NASA JOHNSON SPACE CENTER ORAL HISTORY PROJECT
EDITED ORAL HISTORY TRANSCRIPT

JACK L. WARREN
INTERVIEWED BY SANDRA JOHNSON
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JOHNSON: Today is August 12th, 2008. This interview with Jack Warren is being conducted for the Johnson Space Center Oral History Project. The interviewer is Sandra Johnson, assisted by Rebecca Hackler. I want to thank you for joining us today. I want to start today by asking you how you first became interested in working for NASA and a little bit about your background and your education.

WARREN: Actually from first grade through the twelfth I attended three different schools due to the fact that my dad was a football coach, or a coach of all sports, plus principal at just about all the schools that he was at. So we moved two different times going through school. I spent an extra year in the seventh grade due to the fact that I had a twin sister, and if I didn't have my homework I'd just copy hers. My dad switched schools at the end of my seventh grade, and made me take the seventh grade over at the new school. So, I graduated a year later than I should have and was able to get a basketball scholarship at a junior college, which helped him out, since we were both going to college at the same time.

I attended Texarkana Junior College [Texarkana, Texas] and I attended Stephen F. Austin State College [Nacogdoches, Texas]. I ended up marrying a girl by the name of Lloydine Cummings before I was through with my education. I did go back two different times, but I never got a degree, which did hurt later on in life.

After being married, I dropped out of school after one semester because of bills, and I worked for a year. Then I went back, and after one semester, I dropped out again. I had worked for Armco Steel [now known as AK Steelholding Corporation] almost a year, and I quit there and went back to school for another semester. When I stopped that semester I lacked 18 hours of advanced courses to get a teaching certificate. I came back home to the wife; she was living in League City [Texas] at the time. My wife [Lloydine Cummings now Warren] was teaching English, PE [Physical Education], and coaching basketball at Clear Creek High School. She was also singing at the Red Barn in Webster when she had time. So, I was there a lot to hear her sing and all these NASA people were coming in after their tests and celebrating. I got to know some of them, and they ended up getting me hired by Brown & Root-Northrop.

The reason I got hired is when I was in high school, at the age of 17, I started working on workover rigs in the oilfield, and I became a derrick man. They started me out in Building 32 [at JSC], which has a seven-story vacuum chamber. They needed people that didn't mind heights because we were climbing up and down those seven stories in the back panels, wiping them down, and I didn't mind heights. That's the way I actually got on, because the engineer that interviewed me had worked on an offshore rig. He knew how much mechanical engineering that you get just by being on a drilling platform, and knowing that I didn't mind heights, because most of the work for derrick men is either 60 to 90 feet above the ground, and all you have is a safety belt and a small platform to stand on.

So I started with Brown & Root in 1966, either June or July. I worked in Building 32 and we were called "chambermaids," because it was our job to keep Chamber A and Chamber B cleaned down, all seven stories on Chamber A and three stories on Chamber B, before each test. We were in charge of the instrument air and the chill water as well. We were the ones that

installed the Apollo [Command] and Service Module inside Chamber A. To get the Apollo spacecraft into Chamber A, it took four cranes, and you operated all four cranes at the same time. We also were in support of Chamber B, which held the LM [lunar Module] at that time. On that particular chamber the lid would come off of it, which required one large crane to get the lid off. Then the lunar Modular was lifted and placed into the Chamber onto a stand. The lid was then replaced..

I worked this area for approximately one year, or just after the [Apollo 1] accident at the Cape [Canaveral, Florida] where the crew was killed in a fire in the capsule. I was then assigned to Building 36 clean room, which is just one building over from 32. At that time this was the largest laminar flow clean room in the world. The lunar Modular was in this clean room being assembled and tested. My main job was to keep that clean room operating, but the second job was to take particle counts, three times a day, inside the Apollo spacecraft. Once they had the fire and they inspected the modular, they found things that were not suppose to be inside the capsule. So, now they were logging in all equipment that was carried in and taking particle counts of the spacecraft. All tools at that time started having to be tethered to your wrist, and there was no more tools dropped, all nuts and bolts were counted. So more or less that's what I was in charge of. I was there for about six to eight months, and then I was transferred over to Building 37, the Lunar Receiving Lab [laboratory, LRL].

The Lunar Receiving Lab building was complete and the labs were being assembled with their equipment. The lunar rocks were going to have to be processed underneath a vacuum. They were getting a team together at this time. I was able to get on this team. We were actually mechanical and electrical techs [technicians] and vacuum techs. I cannot tell you what year that the ORI [Operational Readiness Inspection] was accomplished, but the system was built in Oak

Ridge, Tennessee, brought here to JSC and assembled. And it had to pass an ORI, which is an operational readiness test, and after it passed that we were able to take over the system and start operating. For about four months before that, a couple of us were writing operation and maintenance manuals and studying the blueprints and numbering all the valves such that whenever we did take over the system, we would be ready and we knew exactly where everything was.

So it passed the ORI, but we didn't like the vacuum pressure that we were operating at 10^{-3}, so we completely tore the chamber system down and put it back together one piece at a time. We polished all the flanges and used new gaskets. We were able to reach a 10^{-6} vacuum, which was great at that time, on the whole system.

JOHNSON: Why didn't you like the way it was? Did it not reach that standard?

WARREN: It would only reach 10^{-3} in a static condition. If you were working, it wouldn't stay at 10^{-3}. The crew that put the system together had not leak checked the system and they had a lot of leaks. After leak checking the whole system, it was decided to disassemble the whole system and start over. This was because just about every flange leaked. Once we got the system back together, we could maintain 10^{-6} while working in the F-201 Chamber.

During all this time we were going to classes, to learn about the equipment and what the scientists thought that the astronauts might bring back. We were working out every day because when you work in the spacesuit gloves, you had atmosphere on one side and a vacuum on the other. This had you working against a differential pressure continuously. Most techs could only work from 15 to maybe 30 minutes, and they would have to come out of the chamber gloves and

somebody else would take over. There were two of us, a gentleman by the name of Jim [James W.] Bacak and I, and we were a little bit taller than the rest of them, which meant our arms were a bit longer and we could put our elbow on the back inside of the arm, and we could last an hour to an hour and a half, because we were using the back edge of the glove arm as a leverage point.

When it came time for Apollo 11, we were trying to decide what teams we were going to have and who was going to be on which shift and who was actually going to get to open the rock box. There were eight guys that had been there since day one, and what we did was, we drew straws. I was the lucky one, I got the shortest straw. So I was the one that was supposed to open the first rock box.

On that particular day it was very exciting. I think at that time we weren't Brown & Root-Northrop anymore, just Northrop Services. I was taken over to their office and interviewed by the *Chicago News*. They asked a bunch of questions, just like here. The one that I really remember is they wanted to know why I had named my daughter Reagan, and I said because I was watching Bonanza [a television series], I believe, and it had this beautiful lady on there as one of the actors, and her name on the show was Reagan. And I just thought, "Boy, that's a real nice name for a girl."

The day that the Apollo 11 samples came in, we were all waiting to process the box in. It came through three R cabinets [R-101, R-102, and R-103]. In the first cabinet, the two remaining bags were removed and the rock box got a UV [ultraviolet] soak. In the second cabinet the rock box got a peracetic acid spray and soak, then a filtered water rinse and soak, then an alcohol rinse. In the third cabinet a hot nitrogen purge was done to dry the container out. Chamber F-123 was brought back to atmosphere (all the F type chambers were vacuum chambers), and the transfer arm was swung around to R-103, the valve was opened, the rock box

moved it into F-123 (the rock box was on a monorail system). The valve was closed, the chamber was evacuated to 10^{-6}. Once at10^{-6}, valves were opened and the rock box was moved to the F-201 chamber which was the processing vacuum cabinet. At this point my backup, Monte [C.] Schwarz, removed the rock box from the monorail system and placed it on the floor of the F-201 cabinet. We switched out.

There was a gas analysis system that was on top of the F-201 system, and this was to monitor the gas inside the rock box. I attached the evacuation line from the gas system to the rock box. They evacuated the line and it was time to puncture the rock box. This mechanism was real heavy, and that was another reason they wanted either me or a gentleman by the name of Bob [R. D.] Eason to put this on. There was only about four of us who really could handle this mechanism and getting it onto the box working in these chamber gloves.

We tried several times to puncture the box. We never saw any changes in the gas chromatograph. We didn't think it was puncturing. But once we turned the box up and shined a light down into the hole where this puncture was supposed to be made, it looked like it had been punctured. After the fact we found out that it hadn't been punctured, but we decided to go ahead and open the rock box. So I removed the straps. The room was a roar because the room was packed with scientists and they were excited. The viewing room was packed with news men.

Our shift was over, but we would not leave, we were determined to get the box OPEN. It was exciting. So, as I was saying, I removed the straps, took a deep breath and OPENED the rock box. It was not as exciting as I had hoped for. I wanted to see something with color and bright and shiny. What we had was a bunch of loose soil. I thought that the impact on landing in the ocean had crushed the samples. I could see some large pieces, but they were all covered in a

light to dark gray soil. The room was really a roar now, the scientist were really chatting back and forth.

