ORAL HISTORY TRANSCRIPT

J. MILTON HEFLIN
INTERVIEWED BY MICHELLE KELLY
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[This oral history with Milt Heflin was conducted at Johnson Space Center, Houston, Texas on April 9, 1998. This oral history was conducted by Michelle Kelly, Paul Rollins, and Summer Chick Bergen for the Johnson Space Center Oral History Project.]

KELLY: When you first joined NASA [National Aeronautics and Space Administration], what was your first position when you came here?

HEFLIN: The first position I had was called a recovery systems engineer, kind of a fancy title for somebody who would go down to a shop area where we'd build up an Apollo command module 1-G trainer, and put hardware inside of that. And so what I did was, basically, as a project engineer, be sure that the technician, who had to do the job, had the parts they needed, and they had the right kind of work orders to go install that sort of hardware.

What made it so interesting was that, there I was, right out of school, working with a lot of technicians who had been in the Gemini Program, Mercury Program. I mean, these folks have been around a long time, some old salts or whatever. It was interesting, the baptism of fire I had in trying to deal with these sometimes crusty old guys who knew how to do things a heck of a lot better than I did, coming right out of school, and, you know, so I had to kind of learn by doing for them.

KELLY: So you didn't have any formal training?

HEFLIN: Well, no. Formal training for this kind of job didn't exist. Back in the late sixties, prior to staffing up to land on the moon, NASA was hiring really very fast, hiring a lot of people, and what they did, if you had a degree in science or engineering or whatever, and you showed interest, you could pretty much find a job down here. Then once you got here, I think, coming out of school, you know, you established that you could finish something, you know, you could get a degree. And they look for people like that. And then you got trained on the job to do the job. You would bring basic skills with you from school.

KELLY: Did somebody show you around the hardware that you were installing?

HEFLIN: Oh, yes. I had a mentor named Mac Jones, C. Mac Jones. He's still here, by the way, and he's a great person. Used to live across the street from me here, too. Mack was already a project engineer, doing the same kind of stuff, but he'd been here for about a year, and so, you know, he would mentor me and show me around, which was invaluable. I mean, other than that, I would not have had a chance, I don't think, especially against these crusty old technicians.

KELLY: What kind of hardware did you put into the simulators? Was it just the command module simulator?

HEFLIN: For landing to recovery, we had about four or five different 1-G ground, just to be used on the ground, versions of the Apollo command module, and what we would put in, it depends on what we were going to do. We would have one training command module—and we called them vehicles back then, believe it or not—training vehicle, that we would put in the full array of couches, some of the switches would be mocked up that the astronauts would use when they were back on the water, during recovery. The envelope inside, the volume

inside, would be mocked up exactly like it was, so they could get inside and go through egress training.

Once you get to the water, you need to get the hatch—we had a hatch, just like what was on the Apollo, to be able to go through the process of opening the hatch and putting on their flotation gear, and doing all the things they had to do. It was mocked up just so you could go through and prepare to get out of the command module into a raft that would be brought to you by swimmers.

KELLY: I'm assuming that this is in water, right?

HEFLIN: Oh, yes.

KELLY: Where was it?

HEFLIN: On site here, we had—this is interesting—we had a water tank in Building 260, right next to the astronaut gym, and Building 260's still down there. It's a large blue building, in dire need of paint, and it's about a three-story building. Well, we had a water tank in there that, oh, let's see, I want to say twenty-some feet deep, and the diameter was probably again, about twenty-some feet, I suppose, maybe twenty-five feet. And just enough room to where we could take the Apollo command module, 1-G trainer, and put in the water there, and so we could train a crew in this very calm environment.

Back when Ellington Air Force Base was still an Air Force base, north of here, northwest of here, believe it or not, we used the non-commissioned officers' swimming pool, also. We would take a big crane and the command module mockup out there to Ellington, Ellington Air Force Base, and we'd pick it up, you know, crane, put it over the swimming pool fence, down into the water, and so we used that also as a pool.

Then lastly, what we would do, is down here in the Seabrook shipyard, we had an old Army landing craft, I forget what you call it exactly, but it's a flat-bottom boat. That was a terrible thing to be on down in the Gulf of Mexico, but we had a flat—and it had one of these ramps that would come down, you know, to put material onto a beach, but that was all welded shut. The main deck was only just a few inches above the water, and so it was ideal for us to put an Apollo command module mockup on board there, go out into the Gulf of Mexico, where we could get into a real sea state, and test the recovery hardware out there. So we used a tank here, we used the pool out at Ellington, and we got out into the Gulf of Mexico and tested as well.

KELLY: How did you actually come up with what type of hardware there was to be installed? How was it developed?

HEFLIN: Let me put it this way. You've got to be able to find the Apollo command module first, so you needed location aids. So you needed radio beacons, flashing lights, and we even had what we called sea dye. It was a material that once it got into water, would put out this really yellowish-green slick that was very visible from up in the air, if you're trying to search on the ocean surface for it. So that was hardware that we could get from Rockwell International. Rockwell—that's right, it was called, back in those days, Rockwell. I've forgotten the name exactly now of the company because they've changed names so many times, but, you know, Rockwell built the Apollo command module and they would supply us with flight hardware—the radio, or the flashing light, or this sea dye, and couches that we would put inside. They'd supply all that hardware, and we could put into these ground test vehicles, and test them. We'd go out into the Gulf of Mexico, we could have the radios be turned on, we could have aircraft with their homing devices, see how well the radios worked and so forth.

We also had a lot of external hardware that we used, that was not a part of the command module itself. We had a flotation collar that we would put around the command module, once it was back on the water. A swimmer team would do that. We had a raft that you would hook up to the flotation collar, so that there would be a platform for the astronauts to get into once they came out of the command module, they could get into this raft, and either be picked up by helicopter, or whatever.

And we had a lot of odds and ends. We had special kinds of hooks, special kinds of lines, that we would use from the aircraft carrier, to be able to grab a hold of the command module, to be able to pick it up, and that sort of thing. So there was just a lot of loose hardware. There was very little on board the Apollo itself. Most of the hardware that we used for recovery were items that we would take with us, either on aircraft carriers or put into an airplane to deliver.

In fact, we even had a method of where you could—if the Apollo command module did not land in the primary recovery area, let's say it landed several hundred miles away from there, and it would take the ship maybe several hours or it might take the aircraft carrier a day or two to get there, as a possibility. But we enlisted the help of the Department of Defense, and their air rescue service, to be able to drop, airdrop, material to the Apollo and to the crew, if needed, including putting in swimmers, putting their—what they call their PJs, their parajumpers, who could fly over in a fixed-wing, HC-130 aircraft, and open up the rear of the aircraft and bail out. And we could drop hardware to them, too.

And we even developed a, it was called the—and NASA's really terrible with acronyms—this was called the Aircraft Deployed Drift Reduction System, ADDRS. What this was, was it was a system where you could fly over from an HC-130 aircraft. See, the command module's in the water, floating, and it's going downwind, down sea, and so you know which way it's drifting, and as it goes this way, you could take an aircraft and come over and cross its path, a hundred yards or so in front, and we would drop out a flotation

collar and several hundred feet of nylon line, that would then be attached to another flotation collar-like bag, that would have survival gear and a few other things in it, and as the command module drifts—so what you'd have is you'd have two floating packages in the water, with this line across it, and you'd have the command module coming down to intersect that, and the crew had this strange little grapple hook that we developed, where they could take off a vent port in the hatch of the Apollo command module and they could take this little—and we didn't want them to open the hatch, in case the sea state was real rough, you'd get water inside—they'd open this very small little hole, and this little grapple hook, which had fingers on it that would collapse, they could push this little grapple hook out and it would spring open and it had a cable onto it that they would attach inside to a piece of structure, and so now you've got the command module sliding down in the water, with this little grapple hook, and once it crossed the nylon line, it would snag it.

