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The following is the transcript from a NASA Alumni League seminar. The subject of this discussion was the history of the Lunar Receiving Laboratory planning and implementation before and during the Apollo Program.

NORMAN H. CHAFFEE: Our first speaker today is going to be Gary McCollum. Gary was a JSC employee from 1966 to 2004. He started his career with the Air Force at Eglin Air Force Base [Florida] in ’63 as a project scientist. He worked in the Medical Research and Ops [Operations] Directorate as a quarantine officer for quarantine missions and managed the Medical Surveillance Office for the Apollo and Skylab missions. He developed early Shuttle life sciences experiments. He also worked in the Shuttle Program Office and at NASA Headquarters [Washington, DC] to integrate Spacelab and other payloads, and on return to JSC worked on payload integration with international partners. He has got his BS, MS in biology from Texas A&M – Commerce.

He’ll be followed by Dr. Don Bogard, who was a JSC employee from 1968 to 2010. He’s got a PhD in nuclear chemistry from the University of Arkansas [Fayetteville], and did a postdoc [post-doctoral] in planetary sciences at Caltech [California Institute of Technology, Pasadena]. He collaborated with several other young NASA scientists and several outside scientists to design and build the science labs in the Lunar Receiving Lab and to conduct preliminary science testing of the returned lunar materials. He became part of the MSC [Manned

Spacecraft Center]/JSC planetary materials research organization and was a lunar sample principal investigator from 1971 to 2010. Over the period of 1990 to 2010 he was the JSC senior scientist for planetary materials research. He now holds a part-time research fellowship at the Lunar and Planetary Institute around the corner here. So let's start off with Dr. Bogard's discussion.

BOGARD: Thank you, Norm. We're going to do this very informally. Gary and I thought we'd break it up into four equal part sessions. We will discuss those and entertain questions at the end of each of those. On the other hand, if at any time you have a question about clarity or don't understand something, feel free to interrupt. The first part of it, I'm going to cover something about what was the LRL [Lunar Receiving Laboratory]; the history, how it came about, why it was important, how it was physically structured, how it was organized and managed. I've given talks in the [Building] 31 North lunar viewing area before to the open house that JSC has once a year. There've been a number of younger JSC employees come to that and when I've mentioned LRL, some had no idea what I was talking about. So let me start off with a definition that's in the literature on what the purpose of the LRL was.

It was "to examine unknown, possibly dangerous material without contaminating the material or the researcher, and with no prior experience or requirements but staying flexible." Well, that's a pretty large order. To do that, the LRL was a facility like none that had ever existed before, and none has existed since then. It combined two functions that do exist. One function was to protect the samples. Those of you who went on the lunar tour saw how we protect samples where we're not concerned about the samples contaminating us. I've actually toured a Bio Level 4 research lab in Maryland and saw the other point of view. Namely you're dealing with dangerous biological materials. You're not so concerned about the cleanliness of the lab, just in protecting the environment from these organisms.

These are two very different sets of criteria that you have to put into these facilities. So when you bring these two together they tend in many ways to work at cross-purposes. Now you might say, why is it important anymore? I firmly believe if we ever try to bring samples back from Mars robotically, if we ever try to send astronauts there, this issue is going to come up again in spades. The public is much more aware today of issues about foreign life, alien life, and how it might affect the Earth in a negative way. Mars, let's face it, certainly today is a much more likely place for something like this than is the Moon.

In terms of how the LRL came about and was managed, there's an old saying that a camel is a horse designed by committee. Well, the LRL was designed by lots of different committees, and they didn't talk to one another, and they quarreled with one another. It is amazing it came out the way it did. The whole concept behind some of this science began actually in the very early '60s when [President John F.] Kennedy committed us to go to the Moon. The National Academy [of Sciences] had two working committees. The one in biological sciences started debating the concept of contamination, the biological point of view. The committee in space sciences started debating the concept of lunar materials or planetary materials, the scientific value in bringing them back and studying them. This is the first level of lack of communication. These committees did not communicate with each other very much at all.

I'll refer a lot to MSC. What that means is the Manned Spacecraft Center which preexisted of course JSC. MSC was generally totally unaware of any of this. In fact in 1963, at least a couple of the employees here who were brought in early on for training astronauts, Elbert

[A.] King and Don [Donald A.] Flory in particular, worked up a very simple idea of how you can use some simple nitrogen cabinets, you bring the rocks back, and you do a little cataloging and photography of them. Those of you who went on my tour last month will recognize that's similar to what we do over in the lunar vault area. That idea was presented to [Center Director Robert R.] Gilruth, and Gilruth turned it down as not being necessary. Not something they wanted to get involved in.

By 1964, however, these review committees of the National Academy were getting more and more involved in this. [NASA] Headquarters was beginning to hear about this. Headquarters established an ad hoc committee to study this whole issue of bringing samples back and what was required. So now we have three groups outside of MSC involved in this, and still MSC did not really pay any attention. They were really busy. In fact Flory once told me that when he presented this to Gilruth, a number of the engineers in the room were amazed that we would want to bring rocks back from the Moon; for what possible purpose? [John M.] Eggleston is quoted as saying that science at MSC was almost a dirty word.

By 1965, however, it became obvious to MSC management that things were happening. They tried to get involved in it. The problem as they perceived was—and this was true—that things were moving without them. Not only would they likely not control these actions, but that any facility would likely be located at another NASA Center, not here in Houston. Furthermore, and this was really an eye-opener, the Apollo 11 mission could be postponed if there was not a facility ready. It had gone that far. It became a necessary requirement of the whole mission. MSC management suddenly was involved in this. Unfortunately they probably overreacted, created problems between them and NASA Headquarters, problems between them and the two science committees, problems with the ad hoc committee. Then there was another committee created called the Lunar Sample Analysis and Planning Team that came into existence. Lots of different cooks in the kitchen about that time.

Also Congress cut the MSC Apollo science budget in their 1966 budget. So they were facing less money to accomplish this, not more money. Finally the parties got together and began working together and petitioned Congress. Congress was rather dubious of the need for such a facility, and why it should be located in Houston. Finally that was all worked out. There was a rush on the appropriations through Congress. Construction of the LRL, the old Building 37, was begun in the summer of 1966.

It was finished, the construction part, in September of 1967, about a year later. But then you had to outfit everything. All of the science capability, the biological testing capability that Gary will talk about, had to go in there. Furthermore there was a requirement that these all had to be certified before the Apollo 11 mission could be released. I think Gary will vouch for this. Those of us who worked there in the early years, we felt we were constantly chasing the clock, and we weren't yet ready in all this.

By the way, the actual facility components themselves weren't complete until late '68. The serious testing of the facility did not begin until the fall of '68, which is not that far before the launch the following year. Let me talk a little bit about the facility structure itself. Gary will talk about more parts to that in detail. But basically the building had a one-story administrative area.

MCCOLLUM: You want the chart?