Of course as soon as we got the rock box open and out in front of the viewing plate, they let each one of the scientists come up and take look at the material inside the box. The next day whenever I came in, we were already in the process of vacuuming off the soil from the samples, putting the samples on the scale and weighing them, putting the samples on a stage and doing what they called RCL [Radiation Counting Laboratory] photos. Cameras from six different directions took photos while the stage moved up or down. Each set of photos would become a slice of the rock, then you could put all these slices together and get the measurements of that particular rock. They could make an aluminum form or a model of this particular rock, because all of these rocks were just about going to the Radiation Counting Lab, which was in the same building, but over 60 feet below the surface. This lab was trying to get the age of the rocks and needed to be away from the Earth's radiation.

This was done continuously every day, and it never got old. We did have the gloves rupture approximately three times, and these guys got quarantined along with the astronauts that were in quarantine. Same routine, over and over.

After Apollo 12 the processing was done in Dry Nitrogen Cabinets. Rocks and soils were being transferred to the labs downstairs. They were growing plants in lunar soil, were putting lunar soil in fish tanks and seeing what happened to the fish. They were exposing mice to the lunar soil to see what it might do to them or generations after them. Of course we couldn't keep track of all this going on because we were working 12-hour shifts upstairs. We never knew what all the experiments were or the results. We just knew we transferred lunar material downstairs.

In the vacuum lab we installed a new line of cabinets called the SNAP [Sterile Nitrogen Atmospheric Processing] line and downstairs we had NNPL [Non-Sterile Nitrogen Processing Line]. Apollo 13 had troubles and returned to Earth without landing on the Moon. On [Apollo] 14 through 17 I was assigned to NNPL downstairs. The upstairs group [SNAP] was processing the lunar sample that had been put into sealed containers, and the downstairs group was processing all the bagged samples that the astronauts had picked up. The bagged samples were samples in a Teflon bag that could be rolled up and the tag on the end could be folded around the end to keep it from undoing and spilling out. They of course took good data; where it came from, photographed it, put it in the bag, wrapped it up, and then put it in this larger backpack. It has a name, but I can't think of it at this point. That's the samples that we were doing in NNPL.

The large bag that held all the smaller collection bags came in triple bagged in Teflon and was weighed and documented. One bag was removed and the bag with the samples was transferred into the first cabinet. A dry nitrogen purge was started on this cabinet, for approximately five minutes. The large bag of samples was transferred to the next cabinet and the next bag was removed and placed into the first cabinet and the air lock closed. The bag that was removed was transferred out and weighed. The last bag was then removed and transferred out and weighed. This large bag with the samples was left in this cabinet with a purge on it. We then started processing per procedure, each one of the smaller bags.

As a small bag was removed it would be transferred to the next cabinet where it was weighed, the bag contents was put into a SS [stainless steel] tray and the bag weighed and transferred back out. The rock was brushed with a Teflon brush to remove as much soil as possible, then it was vacuumed to remove the rest of the soil. You then would containerize the soil, remove the vacuum filter and soil and containerize it separately, transfer all to the next

cabinet to be weighed, and clean up the cabinet that you just left to get it ready for the next sample from the large sample bag. The rock that was dusted starts a photograph series per a procedure. The removed material from this rock is weighed, packaged and stored. This process went on and on and on, until all the samples were done. At the end, all the bags had been weighed and all the sample had been weighed and it had to add up to the original weight that had come in on day one.

The further you went down the cabinet line the cleaner you got. But you have to understand if you're blowing and vacuuming a rock in one cabinet and then when you finally open this door there's a possibility of a little bit of contamination going into the second cabinet or third cabinet. Once the samples were containerized and bagged, they were passed to the end cabinet to be stored till needed to fulfill a request.

That's the way everything was done. When it went out from here, it got stored in a vault. That's the way we kept track of it all the way, and the SNAP line was doing the same thing. The sample container was entered into the cabinet line, weighed, opened, samples removed, container and bags weighed and transferred out, and we started the process on each bagged sample. The samples were dusted and moved to next cabinet, vacuumed and moved to the next cabinet, photographed and moved to the next cabinet, and then a scientist evaluated the sample and it was reweighed and stored. It was then held here until it was allocated to a scientist or some of it allocated to one of the labs on the first floor.

You had to work in shifts due to the fact that you could only stand up there and work so many hours, and then you would be relieved, take a break and then assigned something different for awhile. I'll stop there on Apollo 17.

JOHNSON: Before we go on to after Apollo, I have a couple of questions about those early days too, when you first started at NASA. You mentioned that one of the reasons you got the job is because you weren't afraid of heights, and you could work on those heights. But what you were doing was something you'd never done before as far as the cleaning and that sort of thing. What type of training did they give you to learn the process that they expected you to follow?

WARREN: Cleaning the chamber was just wiping it down. We were using de-ionized water, and we were using clean wipes. You've got to remember that the chamber is seven stories high. There was an entry on the first, third, and fifth floors. What you had was really a wall inside of a chamber, and the inner wall of Chamber A, they pumped liquid nitrogen and liquid helium into this wall to be used as a cold vacuum-pump. Since LN_2 [liquid nitrogen] is at -342° F [Fahrenheit] and helium is -400 and something, and once they got down to 10^{-4} to $[10]^{-6}$, then they would start pumping the cold liquid in, and as the molecules hit the walls they would stick to them. Also, between tests, the doors would be open and you had some dust coming in. It wasn't exactly filtered. So you had to wipe these walls down from the stuff that they pulled off of the test before. You have out-gassing from the Apollo spacecraft and service module, plus the stands and anything else that was in there. When you get to 10^{-6} everything starts out-gassing. All the molecules start coming off. They start sticking to the walls due to the cold temperature of the walls.

That's why we were called chambermaids; we were actually washing the walls down, more or less like window washers. We started at the top floor and we came down. Now if one of us slipped and fell, we only fell two floors. In between the walls you couldn't use a safety belt. So what we had was a steel chamber with one half inch steel pegs sticking out about two or

three inches. These held the wall material. They held a chrome-plated metal sheet that looks like the rolling metal that sits on a tin barn. That's what it looked like, except this was chrome-coated where it'd be easy to clean.

These pegs held these panels up, and we were able to stand on the pegs and walk up them and wipe the wall down. So we would go up to the highest point, and then we'd start wiping and coming down until we did the whole two floors. Then we'd set up and do the next two floors, till all was completed. It wasn't very exciting work, but needed to be done. I hired on in '66. I wasn't supposed to work any overtime for six weeks. After four days I was on overtime. I worked 7/12s [7 days a week, 12 hours a day] for four months before I got a regular day off. It was like that for five years. After five years, it slowed down, and I thought I was going to get to go back to college, and I applied to U of H [University of Houston, Texas], but since it had been five years they wouldn't take that many hours from Stephen F. Austin. So I just kept on working out at NASA and kept moving up.

JOHNSON: How many of you were in there at a time doing that cleaning?

WARREN: I would say that there was anywhere from 10 to 15 of us, because if you can imagine what the diameter of the Apollo spacecraft was, then the diameter of the chamber was probably 10 times that. So that was a huge area, and in one shift we were doing good if we could get two floors done of wiping it down.

JOHNSON: So it wasn't a quick process by any means.

WARREN: No. It would probably take a week just to wipe the chamber down.

JOHNSON: Was that after a test?

WARREN: That was right before a test.

JOHNSON: While the LRL was being built, and before it was built actually, there was a lot of controversy about whether it was going to be located here or not. Were you aware of any of that going on in your position? That that was coming and that it was something you wanted to move into?

WARREN: We did not know about the argument over where the site was going to be. That was before the time I hired on. What we knew at the time was, the building was being built on site and they were going to need people. I knew that I wanted to be in the vacuum systems part of our program. My best friend, Bob Eason, was in that section and I was in the mechanical section. This would be a chance to get into the vacuum section. We both applied for these openings for Building 37. All of the new hires were trying to get over to Building 37 because we were low man on the totem pole where we were.

I was not on the first crew that made it over to 37, but a bunch of my friends made it. They encouraged the staff in 37 to get me if they could, and they knew from several different things that had happened in [Building] 32 that they could use my experience. Actually 32 did not want to let me go, but I won out in the end.

JOHNSON: What type of things happened that they knew they could use your experience?

WARREN: Well, it was just like one day we had an emergency repressurization of Chamber A. If you had astronauts in the chamber and something happened, if their suit ripped or one of their wrists broke on their suit, you couldn't leave them in a vacuum and bring it down slow, it had to be done as soon as possible, and there was two ways to do it. You had to use just atmosphere and pop a valve and let it come up. Or, underneath the seven-story chamber there was a big chamber that had compressed air in it, and you could use the compressed air to bring it back up to atmosphere.