And what would happen is, on each of these little packages, in the water, separated by this line, were sea anchors. This was another—it was like a little parachute in the water. It's called a sea anchor. So once that happened, then these—it'd go by and these two packages would now come together like this, and they have sea anchors out here, and it would slow the drift rate down to where now, you could drop people in the water and not have to worry about being able to catch up to the command module. And that just made me think, I've got to tell you an interesting story. When I worked with some of the swimmers, the underwater demolition team—and we used a lot of these teams out of San Diego, out of Coronado.

KELLY: Yes, this is part of the Navy.

HEFLIN: Yes, the Navy. It's a Navy group. We used a lot of them out of San Diego, and we used to brief them that, "You guys are really strong swimmers, but you cannot swim as fast as this command module is going to drift across the surface of the water, so don't try, don't

try." And in training, it would be interesting to see those who would be dropped out of a helicopter, and they would miss their target area, so now they're a little bit upwind of the command module, not downwind where they should be, a little bit upwind.

And I've seen these strong, husky, good old American sailors, or whatever, Navy folks, in the water, no further than from me to somewhere across the table here, and they couldn't catch up with it. They're swimming like crazy, got flippers on, the whole business, but they couldn't catch up with it, because that command module, once it got on the surface of the water, it could drift upwards to, you know, ten, fifteen percent of the windspeed down there, and they could just—you know, you get two or three miles an hour going on that thing, and these guys are trying to swim in a sea state, going up and down like this, and they couldn't catch it.

KELLY: Wow. Now that brings to mind, how did NASA coordinate with the Navy, or the Department of Defense, to get ships in the right recovery areas? Did you work on that at all, or were you at least familiar with it?

HEFLIN: Yes. Well, what we did—back in the beginning, and back in the early Apollo days—in fact, Gemini Program and Apollo, we had the Landing and Recovery Division, here at then, the Manned Spacecraft Center, and we were upwards to, I think, 120, 130, maybe 140 at one time, people at the peak of Apollo, civil service, a few contractors, several members of the Department of Defense, who would be stationed here, and be part of our team.

The team here at the space center basically was the corporate memory, that would go from mission to mission, and carry the lessons learned and carry the procedures, the documents, and the training from team to team. The Department of Defense [DoD], by agreement, was all signed up to be a part of the support structure for Mercury, Gemini,

Apollo, every program, including Shuttle. Department of Defense for Manned Spaceflight, called DDMS, they're still in existence today, at Patrick Air Force Base down in Florida, and they still provide Shuttle launch site recovery sort of capability, with the helicopter crews they have down there and so forth.

So we had an agreement with the Department of Defense, and prior to each mission, we would agree as to what was required in the way of support. Back in the Gemini Program, and early Apollo Program, you could just almost go around the world if you—you know, by going from ship to ship, we had, you know, we had ships out there down the flight path, so many hundred miles apart, and we had them scattered everywhere, and we'd have Air Force staging bases around the world, all set and ready to go.

So we really had a real worldwide force, through the Department of Defense, to support us, and these folks would send representatives to the Manned Spacecraft Center, where we would meet prior to every mission, and go over the details of what was required to do the job, and then we would send out somebody from the Landing and Recovery Division [LRD], we would send them out to the various staging bases, or wherever, to conduct training, to conduct briefings and training and that sort of thing.

And yes, I did do that. I did that, first part of my career in LRD, was doing the test and development work for hardware, but I'd be called upon from time to time to be put on a recovery ship or go down to the Kennedy Space Center for launch site support or that sort of thing, as were all the other people in the division, at that time.

So I did that, and I did that from—let's see, I was on eight primary recovery ships, or eight splashdowns for Apollo, during that time, including the very last one, the Apollo-Soyuz mission. I was at the Kennedy Space Center for one launch, I think that was Apollo 12, if I remember right. I was sitting in a hangar, in Gander, Newfoundland, for the launch of the first Skylab mission. We were concerned. Skylab was launched on a trajectory that would cover more of the earth when it went around its orbit, so it launched a little bit more north

than just due east out of the Kennedy Space Center, and so we had a team up at Gander, Newfoundland, with heavy-lift helicopters, long-range heavy-lift helicopters, to be able to—in case there was a launch abort, they would land in the North Atlantic, and we'd have to go find them. So I was a NASA advisor to that group, at the time, up in there.

So the division, basically, we own the hardware that we would send out to the various places, we had logistics experts, and we had recovery experts that would go to either a naval base or to an Air Force location, or whatever, and train the people.

KELLY: And how did you find it working with the Department of Defense?

HEFLIN: Wonderful.

KELLY: Really?

HEFLIN: Absolutely wonderful. I wish that I had kept better records of all these fine people I worked with, because I've lost track of so many of them, but they, you know, typically, for them, supporting an Apollo mission was definitely different than the kind of job they had, for sure. And so it was almost a time for them to kind of, change of pace, I don't want to say "relax," but it was new and different, and a high visibility for them. Oh, really, very high visibility.

So because of that, they were more than just interested in doing a good job. I mean, they thought it was great to support the program. You know, there would be some cases, we'd take one of the aircraft carriers, and, you know, like the—I think the longest trip I ever took, I think was on the USS *Ticonderoga*, for one of the late Apollo missions. We left San Diego, went to Hawaii, then we went all the way down to Samoa during this time, so we were out at sea for close to a month all the time, and some of these—the naval personnel had

just gotten off of a long deployment, and they were called upon to go do this, and so, you know, that wasn't the neatest thing for them to do, from a standpoint of their wanting to be home with their families and so forth.

But they were, they had a, you know, I learned a lot from them. I mean, they definitely had a can-do spirit. The thing I think that I liked the most about working with the Department of Defense was the discipline that I witnessed in the way they do their business. There are times that I sort of wish that we had a similar discipline in this business today, because, I mean, in the military, you've got somebody who's in command, and what that commander says to go do, you go do. That doesn't necessarily happen today in the space business, so I learned a lot from that standpoint. It was really great. Super people.

KELLY: That's great. And speaking of learning from, I guess, past experiences, did you feel that a lot of the experiences from Mercury and Gemini carried over into Apollo, in your experience?

HEFLIN: Of course, I came here at the end of the Gemini Program, but I really didn't have any background in that. I have seen a copy of the Gemini recovery manual, the document that was used to do the recovery process and whatever, and there were a lot of similarities between what happened in Gemini and Apollo.

In the recovery business, I think that it was easy for that to be carried over from program to program, because primarily, the laws of physics dictated you had to do this. I mean, you've got something in the water, floating, and you've got a big aircraft carrier who's boring down on it, I mean, there's only one way you can go about getting to it. I mean, there are different ways you can go do that. And so it was—and you've got to find it. You need ways of locating the spacecraft on the water.

And again, those kind of things, sea dye markers, radio aids, and that sort of thing, were just pretty much carry-overs from one program to another, and a lot of the people—see, when I came here in 1966, you know, we had folks in the division who had been here for Mercury—not here, but down in Florida—and at Langley and other places. In fact, they did a lot of early testing at Langley, Virginia.

But there were a number of people here who had already gone through some of the heartaches in developing this sort of hardware. For example, flotation collars that you use. We had a flotation collar for the Gemini spacecraft, in the shape of the Gemini on the water, and we learned a lot from just how to manufacture that kind of hardware, and the stresses that you have on that kind of hardware. A lot of that was carried right over into developing the Apollo flotation collar that we would use. The recovery discipline, I think, was one to where it was fairly easy to carry over lessons learned, from one program to another.

KELLY: For instance, with the hardware, did you just modify the hardware from the Gemini to the Apollo spacecrafts, or did you develop new hardware altogether?

HEFLIN: Had to develop new hardware altogether. The flotation collar, for example, the shape was different, so you had to do that. You had to build the right kind of shape. Electronics are electronics. You know, we had location aids, radio direction finding type of devices, and what you do, is you just simply take advantage of the state of the art, if you can, at that time, to do that, so that's how that was done.

KELLY: Did you find that some of the hardware that you had developed, you didn't use in the long run?

