

**INTERNATIONAL SPACE STATION PROGRAM
ORAL HISTORY PROJECT
EDITED ORAL HISTORY TRANSCRIPT**

HANS MARK
INTERVIEWED BY REBECCA WRIGHT
AUSTIN, TEXAS – JULY 8, 2015

WRIGHT: Today is July 8, 2015. This oral history session is being conducted with Dr. Hans Mark in Austin, Texas, as part of the International Space Station Program Oral History Project. Interviewer is Rebecca Wright, assisted by Sandra Johnson. Thank you for meeting with us in your office today at the University of Texas. And, we appreciate the time that you made for us to talk about your involvement with the early days of the International Space Station. Actually it was just “Space Station” then.

When you were NASA Deputy Administrator in 1981, discussions were still being held, a lot of opinions being voiced. Can you take us back to that time period and share with us where you wanted to take the discussion of the Space Station and how you got it there?

MARK: I really should start much earlier. This is a book called *Rockets through Space* [P.E. Cleator, 1936]. Inside here, where is it? Let’s see, oh, here it is, it’s on the first page. I got this book on my twelfth birthday from my father, and he says, “The fantasy of today is the reality of tomorrow,” right here.

WRIGHT: How nice.

MARK: This was 1941, and back here in this book there is a section in which the author talks about an Austrian engineer, and they envisioned the construction of an artificial moon, an outward station in space, specifically designed for the purpose of refueling spaceships. We shall see later exactly how it is proposed to carry this out, etc., etc., etc.

But I was about 12 years old when I read this, and I said, “Boy, this is a pretty good thing to do.” It’s a kids’ book, but not quite. There are no equations and I could understand it. So that’s when I started getting interested in the Space Station.

I joined NASA in 1969 at NASA Ames [Research Center], and I was the Director there for eight years. Ames was heavily involved in the Cold War, and I’m writing a book, because every military airplane that we [United States] have went through our wind tunnels there. When I left Ames, I went to the Pentagon, and was Director of the National Reconnaissance Office [NRO] for two years. Then when the Secretary of the Air Force basically got fired, I became Secretary, because in those days the NRO was totally classified. I had a fake title called Under Secretary of the Air Force, but they said, “Okay, you do this job.”

I spent two years that way, and then when President [Ronald W.] Reagan got elected, I returned to NASA essentially at the invitation of the same person who asked me to be Director at NASA. That was [James M.] Jim Beggs. I spent another three years in Washington, DC, in that job, that was the time that we persuaded the administration to pick [Station] up.

In August of 1981, right after I got confirmed by the Senate, I brought [Milton A.] Milt Silveira to Washington. He was in Houston [Johnson Space Center] at the time. We wrote, *Notes on Long Range Planning*. [July 1981]

The first thing that I really found out at Ames about NASA is that they are marvelous development engineers, but I don't think they were very good operational managers. What Milton and I wrote was this—"The major technological development carried out by NASA in the last decade is the Space Shuttle. That basic development is now nearly complete, and the next step is to turn it into an operational system. This effort must have the highest programmatic priority in NASA for the coming years to realize the return for this large investment. It should take about three years in my judgment to make the Space Shuttle an operational transportation system."

Now you will remember, there were only four flights in the first two years, and they said, "Okay, we're operational."

[From *Notes on Long Range Planning*] "It is necessary to arrive at an agreed upon definition of what is meant by operational, and to determine whether NASA should be the agency that operates the Shuttle, or whether some other institutional mechanism needs to be provided for that purpose. The organizational structure needs to be developed for Shuttle operations. No matter how the matter of Shuttle operations is finally decided, the Johnson Space Center should phase out of the operational mission during the next three years. It is very unlikely that it will be possible to control the costs of the operation if the developmental attitudes that prevail at the Johnson Space Center dominate the Space Shuttle as it becomes operational.

"The operation of the Space Shuttle, both launch as well as mission control, should be handled by the Kennedy Space Center, or by Vandenberg Air Force Base" on the west coast.

Now that was a bombshell.

WRIGHT: Yeah.

MARK: The problems we had are precisely because they didn't do that. I remember getting furious when, "Oh, we can't launch today because we've got to change this." Why the hell do you have to change it? Of course, none of the people really talked to me, but I just forced myself on them; they couldn't really do anything different. Let's talk about the Space Station.