It just so happened, that one day we were in the pump room when we had an emergency repress. It went well, but they decided that it wasn't quite fast enough. So the next day they decided to have a planned repress using compressed air. It was much faster. One of the vacuum techs asked the engineer why it was a lot faster and the engineer asked the group. No one had the answer, but I was standing close by and had heard the question asked, and I said I knew the answer. He would not let me answer. He wanted to give them an evening to come up with the answer.

They had a meeting the next day and I was invited. No one had figured out the answer, so he asked me to give the answer, thinking that I would be wrong. The answer was too simple and was just overlooked. What the answer was, is the compressed gas molecules are closer together than ambient air molecules and the gas is going through and opening like an orifice. Once the compressed gas went through the orifice opening and into the large chamber under a vacuum, it would then expand and fill up the volume of the chamber. In the case of the ambient

air, it was being pulled into the chamber and the molecules were further apart and did not expand as much or as fast.

Another time they were lowering the Apollo module down onto the stand that was in the vacuum chamber. It was not level and the holes would not line up. They played around for several hours and I had made several comments, but no one paid attention. After awhile, the whole area was full of upper management and engineers. I got with the supervisor that hired me and had worked on a drilling rig like I had and I told him my idea. He agreed and went over to the head manager and told him what might solve the problem. He called the engineers over and suggested to them what needed to be done.

The spacecraft was being lifted by several cranes which could position the craft over the stand. The cranes were hooked to three cables that attached to a triangle lifting device. From this device three cables came down and attached to the spacecraft. The three lines coming down from the crane hook had adjusting devices; one on each one of them. The main problem was getting above the spacecraft. I managed to get the spacecraft adjusted to a level position and they got the Apollo spacecraft set on the stand and bolted down, and I got down. What had happened was that the lifting device had been sent to be certified and they had changed out one of the adjustment devices and had not gotten it back to the original position. So, I had the right answer again.

JOHNSON: You mentioned that in preparing for the Moon rocks there were some classes, and you worked to learn all the techniques and the different methods that you would use once the astronauts brought the samples back. Who was teaching those classes, and where did that information come from?

WARREN: Well, they had several of the PhDs give us a course in geology 101. We had this class twice a week for several hours, but most of the courses were ongoing through the operation and maintenance manuals that had come in with the equipment; blue prints of the building and the equipment. We had approximately four months before the ORI would be completed. At that point the lab would be turned over to Brown & Root-Northrop to operate. We had to know how the equipment worked and what its function was. By the time the ORI was to be done, we had procedures written, tags made out for all the valves in the system, and had a fair idea how everything worked. Several company reps [representatives] came out and demonstrated their equipment, and what problems might occur.

When we did get the system, we did have problems. Each had to be worked out. The main problem was that we needed to work at a lower pressure than what had passed in the ORI. We had too many small leaks. They had to be found and fixed. Also the monorail system to get the rock box down to the F-201 chamber where the work was to be done on the samples had to be rebuilt; had to be hand crafted.

It took a tech on the outside to operate the monorail system to bring up the next container or basket that you needed to put a sample into. All of this had to be tested out ahead of time, and the carousels—you're talking about something that looked like a star with eight arms coming off of it, eight monorails. It's double stacked. All that had to be welded together. Not all the rails would quite line up, so we aligned it multiple times, and what we did was once we came up with the maximum amount of rails that would line up, that's the way we left it. We would just say, "Okay, we can't put anything in these baskets on these rails, because they just don't quite line up with the rest of it."

So like I said, everything was just tested out: the weighing system, the photography system, monorail system and the vacuum system. The photography system was one of the most delicate systems. You had six cameras aligned to take photos at the same time. These were all focused at the same plane. You would place a sample on the stage and focus on the top section of the rock. Once focused and aligned, the stage would move up and micro-switches would stop the stage after it traveled to the next section of the sample. Photos would be taken and the stage would travel to the next section, till the whole rock was done. All micro-switches had to be set and locked down and tested. You had to have a tech in place to verify that the camera did take a shot and another to make sure that the flash went off. There was the possibility of a camera miss-fire, flash bulb burning out, camera out of film or missed feed, and the possibility of a micro-switch to quit working. After the photos were taken, they used them to be able to make a model of the rock.

Using the model, we could form a piece of aluminum [AL] foil around it, making an AL shell. For any sample that was to go to the RCL lab for getting the age of the sample, this shell [cleaned and sterilized] was placed around it and placed into a RCL container and transferred out to RCL. I can't tell you why exactly the AL shell was needed, other than to shield it from natural radiation.

So we just practiced over and over and over, and as I said, we went to a bunch of classes. The classes were really taking the operation and maintenance manual and going through them, section by section, till we knew them. We took one of the vacuum systems apart and tore down into sections, just to see how long it would take. Also, this would tell us what to expect that might go wrong in tearing down a pumping station that has gone bad. In some cases, we just bought spare pumps or sections, because it took too much time to repair and get back together.

Just disconnect, move out of the way and move in another and reconnect and start back up. This also helped us know actually what we would need for spare parts on hand. Everybody was trained on several systems where you would have plenty of backup for each system.

JOHNSON: About how many people were going to be working in that area?

WARREN: The electronics section was about approximately 10 to 15, and the mechanical section was 15 to 16. So you're talking about 26 guys working either the vacuum chambers or the processing nitrogen cabinets. It's according to whether you were in Apollo 11, 12, or 14 through 17. Once we stopped the vacuum processing, after Apollo 12, we had two processing lines, which took more people.

JOHNSON: What were the backgrounds for the other people that were working with you? Were they varied as far as their experiences?

WARREN: Everybody was varied. We had people that worked in Air Force electronics. We had people that were just in electronics. We had a slew of engineers. I would say for that system, we had six engineers, plus we had managers that were engineers and supervisors that were engineers. When we ran across a problem, everybody just came together and we just worked it out. Sometimes we didn't know the exact answer. Sometimes we would just try something. If that didn't work quite right, well, then we'd try something else.

JOHNSON: It was definitely an interesting time when you really didn't know what you would be facing. You were practicing for something that you didn't even really know what it was going to be when it got here.

WARREN: Yes. The first day when we opened that rock box and all we saw mainly was one or two rocks sticking up and the rest of it was loose soil, that wasn't what we were really expecting. We did have more rocks, but they were covered up.

JOHNSON: There was concern also when they were building the LRL and some of the controversy over the possibility of back contamination and the contamination not only from the Moon rocks, but contamination of the samples from everything else. Of course that's why everything had to be pristine. The fear of that contamination, when some people said we didn't have to worry about it and others thought that we needed to have everything in place in case there were some bugs from space, was that ever a concern for the group, for you personally, or your family?

WARREN: I don't think my wife and I ever even discussed it. As far as the processing group that was getting the sample out to other groups, I do not think that it was a problem to any of them. What you have to realize is that there was a lot of other groups of people in the processing side of the barrier. You had us, the plant people, the animal people, the scientists, and health and safety personnel, the personnel that processed in the materials to support the labs and the personnel that did the laundry. You had to change cloths to go back and shower on the way out.

They had, cameras everywhere making sure that you showered on the way out. They

didn't watch you—I mean they just made sure that you went through the shower room. Whether you got showered or not, they didn't have a camera on you taking a shower. But on the way in, they wanted to make sure we didn't contaminate the samples, so you changed clothes and then you went through a UV hall. That was not a very long distance. We just had to walk through it. I believe that's the way it was. Then you showered on the way out.

I don't think that I ever worried about it, I don't know why. NASA had landed a craft on the Moon earlier and it had a camera on it. During one of the Apollo missions, the crew went to this location and retrieved this camera. It turns out that it had a virus on it; a bacterial-type virus. When they got it back, they tested it. It turns out the guy that assembled it had had a cold. That virus lived on the Moon's atmosphere and was brought all the way back to us, and we discovered it. So what can live out there and what can't, nobody can say. That virus survived it, the Moon's atmosphere. That means there could have been anything there. Any time we bring something back that has to be considered. So, maybe today, I would have a different attitude about it.

But as far as us worrying about it, I don't believe anybody in my team was really worried. We just got to thinking about how hot it is, how cold it is, there's no atmosphere, and there's no water. Well, we didn't think there was any water. I don't know. We just didn't think that it could survive. But nowadays we know a lot more. Anything can survive, a lot more than what we think it can. We did have to sign a waiver.

JOHNSON: Did you?

WARREN: Yes. I believe we signed a waiver saying that if we did get quarantined, we could only be paid eight hours a day, and that kind of stuff. If there was a medical problem they would

take care of us, but we couldn't sue NASA because of it. I swear I signed that type of waiver. I can't be positive now. That's too many years ago.

JOHNSON: Probably in a record somewhere. Well, you mentioned the showering in and out and that sort of thing. So there were a lot of precautions taken to keep everything as pristine on the inside also.