HEFLIN: Oh, yes. Oh, yes. Oh, yes. We would end up using a very small subset of all the hardware we developed for a nominal mission. We developed a lot of hardware for contingencies and that sort of thing. For example, we had a thing that was called a "jammed hatch kit." If we had a launch abort, down in Florida, and we landed in the surf, with the Apollo on the parachutes, or in the Banana River, or some place down there on land, or whatever, there was a good chance we were going to jam the structure, such that we would not be able to open the side hatch and get the crew out.

So we developed what we called the "jammed hatch kit," which was a pneumatically-operated drill and saw, to where you could get up to the top of the command module where we had this tunnel, and basically cut a hole in it, to be able to get the crew out. And we would train—in fact, the Air Force provided a heavy-lift—we even designed a heavy-lift helicopter, to where the helicopter could be used to go out off of Florida and grab a hold of the recovery loop on top of the Apollo, and pick it up out of the water and fly all the way back to land.

KELLY: So you designed a helicopter?

HEFLIN: Well, the helicopter was—the Air Force already had the heavy—it was an HH-53 something, I can't remember the exact number, but it was built for heavy lifting. It had to be able to carry troops and armament and that sort of thing, in Vietnam, and it was a, I mean, it was a workhorse helicopter, long-range, and you could refuel it. It had a probe on it. You know, it was a refuelable helicopter as well, and it had enough lift capability to be able to lift the twelve to thirteen thousand pound Apollo command module. It could lift it up out of the water, and fly back to land.

So we developed the sling, that we used to go from the belly of the helicopter down to the Apollo command module, and that sounds pretty simple, but we had to be careful,

because the length of this made a difference to how this thing would fly, and how it would fly underneath and so forth, and so we developed that out here at Ellington Air Force Base. We took a mockup again, and helicopters, and played with different kinds of hooks and lines and that sort of thing.

So there are a couple of—and this thing I mentioned a while ago, this air deploy drift reduction system. Those were three things that we developed for contingencies that we never had to use, during the time. But that's the way you do this business. You spend a lot of time working for emergencies and contingencies.

KELLY: Did you ever feel that you had to use something that you had developed for contingency? Were there any problems during the missions in the recovery phase?

HEFLIN: We had one early Apollo, and I had—we had one unmanned Apollo that landed outside the primary recovery range. Now this was before we had developed this drift reduction system. Well, actually, as it turns out, we did use—we had a special kind of crane that we would mount on destroyers, since there were a number of destroyers that we could use, as opposed to what we used on aircraft carrier.

Aircraft carrier, we had basically the boat and aircraft crane. It was called the B&A crane, and it was a crane that was pretty high above the water, and you know, it's what we'd use to pick the command module up and bring it on board. But on a destroyer, which is pretty low in the water, we had this, we called a Divitt [phonetic] crane, and that's a common term today with the cranes, but it was a smaller version of the crane that was developed in case we needed to use a destroyer to pick up one of these command modules.

Well, sure enough, that is the hardware that we used back in—you know, it was in one of the very early Apollo unmanned flights that we did, and I don't remember the number, but we did have to use that piece of hardware. So during that mission, it became obvious

during the landing and recovery phase that we were going to have to use that piece of hardware.

KELLY: That's interesting. Did you ever feel like you would have to use something like that during a mission of a manned mission?

HEFLIN: No. And I think what we saw was, with Apollo 7—well, take Apollo 8, for example, which was the second manned Apollo flight, the one that went to the moon and came back, and I was on the USS *Yorktown*. I was in the South Pacific when it landed. This was in '68, I believe, December of '68. It landed very close to being right on target, you know, in the Pacific. The guiding system and the landing systems on board were very good. In fact, they got to be so good, they got to be so good, we used to park the aircraft carrier at the center of an ellipse, basically. It was twelve miles this way and fifteen miles this way, some number like that. It was an ellipse, which was the primary target area for Apollo to land in.

And we used to park the aircraft carrier kind of right at the center, because that gave us the ability to go anywhere in that, within a same amount of time, whatever. We had to move it, because Apollo was so good, it was coming right down, you know, all, you know, it would have, yes, it was coming down too close to the aircraft carrier. What, doesn't that sound good? You ought to be right on target, real close. No. You've got a big ship like that, you've got to be—that thing doesn't turn on a dime, you know, so you've got to be able to approach it.

You've got to be some distance away, to be able to line up to it, to where you can come along side, with this aircraft carrier, and provide a lee, on the lee side of the ship. On a ship that big, you can take a pretty good sea state, and as you come up to it on the command

module, and you're protecting the command module from the sea state and the wind, you have a pretty calm area out there.

So we had to end up, like I said, parking the aircraft carrier. In fact, we even had to go outside the ellipse, because we learned in later Apollo that, you know, not only did we have, on top of the Apollo was called the apex cover, and it covered the very top of the Apollo, which had our flotation bags, the antennas and that sort of thing, and a recovery hook.

Well, this thing came off at high altitude or whatever, by a drogue chute, and it weighed several hundred pounds and it's falling down, and there were other cables that have been cut, and there was a lot of debris, in other words, during this landing phase of coming down. We had one, after one of the—oh, I'm going to say, probably after the lunar landing, Apollo 12, Apollo 13, maybe that time frame, or whatever, one of our helicopters came back on board the aircraft carrier and there was a nylon line wrapped around the antenna. How it got through the propeller or prop, I have no idea, but what this was, was this was, this line was about a fifteen-foot line, with several knots in it, that were put in--this was part of a deployment apparatus, used on some of the hardware on Apollo that came off on high altitude, so this debris actually came down and landed on the helicopter as it's flying out there.

And so we decided, "Okay, now it's time to get way out of this ellipse, get out of the ellipse, because..." You know, this is a long way of answering your question, but the Apollo was so good, the navigation and landing was so good that we had to get out.

And another example of that is, you know, from time to time, we would use the same aircraft carrier, and the same, sometimes the same complement of crew. We had a navigator, a Navy commander, that was a navigator, he was a navigator on two flights. Well, this was the—we had one flight, and again, I can't remember the exact number, you guys might. I know you'll find it in your research. We had one flight where we had loss of a parachute,

during descent to the water, because as we were dumping the propellants from the command module, the nitrogen tetroxide ate some of the riser lines and caused the parachute to collapse.

Well, so we descended a little faster than normal. Well, when we hit the water, the navigator looked at his timepiece, very accurate timepiece or whatever, and I don't recall the number of seconds, but it was several seconds. I want to say maybe up to twenty or thirty seconds or so that we landed, hit the water. He was in shock, because he was so used to—the previous mission he had worked, you know, where we landed within just a small few seconds, hit the water when we said we were going to, and he was also familiar with all the previous navigators, who had passed on to him how accurate this was, and when they said they were going to splash down at 14:06 and twenty-five seconds, that's when it's going happen.

Well, when this thing hit the water, you know, several, several seconds prior to that time, it's like, he was disturbed. Well see, and that's when—and we did not know at the time, on board the ship, I mean, myself, we did not know that we had lost, you know, one of the parachutes had collapsed.

KELLY: Right. And what mission was that?

HEFLIN: Oh, gosh. I'm going to want to say, probably around the Apollo 14 time frame or so. I don't know. It's available somewhere, but I don't remember when it was.

KELLY: That's interesting. How were procedures developed for landing and recovery? Were they developed in concurrence with the hardware as well, or did you train people how to implement those procedures at a later time?

HEFLIN: We developed pretty much all the procedures here, at the Manned Spacecraft Center, back then, with the Landing and Recovery Division. We would bring in some underwater demolition team swimmers, we'd bring in a helicopter squadron, whatever, if we wanted to do something special. But we would figure out, you know, what we wanted to do, how we wanted to do it.

We had, we basically had our own civil service recovery team here that knew how to install flotation collars, knew how to handle all the hardware that we put on helicopters for search and rescue, all those things. And we would simply either get in a water tank here, or go out in the Gulf of Mexico, and we'd install a flotation collar by a certain technique. No, that's not too good. We'd do it again, a different technique. And so once that's done, we would write up the procedure, with photographs or whatever, and then take that with us to the team we had to train. And so we would—

KELLY: So they weren't the same teams, then?

