ORAL HISTORY TRANSCRIPT

TROY M. STEWART
INTERVIEWED BY CAROL BUTLER
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BUTLER: Today is September 21, 1998. This oral history with Troy Stewart is being conducted in the offices of the Signal Corporation of Houston, Texas, for the Johnson Space Center Oral History Project. [The interview was conducted by Carol Butler who was assisted by Summer Chick Bergen and Franklin Tarazona.]

Thank you for joining us today. We appreciate it.

STEWART: It's my pleasure. Thank you.

BUTLER: To start off with, if it's all right with you, let's talk a little bit about your early history with the Air Force and what your experiences there were and your different roles.

STEWART: Okay. I originally was an altitude chamber technician in the Air Force. That was what I was trained to do, and part of that training that I received and a part of that mission was pressure suits. When I started in 1958, it was partial-pressure suits. There were some full-pressure suits being developed, but we weren't operational with them yet. I was stationed at Eglin Air Force Base, and we had, oh, gosh, every kind of aircraft that the Air Force was flying at that time came through our base because it was a test base, and some of the aircraft required that people fly with pressure suits. So we had the responsibility for taking care of the suits in our activity there, and we would go out and at that time what we called integrate the crew

member with the aircraft. We call it "crew insertion" at NASA, but in the military it's crew integration.

This is where I got mostly the pressure suit background, and then I also got into hyperbarics after I moved from Eglin over to Brooks Air Force Base in 1964. I was on the hyperbaric training team for the Air Force then, and we got involved in hyperbarics because of the exposure of our students in the altitude chambers to [high] altitude and the possibility of bends and some of the other evolved gas [problems]… But anyway, the Air Force had about six or eight of these chambers installed throughout the world, and we were a mobile training team [that] went out and did that.

I did that until the end of 1968, when I was transferred from Brooks Air Force Base and assigned to the Air Force Manned Orbiting Lab [MOL] Program, subsequently being assigned to NASA for training, for crew insertion duties. I came here in 1969 as a military detailee on what supposedly was a nine-month training tour and we ended up staying here six and a half years due to circumstances that came up as we were going along.

After that, I moved from NASA into Air Force recruiting so that I could stay in this area of the country, because my ultimate goal was to get one of these NASA crew insertion jobs that I'd been doing as a military detailee. Another reason, my family wanted to stay in the area. So I volunteered for recruiting duty and finished my career as a recruiter in the Texas City area. In 1978, I retired and went to work for ILC [International Latex Corporation], worked for them for two years, and then in 1980 went to work for NASA.

BUTLER: Great. That's a wonderful overview. You mentioned the MOL Program, and then you transferred from that into NASA. Was that when the program was canceled? Can you tell us a little bit about what work you did do in the MOL Program?

STEWART: The only actual work that I did in the MOL Program was what I did here at NASA, because I never went to Vandenberg [California] as a member of MOL. I was assigned down here in January of '69, and I was supposed to stay for nine months and then transfer to Vandenberg, where they were already forming the team and setting up the facilities and things of that nature. But if you recall, as history will recall, in July of '69 the MOL Program was canceled in the early part of July. As a matter of fact, we were at KSC [Kennedy Space Center] training for Apollo 11, and at noontime going to lunch, we heard on the car radio that the MOL Program had been canceled. That's the first we heard of it. We were about two or three weeks, I think, away from launch of Apollo 11, which was our primary concern then. That's how we found out about that deal.

Like I say, I never did really go to Vandenberg. As a matter of fact, they moved—"they" being the military and NASA—moved all of the personnel from Vandenberg and from Los Angeles Air Force Station, which was our headquarters, to Johnson Space Center, kind of a holding pattern. They put us on a three-year military detailee tour, astronauts included. Bob [Robert L.] Crippen and Dick [Richard H.] Truly and all those guys were originally MOL people.

We stayed for that three-year tour, and evidently either NASA wanted to keep us or nobody knew what to do with us, so we actually stayed around six, six and a half years. I left here in October of '74 to do my recruiting tour, and we had some people who stayed, then, and

worked the ASTP [Apollo-Soyuz Test Project] program. I think they left in '75 or '76, somewhere along in there, Frank Hernandez and Byron Smith and those guys.

BUTLER: That must have been quite a surprise, hearing it on the radio.

STEWART: Well, it was. You know, you're going along fat, dumb, and happy, having a great time and looking forward to in two or three months you're going to be one of the two prime MOL insertion technicians, you know, and you're going to go out there and do your thing and get all the glory and teach all the other guys how to do all this stuff, and you're coming up on Cloud Nine, and all of a sudden somebody sticks a little pin in your balloon, and what are you going to do now? So that's kind of the feeling you get when that happens.

BUTLER: That's understandable. I guess it worked out pretty well, though, with working on the Apollo missions. That must have been quite interesting and quite rewarding.

STEWART: Well, it was different from what I'd been exposed to. I'd spent several years training pilots and crew members and other technicians in hazards of high-altitude flight and in the hyperbarics and then came over here, and NASA did things a little differently than we did in the military. It wasn't that hard to transition, because a lot of military people were running this outfit at that time. So we just came over with our eyes wide open, as we were told to do, and just take it all in and use what you can and kind of move the rest out. That's what we tried to do.

But it was kind of a crash program for us. We were assigned—I say "we." There were two of us who came here to do that, a guy named Barry Lewis and myself, and we were to be

the prime insertion guys for MOL. We were assigned pretty quickly to a mission. He was assigned to Apollo 10, I was assigned to Apollo 11, and we started working then with the teams who were already working that mission. So we just picked up, well, not in the middle, but at the first part of that. They had already assigned the teams and somewhere along the line made the decision to assign Barry to Apollo 10 and me to Apollo 11. I have no idea why that came about, and Joe [Joseph] Schmitt might know the answer, because he, I think, made most of the decisions, even though he would tell you that he didn't make those decisions. He had a lot to say about what went on because he was our senior suit technician.

BUTLER: When you did come in in 1969, then, and jumped in at the beginning of—for you it was Apollo 11, was it just on-the-job training? Were there any specific training exercises that you went through before you began working with the crew?

STEWART: Most of the things that we did were hands-on, on-the-job training. We had all had ten or twelve, thirteen years of background in life support systems and protective equipment such as pressure suits and parachutes, things of that nature. So we didn't have to have any basic training. The only thing we had to have was familiarization with the specific equipment that we were going to be working with, and basically a pressure suit is a pressure suit. Once you get to the full-pressure suit, the principle of operation is basically the same for all of them. The only difference is maybe a little bit of the ventilation system and what the closures are like and the cover layers and what the operating pressures are. There are differences in those, but other than that, you jumped right in and did it.

When we first got here, they put us to work disassembling the suits completely. They had some that had to be inspected, so a good way to learn all of the components of that particular system is to tear it down and look at it and clean it and lubricate it and put it back together, and that's what they started us doing, and it was a good background training for us to do that. The suits, of course, at that time were being built and were under the control of ILC, and we shared a lab. I say "we," the NASA people and Air Force, shared a lab with ILC, and we got a lot of training from their technicians, in addition to Joe and Al [Alan M.] Rochford and all those guys that we worked with.

BUTLER: Apollo 11, that morning, as you're helping the astronauts into their suits and then out into the launch pad and inserting them into the vehicle, can you do a walk-through of that morning, what the atmosphere was like? Was there any realization of what was going on and how important this mission was going to be?

STEWART: Oh, I don't know. I think I was still totally in awe of the whole deal at that time. I can walk you through my part, which was not that significant, because at that particular mission I didn't do the crew insertion, I didn't go to the pad, since I was in training, more or less, and hadn't been there very long. Joe Schmitt was the senior technician on that mission, and he did the crew insertion. The guy that went to the pad with him was Ronnie Woods, who at the time worked for ILC. They were using a NASA technician and then sometimes two, and I was the second NASA technician, I guess you'd call it, on there, because [I was] a government person, and then they were using an ILC technician. Ronnie was very dedicated and very good at what he did, and since Ronnie had the background, I'm sure that's why Joe decided that Ronnie would

go to the pad with him. That was a good decision. I had no problem with that. But as kind of like my reward for doing such a good job and everything on the mission, I was assigned to Neil [A.] Armstrong. So that was my claim to fame, I guess you'd call it, is the fact that I worked with him through that mission as his suit tech, and I suited him up for the Apollo 11, and then, of course, after they left the suit room, I had no other things to do except clean up and wait for the launch. If the launch went, then we came home, and if it didn't go, then we turned around and got ready for the next attempt.