BOGARD: Yeah, if you've got it, Gary, that would be great. There was a one-story administrative area that was not behind what we call the quarantine barrier. This building, part of it was designed as both receiving the samples, quarantining the astronauts, being able to study the samples under a quarantine kind of condition. There was a one-story astronaut quarantine. The requirement was they had to be in quarantine 21 days. There were people in there with them to maintain—and I'm sure Gary will discuss that in a fair amount of detail. There was a three-story area for sample handling, which also included a facility 40 feet below ground, which was a radiation counting area. This was behind—except for the radiation counting area—the original quarantine barrier. You had air locks going through between the nonquarantined part of the building and inside. That was the secondary barrier, if you will, for quarantine.

It was back there that the various testing was done. The biological test labs. There was a whole series of rooms, each room just about had a separate species I think in it for testing. There was an enormous room—two rooms, a first floor and second floor, with a big F-201 vacuum chamber—and I'll talk a little more about that later, and there's also some photos of that back there. This was intended to be the primary repository of the lunar sample boxes when they came back. That's where they'd be opened. It's where samples would be subdivided under as close to a lunar-like vacuum as they could generate. The floor beneath that were the noisiest bunch of pumps you can imagine, old-fashioned turbomolecular pumps, just to maintain the vacuum in that facility. Then we had on the third floor a lab for gas analysis and organic analysis. We had next to this big vacuum chamber a laboratory for physical properties and chemical analysis.

Most of the sample examination was done inside glove boxes, nitrogen glove boxes. That's the F-201 [referring to photo]. You can get an idea of the scale from the person standing on top. I'll talk more about that in the second part of my discussion. So the samples had to be behind a primary barrier, which were the F-201 and the glove boxes. The quarantine facility itself was the secondary barrier. The facility was operated at a slightly negative pressure compared to the outside, the idea being if there was anything in there, it wouldn't get out into the Clear Lake environment. The actual nitrogen cabinets or the vacuum chamber were also at a slight negative pressure. Now those of you who saw Building 31 North recall that we operate those at a positive pressure, because we're trying to maintain integrity of the sample. So you don't want anything leaking in. It's fine for the nitrogen to leak out.

But it was true in this whole process that maintaining the integrity of the quarantine was the number one requirement for the whole facility. Everything else had to live within that.

UNIDENTIFIED: On the question of maintaining the negative pressure. How did you clean the air that you were pumping out to maintain the negative pressure?

BOGARD: The LRL had an unbelievable physical plant located on the second floor. There were large incinerators where all air from that quarantine part of the laboratory passed through to be burned. There was a separate freestanding facility behind the building, which had big chemical settling tanks. All the liquid effluents from the building went into these chemical tanks, and were treated with very harsh chemicals before they were dumped into the sewer lines. Then you had an air pressure differential. You had the primary barriers the samples were in and the humans were not supposed to come in contact with those samples or any of the materials related to the samples.

Gary will talk about how that was violated a couple times and the workers in the sample part of the area were actually quarantined with the astronauts. In fact there's a photograph on the table back there of a lot of the people on Apollo 12 that were put back. Some of them were scientists that were brought in. One scientist said later he thought that was a good thing, because he thought he could contribute more by sitting down with the astronauts while their memories were still fresh and going through all the details of what they saw and observed on the Moon. That was Cliff [Clifford] Frondel.

Let me now just mention a little bit about how the administrative part of the LRL was set up. I'm not going to go into any detail. As I said, there was an Academy of Sciences biological subcommittee which created an ICBC, the Interagency Committee on Back Contamination, which was staffed by representatives from Agriculture, Public Health, any kind of government organization that thought they had a vested interest in the biological integrity of the Earth. I'm sure Gary will go into this in some detail.

There was the Lunar Sample Analysis Planning Team, which answered to the National Academy's space science committee and NASA Headquarters. Within JSC, there were separate directorates. Charles Berry was head of a medical directorate whose responsibility was for the biological testing and the quarantine integrity. That organization answered up to the ICBC. Then there was Wilmot [N.] Hess, who was the director for more physical sciences aspect of the Manned Spacecraft Center. Those of us who were involved in the nonbiological sample testing, the physical-chemical part of it, answered up to him. Presumably Headquarters monitored all of this. But in my opinion—and we'll see what Gary thinks—I think the real influence was these outside committees at that point. Headquarters', and to a fairly large extent MSC and even our division organization, number one job was keeping the advisory committees happy with what was going on, because in those years they could and did raise a lot of political issues all the way to Congress.

The whole building itself was under one division; although, as I've just explained, people in the building had different responsibilities and different chains of command. P. R. [Persa R.] Bell was the first Division Chief [other than acting] of that organization. He was a scientist. Actually he was a nuclear physicist. His emphasis was largely on the science. That also, I think, created conflict between the quarantine testing and the physical science studies. So conflict throughout. A lack of clear ideas at the beginning for what was needed, and allowing a lot of outside organizations to get in and get control of it. In my opinion MSC management really lost a lot by not paying attention early on to that.

In about '67—in fact this goes all the way to the Academy committee—they recognized that they needed scientists inside the building that knew something about analysis of samples. So I was one of about eight young scientists hired in '67, '68 specifically to help build the science labs within the Lunar Receiving Lab; the science labs that did the physical-chemical testing, not the biological labs. Gary can talk to that.

There were for each of these labs one or more outside scientists, usually from a university, who were designated as principal investigators, given a large grant of money to help set up whatever science equipment was required inside the lab, and to manage that whole thing. There were several of us working with outside scientists in that capacity.

Then there was another group of outside scientists who did not have grants to set up the labs but who came specifically for the quarantine testing of Apollo 11 and the later samples and so worked in those labs. It was really a cosmopolitan group. There were international scientists there as well as Americans. You had university people who had no responsibility other than coming for a relatively short period of time and doing the testing; university people who had large grants of money to set up the lab and had the responsibility to see that they worked. You had civil servants like myself there—most of us young—who also had responsibility to help set up the lab and see that they worked. We had a large contract staff. Then of course we interacted with the whole quarantine biological side of things through the samples. I think I've gone on long enough on that. I'll turn it over to Gary to talk about the quarantine biological side.

UNIDENTIFIED: Don, was there NSF [National Science Foundation] involvement at that time?

BOGARD: I don't think the National Science Foundation had much involvement, if any, but Gary can talk about that. You could see what government organizations would be interested or concerned from a biological point of view: Agriculture, Public Health, organizations like this. My personal opinion is—and this is strictly my personal opinion—a lot of that interest came from those organizations because they said this is the greatest thing that's happening in our time, we want to have a little piece of the action. So they were more than happy to insert themselves into it in some capacity. Okay, Gary.