HEFLIN: No, they were not. And a number of times, when you would go out, especially early in the program, when you would take the procedures out to a helo squadron, or to an aircraft carrier, and you're working with a deck force. The deck force, those people who are going to be responsible for hoisting the command module back on board a ship. Quite often, during debriefings, we would conduct exercises and training, and then we'd debrief, and you know, these folks have been in the Navy for many years, they've had similar kind of experiences in coming alongside other vessels and doing things. Well, they'd have some ideas, so they would talk to us about that, and we would incorporate some of their changes, from time to time.

KELLY: So there was a real feedback.

HEFLIN: Oh, yes. Yes. Very good. Very good feedback. And the Department of Defense got very good about themselves going from unit to unit, and passing on what they knew.

KELLY: That's really neat.

HEFLIN: Oh, yes. It was great. Absolutely.

KELLY: You've mentioned that you also worked in deactivating the reaction control system once the command module had landed in the water, is that correct?

HEFLIN: Yes.

KELLY: Can you tell me a little bit about that procedure, and exactly, I guess, first, if you can describe how the reaction control system works, like during re-entry?

HEFLIN: Okay. Once the command module was now free-flying, and the surface module was jettisoning away, you had a series of reaction control jets around the circumference of the large diameter part of the Apollo command module, and you also had up on the upper deck, you had a couple of thrusters located up there as well, for control.

And, you know, as it's flying through the, you know, yet very rare atmosphere, not much of an atmosphere, then this was a lot of force, and so these little jets would fire periodically. It's nothing more than very small little engines, that take nitrogen tetroxide, monomethal hydrazine, two things that by themselves, well, they're ugly and don't smell very good and so forth, but you put the two together and they make an explosion, and that plus plumbing and fuel tanks and that sort of thing, and valves, and a computer, and you put it all

together, and you have a way of—see, the Apollo command module, due to its weight and center of gravity, could rotate or whatever, and based upon its center of gravity, and the atmosphere it's coming into, this could allow it to lift, or to go in, or to roll to one side or that sort of thing.

So that's basically how it worked. It worked all the way down till you begin to hit the atmosphere, where you have a perceivable atmosphere, and then it no longer is in control. And the drogue chutes come out, and they pull out the three main parachutes, and then you're just on parachutes, and when you're on parachutes, you're just at the mercy of Mother Nature and the wind, at that point.

KELLY: How did you deactivate the reaction control system then, once it was no longer in use?

HEFLIN: We did it—the flight crew, of course, during descent, they would turn everything off associated with the system. They would close all the tank valves and that sort of thing. Once back on the water, for up until the time we had this parachute collapse, and I'll try to back up, and talk about that in a minute, but up until that time, we didn't do anything on board the ship or during the recovery and return phase, other than take some thruster plugs, we call these thruster plugs we put into the little reaction control thrusters, and we'd have this long tube that would come out, flexible tubing that would come out, reinforced tubing, and we would run that over the side of the ship, and so any vapor that might come out would be vented overboard, and that would just protect anybody working around the command module.

Once we got back to land, and typically, for a lot of Apollo flights, we would return to Pearl Harbor, and we would then take the command module to Ford Island, in the middle of Pearl Harbor, and usually a deserted hangar, they'd make a hangar out there that's not

being used available to us, and we would put the Apollo command module, it's on a dolly by now, on a four-wheel dolly, that you can roll it around.

We put that in a hangar, and we had Rockwell International, at that time—well, the contractor team that provided the services for taking the fuel and oxidizer that were in the tanks, they had a procedure and ground equipment that would come in and flush these propellants out of the command module into holding tanks, to later be able to dispense into a toxic area, toxic waste area. And so the contractors did that.

Back in those days, I was, when I did that job, I was a NASA team leader. What that meant was, I was responsible for arranging for the facility we were going to use, being sure we had security, we had all the support we needed, public affairs. There were typically two of us that would go out, two NASA team leaders, because we did this around the clock. It took us a couple of days to do this, forty-eight hours or so, to do the whole procedure, and we'd work around the clock doing that.

And so we would, as the NASA person on the scene, we were responsible for any deviations in the procedures. We were the NASA signature authority to make those changes if we had to, so we were representing the government NASA, during that time. Now, that was—we would do that after every flight. We also, besides taking the propellants out, we had several explosive pyrotechnic devices that had not been used, because a lot of them were there to--well, they were there backing up other devices if need be, and the team would go in and gain access to those areas, and basically, safe those materials, also, so basically, take their connectors off, and put a safety cap on the connector, to be sure that they would not fire later. Did that every flight.

After we had the incident where we lost the parachute due to—as the crew's descending, there is—after they've used the reaction control jets the last time, there is still fuel and oxidizer in the lines, trapped between a valve and the little thruster out here. It's smart, that before you hit the water, and before you have any people working around this,

was to basically burp that line. Open it up just so you can get the pressure off, you know, and burp any propellants that are out of there as you're descending.

Well, that's—the oxidizer on that mission where we lost the parachute, the oxidizer was very caustic and ate the risers and the parachute collapsed. Well, after that then, it was decided we had to have a way—first of all, the crew couldn't do that anymore, for obvious reasons, so they're going to now land on the water, with this trapped propellant in the line, still pressurized.

So once we got on board ship, one of the first actions we did was to, on board the ship, hook up kind of a mini version of what I just talked about in the deactivation that we would do at Ford Island. This was a very small set of hardware that would allow us to hook up to the reaction control system, and take the pressure off the system, bleed the pressure down, so that there was no way for the propellants now to get blown out of the thrusters. And so we would do that on board the ship.

I'm not sure I ever understood why we did it this way, but—see, I was classified as an engineer, along with several of my compadres, who were on board aircraft carriers, and it was interesting. We were not able to take with us what I would call highly qualified, really very savvy, blue-collar, know what they're doing mechanics. Guys who know how to handle wrenches and screwdrivers and so on and so forth. Well, no, we wouldn't do that. We would train ourselves, you know, engineers, to go do this job.

Now, quite frankly, I enjoyed that. I mean, I like playing with tools and that sort of thing, so it was okay, but it was something that always—I always could never figure out why we did it that way, and to this day, I'm still not really too sure. It probably saved some money, you know, from a standpoint of that sort of thing.

But for this thing we did on board the ship, the very first time it was done, it was done by myself, and a gentleman named Frank Janes, who passed away here this last year. But Frank and I were both dressed up in these ridiculous-looking yellow bunny suits, head to toe,

completely covered up. We had a hose that—we weren't wearing a self-contained backpack of breathing air, and I'm not too sure why we weren't.

For some reason, we decided back in those days, to have an umbilical, a hose hooked to us, that went across the hangar deck floor on the aircraft carrier to a supply tank of air or whatever. And so we were all dressed in these things, and we broke into the reaction control system ourselves, on board the ship, and did this [unclear] procedure.

And what was so interesting about this was, we told the people on the ship. We told the ship captain, we told all those people how hazardous this stuff is. We scared them to death on this stuff, you know, because we had to make a point. This is really hazardous stuff, you know, and everybody needs to be careful about this. I think we scared them so much, the first time we did this, Frank and I were in the hangar bay. It was on the USS *Ticonderoga*, and it was like Apollo 16, I think, was probably the first time we did this. That sounds about right.

And I looked around, we were doing this procedure, and there wasn't a soul in sight anywhere. I mean, we were by ourselves down there. There wasn't anybody there, and I looked at Frank, he looked at me. You know, I thought, "Man, you know, we could go up in smoke here and nobody's going to even know about this." I looked over in a corner, and there was some of the Navy, some of the low-grade sailors, you know, the low-rank sailors, and whatever, were on fire watch, and so they had—and we knew they were going to have a fire watch down there, whatever. I just didn't know they were going to be basically out of sight. But they were off into a corner, and I looked over there and they're almost just peering over the top of this thing, you know, just looking at us, and so forth, during that. [Laughter]

KELLY: Made you feel safer.