That particular day, of course, the whole world, I guess, was really anticipating this thing, and we had had all these elaborate plans and everything to make sure that all of us got to the suit room on time through the crowds. We stayed in town, in Cocoa Beach. We didn't stay on site at that time and still don't, or the guys that work there now still don't. So you had to make your way from Cocoa Beach out to KSC, to the suit room, and they had plans, if the traffic got too bad, to transport the suit technicians by helicopter from Cocoa Beach to KSC. They didn't have any facilities for us to stay out there overnight, and the crew quarters was very limited, and they had the quarantines and all that. Of course, we were all primary contacts, so we didn't have to worry about that part. They just had no place for us to stay. Anyway, that was part of the contingency plan in case the traffic was too bad. Another part was Joe liked to be very punctual, so I think we went out there about six or seven hours before we really had to, but it was okay. Everybody was pumped up anyway, and we had the suit room and the recliners and things. If we needed to take a little break, we could.

I remember I have one picture that somebody took with a Polaroid, and we put a little note on the back that says, "At 4:30 in the morning on—" I think it was July 11, 1969, and I had a part of the suit in my hand, looking at it. I had my little white hat on and all of that stuff that

we wore in this clean room in there. But we just went through our normal routine of getting things ready, but it was kind of eerie. It was really quiet, and nobody was really cutting up or too loose. Of course, when the crew got there, you know, everything was real formal and everything. Armstrong was kind of a quiet person anyway. He didn't have too much to say to anybody, as far as I know. I went through a lot of training exercises with him, and he seemed to be thinking about what he was doing more than any fun and frivolity. So we didn't have a whole lot of that fun and frivolity stuff on Apollo 11. It was pretty serious.

We went through our normal routine. The crew came, we suited them, did the testing that we had to do prior to them going to the pad and made sure everything was the way it was supposed to be, and sent them on their way, as far as I was concerned, and then, of course, Joe and those guys took over and strapped them in and everything. But it was kind of awesome. It was a thrill to be there, and I still, at that time, couldn't believe I was really doing that, but I was.

BUTLER: Then when they landed on the moon, where were you at that time?

STEWART: Oh, man, let me tell you that story. After the launch, we normally, like I said, we'd pack up the training gear, because what happened during Apollo, the crew would move to KSC for training, and the suit technicians would move as a team with all the training equipment—the flight equipment was already at KSC—but we would move down there about six weeks before the launch, and we would go through all the training that they had to go through, and we maintained the equipment down there and maintained a temporary residence down there. So we would get done, then, right after the launch, and we would have to get all the gear, training gear,

that we were responsible for, anything else that someone else needed us to take care of, suit-related or life support-related, and get that ready to come back home. So we did.

I think I left the day after the launch, flew back down here. Of course, my family was living here, but they had gone to my wife's mother's [home] in Oklahoma, western Oklahoma, way out there. So I flew in here. I got here about two o'clock, three o'clock in the afternoon, somewhere like that, picked up my mail, which had been accumulating for two or three weeks, went through that, got my car, and took off for Oklahoma that afternoon. So I ended up staying the night somewhere else, because it had been a pretty long day anyway. I got there to my wife's parents' house the day after that, then. So that was a couple of days after. They live way out in a little town in western Oklahoma called Arnette, and they had no TV stations. The closest TV station, I think, was Oklahoma City, which is about 150 miles away. They had a television, but the antenna was kind of goofed up.

Well, my primary concern when I got there after getting back with my family, my two boys and my wife and everything, was to get some kind of TV reception so we could watch this deal. So we worked on TV antennas and television sets for several hours in order to get this done, my father-in-law and I. It was a black and white TV. I remember that. It was pretty snowy, but we got it done, and I stayed up whatever the time was to watch that. So did the rest of the family. Some of them weren't as interested as I was. I just kept saying to myself, "Now, you know these guys, and you just helped suit this guy up, and you had your hands on this suit, and you helped train these fellows, and this is history, and you're a little part of it," even though my little part was so tiny. I was still kind of awestruck about the whole deal and a little bit emotional, too, when they landed, of course, being a little bit worried when they had the little glitch and then after they landed and got out there and got to doing what they were doing.

My sons were there. They were small, and they didn't know what was going on, but we tried to explain to them. It was just kind of a great experience, and it lasted until that mission was over, and then you went on to the next one. It was totally awesome, but things move along. We moved to the next one. My next one was Apollo 13. [Laughter]

BUTLER: Oh, my.

STEWART: We had three positions on the flight, like I say. We had the lead guy, and then we had the backup, who's the guy that went to the pad with the crew, and he would do the insertion in case the inserter guy was [unable to perform for some reason]—then we had what we called a third tech, and that was the guy that suited up the third person, that didn't go to the pad, so I was third on Apollo 11, and Apollo 13 I moved to backup.

We worked that mission, and my duties were a little bit different. In addition to doing my crewman on that particular mission, I was also being trained to do the crew insertion. So I had a little bit more to do on that particular one, a little bit more to learn because of the drills that we went through at KSC.

The assignments for those flights, that were back in Apollo, were normally the lead technician would suit the commander, and then the backup would suit the lunar module pilot, which is the guy that rode the right seat in the Apollo module, and then the third person would suit the command module pilot. Of course, on Apollo 11, Joe turned that all around so that we could all get our glory, I guess. So I had Fred [W.] Haise [Jr.] on Apollo 13, and he and I, we got along pretty well. I had him on a couple or three flights. As a matter of fact, he was backup

on some and prime on others. He was a pleasure to work with. He's always full of fun and stuff. That was nice. But I got to go to the pad on Apollo 13.

Then my next mission was Apollo 16, and I was the lead technician then on Apollo 16. So I worked my way up pretty fast. That's because I was so good at what I did. No, I'm only kidding. I did try, and I did my best, and evidently they thought it was good enough, so they made me a lead tech. On that mission, I had replaced a veteran suit tech who had been around for a long time. Instead of my lead, he was my backup. So I took the Joe Schmitt approach, and we decided that the best thing to do on that deal as far as suiting people up was to kind of turn it around. So he did the commander, and I did the lunar module pilot, even though I was the lead technician. Then our third guy did our command module pilot.

So we all shared everything because it was—oh, I don't know if it was a blow [to his ego, but]…it wasn't meant to be on anybody's part as far as I was concerned, but for a guy to have been a NASA lead technician and then to move back and have somebody move in front might have been a little blow to his ego. So we did that, and it worked out okay. The mission got off and we got it done and got back, so I guess it was all right.

Then, after that, I moved rapidly from lead tech on Apollo 16 back to third tech on Apollo 17. So you can see how we kind of moved around and everything. Al Rochford, then, was the lead on 17 and I worked as the third tech with him on there. I had been working with Joe Schmitt, and then I worked with Clyde Teague. He was my lead on 13, and then he was my back up on 16, he and I worked together. And our third guy, I think, on 16 was Walt Salyer, Sr. [phonetic]. He was a veteran, had been there quite a while. Then Frank Hernandez worked with us. I don't know if you guys have talked to Frank or not, but you need to. He just recently

retired and moved to Mesa, Arizona. Anyway, I went back to third tech on 17, and that was, of course, the last Apollo mission.

Then we all started working the Skylab Program. Everybody worked all of those missions as far as the training part of it went. Then, of course, they had an insertion team for each one of those. I was the lead on the last manned Skylab. You call it Skylab 3 or Skylab 4, whatever your preference is. Anyway, we had three manned ones, and I was the lead on the third manned Skylab, did that crew insertion and led that team. That was my last one, because right after that we slowed down.

The next mission after that was the ASTP, and I didn't work that. I was gone. I went off to Air Force recruiting school and learned how to be enthusiastic and went on and did that the last three and a half years.

BUTLER: Looking back at some of these Apollo missions, was there any difference in the procedures that you followed for each one or differences in the suits? Did they change over time as you went from Apollo up to Skylab, since I guess they used similar suits?

STEWART: Well, the suits were similar in that they were all full-pressure suits. A full-pressure suit, you just simply inflate the suit to a certain pressure, and whatever is inside it is at that pressure, no matter what the pressure is outside. We trained in Apollo 11 with some A5L and A6L suits, which were early Apollo suits. We flew an A7L suit, which was a full-pressure suit with the zipper going up the back. It terminated here in kind of the lower abdomen area, and then you unzipped it, and it went all the way back up the back between the shoulder blades.

It had a beta cloth cover layer on it, a white beta cloth cover layer, and this beta cloth, of course, was the best fireproof stuff they had at the time, and that was the reason for that particular cover layer, but the darned thing, if you had any allergic reactions at all to fiberglass, because that's basically what it was, then you had a little problem, and I did. What we did when we carried the suits, we'd pick them up and support them with both hands across our arms, and that doggoned stuff would irritate my skin on my arms. I noticed it break out, and I said, "Oh, gosh. What's going on?" So we finally determined that that's what it was. So when I took a suit from then on, I put something over my arms, and it stopped.

