to sleep, come back the next day. I got home, went to bed, and about two o'clock in the morning the phone rang, and it was a good friend of mine who was a contractor, Jack Wyant. And he said, "Archie, the warehouse is closed, and we're down here." He said, "I'm not there, but my men are down there working on a LOX system, and they need a LOX clean gasket, and the warehouse is closed. We can't get it. What do you suggest I do?"

I guess I became unglued, and I didn't say anything derogatory towards him, but I just used some bad language. I said, "Get your butt or someone's butt out there, and get that warehouse open, because we've got a schedule to maintain." I could tell he didn't like that

command.

But the next day at eight o'clock, Martin Raines called me. We reported to work about seven o'clock to try to avoid all the traffic going to White Sands Missile Range. So he had me in his office at eight o'clock. Here was Jack Wyant, and Jack Wyant's contractor boss, the manager for Zia. He said, "Mr. Wyant tells me that you told him to get his butt out here last night. Where did you get the authority to do that?"

I said, "Well—."

He said, "Did you say that?" He liked to back his people, so he wanted to get the word from me that "No, I didn't say that," or some explanation.

I said, "If Jack Wyant said that I said that, then I did."

It kind of surprised him that it came out so quickly. So he excused the other gentlemen. He said, "I'll take care of this." [He] really ate me out because, he said, "You just don't talk to people like that. They're human and they've got feelings. They're our contractor. They're our servants, and you got to treat them with dignity and all that." Then he said, "But I probably would've done the same thing." You know, he's that type of a guy. So I really appreciated the guy.

Another thing that [I] felt so good about, I was talking to you about the "steam team." We'd been working for days and days, double shift, probably. It was on an Easter weekend, and I think it was 1966. It was Saturday. We worked all day Saturday, and at twelve o'clock, probably ten minutes till [midnight], he was still up at the site, and he got on the loudspeaker system and told everybody to report immediately to the blockhouse, that he had a message. He said such things as "as soon as your system is safe," or something, in other words, close the valve or whatever you have to do, and then come on in here.

So we went in, and he gave us a pep talk, and the pep talk was, "Boy, you guys have done a wonderful job. I didn't think that you could do it. We had a short period, and you did the repairs, and you've shown that the system is ready to go." He said, "I'll tell you what. We're

going to quit right now." He said, "I want you to put everything up, go home, get a good night's rest, have a good meal in the morning, maybe even take your family to church, and I want you to be back here at noon tomorrow." That was twelve hours. [Laughs] Twelve hours from the time he gave us that talk until he expected us to be back online, on the consoles, and support testing. I've heard that story told many times by different people, and all of us used different situations, but that is a story that I'll always remember, because he gave us a real, real good pep talk and then told us, "By god, in twelve hours, you better be back online," and that's not very long, not on Easter Sunday, anyway.

ROSS-NAZZAL: Any other memories of any other managers that you worked with, Jesse [C.] Jones or Ken [Kenneth B.] Gilbreath?

BECKETT: Well, yes. Some of them I'd rather keep private. [Beckett laughs. Many of them are my personal friends and I'd prefer not to compare their styles on the record.]

ROSS-NAZZAL: Tell us in general how White Sands Test Facility has changed since you started working there in '64.

BECKETT: It's a lot smaller. Well, it's a lot larger in equipment and buildings, but it's much smaller in personnel. Technological advances have made some of that possible. They have computers now at every engineer's desk, so what he can do is, [if] he wants to have a certain test performed, he can just sit there and type it up, put it in the format that he wants, he can do his own sketches, doesn't have to go through drafting. Drafting was always required if you had a drawing, and you couldn't get by with just a hand sketch. People would probably say you could, but what we had to do is we had to have them legible enough to be able to go in, to attest to all the drawings. I can't remember what the attachment was called, but it made it official. Once it

was in a certain format and attached to your original drawing, then you could go ahead and proceed to do the work, and that way you would have the record to come back and revise the drawing at a later date. But there was none of this hand sketches like I built houses with, but now the engineer can do a good job of doing his own good sketches that are acceptable from a construction standpoint.

So that is one thing that has helped, that you can get a job done easier with fewer people. Another is, on the control systems computers have made it so that computers are actually integrated into the operation so that you [don't] have to rely on humans to do it, so it's faster. It's probably more accurate. The data systems now are so much better, because then, if there was a conflict or a contest between the payroll issuance of funds to people and reducing the data, there was always a conflict. Whenever both requirements came up at the same time, they could only do one or the other, and generally payroll won out because people had to be paid, to keep the morale up and keep them going. You couldn't say, "Well, we'll pay you next week." That just isn't a governmentlike job. They would usually get the payroll out, and the data would have to suffer for a few days. I'm sure that you wouldn't run into that now. They have so much capability with just little hand-held computers, that you could get that job done. The data systems in those days took a huge, huge room with all the tapes spinning around and collecting the data. So that's another reason the acquisition systems can get things done better.