HEFLIN: Oh, yes. I have such a vivid memory of that, and looking out the opening of the hangar bay there at the most beautiful moon, you know, out in the South Pacific at the same time, which is really neat.

KELLY: Oh, that's great. That's a nice memory. Can you tell me a little bit more about some of your experiences on the recovery of ships and what you did? Do you have any other memories, other than 16?

HEFLIN: Oh, yes. Oh, gosh, I—there, towards the end of the Apollo Program—well, let me back up here. What we used to have, back when we were a big division, we would have somebody who would work with a helicopter squadron, we'd have somebody who'd work with the swimmers, we'd have somebody work with the deck force on the aircraft carrier.

Well, as it turns out, as we were winding down Apollo, and we were staffing up other areas, like getting ready for the Shuttle Program, that sort of thing, our division got smaller and smaller and smaller.

Well, I ended up, just really by good—and I say "good fortune," really, because it was such an experience. I ended up filling the roles of like three people, at the end of the Apollo Program, which I could do, because at that point, we were now down to, basically, only putting one ship out in the ocean for Apollo flights. It was the primary recovery ship. Aircraft staging bases, we had cut back ninety some-odd percent. I mean, we just hardly had anybody staged around the world like we used to, because we didn't need to.

I mean, by this time, the Apollo—like I told you, the Apollo would kind of land, you know, right where it was going to. No need to have people around the world. And so what I did was, for Apollo 16, 17, all three Skylabs, and the Apollo-Soyuz, so for six straight water recoveries, I was the NASA point of contact with the underwater demolition team swimmers,

the helicopter squadron, that would embark on the aircraft carrier, and then the aircraft carrier itself, usually the department head on the aircraft carrier, responsible for the deck force.

So what I would do, is I would, prior to the mission, I would go make the rounds. I'd go out to San Diego, if that were the case, which it typically was back then, and go meet the squadron, the helo squadron commander and the swim team commander, and start briefing. And in the San Diego area, I don't recall the name of the little water area there, the little bay, right off of Coronado, right inside Coronado. We would put a training command module out there in the water and let the swimmers work with it.

So I basically just became a keeper of the corporate memory, going from ship to ship and team to team. That's what I did back—and also was responsible for shipping hardware. We had our hardware, our flotation collars, for example, were manufactured down in Florida, and so I'd be on the phone with the folks that would refurbish and handle that hardware and send them messages that we needed to send so many flotation collars here, and so many here, and that sort of thing, and so I kind of did that job as well. So I did some of the logistics work back in that time, as well.

KELLY: That's neat. Going back to your work in the reaction control system, and I knew there was a story on the ASTP [Apollo Soyuz Test Project] landing, how there was either a valve open or shut, or maybe you can explain a little bit better, and the crew got ill from the nitrogen tetroxide that leaked into the Apollo command module. Can you talk a little about that? Did you respond to that at all?

HEFLIN: During command module descent on the parachutes, there is a time, and I don't recall the exact altitude, but there is a time when you want to open the command module vent valve systems up, so that as you come down, you're going to equalize the pressure, the pressure across the—you know, from inside, outside. So what you have is, you know, you're

going to have air beginning to flow inside the command module from outside, because the command module inside is at a lower pressure. Hope I said that right.

And that had to be done, again, I don't recall the altitude—and that valve got opened up ahead of time, if I recall, if I remember right, and I want to be careful here, because I sure don't want to blame the crew. But that's all in history and it's all documented what happened, but basically, there was a valve opened up too soon, whether it was opened up automatically or the crew did it, I just don't remember, but because of that, this was during—jets were still firing, and they were tapering off and there wasn't much left, because you're back down in the atmosphere pretty good, and there are still some residual fumes and stuff that are around the command module at that time, and so basically what you had was, you open that up and so you had some of these fumes that got inside, because you have air flowing inside.

Now, we—and what I remember about that was, the day of recovery, I guarantee you, the day of recovery and probably for twenty-four hours past that time, as I'm working on board the—this was the USS *New Orleans*, I had no idea that happened. None whatsoever. Nobody on the team had any idea that happened. And I think somewhere along these lines, I guess, the doctor is on board—we know the team we took out on board aircraft carrier, we also had NASA flight surgeons that would go out, and the Department of Defense would have some of their flight surgeon people also out there, and I think they were beginning to pick up on, there's something wrong with the crew, and we're not sure what it is. And so they were receiving some sort of medical treatment out there.

It was pretty—from my viewpoint, I was so busy, at that time, doing the things I already kind of talked to you about, we had to do, to prepare the command module to return, I don't remember hearing anything about that until I think we were back on land, that I actually had heard about that. So when we brought them on board the ship, we did not know this had been a problem, so there was nothing for us—you know, we couldn't react.

KELLY: Right. So they were pretty sure then that it wouldn't affect your job in actually safing the RCS [Reaction Control System]?

HEFLIN: Well, yes, because the system itself had—it had done what it was supposed to anyway, the reaction control system. It was this vent valve that had been opened up earlier, so, no, there wasn't any—

KELLY: Okay. So it wasn't going to affect you.

HEFLIN: Well, see, and I don't think—quite frankly, I don't think anybody really knew enough at that time to be able to even be smart enough to call out to the aircraft carrier and say, "Hey, we saw this sort of thing." I don't think anybody put it together, as it turns out.

Now, we had hydrazine and nitrogen tetroxide detectors, so once we got back on board the aircraft carrier, one of the first things that was done was, we had a person who'd walk around, basically, with this detector. They had a mask on, that sort of thing, and just check all areas, and basically, kind of like you see when you land a shuttle today. People have got these poles and they're all looking. Yes, we're doing the same thing. Just checking to see if there's any residual. So that protected us from being concerned about that sort of thing.

KELLY: Well, that's good.

HEFLIN: Oh, yes. Yes, absolutely. That's bad stuff. That is really bad stuff. Because we had an incident, and accident, during one of the deactivation procedures. We were in San Diego. We were in either Pearl Harbor [Hawaii] or San Diego [California], and in San Diego, in fact, I had worked as a deactivation team leader, the mission before this, and I can't

remember the number of the mission, but we had an error made by the team during the deactivation in San Diego, and it caused an explosion.

When you take the propellants out of the command module, and put them into a holding tank, there's a neutralizer that has to be in this holding tank, and I don't recall the name of the chemical, but it's basically to neutralize the propellant, to dilute it, and neutralize it, and so much is required to be put into the tank. Well, there was an error made, and there wasn't enough of this neutralizing material inside this particular tank, and so as the crew there in this deserted hangar in San Diego, near the naval shipyard, as they are pumping this propellant into this holding tank or whatever, the neutralizer gets used up.

Now there's just raw material going in there, and pressure was built up in there, and what I remember the most about this in the investigation was, that this tank was about—and we're talking a stainless steel tank, about so like that, and about so big around, and it was up in the top of one of these ground support equipment carts that was on a four-wheel—it was a four-wheel cart that you could haul around, whatever. That tank went straight up in an explosion, went straight up through the top of that cart, up to the top of a cement roofed hangar dome and knocked the biggest chunk out of that thing that you could see or whatever, and all this stuff fell down. And they had this big old red cloud, nitrogen tetroxide, a big red cloud on the surface and so forth. We were lucky. There were only minor injuries; nobody got killed. And there were no lasting effects from that.

KELLY: What happened after that? Was there an investigation, you mentioned?

HEFLIN: You know, it's like a lot of things that happened. People sometimes get comfortable in what they do, I think. They've done it so many times, and so if you just don't take, you know, even though you've done it so many times, you know, you still ought to go to that procedure, and read step one, and step two, and step three.