"While the Space Shuttle becomes operational, a project to establish a permanent presence in space, (that is a Space Station), should be initiated." We didn't use the word Space Station by the way, because there was lots of opposition to the Space Station. "This should become a major new goal for NASA, and sometime during the next two years the President should be persuaded to issue a statement proclaiming a national commitment to that effect."

That was our principal goal. I remember when I got confirmed I went out to St. Louis [Missouri]; Beggs was still working with General Dynamics [Corp.]. Since I knew him from my Ames days, he opens the door to his house and said—almost simultaneously we said, "We're going to make a Space Station." That's where the whole thing started from NASA's point.

Just in case, so you know, I disagreed, and we argued very, very strongly about the Space Shuttle—but, I had great respect for all these people. It wasn't a fight, it was a genuine difference. Of course [JSC] felt they owned it [the Shuttle]; it was a real mistake to let that happen. Okay, now, the other thing that was important here is, what do we do with the Space Station? This is now *scientific* exploration.

[From *Notes on Long Range Planning*] "An extremely important aspect of this are the medical and biological experiments to be done using the Shuttle to establish what must be done to permit animals, plants, and people to live in space in zero gravity conditions [for lengthy periods]. It is probable that planetary exploration will be deemphasized somewhat until we have

a Space Station that can serve as a base for the launching of a new generation” of manned spacecraft.

So the point here was that if we’re going to invest in that Space Station, the principal purpose of it is to be a staging base to go out into the solar system. Now there were lots of other things that we’d do with it, but that was the primary purpose.

The other problem—Shuttle operations. I went to every launch in the first 14 flights, just to try to keep it the way it should be. I let them run it, but whenever I saw something wrong—I had a console—I just pushed the button and said, “Hey, guys,—listen to this.” That was never done again. None of the presidential appointees ever did that. I think that was a real mistake.

WRIGHT: Based on what I read in your book, [*The Space Station: A Personal Journey, 1987*], Space Station discussions were not only intense, but they seemed to be continual from the time that you took your role to the time that the Congress moved forward after the State of the Union [January 25, 1984]. Again, were the discussions varied because there wasn’t a consensus on what the Station should do? Or did you find it was just an opposition to have a Space Station?

MARK: There was not a consensus of what to do with it. [James C.] Jim Fletcher headed the committee and the committee made four suggestions. One is a Space Station that you visit but you don’t put in a permanent system for people to live on it; that was the least expensive item. The second one was to do that and maybe put *not* a permanent system but one that people can use for lengthy periods and restrict it to say three people.

The third thing was—and this is the one I wanted to do—that the Space Station be the one that Wernher von Braun actually talked about. This was not my design, I picked it up from

him—the Space Station should be a central core, relatively small, where you have permanent residency, but the actual work would be done in a galaxy of other spacecraft, maybe eight or ten, whatever it is, that fly in formation with the Space Station.

My argument went something like this, and Beggs really picked it up. He said that we can build that central habitat, if you will, plus one of the spacecraft that would fly in formation with it; here it is on the cover of my book. This is the small Space Station; here's the first thing that flies with it. The argument was that when we finally go out into the solar system, all the spacecraft are going to have to be built in Earth orbit. The Space Station was the base for that. The problem with having the Space Station we have now, you'd never launch a rocket from it, because if something blows up in the rocket, the Space Station is gone.

Our first argument was, we have to have this village around the Space Station because we're going to go to Mars or somewhere else, and we're not going to launch from Earth orbit. That was the actual first—in my book anyway.

The nice thing about these satellites that go with the Space Station is that you can build each one of them for a specific purpose. For example, talk about zero gravity. There is not zero gravity in the current Space Station. It moves around, and the Sun's heat makes it flex and move. We could have designed and built these satellites for specific reasons, and one of them would be to launch rockets. Instead of putting it in the whole Space Station, you send it off a few miles and launch.

Now I lost that argument, and I lost it because [Christopher C.] Chris Kraft and the people at JSC [Johnson Space Center] said, "We don't want to do that much EVA [extravehicular activity]," because what I talked about requires EVA. Again this was a real

genuine argument. I wanted to do EVA almost right away, that's why we built the goddamn thing. Chris actually resigned over that.