WARREN: Right. We tried to keep contamination away from the samples. We tried to keep any contamination from samples coming towards us. Everything that went in went through at least a UV system. The food for the animals was autoclaved in. All your tools and instruments were autoclaved in. Then, like I said, we walked through a UV lamp to go in, and we were in surgical-type clothes and had a gas mask on our hip ready to put on if there was a spill. Then on our way out we had to shower, and we would change back into our regular clothes. All of the clothes that we had on, they didn't come to the original side, they stayed on the lunar side, and they were autoclaved before they were sent out to be washed. So every time we went in, we had on a new set of clothes.

JOHNSON: Did that process, as far as what you wore and protection, change during Apollo, or did that pretty much stay the same all the way through?

WARREN: It stayed the same through Apollo 12. After Apollo 12 we just wore regular clothes with company emblems.

JOHNSON: That's interesting. You mentioned that you were working long hours for about a five-year period, 12 hours a day pretty much every day.

WARREN: Oh yes. We started out that first year in '66, '67, it was almost 7/12s all the time. But that was when I was over in Building 32. When we went to Building 37 and started on the lunar project, there was a lot of overtime there, but we finally went to 10s instead of 12s, and we ran a 3-shift operation and overlapped the shifts, because we were just working too many hours trying to get ready. We had to be ready before [Apollo] 11 launched. In fact, we had to be ready well before each launch, so we had to work a lot of overtime.

At some period, I think after Apollo 12, we went to ten hours days. Because we just weren't getting any time off. You start making a few mistakes. One of the mistakes was we had lost a lamp on a desk lamp. We were taking data every hour and plotting it on a chart. The pump room was kind of dark and like I said, the lamp burned out. Someone went to the tool crib and got a replacement and it was installed. After a few hours our eyes began to burn, but no one said anything because we just thought that we were tired. You know taking reading every hour and plotting is pretty boring. Anyhow, I went home and had slept about four hours and my eyes were really hurting and it woke me up. I could not open my eye lids. I had to force them open. At this point I called out to work to tell them they needed to check the bulb in the lamp. It was a UV bulb that had been installed into the lamp. I went to the doctor around 7:00. You know, having two kids, you get to know the doctors real well. Our crew was called in early for the next shift so that we could be checked out by the NASA doctors.

At this point they decided that we were going to start getting at least one weekend out of the month off. This was staggered where they could keep the shifts going.

JOHNSON: I know from some of the other people we've interviewed in different areas, everyone was working those long hours, especially during Apollo. Sometimes it was stressful for the families having to take up the slack, and a lot of people talk about how much support they got from their families. Did you notice that too with everyone, that the family was taking up the slack?

WARREN: Oh, yes. My wife was a teacher/coach. She was teaching basketball at first, and then volleyball later on in Clear Creek [Independent School District, Houston, Texas] school system. She more or less just had to run the whole household, because all I was doing was working all the time. Either I was trying to get as much sleep as I could—and then at one point we had our daughter, and that meant she was trying to teach and take care of the kid and get her here and get her there, and the whole load was on her. While she was pregnant it was really hard, because I'm at work all day and she has nobody to talk to, I come home and all I want to do is sleep. She wanted to play cards. She wanted some of my time. That's the way it was.

But our section was like—gosh, a team. It was a family thing. Any time that we had a weekend off it wasn't just us, we all got together. That was the main thing. When we would be running tests, we all met at Vernon's Pizza or the Red Barn afterwards and we celebrated. All the wives got to know each other, and all the guys already knew each other—so a lot of times when we saw that we were going to have a weekend off, we all went to the beach. There'd be 10 or 15 families meeting at the beach at a certain place. You weren't really on your own. If you had a problem, other families were helping you. Especially in the vacuum section, those people, they were really like a family as a whole. It wasn't just one family, it was a team of families, and

when somebody was having problems or you couldn't get one of your kids to the doctor and the other one to music, you just called one of the team and they would say, "Oh yes, I'm off, I can do that." We all worked as a team.

Back in Apollo, in '66, the Russians put up Sputnik [satellite], and all of a sudden it wasn't this department, or that department, or this. NASA, to me, became one team, and we made a mad rush. We had to get up there, and we had to get on the Moon.

Like you said, we worked a lot of hours, but we worked together. If there was a problem and we might not have money for overtime, people worked without being paid, on several different occasions. We were putting 14, 16 hours in. You couldn't put that many hours down on your paycheck, but you wanted to get the project handled and on down the line. So, I think that NASA was more of a team back then than what they are today. Everybody's got their sections now. They're still teams because later on in this interview you'll find out that we have a good team in this building [Building 31], when we did Genesis and Stardust, we are always kidding about A team and B team.

JOHNSON: I know when there is a goal like the President [John F. Kennedy] put forth to land on the Moon before the decade was out, a goal like that will inspire people to work together.

WARREN: Yes, and we did, as far as I'm concerned. It was a team effort.

JOHNSON: Did you live in a community with a lot of other NASA people?

WARREN: I didn't know the NASA people as well as I knew the contractor people that I was working with.

JOHNSON: By NASA I meant both [civil servants and contractors].

WARREN: The contractor people. Yes, actually most of the guys at that time—well, no, it was about 50/50. Fifty percent of them were in apartment complexes. I know in one complex next to me there were at least five guys in it, which was good, because they could ride together. Then when they had time off, they had something that they could do together. I was within two blocks of that apartment. Then there were two other guys that had houses within eight or ten blocks of us. But as far as being in like the Baybrook section, no, it wasn't built up that much. All of us were in League City [Texas], because your engineers and NASA upper management were in Nassau Bay [across from JSC], and at that time we couldn't afford anything like that, so we were in League City, and we were mainly in apartment complexes or renting.

JOHNSON: I know a lot of the neighborhoods and the areas around—because there was such a concentration, and they were all building up because of NASA—a lot of people tended to live close together and work together.

WARREN: This is true. Kemah, Seabrook, El Lago, Nassau Bay, Webster, and League City. I believe that Interstate 45 South was only two lanes or they were working on it and it was down to two lanes. You know if you are working 12 hours a day and almost 7 days a week, you do not want to live too far away from work. So yes, we were all together in this location. And yes, a lot

of the families were close. Another thing, a lot of the people were recruited from other locations, so once they got on they would get their friends on also, then live in the same area.

JOHNSON: The Seabrook area had some communities.

WARREN: Seabrook area, and El Lago is what I was trying to think of. I would say El Lago was a main one, and then you had Nassau Bay, and then the small towns were Kemah, and Seabrook, and then League City, Webster, and then there wasn't anything else. So I guess you would say that most of us lived in League City.

JOHNSON: You mentioned that there was some contamination from some of the workers during—was it after Apollo 11 that happened? You said that some of them had to go into quarantine with the astronauts.

WARREN: Yes.

JOHNSON: What was the process once that happened or once they were aware that they'd been contaminated or cross-contaminated?

WARREN: As soon as the gloves on Chamber 201 were breached, or the gloves in one of the cabinets downstairs—I think a needle punctured one of the gloves where they were maybe working with the mice in one of the first floor labs—there would be an alarm, that meant that someone had breached a system and they and others might have been exposed to lunar material.

Everyone would get their mask on and stay where they were. Safety would get to the breached area and make an assessment. If they were exposed, then they were walked down to the quarantine area and let in. The building was almost divided in half.

Then the safety people would come back and they would—I don't know exactly what kind of equipment they had to try to figure out what was contaminated and what wasn't. But I think they went around and sprayed everything down with something.

I was close to being one of them. I think it's about the second or third weekend to Apollo 11. My gloves ruptured, but John [E.] Powers was my backup, he was about 6'3", 240 [pounds], and he grabbed me and pulled me out of those gloves real quick, and we slapped the covers on real quick, and the outer rubber gloves didn't rupture. So that meant that even though my hard glove broke, since the rubber outer gloves, the protection gloves for the spacesuit arms didn't rupture, then we didn't get any of the lunar dust. He reacted so quick that we were able to do that, where when the other ones ruptured with some of the other techs the actual protection Viton glove actually ruptured. That meant that it sucked in the room air and then it blew a lot of it back out, along with lunar dust and some sample was released to the room, and they got contaminated. So they had to go into quarantine.

Ron [Ronald S.] Buffum was one of the guys that got quarantined. He still works here on site. Maybe not today, but I know he was here last year. One of the other guys was [Robert] George Williamson. He has passed away. I think we had a couple others. I know we had a couple of others get quarantined, but that's so many years ago I can't remember who they were.

JOHNSON: If it was released back, did you then have to seal the room and clean the room and do everything all over again?

WARREN: Yes. We never got to see that done. So I don't know exactly what they did. Safety took care of that.

JOHNSON: When the lunar samples returned and you opened that canister, did you ever have anything to do with the film canisters that were coming back, the first photos taken on the Moon?

WARREN: No.

JOHNSON: The vacuum storage system—from our notes, it looked like it was replaced around 1970 by the Sample Storage and Processing Lab, and they were then stored in pure nitrogen containers. How did that affect the work at the LRL and what you were doing, if at all?