MCCOLLUM: I think Don has already talked about a lot of the stuff that I put together, since we didn't have a chance to get together beforehand. He mentioned the Space Science Board of the National Academy of Sciences convened in '63. The Interagency on Back Contamination formed in '63; the approval of the design for the LRL. This lasted until 1971 when the lunar quarantine program ended. A lot of major milestones in between. Don mentioned some of these people already, but I'll go ahead and mention [a few]. Dick [Richard S.] Johnston was the special assistant to Dr. Gilruth at that time and he was assigned as our back contamination operations director. Bill [Walter W.] Kemmerer was our division chief. He was on the same parallel as P. R. Bell. Ben [Bennie C.] Wooley, head of our quarantine branch. Then Hal [Harold] Eitzen, Howard [J.] Schneider, Richard [C.] Graves and myself as quarantine control officers; all brought in in '68, '69 time period just before the mission.

Bill [William] Carpentier and John Hirasaki were the two individuals identified to go into quarantine with the crew members in the MQF, the Mobile Quarantine Facility. Clarence [A.] Jernigan was our CRA [Crew Reception Area] test director. You've already mentioned these people I guess with the exception of Gene Simmons and Jim [James C.] McLane. I don't know what their involvement was other than more planning for the—you mentioned King and yourself—

BOGARD: Well, Simmons was brought in later. There were several people that came. Everett Gibson is back here. Several people came around 1970. There were already geology types here from the mid '60s who were brought in to train astronauts. So the group I mentioned was specifically to work with the outside university people to build the science labs and perform the lunar sample testing.

MCCOLLUM: The charter of the ICBC Interagency Committee on Back Contamination, which was housed in Atlanta, Georgia, that was the genesis of it, was to protect the public health, agriculture, other living resources, protect the integrity of the lunar samples and scientific experiments, and to ensure that the operational aspects of the program were least compromised.

Had a couple of objectives in mind. The biological containment of the crewmen, the lunar samples and other lunar exposed material, such as the film and the data, had to be in special containers to be opened there in the LRL. Biological assessment of the returned lunar samples to ensure safe release could be effected.

It was very important to go through each of these phases of the back contamination program to ensure that everyone was safe, not only the crew members, but the population as well. Transportation to and from the LRL. Of course the aircraft carrier picked up the crew members and the Command Module after splashdown and then transported them directly to the Lunar Receiving Lab. Then the samples were distributed to the investigators.

BOGARD: Gary, could I make a point on this slide? One major point of contention between NASA and those who wanted the whole quarantine was on splashdown, because recall, the capsule was opened. The astronauts were taken out into a life raft, brought by helicopter to the deck of the carrier, then entered the Mobile Quarantine, which was an Airstream trailer. There were a lot of people upset about that in the advisory groups. But NASA put their foot down on that in saying that the safety of the astronauts came paramount there. They gave in on anything else, but it makes you wonder just how far one has to go to maintain complete quarantine.

UNIDENTIFIED: I have a question about that step. Did the people that came in contact with the astronauts during the initial phase of pulling them out and on the helicopter, did they get quarantined?

MCCOLLUM: No they did not. The biological isolation garments were passed into the Command Module. The astronauts put those on before they came out of the Command Module. So essentially they were protected, and everyone was happy. They went ahead and went into the

Mobile Quarantine Facility in the biological isolation garments. They then took them off once they were inside the MQF.

UNIDENTIFIED: You said they had special suits on that they put on while they were in the Command Module?

MCCOLLUM: Yes sir.

UNIDENTIFIED: So the violation wasn't quite—.

MCCOLLUM: Right, exactly.

BOGARD: The inside of the Apollo module was covered with fine lunar dust.

UNIDENTIFIED: So the Command Module was of more concern rather than the crew from exposure.

UNIDENTIFIED: Comes down to what's practical and what's not practical.

MCCOLLUM: NASA then, as Don alluded to earlier, began actually building the LRL. I'm not going to go into any of that. But we were concerned about the 21 days that was established here after exposure of the host. The 21 days actually started on the Moon as soon as they lifted off, so we were in a countdown from that point on. They were back to the lab within three days I believe of the actual landing on the Moon.

UNIDENTIFIED: Gary, what was the quarantine time in the MQF?

MCCOLLUM: Whatever it took to get from the recovery ship back to the LRL.

UNIDENTIFIED: That was part of the 21 days or was it 21 days in addition?

MCCOLLUM: No, 21 days started on the Moon. It lasted through the quarantine period in the LRL.

BOGARD: But I think that was really only one of the requirements, because another requirement—and this was a little bit of an issue—was that the biological testing had to demonstrate no deleterious effect and then the quarantine had to be officially released. The astronauts early on were concerned about that. So it was more than just an arbitrary 21 days, correct?

UNIDENTIFIED: That's right. There was lots of consternation and they didn't like being isolated that long.

BOGARD: So you were under a lot of pressure in the biological testing to get a yes or no.

MCCOLLUM: Absolutely. I'll get into that in the fourth part of this. We did have intensive medical examinations of the flight crew members during the quarantine to make sure that they were not affected at all. We also had primary contacts that would be protected in the event that they came in touch with the crew members while they were in isolation.

Start of quarantine. We've already talked to the MQF, so here's a picture of it. As Don said, it's a modified Airstream trailer. There's Neil [A. Armstrong] doing his ukulele inside the MQF. We did have special sample return containers for the lunar soil. We had two of those for each of the missions that were returned. Then special containers as I said for the medical lunar samples, films and data tapes.

UNIDENTIFIED: Question on those containers. How many of those retained a good seal as opposed to having air leak in?

MCCOLLUM: They were all certified ahead of time.

BOGARD: I will cover that in a little bit. Bring the question up in my next part of it.

MCCOLLUM: Don mentioned the Class III biological cabinetry where the samples were analyzed and introduced to the test specimens. This is one picture of the technician reaching in with the rubber gloves. You have negative pressure on the inside and the room is under negative pressure with relation to the outside air, so if anything did get loose it would stay in there.

BOGARD: Unless you tie the glove off. That's what happened to the Apollo 12 group.

MCCOLLUM: Not only that. But if you got a leak in the glove, that meant you went into the quarantine also.

BOGARD: One of the scientists noticed apparently a little slit or prick in the glove. He realized that could be a leak, so he pulled the glove out and tied a knot in it, thinking that was the thing to do. The standard procedure then was if you had any kind of indication of barrier violation you called the quarantine officer. They then would come and inspect the situation. All operations were frozen. We had these big red buttons, spill alarms in each of the labs. Those alarms go off, everything freezes. The quarantine officer came and looked and decided tying the glove was the wrong thing to do, because now the hand of the glove is no longer at negative pressure relative to the room. Anything in the hand can leak out. So those people in that p-chem [physical-chemical] test area were sent into quarantine with the astronauts.

But there's more. Before they sent them into quarantine they sent them to the showers. You had to shower going out of the quarantine area. You had a guard and an automatic magnetic door to get out of there. These guys were isolated in the shower while administration decided what to do with them. There was a scientist who had left another lab I think long before this. He was in the shower before the group came in, but the door had been locked. He couldn't get out. Because he came in contact with that group he was quarantined with them. That was Cliff Frondel.