And if I recall, what happened was that they kind of did some of this by memory, and so the procedures were modified. The team was trained again, retrained, in the importance of this sort of thing, plus the procedures were also modified, asking certain other questions and so forth, other things to check off, and we had quality assurance out there with us, and everything that we did would be stamped by quality assurance and bought off and signed and so forth. And, you know, it just was one of those—you know, you can usually look at any accident and you can just find something, sometimes rather simple, that happened.

KELLY: Were there any other risks associated with the landing and recovery hardware or procedures that you helped to develop, or that you had seen actually happening in the recovery phases?

HEFLIN: Well, being a 12,000 pound, twelve, thirteen, fourteen thousand pound object that you're trying to bring up out of the water on a rolling ship or whatever, you know, some of the things we had to do, we had to, we would have sailors who would, we basically had a set of three what we called "tending lines" that would be hooked up to the command module prior to being lifted out of the water, so that as it comes out of the water, you've got a group of sailors over here, a group of sailors over here, a group of sailors over here, and they've all got a line going there, so they can steady it, because, as you can imagine on a rolling ship like the USS *New Orleans*, which is a helicopter carrier. It's kind of a round-bottomed boat compared to the *Ticonderoga* that was an old angle-decked aircraft carrier. You know, it could roll pretty good sometimes.

Well, as you're bringing it out of the water, you know, if you're not careful, this thing's going to start—it's a pendulum, it's a pendulum. And of course, as the old line gets shorter, the pendulum wants to swing faster. Well, we had to train—in fact, this is fun to watch, early in training. We'd have to train the sailors that, you know, this is—you've got to

be careful here. You can't pull too hard, and you're just trying to—as it—pulling's wrong. What you want to do is, as it's swinging away from you, is you just want to kind of steady it as it swings away from you, but once it gets to the end of its travel, don't keep pulling.

So that was some of the hazardous things that we would have to train them to do, because once you got over the deck or whatever, and I've seen this happen, in early training. What is interesting is to go on an aircraft carrier with a team that's never done this, and to watch this from the first time they do it, until they do it on recovery day. I mean, it is, I mean, it brings tears to your eyes, almost laughing sometimes, even though this is hazardous. I mean, there'll be lines everywhere, there'll be sailors pulling and tugging, and this thing's going every which direction, and what is interesting is that you will have talked to them about this, you will have told them that they can't do this.

And you know, you think they're listening, but until they actually try it, because we had to get this thing steady enough to drop it down onto a four-wheel dolly, and it had to be setting on that way, and it set down at an angle, so you had to set it down on the dolly, and when it hit the dolly, it hit, and then it would come down like this, instead of just down like that. And the ship's moving, and it's rolling. Well, you had to steady it so it'd come down and hit the dolly, and then when you let it down, if the ship's rolling or whatever, there's a possibility you could end up getting this thing on the dolly to where, here's the dolly, and it's sitting kind of like this instead of like this on the dolly.

That was probably the most—from my standpoint, as the recovery engineer on board, responsible to tell the team when, "That's good, don't do any more." I had to judge whether or not this thing is setting down on the dolly safe enough, and this wasn't rocket science, basically. This was just looking to see, is this thing setting down on this dolly enough so that all the pads it's sitting on all look like they've got the same amount of surface area, because we're going to transport this thing across roads and whatever, you know, and you don't want to have this thing break anything or do any damage, or whatever.

And only one time, I think I ended up looking at my counterpart, who was in charge of taking care of the person who drove the crane, that sort of thing. I looked at him, I said, "Now, you're going to have to readjust that, just a little bit," and that always brought a great deal of fear in my heart, because once you lifted it back up again, and the ship is rolling, now you're back doing this again.

And back in the early part of the program when we did this, we had a lot of live TV back then, going back to the states and so forth, and so, you know, not only are you doing it, but now your peers back in Houston are watching you make a fool of yourself, you know, if you can't get this thing back on the dolly correctly, or whatever. Late in the program, the media lost some interest, so they didn't show that all the time.

KELLY: You brought some hardware out here, and I'm wondering if you can tell us a little bit about what each of these are. I think they're interesting.

HEFLIN: About this hardware?

KELLY: Yes. And how it relates to what you did, too.

HEFLIN: This is a solenoid valve. Actually, it's a dumb piece of machinery, because all it has to do is open up a valve in here to allow air to flow through it, basically. The Apollo command module had two flotation attitudes that it liked very well. It could float right side—it could float upside down just as good as it could right side up, in the water. And in fact, for the Apollo landings on the water, if my memory serves me correct, just about half of the Apollo missions did end up upside down in the water, and required use of what we call the "uprighting system," which I worked on when I first came to work here.

The uprighting system, which was a system to inflate bags on top of the command module, and if it's under water, as these bags inflate, then the center of buoyancy gets changed, and it just basically flips it right side up. So this is a valve that was—there were three of these valves, one for each bag, that basically would be opened up to allow an air compressor to come on, to pump up these bags. Well, it's a dumb piece of machinery. It's just a valve. You know, a pipe would come in here, and a pipe would go out here, and this is just a little vent deporter, or whatever.

KELLY: Was this one ever used?

HEFLIN: This one was used on Apollo 13. Command module, I think the command module number was command module 109, I think, was the actual command module number.

KELLY: There you go.

HEFLIN: There it is, yes. Command module 109, Apollo 13. I don't recall what the name of the Apollo command module was. But we would, see, we would get these after a flight, because we tested this system down here in Houston a great deal, and in the salt water, these will get eaten up pretty good. So after an Apollo flight, since we only used that command module one time, we would ask for this hardware because we would use it in our ground test hardware that we used, and I just, over the years, have hung on to one of these things. So that's the one off of Apollo 13. It was made by a company in North Hollywood, California. I just wonder if they're still in business today.

KELLY: Well, it's an artifact now.

HEFLIN: Well, actually, this is really kind of ugly. This is a lever lock switch. It's a switch that you can't do anything with until you take some other action. There were several switches on Apollo, you know, that were there so that you wouldn't inadvertently hit the switch and so forth. You had to pull it out to do that.

Well, we would also get these switches brought back so we could put these in our ground test vehicles that we used here, to test the recovery system and so forth. And I'm kind of handy with a soldering iron, and one day I just took this home, put it in the garage, and wired up a battery and a light, and so when you do that, see how the light comes on. I put this on the table. It's occasionally—it depends what mood I'm in or whatever, what kind of a meeting I'm going to have, and it's just interesting to those that don't know me, or know what this is, you know, I wonder how long they will take before they ask about it. So that's what that's about.

KELLY: It didn't take us very long, did it? [Laughter]

HEFLIN: No, no.

KELLY: Apollo started to phase out pretty much—well, especially after 17, Apollo 17, but then you had your three Skylab missions, in which you used the command module.

HEFLIN: Right. And the Apollo-Soyuz mission.

KELLY: That's right. So after that, I assume, you know, that they didn't plan on any more water landings, because the Shuttle was then being developed.

HEFLIN: That's right, that's right.

KELLY: So how did your division actually phase out of what you were doing?

HEFLIN: It, as I mentioned earlier, was probably up 120 or 130 people at one time, and then as we got to the point where we were satisfied that the Apollo guidance system was super, and they were going to land where we figured it was going to be, then there was no need to staff up, and provide people around the world, at various staging bases. That, plus the fact that we had developed a recovery, a landing recovery system, early in the program, and so the engineers that actually did that work in developing those systems, could now be taken and put into the next program, either Skylab or into work in the early shuttle.

And so it was just a natural progression to take the division and just slowly take the people out of that program into other things. We got down to Apollo 16, 17, and the three Skylab missions and ASTP. We got down to a branch size of about twenty people, about Apollo 16 time frame. And Apollo 17, Skylab, we then went from a branch of twenty-some people down to a section of people of about ten, eight to ten, or whatever.

And I don't know, lucky, really. I mean, I was a member of that group that hung around to the bitter end, basically. When we did the last Skylab, and then the ASTP mission, we were again, a lean, mean group of about eight people, and as I mentioned to you earlier, my tasks were multifaceted. I mean, I basically dealt with all the people associated with the primary recovery shift, from a recovery operation standpoint. And that's what we did. All these other people just slowly got siphoned off to go work in the next program.