But anyway, the later flights, I think Apollo 15, I believe, is when we started doing the A7L-B suit, and that one kind of opened at the waist and bent—you kind of bent it in half. It had a little different closure, and the donning techniques were slightly different, but basically it was the same. You put your legs in, and then you ducked down through an opening, and you put your arms through the arms and your head through the neck ring. So the basic donning procedures was the same, as it is today with the suits that are flying in the Shuttle Program. You just put your feet in, and then you put your head and arms in and go to it.

I believe when we went to the A7LB suit, we went from the liquid-cooled garment which we had in the A7L suit, to a liquid-cooled ventilation garment, or LCVG, which was hooked up in such a way that it would circulate air from the lower extremities of feet and down into the arms and hands, in addition to circulating water. It just had a little plenum and a spider-looking affair going down the arms and the legs to distribute the air. Actually what it did was pull the air from those areas and recirculated it then back into the suit and would pull out the bad and put in the good. That was basically the same technique that we used for ventilating the suit and getting the oxygen to the crew members, you know, the pumps and the portable life support

systems, and the O_2 system in the spacecraft would pull out the bad air and put in the new stuff. I think that was the big basic differences.

The set-up on the front of the suit was basically the same. You had the blue connectors and the red connectors, and the blues go in and the red was coming out. So as long as you kept those straight, everything was cool.

Probably the gloves were the biggest difference, I think. I guess ever since we started trying to do work with our hands in a pressurized glove, there have been problems with working with those gloves, and there are still problems with working with those gloves. The gloves improved from what we had during the Apollo and up through, then, the second phase, which was the A7LB, I believe we got different gloves, a little bit easier to work and maybe the fingertips allowed a little more dexterity.

Then worked right on up to what they're using today, which is a whole lot better glove than what we had back then. You can do better work with it, and I'm sure they're going to have to improve in order to get the Space Station built, because the gloves are still hard to work with. Anytime you pressurize something to 4 or 5 psi and try to get a person to put nuts on bolts, just basically, it's hard to do.

BUTLER: Have you done that yourself, personally, worn the pressurized suits and done tasks?

STEWART: Oh, yes. A part of learning the equipment, a very important part of learning the equipment and training crews, is to be exposed yourself, because you can't tell somebody how it is to be there and do that if you haven't been there and done that. So a very early part of anybody's training has been, and hopefully will continue to be, you get in there and do the work

and find out what it's like to do it. I did that. Of course, it was interesting then, when I first started doing it, it was really a kick to get in the suit and be in there and do things that had to be done. All my career I've done that. I've been a suit subject many, many times for a lot of different evaluations of the pressure suits in development and procedures development with already established suits. Just about any time they needed somebody to do that, at the level I was working, I would do that.

Between the *Challenger* and the restart of the Shuttle Program, we went back to pressure suits. The suit technicians didn't have a whole lot to do as far as launch entry suits and things of that nature, putting crews in the spacecraft, because we didn't have any missions to support. So among other things we did, we worked on the 8 psi Suit Program, and I was a subject for that lots and lots of times. I spent a lot of time in that suit and got my pictures in all kinds of magazines and everything. You can't really tell who it is, but I know who it is. I worked with that and some of the development on the different gloves and bearings and things that they were trying out, the hard suit, and this and that.

So, yes, you've got to get in there and do it before you can tell somebody, "Yes, you can do this," or, "No, you can't do this," or, "This is difficult," "That's easy." You spend a lot of time in there. I don't know how many hours, but a lot.

BUTLER: When you were spending all those hours in the suits, did you also do training in the suit in the WET-F [Weightless Environment Training Facility] or the NBL [Neutral Buoyancy Laboratory]? Did you ever do any of that?

STEWART: I never did that. I wasn't certified for work under the water in a suit. I did all my stuff at the surface level, just a natural sea-level environment, and when it got to the more sophisticated stuff, the altitude flights and things like that in the chambers, they had people specifically assigned as suit subjects to do those kind of things and in the WET-F also. And in addition to that, by the time they got to that point, a lot of astronauts were getting involved at that time in the work. Jerry Ross has done a lot of work in pressure suits, and Jim Bajian [phonetic] did some when he was here.

For our launch entry suits for Shuttle Program, Steve Nagle and I did a lot of evaluations for that in those early models. It was us who determined the fact that we weren't going to train people in the suit helmet. I don't know if you ever noticed the training that the crews go through in the water tank over there now, but when they roll out of the hatch to do their simulated bail-out, they don't wear the pressure suit helmet, they wear the old launch entry helmet that we used. After we quit doing pressure suits for those many, many flights, they just flew coveralls and then wore the launch entry helmet. What we found out, Steve and I did a little bail-out exercise in Building 9, and when we rolled out of the side of the orbiter onto the mat, the necks rings of the suit hit us in the mouth and in the nose, and it kind of bruised it up just a little bit. So for that reason it was determined that they can get the same benefits of training but use that other helmet and we wouldn't be banging somebody's teeth and things like that. I went around with a bruise here and so did Steve for a few days after we did that particular run.

BUTLER: No good getting bruised up when you're trying to figure out how to bail out and save yourself.

STEWART: Oh, no. No need hurting anybody if you don't have to.

BUTLER: Right. All the little tricks of the trade you have to figure out on the way.

STEWART: Yes. You know, somebody's got to be first. Fortunately, I got a chance to be first sometimes.

BUTLER: Talking about the suits and the suit-up procedures, and it is pretty standard, but what is it step by step? Can you walk through those steps? What do you put on first? When do you do this, when do you do that for Apollo or space shuttle?

STEWART: Let's do both scenarios, okay?

BUTLER: Okay. Great.

STEWART: Back in the Apollo—if I get this wrong, I'm sure one of these other guys, Al or somebody's going to give you the right scoop. Basically, you start at the bottom and you go to the top. In Apollo, we had a requirement to pre-breathe 100 percent oxygen for X amount of time, I think it was three hours, prior to flight, and you could not break this 100 percent oxygen purge. This is to eliminate as much nitrogen as possible from the bloodstream so that the chances of getting bends or one of the other evolved gas problems in case of a cabin decompression where the suit just pressurizes you partially down, you know, and you're in a vacuum and it'll hold you at 3 psi or 4 psi, whatever the operating pressure of the suit is.

In that operation, we don the suit fully, and the crew member stayed suited until they go on orbit. So they were in the suits for sometimes, five, six hours, something like that, seven hours, completely closed up. What we did, you had what we called the—get all this "NASAnyms" I call them. The world has acronyms and NASA has NASAnyms. FCS, which is a Fecal Containment Subsystem—that was a panty-boxer short-type affair that had extra absorbent padding in it, and it was primarily designed for use on a lunar surface. Some people wore it for the launch; some people didn't. But you would put on a set of underwear of some sort and then a UCTA, which was a Urine Collection Transfer Assembly, which was a little bladder affair which had an elastic band that went around the waist to hold it up in place.

Then there what they called a roll-on cuff, which Al calls it a "Vatican-approved condom." It's open on both ends. One end of it would fit a flange which went to the UCTA, and then, of course, the other end was rolled up onto the person, all of them being males at that time. We didn't have to worry at that time about a female urine collection system. Okay, that article was put on.

Then, if they were wearing the LCG [Liquid Cooling Garment] , which at launch time they normally didn't launch with the LCG. They launched with a set of white cotton underwear and put the underwear on, the UCTA. If they wore that other thing, which most of them didn't, they put that thing on. Then after that, you got into the suit, you donned the suit, and then they put the helmet on, and then you put the gloves on.

After that, they were completely enclosed, and you did several checks of the suit system on—I don't know if you've ever seen the picture of these big white consoles that these guys were hooked to, but we use those consoles for testing the suits unmanned, and we also did a

certain amount of manned testing at suit-up, to make sure, first of all, that the suit didn't leak. There were certain parameters it had to meet leakage-wise.

Then there was also another test, which was a differential pressure test, or delta P test, that we did to make sure that the ventilation systems and everything were working properly. After that, they got back in the recliners, and we purged 100 percent oxygen through the suit on a low flow, and they took a nap or read or whatever they wanted to do until it was time to go to the pad. In that operation, you know, we had these portable ventilators that we used to keep them cool. In Apollo, they served two purposes. They were filled with liquid oxygen at that time. Now we use liquid air, but at that time it was liquid oxygen to maintain this oxygen purge on the suit. So you had a certain procedure that you had to go through making the connections to the suit in order not to break this oxygen purge. So you had to end up at the spacecraft with two connectors open to get the spacecraft oxygen system hooked to. That was when we had four connectors. If you'll remember, at one time we only two, and our command module pilot only had two connectors, one red and one blue. So a different procedure for them.