MCCOLLUM: We actually did simulations on the spills too, so we thought we had everything covered. Let's see here. During the quarantine period the crew and their immediate contacts underwent daily medical examinations. There was a few instances in the LRL operations when the technicians had to be quarantined. Terry Slezak comes to mind. He was the NASA photographer that had his picture in the paper with his hands like this. See me? I've got lunar dust on me. So he became a hero overnight I guess. It'll always be in my mind.

BOGARD: There was the woman inside one of the bio test areas that got quarantined. They didn't know where to put her, so they put her in the MQF, which was mated against the LRL. That's the way they brought the astronauts in. So she was isolated in the Mobile Quarantine Facility for the duration.

MCCOLLUM: We did have a number of recommendations being developed for releasing the crew and the support staff. As long as we didn't have any effects of the lunar sample on the test organisms. I'll get into that in a little bit. As long as we met those release criteria then the crew would be allowed to leave. We did have different types of decontamination procedures in place. We had our health and safety office that monitored everything you can imagine on the inside of the barrier. The three areas that Don mentioned a while ago essentially was the barrier.

BOGARD: The crew area was considered a primary contaminate, so it was separate from the sample handling area.

MCCOLLUM: I guess you were going to get into the principal investigators [PIs].

BOGARD: Not really.

MCCOLLUM: Well, just to show you the magnitude of this. The literature quoted 150 to 200 PIs throughout the world. You can imagine the logistics involved in trying to keep up with how much sample needed to go to one investigator versus another.

CHESTER A. VAUGHAN: What was happening to the spacecraft during this time?

MCCOLLUM: The Command Module?

VAUGHAN: Yes. Command Module. We had propellant on there, we're trying to get it off. I know we stayed on the ship and we decontaminated.

MCCOLLUM: It was brought back to the LRL and had a separate room for it.

VAUGHAN: Until it was proven it was safe.

MCCOLLUM: Yeah.

VAUGHAN: The hatch was closed?

BOGARD: It was part of the crew quarantine area.

MCCOLLUM: Part of the Crew Reception Area at LRL.

VAUGHAN: We were very interested in getting that hardware looked at, the spacecraft hardware, to be sure that we didn't have any issues.

BOGARD: But they didn't let you get to it. It's even worse than that. We had two or three air locks. They were rooms that went between the inside and the outside so you had the pressure gradient across there. They were bathed in ultraviolet light. To take anything in, you could use them. If you had to have any kind of repair work done and you needed a maintenance person, you did not tell them when they brought their tools in they couldn't take them back out again, and that didn't make some of them happy. Now the way you got things out if you needed it out was there was a big dunk tank of peracetic acid, I think it was. You had to dunk the item in peracetic acid, and you better be darn sure it would take that kind of treatment for a period of time. So we had these so-called barrier crossing modes like that. But they had rules as to how you could use them.

MCCOLLUM: Keep in mind we also had the yellow tape too in the air locks.

BOGARD: And Shell No-Pest strips hanging from the ceiling because flies and other flying insects didn't realize they weren't supposed to fly in and back out.

MCCOLLUM: I had a standing joke with Buzz Aldrin the last 30 years or so about watching the roaches come across the floor and crossing that yellow tape during the night. Oh boy.

UNIDENTIFIED: One of the interesting things is how did we get our data out? We were generating data on the inside and we wanted to get it out.

BOGARD: Before computers.

UNIDENTIFIED: There was a Xerox machine that was designed especially such that the imaging part of it was behind the quarantine barrier. You placed your data on this, and you hoped somebody would be on the other side of the quarantine barrier. You'd beat on the window or call on the telephone. "Would you come and please push the print button on the outside." So they would come and push the button on the outside and scan your image behind the quarantine barrier, put your product on the outside.

BOGARD: Think how much easier we can do that today.

UNIDENTIFIED: This is before computers and wireless systems of data. It just didn't exist.

MCCOLLUM: I don't think that was ever documented in the literature.

BOGARD: I think it was put in after Apollo 11.

MCCOLLUM: Was it?

BOGARD: Yeah I think so. We realized we needed it.

VAUGHAN: I'm still a little bit curious about what happened to the spacecraft. Now you guys are saying the hatch stayed closed that long?

BOGARD: They closed the hatch. They brought the spacecraft to a special room with a big roll-up door. They put it in there, sealed the door.

VAUGHAN: Did they bring it to 31?.

MCCOLLUM: [Building] 37.

BOGARD: 37. There was a special room on the back side at a lower elevation. Later on they built big freezers in there.

MCCOLLUM: Here, let me go back to that chart.

BOGARD: There also was a special door for the Mobile Quarantine Facility to be mated against the building and the door opened, and it was left there too.

VAUGHAN: So help me understand, did we bring it there before we decontaminated the bi-props [propellants] off of that Command Module? I don't think so.

BOGARD: I don't know about that. But we did not open the door again I know, so it was not decontaminated on the inside [of the LRL].

UNIDENTIFIED: Decontamination was done on the ship. Once it was put in the LRL it didn't come out until it was released. Nobody did anything to it.

MCCOLLUM: Chet, the location of that special room is right there at the end of that arrow.

VAUGHAN: I remember the Command Module showing up, but you're right, decontamination, most of it occurred on the ship. Then later we started doing it in San Diego [California].

BOGARD: But the fuel was an issue I recall. I don't know what they did with it.

VAUGHAN: Fuel was always an issue. Okay, I'm sorry, but I was just curious.

MCCOLLUM: That's okay, we're encouraging everybody to ask questions.

BOGARD: Anecdotes sometimes give you a better feel for what happened.

MCCOLLUM: Okay. Basically the results were finally determined and we saw no reason to question the fact that we did not find any microorganisms or anything.

JENNIFER ROSS-NAZZAL: I just had a question. Apollo 11 came back during hurricane season here in Houston. Were there any logistics made in case a hurricane was coming that you would evacuate the crew? Where would you take them?

BOGARD: I don't think hurricanes were nearly as much concern in those years as they've been recently. I don't know why, because [Hurricane] Carla was not that long before.

MCCOLLUM: Yeah, right, '61.

BOGARD: By the way, the whole JSC area was flooded in Carla, because I had a fellow working in my lab that lived in Texas City during Carla. He came down the freeway before they closed it. He said nothing but the freeway was dry land then.

UNIDENTIFIED: This was all ranchland at that time. There weren't any facilities here.

BOGARD: But the point is that I don't think there was that general concern. On the other hand the walls of this building are fantastically thick. It was felt to be a secure facility. But clearly it wasn't secure against rising water, because it's not high like the 31 North facility. Are you going to cover the different kinds of species?

MCCOLLUM: Yes, in the fourth part. That's what you wanted?

BOGARD: Yes. Let me make a couple of comments about the quarantine part. Sometimes anecdotes really stick in my brain that way. I was one of four scientists in October '69 sent to the ICBC at the Centers for Disease Control [CDC] in Atlanta to give them a briefing. I was there to give the physical sciences testing results, the other three were there to give the results of quarantine and the biological testing. One was [Dr. Charles] Walkinshaw.

MCCOLLUM: Chuck Walkinshaw.