KELLY: Do you think anything that you had worked on in the Landing and Recovery Division in Apollo carried over into shuttle, and was there any lesson learned, or were there any procedures that were similar?

HEFLIN: Well, that's a hard question, because the things that we did in recovery were so unique, so very, very unique, that I can't say from a technical standpoint that there was anything that we ended up carrying over.

KELLY: How about with the SRBs even? Solid rocket boosters [unclear]?

HEFLIN: Michelle, that's good to bring that up, because, sure, as a matter of fact, since we do go out today and recover, on the water, the SRBs, there were some of the techniques that were employed, relative to what we did on Apollo, that were carried on, and used out there. Oh, absolutely. In fact, I had forgotten all about that, but that's a good point. Yes, that is a good point. No, that's good.

And in fact, having you said that, I remember, you know, I can now, I can remember that when we had done the last recovery, and it had been—and that's 1975, and we didn't fly Shuttle till '81, during that time span in there, somewhere in there, I remember folks in Florida needing some information and data on how we had done our job, and we provided that to them. So that was probably—that was carried over.

I think one of the things that we did learn from our aspect was, we learned the wonderful partnerships that you can have between this agency and the Department of Defense, that I think carried over somewhat into the shuttle era as well. Very different today than of course it was back then. Back then, the Department of Defense was there to be the people who did the recovery, as compared to the Department of Defense today that are customers of the shuttle and that sort of thing. But we learned, I think we learned a lot about the manner in which you work with an agency like that and that sort of thing. So that was carried over.

KELLY: That's neat. Those are important lessons to carry over.

HEFLIN: Yes. Yes, they are, they are.

KELLY: Do you feel that there were any other lessons? I know that's a tough question.

HEFLIN: None of them—you want to tell me?

KELLY: No, I don't know of any. [Laughter]

HEFLIN: None of them come to mind right now. And again, I think part of the reason was that what we did in landing and recovery was really unique to the water recovery of phase of this country's human space program, in a very unique time, and so there was, you know, there's not a whole lot from that, that goes anywhere else, I don't think.

KELLY: And would you care to speculate if there will be any other future water recoveries?

HEFLIN: Water recoveries? I've often wondered about that. I'd be interested to see that if we are really fortunate enough to get some system on Mars and then have it grab a rock or two and come back. You know, you've got have some way of finding that and so forth. Of course, since the world is covered mostly by water, it makes you want to—and I have no idea what kind of systems we're thinking about, whether or not they will target that to an ocean area or whatever, or they'll try to pick it up during descent, you know, before it hits the ground, that sort of thing. But no, that's the only thing I can think about, some small payloads or something like that, potentially, or whatever, but no, I don't see humans being subjected to water recoveries again. Just no need to.

KELLY: What do think the biggest challenges that you faced were, at least in the Apollo era, during your time in the Landing and Recovery Division?

HEFLIN: Biggest challenges. Probably for—are you talking me, in particular?

KELLY: You, in particular, the division as a whole.

HEFLIN: I think the biggest challenge early for the division was to find a comfort zone of how much you could entrust to the people who were really going to do this job for you, and it wasn't just all NASA working together. It was a very diverse organization. We had to work with Air Force, Navy, Marines, and so you had all the services that we're dealing with and their own cultures, and the way they do business and that sort of thing. That was probably one of the biggest challenges.

Technically speaking, clearly, the challenges for the Landing and Recovery Division, technically speaking, weren't near as significant as they were for getting somebody onto the moon. You know, no way. So I would say probably just the manner in which we had to set up a worldwide organization, around the orbit, to stage aircraft carriers or destroyers or whatever, or to enlist the aids of some Air Force base somewhere in a foreign country and that sort of thing. Those were huge logistical nightmares and challenges to do, I think.

For myself, I think the biggest challenge I probably had occurred late in the program when I was a member of the very small group that continued to do this, because I had to remember a lot of stuff, and I had to--and so, I mean, when you're dealing with all those different agencies and different commanders and so forth, it was just trying to keep it all straight and so forth was probably the biggest challenge that I had. Technically speaking, my technical challenges have probably all occurred since Apollo, I mean, after Apollo, for me.

KELLY: I think it would be tough learning how to not get sick on the ships. That would be a tough one.

HEFLIN: Yes, yes, yes.

KELLY: Conversely then, what do you think your biggest accomplishments were?

HEFLIN: In Apollo?

KELLY: In Apollo, yes.

HEFLIN: I would have to say that my biggest accomplishment in Apollo was not falling off the side of an aircraft carrier at night in the South Pacific.

KELLY: You're being humble. Seriously.

HEFLIN: Hey, it's an awful dark place, awful dark place to be. Oh, gosh, Michelle. Well, actually, I probably, you know, I probably touched on it just a while ago and you were trying to answer the other question, really. I think all of my career, my technical expertise has always been adequate, but not super or superior. My skills have typically been in team-building and recognizing who does what, how they do it, what their pressure points are, taking advantage of their skills, not trying to force something onto them that is unnatural and that sort of thing.

I mean, there's more than one way to skin a cat, people will say or whatever, and so probably my biggest accomplishment was the, for lack of anything else, maybe the people skills that I brought to the job, and would go from ship to ship, or team to team, or whatever,

and find a way to get these folks to work as a team and to do it in a noncontroversial way, if at all possible.

I mean, you can imagine, in organizations like this, where you've got unit commanders and helo squadron commanders and Navy ship captains and so forth, who are on a career ladder. They're going places and so forth, and having some thirty-some year old short haircut NASA guy show up or whatever, and trying to tell them how to do their business or whatever, is something that not everybody has got the skills to do, and so I could--and I'm not bragging here, because there's a lot of things I can't do. A lot of things I can't do--

KELLY: No, you're not. But that's a real skill.

HEFLIN: Well, that's something that I—so I think probably my greatest accomplishment, I think, in Apollo, was towards the end of the Apollo Program, and it was making sure that we didn't do anything stupid as we were winding down the program. I was there on board USS *New Orleans* for the very last splashdown, on the Apollo-Soyuz flight or whatever, and with a great amount of pride, you know, saw that team come together and safely get the crew back on board the aircraft carrier and get the command module returned to the United States or whatever, without an incident. And there were plenty of places for us to fumble around and do something stupid. So that's probably my greatest accomplishment.

KELLY: I still think you're being humble. I do. Are there other stories that you'd like to share?

HEFLIN: Oh, gosh. Let me think here. You know, we got a time out.

KELLY: I heard they were considering doing a land landing. Were you involved in that at all?

HEFLIN: No, I was not. But that's right. Back in the very early days of, I think, going all the way back to even before Apollo, there was some consideration about putting some kind of rocket thrusters or something onto the command module—not the command module—Gemini, or whatever, but that soon went away.

Let's see, what kind of stories can I tell and get away with here, or whatever? Oh, John Young. John Young is such a neat guy. Of course, he's still here today. We used to—for lunar landings, when we'd get back on board the aircraft carrier, one of the jobs that I got to do, which is kind of exciting in a way, was to take the lunar sample return boxes that were in the command module, and we would take them out and then we would take them into a small, little controlled area that we had, and we would triple, basically, triple-bag them, bag them, heat seal them, put them in bags and heat seal them, to return to the United States. And so I was doing this job, and there I'd be, just, you know, hands just covered with moon dust.

KELLY: Were they already in bags?

HEFLIN: Yes, they were. They were already in bags, but I mean, that the command module that they brought this stuff into, I mean, there was no way not to have lunar dust in there. I mean, it was sometimes, you know, it was everywhere, so, you know, it was just, you know, I--for me, just to think about, you know, you know what's on your hands? That's dust from the surface of the moon, or whatever, was really kind of an interesting thing.