Anyway, you had these certain procedures that you had to go through, and you had to develop when you were going to put what connector into where. It was kind of a scramble, so that procedure had to be worked out.

We would remove the crew member from the chair. We would attached the ventilator to the proper connectors, and we would begin the purge with the ventilator, make sure that we had a good purge on the ventilator, then we would turn the console off, disconnect those connectors, and that left two blank ones, so when we got about half way to the pad, we changed the ventilators because they wouldn't last long enough to go from suit room all the way to the pad and all the way up and hold the guy. So we had to do a ventilator change in the transfer van.

We did that, and then you would end up with blank connectors where you needed them, except for the command module pilot, and that situation with just two connectors was pretty simple to do. You just disconnected the ventilator from the outlet, and you would plug in the outlet for the spacecraft and let the ventilator purge just for a minute, purge that hose, and then you would go to the inlet connector in that spacecraft. Anyway, that procedure was used for Apollo and Skylab.

Then the first four shuttle missions—and I'm jumping because I didn't work the ASTP deal—the first four shuttle missions, we used borrowed Air Force suits from the SR-71 Program, which basically were the same thing. They were a full-pressure suit. They had connectors that supplied oxygen to the suit. They were different than the Apollo ones, but it did the same thing. We had a seat kit which was attached to the seat, it was attached to the crew member and was attached, then, to the orbiter, but we used their seat kit—"theirs" being the military—the seat kit and the escape system. Remember, we had ejection seats in our first missions for the Shuttle because we didn't know exactly what was going on. That was the escape system.

The procedures for that, since we didn't have to have a de-nitrogenation, we would put the crew members in the suit, and you still do the suit integrity tests in the suit room to make sure everything's working properly, but the difference now as opposed to then is that after you do the suit integrity test, the crew member takes the gloves and helmet off, and they go to the pad without gloves and helmet on, and then when you get out to the pad and do the crew insertion, you put the helmet and the gloves on. That's still the way we do it today. That's the way we did it then.

We would get the two crew members that we had, and the suit tech would be up in there. We had to have a work platform because the ejection seats were so high. You'd do the crew insertion on those two guys, and that was about it. Basically the suit-donning was the same. You put on the undergarments, whatever they happened to be. At that time we had no liquid cooling for the launch entry suit, so it was all air ventilators. So they'd put on the urine collection system, whatever that happens to be—we have several different ones—then the underwear, then put the suit on, put the gloves on, put the helmet on, and the boots, and you're there.

With the Shuttle Program, of course, we have the harness, which is normally put on at the pad, and that attaches to a parachute which is in the seat of the orbiter already for each crew member, and that was pretty well the case in the first four flights.

The first three flights, I worked landings for shuttle. I didn't even go down to—well, I had been down there, of course, but I didn't go there for the suit-ups or anything, because, if you remember and even if you don't, this is the way it was. Everywhere that there was a possibility that the shuttle would land, no matter—you know, overseas and at White Sands [New Mexico] and at Edwards [Air Force Base, California] and at KSC—of course, the team that did the insertion stayed at KSC—we had a suit technician assigned to each of those areas. So my assignment during that time was White Sands. So I went out there and stood by. The primary landing site, of course, at that time, was Edwards, and we had other people out there. So that was the first three.

Then I did the crew insertion on the fourth mission with [Charles G.] Fullerton and [Jack R.] Lousma, and then we landed that one at White Sands. Well, what happened on that one is that Ronnie Woods went to White Sands to cover the launch-day landing opportunities. Soon as

I got done with the crew insertion at KSC, I jumped on a plane that afternoon and flew to White Sands, and then Ronnie Woods and I worked the landing at White Sands for that mission. So I got both ends of that one, which was kind of a kick. You send them off, and then you're right there to meet them.

We still do that today. Whoever the team leader is for the launch meets the crew wherever they happen to land, as long as it's KSC. They normally go to the prime landing site, which is now KSC. It was at one time—it could be either Edwards or KSC. Whichever the prime landing site happens to be, that's where the lead technician goes, and now they just go back to KSC. They don't stay there the whole time. There's no need leaving somebody there with nothing to do for a week or ten or fifteen or whatever days.

[Tape recorder turned off.]

BUTLER: We were just talking about the space shuttle suits and the early missions and your work out at STS-4, going from the launch to White Sands. What was your next mission, then, on the shuttle?

STEWART: Oh, my goodness. Well, when we stopped flying with the pressure suits and started flying with just the coveralls and the helmets and then what we called the PEAP. That was another one of our responsibilities, is the Personal Egress Air Pack, I think they called it, that hooked on the side of the seat, two bottles of air for use in an emergency situation, which—well, when they had to be used, it was far-fetched from what they had to be used for, so they didn't do much good. Air doesn't do you that much good at that altitude.

Anyway, the NASA personnel all worked together on a whole lot of those missions, and they all kind of run together, if you want to know the truth, in my memory. There were some significant things that happened during that time that still stick in my mind, and one of those was on one mission that I was the lead on, and I think it was—I don't know the designation to it—anyway, [Ellison S.] Onizuka was on that mission and I forget who else it was, because the significant thing is the fact that we had to change out a visor at the last minute on a helmet, and it was because during the preparations for suit-up, there weren't a whole lot during that because you didn't have a lot of things. The only life support equipment we had, actually, was a helmet. We had a harness which had a life preserver on it, it had no parachute, and that was just about it. The PEAP was already at the orbiter on the side of the seat so we didn't have to worry about that.

Anyway, the helmet had to have anti-fog applied to the inside of the surface of the helmet. Anti-fog for us is a mixture of detergent and vacuum pump oil, vacuum pump oil which is oxygen-compatible and a detergent which would be oxygen-compatible. They mix these together and make up a compound which will help to keep the visor from fogging because of the exhaled breath. Anyway, you have to apply that stuff X amount of time before you use [the helmet]. In doing this, you know, you've got to be real careful with everything. Anyhow, we scratched the outside of one of the visors in applying the anti-fog, and the scratch was in such a place on the visor that it couldn't fly that way.

The helmet that Onizuka wore had to be specially modified so that it would fit him around in the neck area and ear area. I don't know if you remember those clamshell helmets, but they squeeze together, and his would pinch him, but we made a modification to it. We didn't have another helmet that was modified for him, so the only other thing we had was a visor. So

we changed out. On flight morning we changed out a visor and ran a test on the helmet to make sure it was okay. That was kind of a scramble deal, and it was fun in that it was a challenge, because, you know, after a while, things, if they can get routine, get routine. You do the same operation many, many times over and over again, never to the point that they get boring, but it gets to be a routine. Well, that broke the routine.

Another thing during that program that was a kick to me, and I know it would be other people, is my oldest son was on the team with me. He was assigned. He went to work for ILC, and then he went to work for Boeing later on. Anyway, he got assigned as a member of the crew insertion team. On this particular mission, he and I and another guy, Max Candler [phonetic], who you should talk to also—he's been around forever and worked for every contractor that ever had a job on this [site] as far as life support goes, and he still works over in Building 7.

Anyhow, he, my son Troy, Jr., and Max and I had this particular mission, and we travel quite a bit together and did the suit-up and the crew insertion. There wasn't much suit-up. You lay out the stuff in the crew quarters, they get into their clothes, and then you meet them at the pad, basically, or meet them at the transfer van. Anyway, we worked that mission all the way through together. I don't know, but that was kind of a kick. We worked some other ones while he was still there with us. It was nice to have your son working with you, alongside you, and he still works at Ellington over there for Dynecorps [phonetic]. He's the life support technician there, and he's also a life support technician in the Texas Air National Guard, which all runs hand in hand. [Laughter] But that was one thing that was interesting and was fun, and I'll always remember that.

BUTLER: That's pretty special, to have him.

STEWART: It was. It was great. It sure was.

BUTLER: Followed right along in your footsteps.

STEWART: Well, I don't know if that's good or not. [Laughter]

BUTLER: Since the crews were now wearing the flight suits rather than pressure suits, what did you job entail overall?

STEWART: We were responsible for—and the lead still is, to an extent, responsible for that—everything that those people wore, from the underwear, the socks, the boots, which were special boots, the coveralls, pens, pencils, and other items of what we call crew preference items that they were allowed to carry on board, anything that was on this crew option list that this crew member wanted. It was our responsibility to make sure that it was tested, prepared, ready, and where it was supposed to be when it was supposed to be there. That included, like I say, all of the clothing, the pens, pencils, knee boards—with twelve cards on them, by the way; that was an Al Rochford requirement. [Laughter] The helmet, the harness—which those two things were individually fitted for the crew member—and, like I say, everything that they wore. It was our job to make sure that that was at every training exercise, ready to go, and it was also at the launch site and ready to go for the launch.