BOGARD: I don't remember the other two. Up until that point people who were not on the biological side thought this was a lot of hooey if you will, nonsense. We realized we had to go along with it. But almost everyone inside the building and outside the building associated with the physical-chemical testing did not really believe in this. I learned something at the CDC I had not appreciated.

Most of us thought that the quarantine concern was bringing lunar organisms back. But in talking to some of the scientists there I found out they were much more concerned about terrestrial organisms having a long sojourn in space, mutating and coming back. This was early enough in the process of understanding the effects of radiation mutation on organisms. I hadn't appreciated that. I don't think a lot of people would. But it was a difficult place to work because you had all these quarantine rules. For example the contractors—most of them were young too—in order to keep sane I guess started writing on their white shirts. You've seen pictures. We were all dressed in special clothing for that. They'd write comments on the shirt.

Then they started doing things like wearing the shirt backwards, not wearing socks, something like that. Every time this happened management would come out with a policy statement of you don't do this. They'd think of something else to do. Finally management came out with a policy statement. "You shall wear complete uniform, which consists of—." Little things like that went on all the time. It was because it was a stressful environment. We had three around-the-clock shifts. Sometimes one shift would be there much longer than 8 or 10 hours because of other issues. So it was tiring, it was stressful. That was just one way of relieving the tension.

In terms of Dick Johnston, the thing I remember about Johnston was he taught me what it means to be a manager. Those of you who have been managers may appreciate this. This happened I think about January, February, whenever Dick Johnston was sent to take over from Bell. P. R. Bell was a scientist. Scientists and engineers I think when they have tests like this emphasize what's not working right, because they want to identify it so they can fix it. We'd go through these simulations and things wouldn't work right, so I'm sure the reports they issued were about what didn't work. Dick Johnston was sent over immediately after one simulation. These simulations would last for long periods of time. We'd build up for them.

He was sent over and called all the scientists into a room. He gave us this dressing down about we had to get this lab ready. "You did poorly. We're going to have another sim. You're going to do it right this time." We all looked at one another thinking, "But we haven't fixed the problems." So at Johnston's insistence we had another sim. Most of us thought at least as many things went bad as did the first time. Johnston called us in again. We expected another dressing down. He told us how proud he was of us, how great things had gone, and he was ready to verify the facility. Right then I learned what it meant to be a manager.

MCCOLLUM: I didn't mention how I got involved over there. I was working for Deke [Donald K.] Slayton at the time. Deke sent me over there before Johnston I guess, and wanted me to start coordinating between Dr. Kemmerer and Dr. Bell. He said, "They don't talk to each other. Kemmerer wants to do this and Bell wants to do that." So what I started doing was having daily meetings with everybody and trying to get everybody on the same page, and it started working. Slowly one by one we got all the issues on the piece of paper and got them worked. But you're right about Johnston, he was quite a manager. Okay. That completes my part. If you want to go ahead and do yours. Sir?

VAUGHAN: We were in a race to go to the Moon.

BOGARD: I understand.

VAUGHAN: The Defense Department was more worried about whether we would be annihilated by the Russians versus some of these species coming back.

BOGARD: Those of us who were not in the quarantine weren't concerned about that decision. We were happy to get all of it.

UNIDENTIFIED: On clearance from the quarantine. How many different organizations were involved? You mentioned something about 120 some PIs.

BOGARD: That's after the quarantine was lifted. The ICBC I guess had the final write-off.

MCCOLLUM: ICBC was the final authority. Well, I say final authority. It went all the way up to Sam [Samuel C.] Phillips, the program manager for the Apollo program, to approve everything.

UNIDENTIFIED: But all the work though was done within the lab here. None of the samples were sent out to be analyzed or be assessed.

BOGARD: Yes and no. I'll talk about it. Okay. I want to talk a little bit about the sample flow now and the kinds of experiments that were done. Not in the biological testing area but in the physical-chemical testing. There's a photo here of the box being received. I think it's up on the table. One of the four guys unloading the box is Gary here. In fact there's a big color photo of that in Building 31 on the wall. The box was brought in.

We had the big F-201 vacuum chamber. It's the most expensive single part probably of the LRL. There was a lot of early interest in trying to keep the lunar samples under a lunar-like environment. Well, the lunar daytime atmosphere is one part in 10^{12} that of the terrestrial atmosphere. It is really a serious vacuum, and it gets even more so at night. That whole technology was before its time, it turned out.

The vacuum chamber was in here. An operator, usually a couple of the biggest contractor guys we had, would stand here, and they wore big space suit type gloves so they could reach in and manipulate anything inside. There were two big vacuum carousels on either side of it. One held tools and other things and one was for samples. We put the box in through a gas nitrogen line where the box would be cleaned on the outside first before it was passed into this big vacuum component. I mentioned there were lots of big turbomolecular pumps through the floor. That's a metal floor we're sitting on.

Once in there, the first thing that would happen to the box is they would take a pressure reading. There's a septum on it where they attach a device and by capacitance roughly estimate the pressure. The next thing was that we had two small mass spectrometers sitting on top of the F-201. They're right here, mounted directly on top of the vacuum chamber. There's a close-up photo of them back there. We would attach a probe to the septum on the box with an O-ring seal, and we would puncture that and draw any of the gases out into these mass spectrometers. The electronics—and most of us—were one floor up doing the analysis. There's a whole series of valve arrangements there you can see.

Once that happened, the box would be opened, because we'd drawn off the gases. The samples would be removed. Of course, what the samples looked like wasn't new. On the Moon, the first thing the astronauts did was take a contingency sample. They weren't sure how long they'd be there, so they grabbed some random materials, put them in a sack. Those were in the return capsule as well and went into quarantine with the astronauts. But samples in the box presumably were more pristine, because the return capsules I'm told weren't exactly nice-smelling or all that clean after they'd been in space that long.

By the way, one time there was a leak in one of these gloves. They had to physically go up and pull the glove operator out of it. With that kind of vacuum and atmosphere on the outside, you can imagine the suction that would be involved. But it just never was able to prevent all outside air from getting inside. Just all kinds of trouble with it. It was very difficult to operate for a glove operator. A lot of the internal ideas didn't work very well either.

The F-201 was used, however, for both boxes on Apollo 11. Between 11 and 12 we co-opted one of the biological test labs, and set up a quick lab for processing one of the Apollo 12 boxes in the same kind of nitrogen environment you saw in Building 31, which is what Don Flory and Elbert King in 1963 had recommended doing. The Apollo 12 samples were split that way. After that the F-201 was abandoned.

While the samples were in the F-201, several subsamples were taken. We had containers that we could put a sample in and seal. These containers then could be bagged in Teflon bags which were brought out. I mentioned we had ways of sterilizing these when they came out, usually in an air lock. It was ethylene oxide I think. Ethylene oxide in the air locks, peracetic acid in the dunk tanks. But we would sterilize the outer containers.