John Young, one of things we had to do was locate their personal dosimeters, that they'd wear for radiation, and I don't know, I think the crews liked to play with us. They

liked to—you know, those places—on their spacesuits they wore, there were special little pouches to put the dosimeters into, and do you think they'd leave those there, for us recovery guys to go find or whatever, when we got back on board the ship? No. You know, they like to find somebody—I don't know, they would put them in the strangest places and whatever. So I went up to—after John Young's mission, which was Apollo 16 or 17.

KELLY: Sixteen.

HEFLIN: Sixteen. Apollo 16, on the USS *Ticonderoga*, I couldn't find his personal dosimeter, so I went up to his state room that he was in or whatever [makes knocking sound], and knocked on the door. "Come in!" And I walk in there, and there's John. For some reason that evening, as we were steaming back to Pearl Harbor, he chose to have his evening meal in his cabin or whatever, you know. So I walked in. I said, "Sorry to bother you, sir, but I just can't find your personal dosimeter. Can you tell me where you think it is?"

"Oh, let's see, I don't know, I think I put it down in the right leg of the suit, or I don't know. It's down there somewhere in the crotch area. I don't know, but it's down there in that suit somewhere. I know it's inside the suit itself."

And I said, "Okay, John."

"If you can't find it, let me know. I'll come down and help you."

I said, "No, I think I can probably take care of it."

And so as I'm getting ready to leave his room and I walk out, he says, "Milt!" I turn around, and he said, "Have you got your moon rock yet?"

I said, "No, sir." And so John Young got ready to get up out of his seat. I said, "No, John. That's perfectly okay, you know. That's all right. I don't need a moon rock." Now, of course, I think he was just pulling my leg. We don't think John's got any moon rocks, do you?

KELLY: No, nothing like that. [Laughter]

HEFLIN: But he liked to pull my leg, or whatever. You know, John's of course still with the program today. Yes, John is such a neat guy. Gosh. I don't know. There's probably—you're asking me now to think of some of the things that have occurred.

I'll tell you one of the scariest things that ever happened to me was we actually had a man overboard drill, not a drill, we had a man overboard. Turns out, he was not overboard, but he was missing, and they found him. But I'll tell you what, to be on a big aircraft carrier, and to be awakened, you know, at night, by the claxons that go off or whatever, and then you have to muster and so forth, and you do that, and you think—and when you're out at sea on a moonless night or whatever, I mean, it is just pitch dark out there, and you're thinking, "Gosh, somebody goes off this thing, we'll never find him."

That's always a—you know, I made a comment about, you know, I think my biggest accomplishment's not falling off one of those things. I used to like to get out on board, you know, in the evening time, after supper or whatever and seeing a movie or whatever we'd do that evening, just strolling up and down the deck or whatever at night was just really very, very pleasant. And you could go sit on the edge somewhere and watch the phosphorous in the water and so forth. It was really pretty. But I mean, it was a scary place to be. So I'm not kidding you. I mean, having not fallen off was a big accomplishment.

KELLY: I do actually have another question that comes to mind, and it relates more or less to the lunar pathogens that scientists thought were going to come back from the moon. Were you involved in, I guess, handling any of the procedures when the crew returned?

HEFLIN: I was involved in something that was almost--I mean, I really—in a way, I felt silly about this, but, you know, I'm not a scientist and I'm not a biologist and I don't know, I was involved in the development of the biological isolation garment, called the "BIG." Ugliest thing I think I've ever seen anybody ever have to wear, but this was the garment that once they got back on the water, the swimmers would open the hatch, throw this stuff into them, they'd get into this stuff. And then, of course, as we've all seen—you've seen movies of them walking off the helicopter on board the ship, and they're wearing this stuff.

Well, I was in the—helped develop that. And I went to, I think I went to Fort, I want to say, Dietrick, in Maryland. I hope I said that right. But they do a lot of testing of that kind of material or whatever, and back when, oh, I guess, in 1967 or '68 or so, one of the—you know, again, I'm a relatively new NASA employee, and I'm taking a—I'm going back to Washington, DC, and I'm carrying some of this material to take to this laboratory to be tested or whatever, and I'm still trying to learn how to be a NASA employee and not be scared to death every time I go somewhere, which I was early in my career.

And I remember being so intimidated by getting to Washington, DC, and, you know, getting a rental car. In fact, it wasn't a rental car. Back in those days, you could get a GSA car, it was called. It was a car that had "U.S. Government" written all over it. But then I had proceeded to—I don't know how I—on my way to going to Fort Dietrick, I ended up going the wrong way down a one-way street or whatever, in kind of a seedy part of the outskirts of Washington, DC, with people hanging out of windows.

There I am in this government car, you know, driving down this street or whatever, going the wrong way, carrying this material that's important to get tested, you know, so we don't all die of lunar pathogens when they come back. And boy, I can remember that. And getting the stuff there, and again, talking to—these are real scientists. I mean, these are real scientists I'm talking to, and what they're going to do. And I—you know, it's like, wow, this is really something for me.

I think one of the most interesting tests that I did get involved in was what we called the "cold weather test." In fact, it's depicted up here on this wall up here. I don't know whether you can see it, but there's an Apollo command module up there that's all iced over, and it's got a flag on it. It's got a flag on it. That was done down in a climatic hangar at Ellington Air Force Base. We were concerned about, during Skylab launches, like I mentioned earlier, they were going to be launched more on a northerly track and you could land in the—am I doing this on my own now?

KELLY: No. We're about to run out of tape. In the video, we're going to have [unclear].

HEFLIN: Okay.

KELLY: We want to stop, which is what we're saying.

HEFLIN: That's good. Me, too.

KELLY: Can we pause for a sec?

HEFLIN: Me, too. Below freezing, and we had a wind machine that we could blow water over this thing and freeze it up, so we had a crew inside this thing for forty-eight hours, testing the recovery and systems inside for in case it landed in the North Atlantic. That was one of the most interesting tests I did, because we did this in the falltime, and I'd be inside this chamber, working, during the day or whatever, parka on, if I'm outside, doing—had a parka on, you know, gloves, and all that sort of thing, and then when I got through, I'd go outside and go to the beach, at Fort Walton beach down there.

KELLY: There you go. Was there an astronaut crew staying there, or were they just engineers testing it?

HEFLIN: These were engineers, engineers in spacesuits, yes, yes. Astronauts didn't want to get in this. I don't blame them.

KELLY: What would happen to that module? That's a test vehicle, right?

HEFLIN: Yes.

KELLY: Did they cut that up for scrap or [unclear]?

HEFLIN: Actually, this one's called command module 007. It is presently in the Boeing Museum in Seattle [Washington], if I recall.

KELLY: Is this one of the Block I?

HEFLIN: Actually, Block I, and then it was converted to Block II. Actually, it was Block I to begin with, and Block I had a much taller tunnel. And then a Block II had—this was the Block Two version or whatever, and it was, for all practical purposes, it was built—I mean, it was same shape, same weight, and so forth, and it had—it was our most sophisticated Apollo trainer that we had, because it had spacecraft-like flight hardware inside, for the switches that we needed for all the systems, and for recovery and that sort of thing, and the air compressors that would inflate these bags and so forth.

Yes, when I saw—in fact, I lost track of where this was. There was this one and about two others that I have fond memories of, and attachment to, and I lost track of it. And

I've been around this thing a lot, back during the program. And I was up in Seattle, in a meeting, and had an occasion to go to the museum up there, and it was like a religious experience, because I walked up on this thing, and I said, "I'll be dog-gonned."

KELLY: Did you recognize it right away?

HEFLIN: Yes. Oh, yes. Sure did.

KELLY: I've heard that from a lot of people, especially from crew members, who say that they just had such an attachment to their command module.

HEFLIN: I'll bet.

KELLY: And even Mike Collins, when we interviewed him, he said that he wrote on it. Like he just had this impulse when he left. He said, "I love that thing so much. It was my home forever, and I wanted to write on it." So he took a pen and he scribbled on it.

HEFLIN: And they were never used again, so you could do that. Yes, exactly.

Kelly: And he also said he hated his BIG [Biological Isolation Garment], too.

[End of Interview]