WARREN: I think that some of the containers that were sealed under a vacuum are still under a vacuum even today. What I mean is the containers that we used for the vacuum chambers were stainless steel heavy duty containers. If you seal a container under a vacuum and then bring it out to atmosphere pressure, it will collapse due to the pressure that the atmosphere put on the container, if the container is not strong enough. We used the same containers with the GN_2 [gaseous nitrogen] cabinets. This was due to the amount of containers that we had bought and the expense of these containers. Sealing a sample in a Nitrogen Cabinet was usually at a positive pressure of 1 inch water gage pressure which is 0.036 psi [pounds per square inch]. The oxygen level is supposed to be less than 20 ppm [parts per million] and the water level was to be less than 50 ppm. This was to keep the samples from rusting. So, with the GN_2 cabinets, after using

all the heavy duty stuff, we went to a lighter container. The sample was Teflon bagged and the put into a container or put into a container and some Teflon sheeting put in with it for cushioning material. Then the container was triple bagged and stored.

JOHNSON: You mentioned that when you were working under that light and actually had that UV exposure, but you were cataloging everything as it was done, is that correct?

WARREN: What we were doing was baking the chambers out. This was a method of removing hydrocarbons from the chamber walls. You pull a vacuum on the chambers, then install form fitting heaters and blankets [insulating], apply electrical and bring the chambers up to 475 degrees Fahrenheit. This turns the hydrocarbons to a gas and it is evacuated from the system. We had liquid nitrogen cold traps in the vacuum line just above the vacuum pumps that would re-condense the gas back to a solid. You had to maintain this temperature for several days, so we were getting the readings off the thermocouples that were attached to each chamber. These were recorded and plotted. Variac [variable autotransformers] for each blanket were adjusted according to the readings you got. It would take you approximately 45 minutes to do it all. You'd have a 15-minute break, and then you'd start over again.

JOHNSON: How large were those vacuum chambers?

WARREN: I would say that F-201, which was the main processing cabinet, was approximately 4 foot tall, 4 to 5 foot wide. The depth was probably 4 foot. The transfer tubes were about 16

inches in diameter, maybe 20 and 3 to 4 foot long. The carousels were about 5 foot in diameter and about 5 foot tall. That's the main storage chamber. It was sitting on a rolling cart.

We also had one, F-601. F-601 had a manipulator in it, and it was a vacuum chamber inside of a vacuum chamber. What they were trying to do there was seal some sample in containers at an ultra-high vacuum. You would pull both of the chambers down at the same time. But with having a vacuum chamber on the outside and an inner vacuum chamber, you didn't have all this pressure of these molecules trying to get through any leak that you might have. The inner chamber had some real sophisticated ion pumps in it. The meter on the inner chamber just read less than10^{-8}. We knew we were better than 10^{-8}, and we were thinking we were somewhere around 10^{-10}. It could have been even further. At that time they didn't have any instrument that could read it.

The sample was placed into a special cup and transferred into the inner chamber and placed in the center. The manipulator was used to pick up the cup and place it into a Varian valve assembly. This assembly was a large cylinder type container with a Varian valve at the top and an ion pump attached to the bottom. This assembly was attached to the inner chamber on the bottom. The valve stem came through the outer chamber bottom bell and was sealed with an 'O' ring compression fitting. Once you placed the cup with the sample in it down into the Varian canister and released the cup and removed the manipulator, you could close the valve and turn on the ion pump. These assembles could be removed and attached to a pumping station. I think there was about eight of these on that F-601 chamber. I do not know what ever happen to these containers.

JOHNSON: Actually cleaning those chambers and getting them prepared too was another process that I've read that you were involved in.

WARREN: Okay, yes. Those chambers, I don't know how we'd clean them nowadays. What we used back in those days is completely illegal nowadays. We used a benzene-methanol mixture. I think it was about three-to-one or four-to-one benzene to methanol [ratio]. Benzene evaporates so fast that it causes a chill condition which takes moisture out of the air and leaves water wherever it evaporated. So you needed the methanol to absorb the water, or you spotted everything. But we used benzene-methanol.

The pumping headers were removed and swabbed with this solution. This piping was taken outside of Building 37 to have this done. Of course everything as soon as you cleaned it was bagged, then brought inside and swabbed down with distilled Freon 113 and a GN_2 purge put on the pipe to dry it out.

When we got down to Apollo 11 and it was getting close for it to launch, we took the smallest guy available, who was a gentleman by the name of Dan [Daniel I.] Jezek, and we sent him into the chamber system. He was small enough to get down that transfer tube. He was the only one that I know could have done it. He swabbed down the whole inner area. We had taken all of the viewing glass windows out, and we had a good purge going in. He also had a mask on where he wouldn't be breathing all that benzene-methanol. A good circulation of air. He swabbed down the whole area and started backing back out and swabbing as he was going. As he was doing that, we were putting up ultraclean cloth over all the openings such that you could still have a breathing area, but nothing could go inside the chamber and re-contaminate it.

A soon as we got him out, we started a good purge on the chambers with GN_2, that's another reason he was having to wear an air line and a mask, was because we were purging with GN_2 the whole time that he was in the chambers. We had people there to get him out if he had a problem. Actually, I think we had the transfer tube off. We cleaned it and put it back in, and F-123 we had the R cabinets off such that we could clean that. After the benzene swabbing of the chambers and the vacuum headers got a heavy rinsing with distilled Freon 113. So it was cleaned right before Apollo 11. For 12, I don't know if it was done right before it or not.

JOHNSON: You mentioned after you opened the Apollo 11 samples, and then you and your team did the work that you needed to do on them, and then you backed off and let the scientists come in, and I know when they were building the LRL and as to the design and everything there was some back-and-forth between the engineers and the scientists on what they should and shouldn't do. What was your relationship like with the scientific community or the ones that were involved? How did that work between your area and those folks?

WARREN: The scientific people—the best way I can explain that is that we knew who they were. We knew who they were because they have given some geology 101 classes The scientists themselves, they were down on the first floor where they had their labs to do their experiments, and they usually had some university tech working with them. So we didn't have that much time with them—we knew each other and we spoke to each other, but that was about it as far as the scientific. Now we did work with, like I told you, we were going to pull the gas-analysis sample off of the ALSRC, the rock box, before we opened it. We knew who the lead scientist was, but

we worked mainly with the university tech that was working with him more than we did with the scientist himself.

JOHNSON: So you just had somewhat of a working relationship.

WARREN: Yes. But by the time Apollo 17 rolled around, well, everybody knew everybody.

JOHNSON: You also worked on those lunar sample information catalogs for the Apollo missions, as far as cataloging the information. Your name appeared on a lot of those. Do you have any memory of that? Or does that ring a bell?

WARREN: Well, no, I think what happens there on the lunar catalog is that since we did the photography and we did the weighing, they just gave us the respect that we worked on it and just put our name on the catalogs. So if you were working on SNAP line you got a certain set of samples, and you carried them from day one all the way to when they got packaged up and stored. So you were doing the dusting, the cleaning, the data work, and the photography, and putting them in a container and sealing it and getting it out. Then they would take that data and make a catalog out of it, and just in respect that we did the work they just put our name on the catalog. So I really can't tell you much about it.

JOHNSON: I know the universities and those kinds of folks were coming in to get samples to work on, and experiments and things being transferred to other universities. Did you have anything to do with any of that?

WARREN: You get scientists from different universities. They were to do a certain experiment and usually brought in their own equipment. It was decided who would be working with them and these technicians would study the info about the test and go over the photos of the equipment. Maybe have several meetings with the scientist and then put the equipment together. At this point the scientist would run the test and the techs supported him or the techs ran the operation with the scientist in the background getting all the data.

In some cases you would just have a scientist come to visit and watch you do his allocation. Usually he would have looked at the rock photos and he wanted a particular piece of the sample, so he would be there to make sure that he got what he wanted. Just a note, while working on a sample, if a piece comes off of the rock, you have to do photography of the piece and where it came off of the rock. One thing that we did was take lots of photos to back us up. You took photos as you first got the sample out, during the allocation, any abnormality, and again as you were packaging it back up for storage, after the allocation. You just don't get things done too quick. Lots of documentation has to be done when you get a sample out. Besides the photos you have to weigh the sample several times during a sample allocation.

JOHNSON: We've been going about an hour, a little over an hour and a half. If you'd like, we can go ahead and stop for a minute and just see where we are.

WARREN: Yes, that's fine with me too.

[pause]

JOHNSON: So we're going to talk some more about the Apollo program. As the program was winding down and the missions were coming to an end, what were you doing at that point at the end of the Apollo program? Were you just continuing to process these rocks as they came back and the materials? Did that continue long after Apollo, the actual missions ended?