One such sample went to the radiation counting lab, which was 40 feet below ground, which by the way in the early design of the LRL was intended to be behind the biological barrier. They decided it would be too complicated to take it out, so they came up with this way of sealing samples in containers. The sample on the inside of the container is still contaminated, but as long as the outside integrity is there, you could take it down to be counted. By the way in later years they put astronauts on cots down there and did whole-body counting on their potassium content in that same facility.

Another sample—and I was involved in this—we had a pneumatic system. They took a small sample and they shot it down to a floor below to what we called the physical chemistry test lab, where it went into a reaction cell. We then exposed that sample one at a time to different gases, like nitrogen, carbon dioxide, oxygen. We had a gas chromatograph to measure whatever gaseous reactants might be given off. We were interested in the chemical reactivity of lunar material.

I want to emphasize again, we were really ignorant of the Moon at this time. By the way, we really didn't see much gas in the boxes, the pressure you ask about. All of them were at considerably higher pressure than on the Moon. Most of that, however, was degassing from the samples in the boxes, because the samples are loaded with hydrogen and helium from the solar wind.

UNIDENTIFIED: Outgassing of volatiles?

BOGARD: Yes, hydrogen and helium from the samples inside. The boxes were machined out of a single block of aluminum the size of a small suitcase. For a vacuum seal they had indium, which is a soft metal, around the edge. They had a protector over that. So when the astronauts would put samples in the boxes they'd pull the protector off and close the lid. The idea was that any particle of lunar dust would get in the indium, and the indium was soft enough that it would give.

I think one or two of them leaked up to the atmosphere, but most of them did not. The first Apollo 12 box we put into the nitrogen cabinet, we put it in the air lock, and we had to sterilize its exterior. A vacuum in the air lock was used to remove the air, then ethylene oxide was put in to sterilize the outside of the box. After that, the air lock was pressurized to nitrogen and the box moved into the cabinet. We sampled the atmosphere in that box while it was inside the cabinet. Well, we didn't find ethylene oxide. It had reacted with the lunar samples. But we found the Freon carrier they used for ethylene oxide. In the process of pulling a vacuum on that box, they vented it into the air lock then filled it with the sterilizing gas mixture. So it was a constant series of things where you had to react. None of this had been done either at all or enough that you had any real experience of what was going to occur.

Another thing that we did fairly early, and I was instrumental in this as well, is we realized some of the tests could not be easily done with quarantined samples. I actually worked with some of the people in the quarantine control for a quick way of doing heat sterilization of materials. We could get them out from behind the barrier, while the quarantine was still going on, sterilize some of the small amounts of the lunar sample and do testing.

Let me give you an anecdote as to how the groups interacted, the advisory groups, and how we worked. The people, those of us who could go behind the quarantine barrier, were called the Preliminary Examination Team. You had to be on this restricted list to get back there. The members of the Lunar Sample Analysis and Planning Team, who were an advisory group, couldn't go back there. They were on the outside. So once a day one or more members of the Preliminary Exam Team would come out and give briefings to the outside group as to what we were finding. There were over 2,000 members of the press registered to come on the Center at that time. Any one day during this, there were probably 200 of them out in front of the main door to Building 37.

Neither of these groups had much to do other than wait and talk to one another. So there was a lot of discussion between the press and this advisory group, who really didn't know much about what was going on but knew what should be going on. There were two main concepts of what the Moon might be like. Just giving you these concepts emphasizes how ignorant we were. Harold Urey was a Nobel Prize winner in chemistry. Back in the '30s he was the first person to separate an isotope of an element, hydrogen from deuterium. He won the Nobel Prize for that. He'd gotten interested in planetary science in the late '40s, and wrote a book about the Moon. In the ’50s he actually wrote a paper in which he advocated that the lunar maria were dried-up seabeds. He thought the Moon was a volatile-rich primitive object dating back to the early formation of the solar system.

The US Geological Survey had a contract with NASA to help train astronauts. By the way that was another source of conflict. The Survey thought they had exclusive rights. The geologists that were hired at MSC in the mid ’60s thought they should be heavily involved. So there was conflict between these two groups doing astronaut training. The Survey at that time, especially led by Gene [Eugene M.] Shoemaker, espoused the idea the Moon was young and volcanic. You’ve got to remember in those years geologists did not think impacts were any kind of important geologic process. Although some scientists recognized most of those holes on the Moon were caused by impacts, they were craters, a lot of people thought many of the holes were volcanic edifices, and the Moon was young and volcanic. Very different ideas about the Moon.

There was a fair amount of conflict and cat and mouse playing between the group on the inside doing analysis and those on the outside. Of course one way you could maybe differentiate between these two views of the Moon is how old are the rocks. Well, Oliver Schaeffer, who had the contract to do the noble gases in my lab—and by the way my lab hosted about three or four principal investigators. Ray [Raymond] Davis, who later won the Nobel Prize in physics for his work on neutrinos, was an investigator up there. Klaus Biemann was the PI for organic analysis of lunar samples. He later became a PI on the Viking mission for some of the organic analysis on Mars.

In my lab we were measuring argon-40, which is a decay product of potassium-40. It’s one of the radioactive decay series that we used for determining ages of samples routinely. Ross Taylor, who was an Australian, was down in the p-chem test lab, and that’s where they were measuring potassium. In principle, although we weren't supposed to do science—although how one analyzes totally new samples and doesn't do science wasn't clear to any of us—you could put these two numbers together and come up with an age.

Schaeffer and Taylor would never give the number to more than one significant figure when they would brief this outside group. Potassium one number, argon one number. Even though the outside advisory group would admonish them, "You must know better than that." "No, we don't, this is all we're willing to tell you." So the age remained unknown for several days.

Until finally one day I gave part of the briefing and gave two significant figures. I thought it'd gone on too long. By the way, before this time, when we opened the first box and saw that the rocks were volcanic and very fresh-looking, it looked as if the young volcanic theory of the Moon was the correct one. Harold Urey, who was there along with many of the others, got very discouraged and went back to La Jolla [California].

When I gave the numbers to two significant figures and said, "Now you're not supposed to do science, but if you do put these together, this is the age of this rock," immediately Jim Arnold, one of the professors in the room, went to the bank of telephones outside, called Harold Urey, and said, "Harold, come back to Houston, you were right after all, the lunar rocks are old." Gene Shoemaker wasn't in the room that day representing the young volcanic idea, so the word got to these 200 reporters outside before he came to the building.

When he came to the building it was like running a beltline. The press suddenly had some raw meat. "Dr. Shoemaker, what about this? The lunar rocks are old." He denied it. He said, "No, there's something wrong, you've heard wrong, they made a mistake, they can't be that old." Well, in a sense they were both right. It is a primitive body. We've learned a lot about the early solar system. But it's also a volcanic body with a lot of those characteristics. It's a good story about the interplay among groups; how new lunar science was.

The press was so interested. I got a telephone call late one night from—I think it was Izvestia [newspaper] in Russia wanting to ask questions about some of the science testing. Thinking about it later, I realized I had to be speaking to an interpreter, because it was a really weird type of conversation.