So I think the capability is much better for getting a job done with fewer people than it was when we first started out there. And I think that started in 1969 when the R&D contractors were finishing up and, they issued a—what do they call it when you go out for a contract?

ROSS-NAZZAL: RFP?

BECKETT: RFP? Is that what it is? Request for proposal. Yes, that's what it is. Whenever they issued a request for proposal, the R&D contractor didn't even respond, even though it was the

same type of work that they'd been doing through their home office. A conglomerate of LTV, Aerojet, and Service Technology won the contract, and I think Service Technology was a subsidiary of LTV's. What they did is they based their proposal on one engineer per discipline, where many times before [with] the R&D contractors, [a task] was a pretty big operation. They would have three and four mechanical engineers or electrical engineers assigned to a given task. That [way] they could have a faster schedule and probably more accurate, because they were relying on four heads instead of one.

But in the ADL programs and the programs in [1969], starting at that contract time, they had one engineer that was responsible for everything on that site in his discipline, and I think that trend continued on into the later years where they found out that they could get the job done. And if there wasn't a big schedule impact, that's the way they started operating. The fact is, I think they got to the point where they always underestimated their manpower to win a contract. I think after they won the contract, then they would rely—and I think NASA is probably aware of it, they would rely on the additional funds being provided for consultants like myself to get the job done whenever the need [arose] to have a special project done. So it's just an entirely different way of operating.

ROSS-NAZZAL: What do you think is your most challenging milestone in working for NASA?

BECKETT: My personal milestone was the steam jenny. That was the most challenging item I had, is to take a system that was a good system, basically a good system, but it had several places where it was a bad design or it had a design that wore out easily. They had relief valves as pressure-regulating devices. It was cheap. It would work, but the pressure, say, of the fluid, the LOX or the alcohol or the water, going to the modules where they had this hazardous combustion were just going like this [gestures], high pressure, low pressure, just back and forth, because that pressure relief valve was just sitting there flapping. It was wearing itself out, but it

was trying to maintain an average of whatever the set point was. And that was a bad situation, but that's the way it was bought, and that's the way we had to live with it for the first few weeks.

We started trying to get the improvements in where we [used] flow control valves that were long and tapered, and they would sit there and hunt and finally get on the pressure that you wanted. You [adjusted] everything so that you would have a smooth curve. Smooth curves get much better results than three fluids mixing together that all of them are doing this [gestures], because in one you would have a high pressure, and the other low pressure when they were coming into the small area where the combustion was. So it was a very challenging thing to get all the piping and all the controls done.

They also, in these modules that fired these—X-15 is what it was. It wasn't X-12. The X-15 engines. To get these things to fire, they had a very, very intricate system where they had first stage, second stage, and third stage combustion, and they relied on pressures building up before the second stage would cut in. They were called Barksdale's [switches]. That was a brand name. But they were spring-mounted, and those things would sit there and do this [gestures] when they were being actuated, and if they went up, fine, because good solid contact was made. But when they would flop down, they could de-energize the system, and it would shut down where you couldn't get past that stage. So what the electrical people came up with were snap switches where it was like a concave, that whenever the pressure would build up, it would build it up like this to a certain point [gestures], and then it would snap, and once it got into this position, you truly had to have a loss of pressure to have it come back. So it made the reliability much better, and, boy, [the] improvement in [the] operation of our steam system was here like this [gestures], and as soon as those pressure switch problems were overcome, our reliability took a big jump.

To me, the whole system was most challenging. We had a shutter valve that wasn't [in] when the system was first installed, and somebody—it wasn't me, but somebody realized that, hey, if we ever have a failure, this big gate valve that takes several seconds to close is not going

to protect our test article. That shockwave is going to start out here at the end of the [180]-feet-long ejectors. We had two ejectors. Each one was 90 feet long and connects [to each other]. It would take just milliseconds for [a shock wave] to start at the end of that, come back up the ejector system, up through the [diffuser], and it would just wipe out the test article. It would probably completely ruin the skirt. It would backflow and probably damage the engine.

So we said, "We can't have that," so we had to come up with a shutter valve, which was like a Venetian blind, that was here [gestures]. It was open where they'd be almost parallel with the flow, but they'd be slightly [cocked] so that they would close automatically if your electronics failed. Probably enough air would've gotten by to do damage, but they were cocked a little, just like a Venetian blind on your window. When air would come through, they'd go ahead and close.

But primarily you wanted it [to close] as soon as the steam pressure started dropping down from a failure, as soon as the pressure got down to 270, which was the criteria we established that would make the ejectors work. As soon as that pressure dropped down, then in milliseconds it had a signal that would slam the thing shut very rapidly. [The shutter valves were] very expensive, couple hundred thousand dollars at that time for each one. We put in two. They were an expensive mod, but necessary to protect [a test article]. It protected the vehicles many times during the remainder of the test period.