WARREN: Yes, we're still doing it right now. In the background here [points to the lab behind a window], what you're looking at is the new Lunar Receiving Laboratory, I guess you would say. We have approximately eight stainless-steel cabinets set there such that we can process the same mission in more than one cabinet, but yet we have a cabinet for each mission so that we don't have any cross-contamination. Where we used to have up to ten or twelve people working in the lab, we're down to three people working in the lunar lab. But there's also two other people working in the meteorite lab. There are two people working in Stardust and Cosmic Dust. If there was a big push, all of us could be brought back as processors into one lab.

So yes, even after the Apollo Program did wind down, we've been processing lunar samples ever since. The reason for that is that every year instrumentation gets better and better, so as the universities can afford to purchase these instruments, and they get them on hand, and tested out, they want to retest the same samples they did before to make sure that the data that they got was good and they don't need to rewrite their papers. So the lunar program goes on and will keep on going on.

In 1970, at the end of the Apollo Program, I left for four months and went out to Texas Instruments. Texas Instruments offered a three-day workweek. It was a 12-hour shift. That looked really great. I was still living in League City. It took me an hour to get there and an hour

to get back, which gives you a 14-hour day. What they didn't tell you when you were hired on was that they specified what three days they wanted you to work, and mine turned out to be Thursday, Friday, and Saturday, and my wife is a schoolteacher. I never got to see my family. Also, they wanted you to work overtime which made me have to work Sundays and Mondays too. After about four months, I got a call saying that if I would show up for a visit at NASA in Building 31, I would be asked to hire back on with Northrop Services.

I showed up to visit with the troops and as I was told, a new Northrop manager came up to me, introduced himself and took me to his office. He said that NASA personnel in the lunar program wanted me back and that he had talked to his upper management and that all that he could do at the time was offer me my old job back. But, if I was as good as NASA thought, he would promote me up the ladder starting in six months. He was true to his word.

During the time that I was gone, they moved from 37 to Building 31. The lunar lab, what is now the meteorite lab, was in that area. During the cleaning of one of the cabinets to turn it around for another mission, we had a small fire because we were using deionized water and soap to wash the cabinet, and then we used isopropyl alcohol to remove the water. In the process of doing this, we had a slight fire, and at that time NASA decided that 20 percent of the collection should be put somewhere else. We put them in three different buildings here on site. They had some vault-type rooms, and we were able to clean them up and install some stainless steel cabinets to hold the samples.

We put in three stainless steel cabinets in each one of these three buildings in these three different vaults. We kept a purge on these cabinets with samples in them. Later on they got to thinking about these vault-like rooms in these buildings weren't quite secure enough. So we had

a vault built at Brooks Air Force Base in San Antonio [Texas] in one of their bunkers. We took the collection there. They also had Air Force Security at this location.

So, you can see that I really was not processing lunar samples anymore, but still in the program. The location had been decided on and I was working with the company that was building this new ultra clean vault in a bunker with support areas that were also ultra clean.

JOHNSON: Were you involved in getting everything set up at Brooks Air Force Base as far as getting the design?

WARREN: Yes. I worked with the NASA engineers. I was mainly in charge of making sure of the cleaning of new equipment being brought in and the air conditioning ducts. Making sure that the filters were sealed and doing the proper job. We were using HEPA [high efficiency particulate air] filters. At that time they were specified for .5 microns at 99.999 percent efficiency. I did particle counts every evening after the workers had left.

So, my job was to make sure that the building was put together in a clean manner. The duct work was cleaned before it came in and stayed clean while being installed. I also checked the supply ducts once the A/C [air conditioning] was turned on. We brought in a crew from JSC and we took down all we could, accept for the A/C supply and return ducts, and then wiped all the walls and ceiling down three times. Everything that could be disassembled was, [it was] cleaned, reassembled and installed back to its location. I went from being a lead tech to a job title called Systems Specialist.

JOHNSON: Did that involve a lot of travel back and forth between here and San Antonio for you?

WARREN: We'd go out and spend two weeks, and then we'd come back for one to two weeks. NASA's lead engineer was Bill [William A.] Parkan and he would just call and say, "I'll need you in three days" and for how long. Of course the schedule changed all the time. I was usually out at Brooks AFB for two week periods. They would get so far and then they would want to check the particle count of the rooms and the ducts. Then if I didn't think it was clean enough, I was out there that afternoon after they left, vacuuming and maybe wiping down stuff or taking sample swabs while they weren't there, and I wasn't interfering with their work. So I would be out there anywhere from a week or two weeks, and then I would come home for a week or two weeks.

JOHNSON: How long did it take to get that facility at Brooks set up to receive the lunar samples?

WARREN: I think the total, from day one on construction, I would say ten months.

JOHNSON: How were the actual samples moved? What type of security was involved with that?

WARREN: First a scientific team had to decide what was to be shipped out and what needed to stay. The samples were packaged in baked out Teflon bags [two each] and placed into a big heavy stainless steel can with a Varian vacuum seal lid. Then these cans were triple bagged in Teflon bags. This was all done inside a GN_2 processing cabinet.

They took a regular Travelways-type bus, took the seats out of it, or most of the seats, and made places for tie down straps and cleaned it up.. It was an air ride type bus. We needed

room for the four isopod type containers [reusable shipping containers] that were to hold four to five of the packaged SS containers. We also needed room for the assorted equipment that would be needed.

Of course you had to have a crew here at JSC. Then you had to have a crew out there to receive them. We went out ahead of time, and I was out at the receiving end, and we swabbed the whole building down again, everything from ceiling to the floor. The lamps were taken out one at a time, wiped down, and put back up. It took us a week to do our pre-cleaning. We were set up to go, and it got on the news the day before we were to receive the samples, so we canceled. Somebody leaked the story out.

Several days later they put them on a bus and headed out. I can't tell you exactly all the security that was involved. I do know that they had several cars two to five miles ahead of the main motorcade and the same behind the main motorcade. The main motorcade was escorted by two to three Texas Highway Patrol cars, along with several NASA security cars. And of course you had security on the bus. This was all done at night.

They got to Brooks Air Force around 5:30 am. I was one of the crew to be in the vault, So I did not get to see all that went on outside the bunker area. They only stopped once, and I do not know exactly where. It wasn't a potty break. The whole caravan just stopped. It was something like a security measure. Everybody checked in. That threw the timeline off, just in case, "Hey, they left at this time, they should be here at this time." It was like an unestimated time that they were going to stop. That would throw off anything down line that somebody had planted something, it would throw it completely off. After a certain number of minutes then they took off again, and they arrived around 5:30 am.

It took them a long time to get the first isopod into the bunker for us to get to the vault and unload. It took the whole day to get all of this done. By the time I got out the bus the escort were gone. What was set up then was to come out and purge the cabinets every so often. NASA wanted to keep the gas inside the cabinet to a level of 20 ppm on the oxygen and 50 ppm on the water content, the same speck as at JSC. This took several weeks at first, then we went to a six month schedule. This still goes on today but the samples are not at Brooks anymore.

JOHNSON: When they were at Brooks, was there anyone that was trained there in case something happened that they would know what to do with those samples? Or was it just security and that was it?

WARREN: It was mainly security, because I don't believe—well, first off they couldn't get to the samples because there's two locks on the front entry way, such that Brooks security had one combination, and the curators here at NASA had the other combination. The same for the vault door. There was nothing on the inside of the vault that would burn. The only way anybody could destroy the samples is to use some kind of bomb that would have to penetrate the bunker. Remember, I told you the vault was built inside of a bunker. It was fenced off, and we had all kinds of security; sonic alarms, heat alarms, the actual gate, and the wire fence. Since it was on an Air Force base, all these types of alarms were checked on the six month visit. They would never know what time of the night we were going to set off an alarm. Once the alarms were activated, the Air Force security came in from all four directions, armed and with their dogs. They had to meet a certain response time, and they met it every time.

Going back to their security, on one of our trips—we still say somebody planned this, but they say it wasn't. We entered the facility with a security guard escort as usual. He had to do one of the combos and we had to do the other. We prepared to go into the vault area, remove all watches, rings pens, etc. First let me explain the layout.

You entered the bunker through a water-tight door, like on a submarine, and it had two vault-type locks; one for the Air Force and one for NASA. You entered into a large area with an office to the left and a large room with no windows in the back center. To get into this large area there was only one door and it had another vault-type lock on it. The Air Force had this combination. As you entered this door you came into a small room that had the monitor system and the main manifold for the purging system. The next room was the gowning room with all the clean room clothing. You put this clothing over what you were already wearing. The next room was to the left and it was the anteroom to the vault. To the left was the vault door and it also had two locks on it. This door was opened and inside you had three stainless steel box cabinets with a manifold system to purge the cabinets. That is the layout.

NASA opened their combination and then the security guard opened his and the vault door was opened. Then, the gate door was opened by a key brought from JSC. We started doing the checking of the parts per million of water and oxygen on the three storage cabinets, one at a time. Once we got the readings, we would go back to the by-pass mode and let the instruments clean up. This takes a while.