We also provided a clean set of clothing at the landing site. So each crew member was issued, I think, three of those flight suits. They would launch in one and then we would take one, whoever was going to be covering the landing site would take one for each crew member along with any other clothing that they wanted us to take out for them at landing, we'd take that out there. Most of the time, what you did was you took the one that they'd been training with—I remember when I went to White Sands—take their clothing from them, and then you'd take it out, and most of the time it had to be laundered because they'd been training with it right up to launch time.

So the first thing we did after we got either to Edwards or White Sands, to Los Cruces, is where we stayed, get it in the laundry and get it cleaned. It had to be dry-cleaned because it was cotton and had been treated with a fireproofing chemical, so you couldn't wash it, first of all, because it would wash the chemical out; secondly, because it would shrink the cotton and it wouldn't fit them anymore. So they were dry-cleaned. So you had to get them to the cleaners, get them dry-cleaned, and normally you got there like at one o'clock in the afternoon, and you'd ask the people to have them out either that afternoon or the next morning for you. In case the shuttle landed due to some emergency, you'd have the clothing for them.

So we did that, made sure everything was where it was supposed to be when it was supposed to be there. We were responsible for the set-up of the transfer van, and still are, that takes the crew members from the quarters or suit-up area out to the pad. It's our responsibility to make sure that the ventilators are there, that they're functional, in place in the van, and any other equipment that is required on the van for the crew member. That was basically it.

Anything that had anything to do with either life support or crew comfort, it was the suit technicians' responsibility to make sure that it was there. So that's what we did during that particular time.

That's when we almost got fired, as a matter of fact. We didn't really get fired, but they almost did away with the requirement for NASA suit technicians during that period of time. There wasn't really any pressure suit work going on as far as launches and entry and stuff like that, and we had one person who, I think, made the statement that "Anybody can take panties and bras to KSC for the crew members." By that time, of course, a lot of females were flying, and that's where that little statement came from. But anyway, anybody could haul crew clothing to KSC, but there was still life support equipment involved, which required expertise in oxygen systems and life support systems. So that got all hashed back and forth between one division and another division and the Astronaut Office, and finally Mr. [George W. S.] Abbey put out a letter and said, "Look, we're going to have an astronaut and we're going to have a NASA suit technician on the crew insertion team at KSC, period. There is a requirement for that." That was when he was in charge of flight crew operations, I believe it was at that time.

So that settled that again for a while, and that's the way it remained until, well, January. Just before that, we were notified that they were going to phase our jobs out over a period of time. As we retired, they weren't going to replace us. It was, "You're not going to get kicked out, you're just not going to be replaced," because of what I call "the contractor in the sky," USA [United Space Alliance] taking over all normal shuttle operations. So what they were going to do is just kind of phase us out, and that's happening at the present time. Al retired, and I retired, and they're not replacing us. They're phasing in—we had some Lockheed folks that were working with us as our backups. They're still using them, and then they're phasing in people

from what was Boeing FEPC, now USA, to take over those crew insertions jobs eventually. So there's only one NASA suit technician left in the whole world, and that's Jean Alexander.

BUTLER: Pretty special job, then.

STEWART: Well, we thought it was. At first, when we first came in '69, there were about five NASA suit technicians. Let's see if I can name them. There was Joe Schmitt, he was the lead guy, senior, and he would always tell you he wasn't the lead, but what Joe said went, so he was our lead guy. Then Walt Salyer, Sr., and he was a retired military guy from the Navy. Clyde Teague, he was a retired Air Force guy. Dick Sandridge [phonetic], he got caught in a reduction in force, as did Clyde, when they had one right after Apollo, I think. And Al Rochford, of course. There were five of those guys when I got there. Then they moved in two military, and then when they transferred all of the MOL people, moved in two more suit techs also from the military, Frank being one of those, Frank Hernandez, and a guy named Byron Smith, who has been retired from the Air Force for quite a while, but he's still around, not here, but up in New Boston, Texas, he lives.

BUTLER: Just a handful of you.

STEWART: Oh, yes. Then, like I say, a couple of those guys got caught in a reduction in force, when they had a reduction in force, and then Walt Salyer, Sr., retired, and that left only Joe and Al as the NASA technicians. Then that banged along that way, with Joe and Al and the military guys and then supplemented by the contractor who had the suit contract, whoever it happened to

be at the time. Most of the time it was ILC or Hamilton/ILC and then Boeing and right on along.

BUTLER: On the shuttle, the flight suits were being worn up until *Challenger*, and then after that, the decision was made to go back to pressure suits. Would those pressure suits have made any difference on *Challenger*? And what were the changes in those pressure suits from the earlier ones or were they pretty much the same?

STEWART: The question as to whether they would have made any difference is purely academic at this point, but the suit would have given the people a chance to move about whatever was left of the cabin and attempt to get to the hatch to get out of there. So if you can think in the most positive of thoughts, yes, possibly somebody might have gotten out of that thing if they had had pressure suits. Whether that's reality, we don't know, but with a pressure suit and parachute it's possible that they would have been able to get out of there and survive that thing. Again, we don't really know what the integrity of what was left of the cabin was at that time, but had they been able to sustain consciousness, which they couldn't with just the breathing air, the possibility of somebody getting out of there is still there. So, yes, maybe they would have.

As far as the differences in the suits, the suits that we used for the first four missions were full-pressure suits, and, as I say, you encapsulate a person in an envelope and you pressurize that envelope, and that person just works that envelope as best they can at that pressure.

The suits that we ended up with for the first part of the shuttle program after return to flight were partial-pressure suits. As a matter of fact, they're still using some of those, but over

the past couple of years they've been phasing those out, too, and going back to full-pressure suits for launch entry suits. Those partial-pressure suits utilize a system where you only pressurize certain portions of the body, critical portions of the body, and the way that you do this is you inflate a bladder which pushes against a restraint layer on the suit and also exerts pressure at the same time on certain areas of the body such as the calves and the thighs and the upper body in here and also, of course, the head. You maintain pressure in these bladders, which gives you the counterpressure that you need to be able to get the oxygen down into the lungs where you need it. Of course, the pressure around the body also would keep the gases from coming out of solution in the bloodstream, which is the evolved gas problems that you have, bends and such as that.

The full-pressure suit, of course, puts them right back into a fully encapsulated environment that protects the entire body and is, in my opinion, a lot easier to work with. It's a lot easier to work in the full-pressure suit, it's not as restrictive, and it gives better protection.

This is one thing that rubs me really bad about the way that things were done between the *Challenger* and the return to flight. The NASA suit technicians, Al Rochford and Jeanie and I, were just almost totally excluded from the process of getting these return-to-flight suits done. There was a guy that we worked for who was assigned the responsibility for the project to get the things going, and then there was another manager who was assigned to make sure that the job got done. Anyway, they moved those folks completely out of our division and moved them over into another division to get this program going, and basically what they said was, "We don't need your help. Thanks but no thanks, and we'll let you know when we need you again."

Then it rocked along and rocked along. Finally they came up with a suit, and one day they called us over and said, "Okay. Come pick up your suits. This is what you've got to work

with." This kind of, to me, wasn't the right way to do these things. Of course, I didn't have a whole lot of say, at my position, as to how things were done. I realize that there were people under the gun to get a program going, but I still never will understand why they didn't take advantage of some of the expertise that was available to them to get this job done. So that'll always be a little thorn in my side, no matter what. Don't get me wrong, I'm not bitter, and never have been, but that one thing right there just kind of irritates, and if you get an honest answer out of Al and Jean [Alexander], they'll tell you the same thing.

BUTLER: That's understandable. It would make sense to consult the experts.

STEWART: It should.

BUTLER: What did you do during the interim between *Challenger* and the return to flight?

STEWART: Basically we refurbished a lot of equipment within our division that needed some work done to it, and because of our expertise in those areas and the fact that we had time to do that, we did that, such as the MMU, if you remember, the [Manned] Maneuvering Unit, we had some of those that were display models, and Al and I reworked one of those things. That's one thing we did. Some pressure suits from the old program, we reworked some of those and did some work on the hard suit, the 8 psi suit, I did some of that.

Basically things that had to do with life support. We supported some EVA [Extravehicular Activity] work and a lot of research and development work in suits and other things. It was going on at that same time, which didn't have anything to do with flying the

shuttle or actually with launching the shuttle, but was being done, such as the hard suit, 8 psi stuff. Like I say, I did a lot of that and supported quite a few tests as a suit technician and then as a suit subject also on that particular program.