So part of the challenge was doing that, because we were on a time schedule as well as trying to make improvements that were reliable rather than just operate with a system that was a good system overall but had a bunch of weak joints [that] finally had to [be corrected].

You asked what was [my] most significant accomplishment, I think, in your e-mail, and I think getting the job done on that particular system was my biggest accomplishment. I was proud to have worked for NASA. I feel that it changed my ordinary life into an extraordinary life, because I have those memories of all the activity that we did out there, plus the fire, and meeting [the astronauts] personally. It was just a wonderful time of my life.

ROSS-NAZZAL: If you don't mind, would it be okay if I asked Rebecca and Sandra if they had any questions for you?

BECKETT: Sure. I don't mind.

ROSS-NAZZAL: All right.

WRIGHT: I've got one for you, and it's on that same topic you were just talking about. You spent so many years there, and you were doing different [jobs]. Can you share with us your thoughts of once you saw the astronauts land on the Moon?

BECKETT: Oh, man. Fantastic. Still is. We didn't have a lot to do out here at White Sands during the missions, but we kept ready to support. We were in standby, so to speak. We would load the tanks or whatever it was, pressurize up to helium pressure on the tanks to what they were supposed to be operating on, and then as we would get word of a certain change, we would change to try to be in position so that if something happened we could fire our engine. Like if they got around behind the Moon and all of a sudden they said, "Hey—." You couldn't hear, of course, then, because they had to come around from behind the Moon before you could hear them, but if a problem developed, we wanted to be in position where it would best support the mission, where we could do as fast as possible whatever we were requested to do.

Since we were so involved in the descent stage, more so even than the ascent, the ascent wasn't throttleable. It fired, and it just came on. It was off or on. The descent stage was [throttleable]. You're not old enough to remember, but when they came down [approaching the lunar surface], and they were hunting for a place [to land], they had it on the computer, and I guess [the computers] would recognize that it wasn't level, it was on a certain slope, and that

thing was only designed for a certain slope, or otherwise it would tip over. It was a very light bird, you know, spindly legs and everything else. Well, if there was a hole where one of the legs would go down the hole, it would be very topsy-turvy.

So the computer was looking for a good place to land, and they finally got down so I think they only had eight or ten seconds left in their propellant, and that's when [Neil A.] Armstrong is the one that had to take over manually, and he came on down and landed it. That was a miracle. I mean just a flat miracle. Eight seconds left after all that mission, to go ahead and find a place and drop down and be stable enough and level enough so that they could come back and mate with the mother ship, the command module. That was a very wonderful day.

WRIGHT: I'm sure all of you at White Sands must've taken great pride in knowing you contributed to that.

BECKETT: Oh yes, yes. The fact is, all these guys that I meet with all the time, we get into that same situation. You know, we have memories, and we recall some of the same situations out there where they were near misses, but yet you were successful.

I remember the time when we first supported the twelve-minute firing. When we first started off, I think it was twelve or thirteen minutes' duration, and we never could get very far, and that one time that the steam jenny supported their whole mission duty cycle, took up all of our time, and it was still successful. It was leaking badly, and we couldn't tell whether it was water or LOX, but there was a lot of vaporization where it hit hot metal, whatever it was. It would vaporize, so there's a big cloud [of something which] came up over our system. All we could see was the vapor, but yet all of our instrumentation told us it was in good shape or that it was working satisfactory, and we supported the mission. That was really a milestone. Very proud.

WRIGHT: Thank you.

ROSS-NAZZAL: Do you have anything, Sandra?

JOHNSON: No, not today.

ROSS-NAZZAL: Is there anything that you want to talk about, about White Sands that we might not have touched on, that we may have missed in our research?

BECKETT: Gosh, there's so much that I got into those—let's see. How many years was I out there? I know I was out there about fifteen as a NASA employee and twenty as a consultant. Of course, it was only part-time. Maybe continuously for three months, and then I'd be off for a week or two, or sometimes I'd work half-days. So I was out there a total of thirty-five years. There's so much I could talk about. It all wouldn't make sense anyway. [Laughs]

ROSS-NAZZAL: All right. Well, then, I guess we'll close.

BECKETT: Let me say just one thing. I'm proud to have worked on the Apollo Program, the space program, and also the Space Shuttle, and it reminds me of a saying I once read here a year or so ago. I'm proud to be an American. I'm proud to be an American that can serve his country, and that was in World War II. And I'm proud to be an American that was on [the] Apollo space program because Ameri*cans*, instead of Ameri*can't*s, are what made the space program possible. If you ever look at "American" and "Ameri*can*," it's amazing that they're spelled the same way. [Laughs]

ROSS-NAZZAL: You did a great service for this country, and thank you for sharing your

memories with us. We enjoyed it.

BECKETT: Okay. I appreciate it.

[End of interview]