I was in the monitor room and we had a knock on the outer door. I opened the door and there stood a Rottweiler [guard dog] showing his teeth, drooling at the mouth, and making a low bass sound. The guard had his hand on his .45 automatic [pistol] and he did not smile. I said, "YES" and he said, "ASSUME THE POSITION." I said, "WHAT?" He said, "UP AGAINST

THE WALL." I did not know what this meant, since I had never had to encounter the police before. He said, "FACE THE WALL, PUT YOUR HANDS ABOVE YOUR HEAD AND PUT THEM ON THE WALL, AND SPREAD YOUR FEET APART." I now knew what he meant.

Also, at every word, the .45 came out of the holster a little further. I look at the two techs, that were on the floor plotting the readings, and told them what was going on and that they needed to get up and an assume the position. The guards [two of them] came in with the dog, one stayed with us while the dog and the other security guard went all the way back to the vault. He did not follow the protocol. After about ten minutes, they all came strolling out, all this time we are all up against the wall. They finally let us take our hands down. What had happened was that the guard had not taken his two-way radio back with him to the vault. He had left it out in the outer office. The control center checks in with him every 15 minutes once the outer door is unlocked. He had not answered, so the guards made a run. We all came out, discussed what had happened. One person went back and vacuumed all the rooms and we started all over again, this time with a two way radio.

JOHNSON: Not what you expected to see when your opened the door, was it?

WARREN: No, especially to see a Rottweiler with his doggone teeth showing and foaming at the mouth.

JOHNSON: That's not what I would want to see when I open a door.

WARREN: Since I had never assumed the position, I really didn't know what he was talking about—I had never been in trouble with the law before.

JOHNSON: Why was San Antonio chosen in the first place?

WARREN: I think that there were two locations, White Sands [Missile Range, New Mexico] and San Antonio. NASA knew that we were going to have to visit the location at least twice a year. If we needed to transfer out more samples or retrieve some samples then it would be more than that. Brooks was closer and it would be built in a bunker, and you had the Air Force security. After it was built, everything was free, I think. We might have paid them a small fee, but it wasn't that much a year, because their security was already there. That was one of the reasons we left though, because when the Air Force gave the base to the city, then you had to use the city cops. Their response time was way too slow, and they wanted to charge us a higher price. So we moved out to White Sands. The security is even better at White Sands than what it was in San Antonio. We go through three different gates and we end up with two different badges before it's over with at White Sands.

JOHNSON: Is it a similar setup as at Brooks?

WARREN: It's not in a bunker out there. We're up against the mountains on one side. But at White Sands, you're so far into the territory that nobody can get to you unless it's by aircraft. All of that's monitored, so nothing's going to get in—aircraft aren't allowed to fly over that area.

For anyone to figure out what building we're in would be difficult. We aren't even allowed telephones. Telephones now have cameras in them. We are allowed to bring in a computer.

Your security badges have to meet—gosh, I don't know. Security here on site, you've got about four different levels. You have to be at a certain level to even be able to get into the area that we're going into.

JOHNSON: Was it the same collection that was at Brooks that was moved to White Sands?

WARREN: Yes. We had packed everything in isopods just like what we had done for Brooks and stored the isopods in the vault. We were ready to go. We did not use a bus this time. We contracted out to a moving company with a climate control and air ride trailer rig, and we did not have highway patrol help this time. But, NASA security had made arrangements with some of the larger towns and they got through each town easily. They had four vehicles of security and a lead car, plus a car quite a ways back.

They just didn't want to advertise it. Nobody knew when we were leaving. Nobody knew what time they would be there. There was no set time to be at any particular place. They gassed up in shifts. You couldn't travel from there all the way to White Sands without gassing up. So one shift security went while one shift was staying with the 18-wheeler, but they were unmarked cars and pickups so nobody knew what was going on.

It was all synchronized, and everybody had the earphones on, and communication was going steadily throughout the whole process. They had an advance car two to five miles out in front. If they ran across a big bump they would call back, "Hey, between marker so-and-so you need to get in the left-hand lane, there's a big bump in the road and we don't want to go across

it," even though it's an air ride 18-wheeler. So everything went smooth. But yes, it was a big ordeal also.

JOHNSON: They just went right down I-10 [Interstate highway] all the way?

WARREN: I don't know the route. In fact, I don't think anybody knew the route but security, until that morning. I think they had two security cars in front and two behind, and the lead security guy said, "Okay, we're going out this way, we're going to hit so-and-so." He said, "Okay, in five miles we're going to be taking a right on so-and-so." The 18-wheeler guy knew exactly where he was. In fact, he, I think, had one of the security guys in his cab, because he had to communicate to tell him what to do. That's the way they did it. Instead of having the big deal with the highway patrol and all of that, they toned it way down, and nobody knew that they were hauling rocks. It wasn't advertised or anything.

JOHNSON: Probably wasn't quite as interesting to the public by the time it was moved again in 2002 as it was earlier, either.

WARREN: True.

JOHNSON: What percentage of the collection is actually out there?

WARREN: Approximately 25 percent of the lunar material. You also have samples from Stardust and Genesis.

JOHNSON: You mentioned earlier that the scientists are still studying this because of the technology changes and the changes in the instruments. Then there's also been a lot of technology changes here in the lab. Not just with the instruments themselves, but going from when you were first cataloging and writing everything down to computers being used on a daily basis and those kinds of technology changes. If you can just for a minute talk about some of those changes and how it's affected the work here in the lab as far as the lunar samples.

WARREN: We still keep a paper copy; do the work with a paper copy then update the computer. This way you can get the data on line and everyone has excess to the data. We use digital cameras today and the photos can easily be transferred into the computer system. The old system was Polaroid negative film that was sent over to a processing lab here on site. I do not know what the lunar system is today, but in Cosmic Dust the photos are taken by digital camera and put into the computer system. We make CDs for backup data for each PI [principal investigator] that we send samples to.

Not much has changed. The balances are digital, smaller, and more accurate. The cameras are better; digital, smaller, and better. We still do the processing using paper and pen to keep the data, then transpose the data to a computer. Procedures are still the same for handling the samples. Bagging of the samples has not changed. You do have some PIs that want their samples in different types of containers or mounts and we change our procedures to accommodate them. The monitor system to analyze the nitrogen in the storage and processing cabinets is in its third modification.

Looking into the lab, the work is the same, but the instrumentation is a lot smaller and better, most likely due to the space program. Since the instruments are better, scientist are checking their original data results against the new instruments. We only have three to four people working in the lab at this time. The procedures are the same and we still use data packs to keep records. After the records are done, then you put the results into a computer. The photos are digital and are kept in a data base along with a DVD backup. Less processors, same procedures, better equipment is all that I can see.

The monitoring system has been modified twice since the original systems were designed. It is a lot more sophisticated now, and you can actually check any cabinet from your computer at your desk. We still have the same goals to meet here also, a maximum of 50 ppm on the water content and 20 ppm on the oxygen content. As the results get higher the GN_2 flow to the cabinets is increased.

JOHNSON: The lab itself, when it was built, was built to withstand high water and a possible hurricane.

WARREN: Yes, we are a half floor off of the rest of the floors on this building, the next building that it's attached to. That gives it an extra 20-something feet above what the ground level is. Since we're right here on the coastline, on the ground level, we're only about maybe 12 feet above sea level. This gives us another 20 something feet. So we're about 32 to 35 feet above sea level on the first floor. The lunar lab is much higher than that. We're about two and a half floors up. During hurricane season, we only have out the samples that we're actually working on. Then if we have a hurricane coming in, or if we see there's any possible way that it's going

to be coming in, we get everything into the vault. The vault was built to withstand—oh gosh, really it was built to withstand a tornado—at least a class four hurricane. I don't know how you classify them, but the walls for the vault are extremely thick. They have twice the rebar in them that a regular wall would have. Then the vault is lined with stainless steel that was welded.

All penetrations going into the vault had to be drilled through the stainless steel and all the other areas. This is another building that once it met the ORI, everything was taken out. The vault was stripped, and it was cleaned from top to bottom three times. We cleaned it with soap and water and alcohol wipes, rinse, and then we cleaned it again, and then we cleaned it again. The guy came through with his little wipes. He said, "Okay, that did it." So then we moved to the main lab, and each one of these rooms was done the same way. All the fluorescent [lights], all the piping was removed and cleaned over in Building 9, and all the electrical lights were removed and taken outside and cleaned and put back together and brought back inside bagged. Each lamp has its own electrical cord plug-in. All of the faces, I don't know what those [demonstrates] are called, but those long panels there have the electrical wire, all the facing was taken off and all that was vacuumed and wiped down. That lab was cleaned three times also. Then the cabinets were brought in. Well, all the tubing was brought in and reassembled. Then the cabinets were brought in and reassembled.

As far as I know the lab has never flunked the particle count. The lab is to meet the calibration of a Class 1000 clean room. Particle count is now done only once a month I believe, but it has never flunked.