Then something I'm kind of proud of, during that interim time there was a team formed. They called it the—let's see if I can remember. Emergency Egress Working Group, I think, or Emergency Egress Rescue Working Group. EARWIG was the NASAnym for it. This was a team of people from KSC and JSC, and the primary mission for that team was to look into the safety of the operation for the crews and develop procedures and equipment changes and things like that, that would help to make launch a safer operation. I was chosen as the suit technician representative for that particular team.

So we did a lot of pressure suit work in that program. We had some old training suits left over from the first four flights, so we utilized those when we needed suits for a particular thing such as driving the armored personnel carrier or tank that the crew members drive now. Everybody used to be trained in that. We needed to make sure that what we were doing there was the best thing that we could do, so we ran tests with astronaut personnel and the people at KSC and the suit techs from JSC.

We also kind of refurbished the white room up there at the 195-foot level. We had a lot of input into how that thing should be set up as far as accommodating the crew equipment for the crew when they got up there and some of the emergency equipment that was involved. My primary expertise, of course, was in the crew equipment, so I got more say as to where the shelves were, what kind of shelves we needed and where they were going to be, and things of that nature. So I had a little bit to do with redesigning that and then a lot of the procedures that were used for rescuing the crew, got our word in on that.

Like I say, I was the rep from the suit tech world, but Al and Jean and the other folks that worked with us, I got input from them which I passed along to the team. But that was a fun-type thing, and at that time I was looking for something productive to do, and it came right at the right time, because I'll go back to anybody can refurbish a mock-up, but getting in on the development of the new procedures and working a lot with people at KSC that you hadn't worked with before, such as the fire rescue personnel, the close-out crew members down there, the volunteer close-out crew members, who are actually mechanical technicians that work on the shuttle except at launch time and then they become close-out crew people, the NASA quality people that KSC would never—you'd just see one every once in a while, and then, of course, a lot of the astronauts that were on the support team. We got to know them a little bit better and worked a lot closer with them to understand a little bit more about each other, and they, of course, us. So that was fun, and it was productive work, and you can still see the results from that. I'm quite proud of having been a part of that, also.

BUTLER: That's definitely a very important thing to have been a part of. You mentioned developing procedures or modifying procedures for crew rescue. Can you expand upon that?

STEWART: Well, what we did, we took a look at what we were doing as far as rescuing the crew from the crew module, and went through those procedures as best we could, of course, without actually going in. We have mock-ups that we can go into and pull people out. So we ran those procedures. Then we took a look at what we were doing and said, "Well, could we do it better?" And the answer is always yes. You can always do something a little bit better. So then we developed procedures which we thought—"we" being the entire team in the world that does

this—were better and safer and would give us a better chance of getting people out of there without them getting hurt or some other disaster happening.

So we refined, mostly. The procedures were in place as far as that part, but we just refined them to suit the more modern needs of the equipment that we had as we knew it, because, if you remember, we were launching with coveralls, we didn't have anything as far as breathing apparatus for those folks except that PEAP, which was air, breathing air. Well, for the Shuttle Program, the suited Shuttle Program, we have now integrated into the parachute harness an emergency oxygen system. So that emergency oxygen system, combined with the harness itself, which includes the life preserver, makes it more difficult to get a person from the seat down between the seats, in some cases, down onto the slide board and out the hatch, because you have several more hang-up points. So we had to develop procedures for that.

In the design of that equipment, they had to take some of these things into consideration. Were we going to be able to get the crew member out? How much problem was it going to be? How big could it be? How long? All of that. So the stuff we have today is a result of the things that the EARWIG worked on in conjunction with the engineers at KSC and JSC. We just took what we had and refined it and adapted it to what we knew we were going to have, and today we have a pretty good operation.

As a result of that and some other things that happened, we have a very good training program now for the close-out crew people. We used to go to KSC and train on an old beat-up wooden mock-up that kept falling apart down there, and it wasn't very realistic at all. The seat belts didn't work, and it had no actual real connections to work with to take a crew member out, so we had an opportunity to voice our opinion, which I guess I never had any problem with doing so.

As a result of an incident that happened at KSC when we went for training one time, it was determined that, yes, in fact, close-out crews needed to train together, they needed to train on high-fidelity equipment. Subsequently we're bringing our close-out crews here to the hi-fi mock-ups in Building Nine, taking the suit technicians and astronauts from JSC, bringing in the close-out crews from KSC and training as a team, together, here on high-fidelity equipment. We've been doing that for about a year and half now, and it's worked out real well. I'm confident that if the need arose, that those people would be able to do it a lot better now than they have in the past.

The same thing happened with the fire rescue personnel. They were trying to train those guys on that old stuff down there, and it didn't work. So we finally talked them into bringing them here. The only reason that it was a big hang-up was money, travel money, and getting those folks off from their regular job to come and do that, because that's actually not a part of the regular job for close-out crew members down there. They are volunteers, and they just do that on launch day. They may be working third shift or second shift. Well, when close-out crew time comes, if they're a member of the close-out crew, they come off of that shift and go on with the close-out crew. After the launch is over, they go back to their regular shift. In our particular situation it's a part of our job, so we're into it all the time.

But as a result of all of that, I believe, last I heard, they were getting a new, refurbished, more up-to-date, more in configuration mock-up at KSC to do their training with, but I think they're still going to be coming here to do the integrative training with everybody. That's another result of the EARWIG stuff.

The slide-wire situation down there, we ran a test. No one had ever actually ridden that slide wire before. They'd always just run down with the sandbags in it. So during this time of

reevaluation, we ran a manned operation with the slide wire. Charlie [Charles F.] Bolden [Jr.] was the astronaut in a pressure suit. I was there to support that test. One of the firemen, a rescue team leader named George Haggart [phonetic], and then the senior close-out crew guy—his name was Junior Bumgardner [phonetic]—they all three were in the basket and rode the basket down, first manned run of the basket down to the landing area and then into the bunker. We had the fire and rescue people doing what they were supposed to do, get these guys in there and everything.

During that same time we worked on equipment for the bunker to make things better there. We established a communication system so that the crew members could go to the bunker after they disconnected from the orbiter. We had a quick disconnect on a helmet cord [which] we adapted [to] the bunker telephone system so that the crew member could just go there, plug in their helmet cord to the telephone and be able to talk to the LCC [Launch Control Complex]. That was one significant improvement there.

There were some others. We got ventilation air down there to the bunker so that while they were still in a suit they could hook up to that ventilation air and at least cool down their bodies a little bit, because it is work to get out of the seat, out of the orbiter, across the swing arm, into the basket, down to the bunker, and into the bunker, especially in Florida in the summer. So that was another thing we got, a system so that each crew member could immediately plug into the air.

Of course, there are other pieces of emergency equipment there in the bunker that were developed as a result of the EARWIG stuff. There still is an emergency egress working group, and they meet regularly and come up with things. As a matter of fact, if it hadn't been for that group there, this training that we're doing at KSC wouldn't have been pushed as much. So it's a

good thing to have. Now Jean Alexander is our representative on that group right now, since she's the only suit tech left.

BUTLER: Very important group.

STEWART: Oh, you bet. I think so.

BUTLER: Hopefully we'll never have to put much of that to test.

STEWART: Well, hopefully the equipment that we work with—"we worked with"—I still talk as if I was still in the program, but, you know, I still know everybody and know what's going on. But anyway, and this is [something]…you try and impress on the new folks coming along, the equipment that we work on and that we use has to be able to immediately do what it's supposed to do, but you hope that it never has to be used for that purpose. It's kind of a funny feeling, but you don't want to ever know if it's going to fail. At least I don't. I don't want to know whether it worked or not. So let's keep it the way it is.

BUTLER: That's right. Better to be prepared for whatever can happen and not have to find out.

STEWART: Not have to use it. That's right. [Tape recorder turned off.]

[BUTLER: During this interim time you also worked on the 8 psi hard suit. What were some of your duties in that regard?]

STEWART: Well, there was a certain amount of just routine maintenance on that suit. The suit itself is made up of components which are interchangeable, such as rings, bearing rings and sizing rings, and things of that nature which you can replace to adjust the size of the suit for a particular person. So that has to be maintained. So we did that, kept the thing clean and lubed and sized for people who were going to be doing the manned tests. As I said, I did some of the manned testing inside the suit myself in the early, early development stages. In other words, if they get a new bearing in, which we've got several of, and they needed somebody to run a series of cycle tests or something like that on this new bearing to measure torque or to get objective and subjective data from it, then I would do tests like that. And a new glove, to evaluate that glove in the glove chamber or something like that, I did that, and then I actually supported a lot of the manned runs with people other than myself as a subject. I was the suit technician. We'd take the equipment over there to wherever it had to be, suit the person up, monitor them while they were doing the test, and, of course, take them out of the suit and take it back to the lab, clean it up, and get it ready for the next test. I did real suit tech work there in addition to some of the testing itself, but wasn't involved too much in development of the pieces of equipment like the gloves and things of that nature. They were already involved in that.