We had a nitrogen cabinet in the p-chem test lab, so a lot of this testing went on there. There was a spark gap spectroscope set up inside the nitrogen cabinet, an old way of doing chemical analysis. Being inside this nitrogen cabinet really created headaches if you had to do anything. Take the normal things you do around your house and put big mittens on your hands and imagine how much more difficult it is. Well, we had that in spades.

The organic analysis, they had little nickel capsules, and they would load some lunar sample in a nickel capsule, crimp it to seal it, sterilize it out, bring it up to the mass spectrometer, load it in the mass spectrometer. They had a way of puncturing it inside the source. Heat it up, drive organic material off. Now the sample was potentially contaminated. That contaminant goes through the mass spectrometer into the pumps. The mass spectrometer operates at high vacuum. What do you do with it? Well, you have these special filters in this pumping system. So it wasn't just the building you had to control the quarantine, it was also various operations.

On either side of these filters was a big valve. Steam was piped to the filter. We had liquid nitrogen, steam; utility lines all over the building. You'd close both these valves, run steam through the filter to sterilize it, then you could open it and replace the filter. Nobody would ever do that purposely on a vent from an ordinary pump, which is why we worked on sterilizing some samples in order to do some analyses outside of quarantine protocols. We had a lot of those.

It's not an easy way of doing science. Now this was a preliminary exam. You asked a question about the 200 investigators. When the quarantine was lifted, there was a whole distribution. That's still ongoing to lunar scientists all over the world. There were actually more than 200 eventually that got lunar material.

Let me tell an anecdote here too which gives you a flavor of how important lunar samples were perceived to be was at the time. One of the scientists in my lab, Joe [Joseph] Zahringer, was from the Max-Planck-Institut fur Physik in Heidelberg [Germany]. While he was spending all his time over here, back in the Max-Planck-Institut fur Chemie in Mainz, a rival institute also in Germany, they were talking to the press about how they were going to get lunar samples. They were getting all the publicity in Germany about the science that they would do.

Zahringer couldn't take any samples back until after the quarantine, but he made friends with a division secretary and other people, so when he was back in Germany he was in daily contact to find out how close were they to packaging individual samples and sending them to investigators. When they were close, he came to Houston early, before the official notice was received in Germany to come pick up your samples. He has his sample in hand going back to Germany before the rival group gets on the way. He has prearranged for the press to be there. So Zahringer and Heidelberg now get all the press of having the first lunar sample in Germany. That was big news then. It's hard to overestimate the excitement I think that not only scientists but a lot of the press and general public felt about this. I should let Gary get on with his presentation.

MCCOLLUM: Okay. Basically Dr. Walkinshaw's botanical investigations dealt with quite a few species. I'll go through and try to read [the slide]. Onion, algae, cabbage, pepperweed, watermelon, lime, cantaloupe, cucumber, soybean weed, sunflower, lettuce, tomato, club moss. As you can see there's quite a selection of different types of plants. Try as he may, he could not affect the growth pattern on any of them.

BOGARD: Remember some of these are growing inside these cabinets.

MCCOLLUM: Oh yes. All these were exposed in the biological cabinetry.

UNIDENTIFIED: They put lunar dust on them, some of the regolith.

MCCOLLUM: Let's see. The virological investigations. You've got African green monkey kidney, human embryonic kidney, embryonic lung, embryonic kidney, rainbow trout, minnows, cattle kidney and swine kidney.

UNIDENTIFIED: These were not petri dish type experiments. These were more with plants themselves and with biological organisms.

MCCOLLUM: Absolutely. That's what I'm covering was the biological side of the house.

BOGARD: There was a whole organism testing concept.

MCCOLLUM: Then the third category was the zoology investigations. Here you've got all kinds of different bacteria and single-cell organisms that were exposed. Again the results were basically for [Apollo] 11, 12 and 14. They experienced no health problems as the result of their exposure to the lunar material. I don't know if you wanted to go into any more of that or not.

BOGARD: Why don't you talk about Chuck's experience with the press, because the corn grew better.

MCCOLLUM: Okay. But I did go ahead and bring my albums from [Apollo] 11, 12, 13 and 14. My way of documenting some glorious years that I really enjoyed during the quarantine program, even 13 with the aborted mission, being out on the recovery ship. I would have been in charge of the quarantine on that mission, but as it turned out my role got changed real quick. I ended up assisting the ship's physician in the OR [operating room]. That was a unique experience in itself. I brought the albums if you want to take a look, go back in time, read up on what happened during those missions.

UNIDENTIFIED: So Gary, what mission did we stop the quarantine?

MCCOLLUM: [Apollo] 14 was the last one.

BOGARD: The argument was that several different types of samples would have to be tested, like regolith, a volcanic rock, a breccia. Also they wanted subsurface samples like core tubes. They wanted to test different domains on the Moon. Apollo 14 visited a rather different highland area—11 and 12 went to mare areas—so they definitely wanted that. Again, it was not all engraved in stone beforehand. I'm sure the ICBC reacted to some degree too in real time as to what they wanted.

I mentioned Walkinshaw, a lot of this was in the press. He had these corn plants and fed lunar samples to them. They seemed to grow better than they did without lunar material, so the press was very interested in that.

But it was one concept of how to test organisms. In the mid '90s I was on a NASA study group. We met many times at [NASA] Ames [Research Center, Moffett Field, California] while fleshing out some of the concepts of a Mars robotic sample return. We had JPL [Jet Propulsion Laboratory, Pasadena, California] engineers there. One of several times NASA thought they were serious about that. A member of the group was Ken [Kenneth] Nealson, who's a biologist then at the University of Wisconsin. I remember having a long conversation with him at one of these meetings about how best to test for an organism if you don't know its characteristics. His opinion was that you would not do it on whole-organism testing today. You'd do cell culture. But I have read that in at least some of the advisory groups that are still advising NASA, still like the idea of whole-organism testing. You could build a Noah's ark where you're putting almost everything in there and have enormous issues.

The LRL cost $24 million through 1970. That's about $140 million today. That's about the cost of a small robotic mission. Who knows what that would cost today? It seems to me the biological testing could be very open-ended.

MCCOLLUM: Could be.

BOGARD: You don't really know where to draw the line.

UNIDENTIFIED: Did they ever find anything on the mutation issue that you mentioned earlier? Mutation of the organisms you're carrying with you?

BOGARD: I don't think they studied it.

MCCOLLUM: The one PI did come up with a find with a microorganism, but it was later refuted because it was determined it was terrestrial. In other words they carried it up there and they brought it back.

BOGARD: But the testing was oriented toward the idea let's take various types of living things on Earth, expose them to lunar material and see if anything bad happens to them. In my opinion just thinking about that, that's a difficult proposition, because there's so many different organisms. How do you determine when bad things happen? It may be subtle. Maybe it takes a long period of time.

CHAFFEE: Well, gentlemen, thank you. Thank you very much.

MCCOLLUM: Oh, got another question here.