JOHNSON: That's a lot of cleaning.

WARREN: Well, you have a lady that has a schedule of what has to be done. She works harder than anyone else in the building. Floors are vacuumed, cabinets are wiped down and the walls are wiped every so often. It continues. The air handlers are monitored daily and when the gauges show the wrong differential pressures, the filters are changed out.

JOHNSON: We were talking about the security at White Sands and at Brooks. In 2002 there was an incident here where some lunar samples were taken. How has that changed the way things are done here at the site? Or has it changed anything? If you want to talk about that incident.

WARREN: Oh, I will talk about that incident. I don't think we lost anything. I think we got all the lunar samples back. I'm pretty sure we did. It had nothing to do with the lunar lab. We have not changed the security system. I don't think you could add any more security than what we now have. I'm not going to say what type of systems we have or how many types of systems we have. But if you think you can get in here—I don't think you can. What happened with the lunar sample that got removed from this building—[it] was in a file safe in a lab downstairs of one of the scientists here in this building. It really had more meteorites in it than it had—oh gosh, probably a couple hundred pounds of meteorites in it. Maybe not that much. But it was owned by Everett [K.] Gibson. Those were his personally bought meteorites. He did have some lunar sample, which would probably be not more than what you could hold in a thimble that a lady would use whenever she was sewing. The type of experiments that he was running did not take very much material. He was using mainly sample pressed into gold, and then you would hit the sample with a laser, and the heat from the laser would vaporize the sample, and then he studied the gases that were coming off of it. You don't need that much sample.

The gentleman that did this—I'm not for sure, I think he got an 18-year sentence. There were three other participants, two girls and another guy. The girls got—I don't know if they had to wear an ankle bracelet or not, but they had to stay at home for several years with mom as their guardian and strict control. Then the other gentleman, I think he had to serve some time, but I don't know exactly how much.

The one that actually—the ringleader, we had wined and dined. He had seen more of the site than I have. He had even had an astronaut's suit on and had his picture taken in it, and he had been out to the Neutral Buoyancy Lab [Sonny Carter Training Facility] and done some stuff out there. He had been over to the building [Building 5] where the astronauts do their training where they're trying to land the [Space] Shuttle and other things. This kid had been given every opportunity out here. He got to see more than anybody else that I know of and was treated well.

It turns out he had been stealing for a long time. That was the only episode that we caught him doing. But when they got into his background, he had worked for some museum in some other location, and once they went to his house or where his wife—I believe he was separated from his wife. Once they went to the wife's house, and the FBI [Federal Bureau of Investigation] started asking, "Well, is this yours?" "Well no, that's his." "Well, did he pay for this?" And she said, "I can't answer that." Well, then they went to the museum, and they had to do 100 percent inventory, and they found out that a lot of the stuff in that house came from that museum, and he had been doing this for a long time. And now he is serving his time.

He did come in over a weekend. It took four of them to load the file safe, which weighs 600 pounds by itself, into an SUV [sport utility vehicle], and carried it to a motel room. He went to Home Depot [home repair store] and got an electrical-type saw and sawed into this cabinet

and got the samples out. Of course that was done on probably—I'm not for sure if it was done on a Friday night or a Saturday during the day.

We didn't catch it until Monday morning. We had no idea that it was this kid that had done it. I was amazed that it happened. We did not know who it was that had done it. He may have still even been working out here whenever it happened. I don't think he was working in this building at the time, but he had access to this building. I think that he was actually working over in the robotics area, I think, or somewhere else here on site. But since he had been over here we just—if we saw him, we just considered that he was over here interviewing somebody or asking them questions or trying to get some information, because I thought he was an intern myself. Anyhow, he decided he needed, I guess, some more money, and so he stole it. And he was trying to sell it, and he put it on the Internet, and he got caught.

We have this kind of stuff all the time. Every year we spend quite a few thousands of dollars trying to prove either something is not a lunar sample, or finding a lunar sample and getting it back in our collection. It was just like—the government asked us to give a certain country a small lunar sample in a display case, and we gave that president of that country or king or whatever he was of that country a sample. Then somebody took over that country, or they had a rebellion, and it disappeared. Sure enough I think I will say about two years ago, it was somewhere between 2004 and 2006, there was a sample being auctioned off, and we went and got it. The guy said, "No, it's mine, I paid money for this." We said, "No, I'm sorry, but this is the US government's property and we're taking it. We'd like to know where you got it from." Turns out we have photographs, so we knew what sample it was. We knew that that sample had disappeared. This guy had paid $40,000 for this sample. He was trying to get a lot more than that. So he was out $40,000 because it's government property.

We've had people too say they had soil, and it was molybdenum disulfide, which is a powder lubricant. We have to run tests on it and verify it. Then people have passed away that worked during Apollo 12 era, and some of them were on different projects, and one of them was given a rock model. He said he had lunar soil in it. Well, we can't verify that because it was in epoxy and it's a model, and we looked at it, it was clear. We scan it with a microscope, we just gave it back to his daughter and said, "Here, nobody can prove it." But I'm pretty sure that somebody just said that it had some in it. It's a model of one of the rocks.

So we spend thousands of dollars every year proving that something either is lunar and it got stolen from somebody. As far as we know, we haven't ever lost anything here at JSC. We have an inventory every year. We have to take the samples out and weigh them. The way our system is set up, everything's in trays, and they're sealed. If the seal is broken at the end of the year, that tray has to be inventoried. Then you take out 10 percent of that tray, and you take it all the way back down to the sample, and you weigh it. The weights have to be within a certain tolerance. We do that every year. That's the way we can say that we have not lost any sample. Samples we've shipped out to people, we can't verify that all the time, because some of them say that it's going to be completely destructed in the test. But if there is something being auctioned or on eBay or something like that, the FBI gets involved, and then soon as we get the sample we have to test it to verify that it's not lunar or that it is lunar , and if it is lunar where'd they get it and how'd they get it.

So that's the security as far as this building. If we hire somebody new, it takes six months just about to get their clearance. It's that strict of a clearance to be done.

JOHNSON: With good reason. Is there anything that we haven't talked about as far as the LRL or your experiences with Apollo that you would like to mention before we stop for today? I know a lot of it overlaps into the other work.

WARREN: Well, not really. I guess the only thing that since people will be maybe—somebody will be interested and want to listen to this—people are always asking me, "Well hey, I have a brother working out there," or, "My uncle used to work out there." There must be 50 something buildings out here, and I have been lucky enough to work in Building 32 on Apollo spacecraft and then work in 37 and 31 on the lunar. I've been on Stardust, Genesis, and Cosmic Dust program. I have been so busy that my wife as a schoolteacher has seen more of this site than I have. She was with, at that time, Friendswood High School, and she was able to get on out here, for teachers , for a whole week. I don't know how many teachers they had, but somewhere around 20. They, for lack of a better word, wined and dined them. Every day they got to go to one or two buildings, and they got the royal treatment and a good tour and all explained to them. I've have been to five or six buildings on site. That's all I've gotten to go to.

JOHNSON: You've been working, you've been busy. You haven't been touring those buildings.

WARREN: I've been busy. Well, here's another thing. On our slack points one time we got real slow. I don't know exactly when that was. But then what is called the Neutral Buoyancy Lab that's off site, what I call the large aquarium off site, which is fantastic. It's absolutely fantastic. It used to be called WETF [Weightless Environment Test Facility], and it was in the round building over here [Building 29]. But it was there. They had a slimmed down crew, and they

had vacation coming up, and they had people getting sick, and they asked for volunteers. Eight of us out of this lunar building volunteered, and we had the time of our lives. We got SCUBA certified. We got to swim with the astronauts. We really had a good time. So when we did have slack periods, at that time people were cross-trained for other buildings, and we ended up getting to do that, and that was really great.

JOHNSON: One thing I want to ask you about—did you have a lot of contact with the astronauts after they flew their missions with Apollo and came back? Did they come in and do anything with the samples or look at the samples?

WARREN: I don't know exactly which mission that we had the first geologist go up. But on that particular occasion, he came in several different times, and we got to talk to him and ask him a few questions here and there. Before—well, 11 and 12 they were quarantined. They had their own samples down there. All of it didn't get brought up here at one time. Once they were quarantined and we had opened the first box maybe, or somewhere about the time we opened a box, they had some samples out downstairs looking at them, photographing them, which they weren't supposed to be doing, but they did.

Afterwards, when the quarantine was over with, and we were still processing samples, I think they may have come in at least once just to see how things were. And maybe they were asked to come in, because here we were, they had done their work, and here we were working hard, "Hey, go in and pat them on the back." I don't know. That doesn't mean we got to see them. We could have been working real hard, and they came in, and just only a couple of people

got to see them and got to talk to them. But yes, I would say that I got to see every one of them, from a distance.

JOHNSON: Well, if there's not anything else for today I think we'll stop, and when we come back next time we'll talk about all your other experiences beyond Apollo.

[End of interview]