A guy named Joe Cosmo [phonetic] was the project engineer on that, and still is, working with the people that he worked with, you know, that bring in—say, "Okay. We've got a new bearing coming," and we would take a look at it and do what we had to do, but basically the job of a technician as far as keeping the equipment ready to go and making sure it was where it was supposed to be when it was supposed to be there.

BUTLER: What is the difference, benefits, disadvantages, etc., between the hard suit and a soft suit?

STEWART: There are two, in my opinion. Of course, Joe Cosmo may be able to give you a lot more detailed information about this. But basically there are two advantages to the hard suit. First of all, the hard suit can be pressurized to a higher pressure than the soft suit—let's say 8 psi. It's easier to take a hard suit and safer, pressurize it to 8 psi, than it is a suit with soft goods, with soft goods put together the way soft goods are put together, sewn and glued and things of that nature.

The second advantage is that with the hard suit and the way that you can do the bearings in the gloves, the bearings in the shoulders and the waist and wrists and elbows and knees things where they need to be, the hard suit concept makes it easier to work these bearings at the higher pressures. You have to have the higher pressure, so the hard suit is the best way to go there, plus you have to be able to work in a suit that is at that higher pressure. So, those two things, I think, are probably what's important about having a hard suit design as opposed to a soft suit. You can't bend that soft suit as easy as you can move the bearings the way they're arranged in a hard suit.

BUTLER: You mentioned Joe Cosmo's still working on that. Is that something that you see for the future manned missions?

STEWART: Oh, yes. I think so. I believe so. It's easier to change out the parts. Now, please keep in mind that I haven't worked with this suit in several years, but from what I remember of

it, it's easier to change the components in the hard suit. It's easier to use one set of hardware for more people in future missions, like you're going to be going to Mars and back to the moon, supposedly, and also on Space Station missions you're not going to have suit technicians up there to take care of the equipment. You're going to have to have something that can be used, a minimum of suits and equipment for the maximum amount of people. I think the way that they're going now with this hard upper torso and things, the interchangeable components with the quick—well, use of piano wire, actually, to hold the pieces together, that makes it easier for people who are not trained suit technicians to change out the parts. In other words, the astronauts that are there are going to have to change the parts out to fit the next person that's going to use that suit, because everybody cannot have their own suit pre-fitted on Earth and taken to wherever they're going to have to take it. They're going to have to change out the parts where they are.

BUTLER: Absolutely. Well, I guess we'll have to watch and see what happens.

STEWART: I guess we will. Hopefully it'll happen in our lifetime—well, it will in yours, but it won't in mine, probably, but that's okay.

BUTLER: I don't know. I think you've still got quite a few years ahead of you.

STEWART: I hope so.

BUTLER: Looking at suits and differences, you also worked, when you were working with the Shuttle Program, on some of the Shuttle-Mir flights. Is that correct?

STEWART: Yes, I worked on some of those, not very many. Most of those, my rotation just didn't put me on them. I think I worked maybe two of those.

BUTLER: In the course of any of that work, did you get exposed at all to any of the Russian suits or differences, or maybe by working with some of the international members, having them compare some differences?

STEWART: *I didn't get very involved with that at all. I saw the suit that Shannon [W.] Lucid had, and I saw another suit that one of the other—I think it was Jerry [M.] Linenger, his suit that he had. I saw the EV suit that they wear and was able to take a look at it, then I saw primarily the escape suits that they had for Shannon and for Jerry and for those folks. They're basically a full-pressure suit. Their entrance and closure is a little bit different than ours, but basically it's the same stuff. They've got gloves. They've got a suit. They've got a helmet. It all works basically the same. You get in it, you close it up, you pressurize it. That's about it. There are a lot of similarities, as I'm sure everybody would understand, people taking trade secrets from other people. It happens. It happened then. They copied a lot of our stuff. We may have gotten some ideas from them and put them into effect on ours. I don't know that for a fact, but I'm sure it probably happened.

BUTLER: Looking at the Shuttle-Mir Program, but also tying in a little bit with Apollo-Soyuz, even though you didn't work it, your background was with the Air Force, and you had been trained that Russia's the enemy, basically. How was the feeling when you began to work with them? Was it something you were surprised about, that it happened?

STEWART: Well, I was surprised that it happened. Let me put it this way. I wasn't very pleasantly surprised, and I'm still not. I don't particularly agree with everything that's going on with that particular program. As far as the people themselves, the folks, astronauts, and that's primarily who I've been exposed to, the cosmonauts, they're great. They're absolutely great people to work with. They're just like you and me and everybody else. They have a job to do and they're there to do it and they're going to do it the best they can, and we're going to do the best we can. Since we have a job—based on my military background, the mission is given to me and I will support it. I don't always have to agree with everything that's going on, but that support is there.

BUTLER: Moving into just general topics now, looking back over your whole career—

STEWART: That's a long time.

BUTLER: —are any of the people that you worked with, either astronauts or fellow suit technicians or contractors or anyone like that, are there any particular people you'd like to say anything about or mention any stories about?

STEWART: Well, I won't go telling tales on anybody, but, yes, there's a couple of people that I think influenced me. The first one was Joe Schmitt, who was the lead suit technician for many, many years. He was the original suit technician for NASA. He came from Langley when they first started the program and went all the way through into the Shuttle Program, and then he finally retired. He was my mentor, and I learned basically what to do and how to do it, or tried to copy as much as I could from Joe, because I was impressed with the way that he worked with people and, of course, his knowledge of the hardware and everything.

I didn't have the knowledge of the hardware in detail that a lot of the folks had, but I'm a people person. If I had to categorize myself one of two ways, either a people person or a hardware person, I'm a people person, and I learned from him how to deal with the people, or at least I think that's where I learned it. I was totally impressed that we would walk around the campus, and of course everybody knew Joe, but Joe knew everyone by first name. It wasn't, "Hey, how are you doing?" and you ask him who is it, "Oh, I don't know, but I know I know him." It was always Joe knew this person by first name, and they knew Joe by first name, and he knew everything about them. That impressed me. I took that and tried to put that into operation.

Of course, I learned a lot about work habits, what it took to get done, what we had to do. It's a pretty demanding operation, particularly back in Apollo, and it's not that much better right now. You're under the gun all the time to get something done and get it done within a certain amount of time. Of course, you still have to put out a top-quality product. So he, in the NASA Program, was probably the person that impressed me the most as far as a person I was working with. I've enjoyed working with Al and Walt and all of those other guys, but, I don't know, Joe was my guy. [Laughter]

BUTLER: We'll be sure to tell him that you think so highly of him.

STEWART: Have you talked to Joe yet?

BUTLER: We have talked with him about setting up an interview, but we haven't had one yet.

STEWART: Well, I'll tell you what, you're in for an hour or two of pleasure when you start talking to that man.

BUTLER: That's great. Looking back again over the course of your career, would you ever have imagined where it would end up and where it would lead you?

STEWART: Early in my career I had no idea that I would be doing today what I'm doing, but in the late sixties and early seventies, I knew that what I was doing before I retired is what I wanted to do, so I worked toward that goal. That's the reason I went to work for ILC when I retired. That's one of the reasons that I went to recruiting school and recruited people for the Air Force for two and a half years. That wasn't the most enjoyable experience I ever had, by the way, but I knew that that's what I wanted to do. But as far as way back in my early Air Force career, I had no idea that that would ever happen.

From '70 on, I knew that if I had anything to do with it, I was going to be a NASA suit technician, and that's the way it ended up. Whether that's a lofty goal or just one down here somewhere, that was it, and we made it.

BUTLER: I think that's great. You mentioned ILC, and I think I missed that earlier. You worked with them briefly before you did come on as a NASA suit technician.

STEWART: Yes. There were no NASA slots available at the time that I retired, so I applied to ILC. I knew the basic corps of people that I'd worked with while I was here in the military were still there. A lot of them had gone, of course. They had had a big downsizing, but basically I knew them and they knew me, and evidently I did a good enough job when I was here as a military person to warrant them hiring me at that time. So I went to work for them, still, you know, hoping to get a government slot, even though there were none open, but I could do the job because they had the contract.

Part of their contract was to supply the technicians that worked with the NASA guys on the crew insertion. So I could work my way through ILC and get into one of those jobs. When I first came on board with them, I didn't work in that particular area, but I later one got involved in that, probably the last nine months, year, that I was with them.