UNIDENTIFIED: Basically the types of protection you were doing was both forward propagation which we talked about being taken to the Moon and then brought back a mutation, then what was at the Moon being introduced as some kind of virulent interaction with our environment once it was brought back. But the third thing is to prevent primarily our concerns both in 11 through 17 was introducing our own self-contamination to the samples, to make sure that you could discriminate what had previously happened versus what's happening now. So that is why you continue to quarantine even after 14.

BOGARD: Well, we don't call it a quarantine. A quarantine has implication of a biological kind of issue. There are a lot of materials today that are processed in environments to try to keep them from being contaminated from the terrestrial environment when they're processed. So what we're doing in that regard is not unusual. We limit the kinds of materials that go into the nitrogen cabinets—you've got to put something in there, so there's always somebody you don't quite make happy—and we keep out the terrestrial atmosphere.

By the way I was involved early on—mentioning about bringing Mars samples back—in trying to come up with basic ideas of how one would design a better facility for handling Mars material. It's difficult. Some of the things we looked at were the primary barrier being a double barrier. The wall in between has negative pressure, so you can prevent terrestrial air from going in on the sample, but also prevent the sample contaminants from coming out. That only adds to complexity and cost. But if we bring samples back from Mars—and if you send astronauts there, by definition you are—it's going to be a big issue. It's going to be an expensive, technically complicated, publicly-laced concern with all this. I personally think if we ever do it we will come up with some way to argue that the Mars surface is already sterile and as long as we don't dig below the surface we're okay. Otherwise I'm not sure it's going to happen.

UNIDENTIFIED: One other comment, Don. Basically your facility is still being used post Apollo with the geology and that series of flights that we went and captured inner solar material.

BOGARD: Yes. Two things happened in Apollo. Apollo lunar science was really the beginning of modern planetary sample science. Second, Apollo experience expanded to all kinds of later sample studies. In fact we have a saying. You've heard the saying that one picture is worth a thousand words. Well, we like to say one sample is worth a thousand pictures. Beginning with Apollo we honed basic ways of protecting the sample, what kind of materials are acceptable, which ones aren't.

Let me just mention an example of organic testing. I mentioned they measured organics in lunar samples. If Harold Urey had been right there might have been lots of organic material there. Some meteorites contain very high amounts of organic material, including amino acids for example. When they initially measured organics in lunar samples, it was contamination. We did a lot of work between missions trying to reduce the organic contamination level on tools and sampling devices we sent to the Moon just so they could push down the lower limit of lunar organics.

They never did measure in those early experiments true lunar organics. Of course even if they'd been there, they'd probably have been destroyed by the extreme radiation environment. But we learned a lot about how to handle materials to lower the organics, which I'm sure JPL uses today when they prepare spacecraft to send to Mars for the purpose of looking at organics still again. It wasn't just organics. You remember when we used to have tetraethyl lead in our gasoline and lead was in paint. We humans really have concentrated lead. Well, lead is a very important element in radioactive dating, so we had lead contamination all over a lot of this early material we sent. We learned how to reduce that kind of contamination, so there's a lot of the technology that's been perfected and passed on.

UNIDENTIFIED: He touched on it just a little bit, but I was going to ask about the Stardust mission, what kind of controls they've placed on the return.

BOGARD: The Stardust, a lot of that experience came because different organizations have flown aircraft in the stratosphere for a long time collecting dust. It was actually used way back in the '50s and '60s to collect dust from radioactive fallout from weapons testing, to understand a lot of global circulation, nature of the weapons and so on. Then they realized that there's things there other than terrestrial particles. At JSC we've had what we call a Cosmic Dust Program where aircraft, WB-57s, are flown out of Ames with special filters on them. They aren't opened up till they get in the stratosphere, That material is brought back to Building 31 for curating that kind of particle.

Those particles come from comets. So we developed a lot of the technique and contamination control doing that kind of work. Stardust material was just more of the same if you will, although JSC did build a separate little lab for it. There's a special little lab on the second floor of 31 just for Stardust samples, just like we use part of the old lunar facility for curating Martian meteorites and part of 31N for curating the Genesis solar wind material. So it snowballs. What we learn on one mission helps the next one.

UNIDENTIFIED: That brought to mind we also have Dave McKay and the group that's involved there with the meteorites to find out whether they're Martian, or whatever. It uses similar facilities for doing that scientific investigation.

BOGARD: Yes. In fact I was on the founding advisory group of the Antarctic Search for Meteorites. It's a three-agency program now with NSF and Smithsonian and NASA. We use some of our lunar-developed knowledge. Of course the meteorites on the Antarctic ice are not pristine like a lunar sample would be. On the other hand the ice doesn't contaminate them the same way as the hot desert meteorites that are found in Arabia and North Africa. So we prepared special collecting materials including Teflon bags for collecting meteorites.

We learned very early you can easily heat-seal Teflon. It'll take a lot of abuse on the outside. It's a relatively simple mass spectrum. It doesn't interfere too much with an organic analysis or with most inorganic analyses, so those kinds of useful materials we learned.

In fact I'll tell you this anecdote. A couple of technicians and I went into the big cooler put in the building 37 room where the Apollo spacecraft was originally placed. The medical directorate built two big walk-in coolers, one at -40, one at 0. This was before we sent the first crew to Antarctica with different kinds of plastics, different kinds of tape, to collect samples. We wanted to test these materials at -40, make sure that they had a bag that would stay flexible to put the sample in that they could tape up. You would be amazed how many different kinds of polymers, plastics become stiff as steel at -40. You can hold a roll of really sticky tape, and it just unrolls onto the floor.

Again Teflon bags were great. They remained flexible, so we learned one other way we could use Teflon, namely when it's -40. So there's a lot of interaction; this knowledge base that feeds forward.

CHAFFEE: So let me ask you. The samples now, I understand that we kept some of them pristine for future analysis.

BOGARD: The lunar material?

CHAFFEE: The lunar materials. Is that still true?

BOGARD: Yes, most of the long term storage are of course out near White Sands [New Mexico]. For some of the more diverse or interesting samples, a subsample was taken with the intent of keeping it very long term and not using it short term for analysis.

CHAFFEE: So the San Antonio [Texas] stuff went to White Sands eventually?

BOGARD: Yes it went there. We even had storage in Building 1 early on, a place in one of the secure rooms up there, to store materials temporarily. Before Apollo 11, we had given almost no thought to what happens when the preliminary exam is over and the quarantine lifts. We were more unprepared for that in many ways than we were for the Apollo 11 sample return.

UNIDENTIFIED: Are the long term samples being stored in nitrogen?

BOGARD: It's in nitrogen. The cabinets don't have gloves on them. They're sealed in such a way that you can purge them with nitrogen and basically turn the nitrogen flow off, or very very low. They're just like a vacuum-sealed container on your grocer's shelf. We go into there very seldom.

CHAFFEE: Well, let's see. I think this was an outstanding session. So I thank all you guys for coming and Don and Gary.

BOGARD: You're welcome.

VAUGHAN: Want to thank you guys for this.

[End of interview]