When I came back from the Air Force after that three and-a-half-year recruiting tour, the first thing that they assigned me to do when I came back to work for ILC, they had a bunch of pressure suits from Apollo and Skylab, A7Ls, A7LBs, that the shelf life had run out on, and they had to be disassembled, inspected, documented, and reassembled. So I did basically the same thing when I came back to ILC as I did in 1969 when I first came here. Joe had us tearing suits down in '69 to learn them, and then when I came back, those guys—Ronnie Woods, as a matter of fact, was my lead. He still worked for ILC at that time. He was my lead tech, and they put me back to work. I had ten or fifteen or something like that of those suits, and they put me in

there by myself, said, "Okay. Go to it, Bud. Tear them down, check them out, document it, and then if they're worth putting back together, we'll put them back together." So that was my indoctrination the first couple or three months I was at ILC. I eventually became a lead tech for ILC also, and we worked a couple of shifts, and I became the second shift lead tech, and then I went to the crew insertion group. I was still working with Joe and Jim Slusher [phonetic] and Al Rochford and those guys.

Then in 1980, they had lost five NASA technician slots, and so it was decided that they would replace those five with two. Ronnie Woods and I applied for those jobs and got those jobs, based on whatever the criteria was at the time. We'd like to think it's because of our experience and the way we did our job when we were doing that, but we also, if you realistically look at it, we were in the right place at the right time and probably had a lot of friends in places that were able to influence who got hired. So if that's the case, then that's okay. I don't really care how it happened. It happened, I'm glad, and we got that experience.

BUTLER: And you've been able to do quite a bit for the program.

STEWART: I hope so. I hope I made some kind of little dent in the program somewhere along the line.

BUTLER: What's on the books for now?

STEWART: Man, I've been working so hard since I retired. I retired in January, and I've been remodeling my house and now I'm remodeling my garage. I'm about half through with it. After

that, I'm not sure. I'm going to try to not have to work for somebody. I'm just going to try to just do what I want to do. If it works out that I need to go to work for somebody, I'm sure I still have enough friends here and there that know how I work and what I do that I could probably get back into aerospace if I wanted to. I have no immediate plans to return to work. I'm going to enjoy my retirement and do my family projects and home projects and help raise my grandchildren, and that's it.

BUTLER: That sounds like a good deal to me.

STEWART: Pursue my hobbies. I fish and I play a little bit of golf and work on little projects. I have little garden, vegetable garden, things like that.

BUTLER: Sounds great to me.

STEWART: A little community service. I have one committee that I'm on. I live in Webster, and I'm on the Parks, Recreation, and Beautification Board there. So I get to say a little bit about what happens in town there, and I may do some more volunteer work. I've always wanted to build at least one house in this Habitat for Humanity program, so I may get involved in at least one of those, because I've developed some skills recently that can be used there in doing that project at the house. You know, things like that. Other than that, I'm going to enjoy the rest of what I've got left.

BUTLER: Seems like a good plan.

STEWART: Well, it's a plan.

BERGEN: Looking back at Apollo and Skylab, I was wondering if you could tell us a little bit about some of the differences between the training you did with the astronauts in Apollo and what you did in Skylab.

STEWART: As far as the launching, the crew insertion and everything for both those programs was basically the same because we used the same spacecraft and we used the same pressure suits. So that part of the training was the same. The simulator training that they did, as far as I was concerned, was basically the same. I know the procedures were different for them inside, but what we did was exactly the same stuff. We got the suits ready, we took them over, we suited them up, we put them in, we waited until they got out, we took them out of the suits, we took the suits back and got them ready for the next time.

The basic differences were, in Apollo we were training for lunar surface activities, and we did a lot of work outdoors, out here on the rock pile, at NASA, JSC, and then on that lunar surface training area that they had at KSC. Suit technicians' work was not all glory and fun; it was work when we worked down there. At one time, in order to keep those guys cool, we had ice water in little pumps that we had to supply ice water through that liquid-cooled garment. Well, it had to be portable, and the way to make it portable was to put the thing on the suit technician's back and have them follow these guys around.

So that's what we did, we carried these little icepacks of ice water with a little pump, and we circulated the cool water through, and we stayed as close as we had to, yet as far away as we

could so that we didn't interfere with these guys. They were hooked up with the liquid-cooled garment in the suit.

Then we also had to supply breathing air to those guys, and when we first started, we didn't have a portable airpack that they could wear that was functional, that would give them freedom of movement. So we had a little manifold in a mock-up of a backpack, but it had an air hose attached to it, and that air hose was attached to a great big—you've seen these trailers that they have for breathing air and stuff. There are a lot of them around on site. We had the breathing air in those trailers. We had 150 or 200 feet of black rubber hose that trailed around behind these guys. Well, somebody's got to be there to man that hose. It's kind of like a fire hose. After a while, it gets heavy. So you have two technicians, and one would carry the air pack and the other would back him up, and you handled that hose while you were carrying the air pack. So that made it a lot different.

Also, for Apollo, we did the training at KSC, basically. You moved there two months before launch, and you stayed there with the equipment. We got a break. After three weeks, we'd come back for about four or five days, and then we'd go back to the launch. Of course, the crews flew back and forth. They didn't stay there all the time. But the support people just stayed. We stayed right there.

During Skylab we did all the training here, and the only training devices that we used for Skylab were the command module simulators and mock-ups and then that mock-up that they had of the Skylab, which we didn't get involved too much in that particular portion because most of the training they did there was stuff that they were going to do after they got on orbit. So they didn't use the suits too much. Every once in a while we'd have to go there when they would practice taking the suits off and storing them away, simulating after they got on orbit.

Another exercise was putting the suits back on for the return. So we would take the stuff over and monitor that particular operation. Those were the differences. Basically, the Apollo was a little harder than the Skylab, if you want to know the truth. It was better for us, and, of course, we were younger then. We were in our early thirties, and we could handle all that situation.

BERGEN: You also mentioned that between *Challenger* and the return to flight, that you felt like the suit techs didn't have much input into the decision-making process. Do you feel that in earlier programs you had had more input?

STEWART: No. Well, we've always had this input: we take the comments from the crew members and take them back to the engineering personnel. But,no, as far as having a say in how things were going to be, we never had that. They would take your suggestions. If you had a suggestion, somebody would take it and look at it, and in some cases, I guess, they got implemented and some they didn't. Between *Challenger* and return to flight, we just didn't have any input at all as to the way things were going to be. These guys were probably under a lot of pressure to get things done and to get them done quickly, and the equipment, the suit that they bought, that partial-pressure launch entry suit, I think the only reason we came up with it is because that was what was available at the time. We couldn't get enough, or we couldn't get back into the SR-71 suits. Basically, right now, the new launch entry suit is basically the same thing as the SR-71 suit was, a little different cover layer, just a little different, but not much.

BERGEN: I was wondering if there were any changes in your job when women became part of the astronaut corps. Did that have any impact on what you did?

STEWART: It had no impact on the basic operation, and for the most part it had no impact on the way we operated. We would take the equipment to a suit room and lay out the equipment for all the crew members. When we first started, back when like Sally Ride and Anna Fisher and those guys, basically Sally Ride, I guess, started training with us, we only had one suit room. We didn't have two separate facilities at that time. We had one. So what would have to happen is that, most of the time, the female on the crew would just use a facility, either the female rest room or a facility separate to get into the basic undergarments, and then rejoin the rest of the crew for the suiting. That's the way it still works today. They have a separate suiting room at most of the facilities now for the females, but as far as our basic job, it didn't change. Some of the equipment changed, naturally, because women wear different things than guys wear. We did things the same way for everybody else. The females have to use the same equipment as everybody else uses.

I mean, the stuff is designed for a male individual sitting in an airplane seat. When it pressurizes—I don't know if you've ever notice, you lay a pressure suit up on this table and you pressurize it, and it goes to a sitting position. It doesn't stretch out into a walking position. So the patterns are cut that way.

But anyway, all the stuff is sized. This, now, creates some problems in fitting females, because the suits, again, are designed for males from fifth to ninety-fifth percentile male. We had some problems after we started flying a lot of females in that they didn't fit the fifth to

ninety-fifth percentile male equipment. So some modifications have been made, but the equipment is basically the same for everybody.

BUTLER: Is there anything that we haven't covered that you wanted to talk about?

STEWART: Man, I hope not. [Laughter] I think I've probably spouted off enough about that. Again, the only thing that makes me real proud about the whole situation is that I had a goal when I came to—well, actually when I left NASA, I had the goal to come back. That goal was realized. I mean, I realized that, and I think that I have done some significant things to help the manned space flight program. I like to think that. I'm quite proud of what I did. That's probably basically about it.

BUTLER: I think you've got a lot of be proud of, and I think you did have quite a significant contribution.

STEWART: Well, it was a good run.

BUTLER: Thank you for sharing with us.

STEWART: It's been my pleasure.

[End of Interview]