I don't know if you've been told about the rescue of the Solar Max satellite. Well, Milt Silveira came to me and said, "Why don't we pick that thing up and have it fixed?" I went to Chris, "Let's do that." He answered, "We're not going to do this."

I asked him, "Why not? We've done EVA before. We did it on every Apollo mission, so what's wrong?" Chris said, "Well, it's very dangerous." I told him, "I know it's dangerous but the whole business is dangerous." We had this on and on and on. Finally Chris said, "Well, I resign." I said, "Good." I had great respect for this guy, still do; but the problem was that he just plain refused to do it. After that our [center] directors weren't nearly as good as he was. Aaron Cohen was good, but he was not a Chris Kraft.

WRIGHT: It's interesting so much EVA was used to create the Station that is there now.

MARK: Of course, of course. It just blew my mind. Then we rescued that satellite, that was one of the big successes we had, we rescued it and fixed it. They didn't pick it up. Okay, let me talk about *Challenger* for a minute, because the picking up of the Solar Max was really done almost just a few months before I left.

I left NASA not because I was—I really—well, we had two kids. We sent them to expensive schools. I was in debt for \$40,000. I had absolutely no sense of wanting to leave NASA, because it was really an exciting thing. Then I got this phone call from Jess Hay [Board of Regents, University of Texas]. I used to be at [University of California] Berkeley, and I knew how to run things. One thing led to another. I was getting \$75,000 a year for being [NASA]

Deputy Administrator, and the chancellor's job here in those days—today it's \$1 million—but well, it was \$150,000, a little under \$150,000 when I got there. I just said, "Hell, let's do that."

About *Challenger* – the problem of the gasket was well known. We saw it for the first time on the second flight. What happened was that we didn't see it again. We had seen the erosion again on the tenth flight. During the flight readiness review for the eleventh flight—I presided at all the flight readiness reviews, which is another thing they didn't like, but I did it anyway. I shouldn't say this because they were all good guys, but oh, well— I wrote this memorandum here. [Refer to pages 27-30.] This was to [Lawrence B.] Mulloy at Marshall [Space Flight Center]; he was the solid fuel rocket guy. It said: "Perform a formal review of the solid rocket motor case-to-case and case-to-nozzle joint sealing procedures to ensure satisfactory consistent closeout." It was one sentence. But, then I said, "We're not going to fly until you guys fix it." This was just at the point at which we decided to come here [University of Texas, Austin, Texas]. To this day I am—well, enough said.

Next thing that happens is that no deputy administrator was appointed to succeed me for 13 months. What happened was that Beggs got into a fight with the White House. Probably everybody knows that story. The White House wanted to have [William R.] Bill Graham to succeed me and I knew Bill very well because we were both in the nuclear weapons business. He's a good guy. But Jim said, "Look, he's got no experience in space, he's got no experience in management, he's a theoretical physicist." I said, "Look, I know this guy, he's good, teach him."

Beggs did not have much technical background. He was a superb leader and a superb political operator, he was really great at it, and he had great common sense and good judgment of people, so I enjoyed working for him, but he wouldn't do this kind of thing. What happens is, finally Graham is appointed; a week later Beggs is indicted for something he allegedly did at

General Dynamics. There are people who think that the White House maneuvered this; nobody knows, but that's what happened. He was told, "You can't run [NASA] anymore." Poor Bill sits there. I remember sitting in the chancellor's office downtown; I spent hours on the telephone, because Bill kept calling me. He said, "What should I do here? What should I do there?" He had absolutely no start.

On December 3rd, [1985] I wrote to the Vice President [George H.W. Bush]: "Mr. Bush, I am saddened and dismayed by what has happened to Jim Beggs. Jim's probable absence from his post until his legal problems are resolved leaves NASA in a very real leadership crisis. The new NASA Deputy Administrator, Dr. Bill Graham, is an excellent man, but he has been aboard for less than a week. He has no background in NASA or in NASA-sponsored programs, and he's never managed a large operation. To give Dr. Graham a chance to learn the ropes, I suggest you ask Dr. James C. Fletcher, the NASA Administrator from 1972 to 1977, to become Acting Administrator for a limited period of time, say two to three months, which would give Dr. Graham time to become thoroughly familiar with the situation so that he can serve as Acting Administrator until Jim's case is settled. I have not talked with anyone about this suggestion, but I believe that some step of this kind is essential. If, God forbid, there is a serious accident in one of the forthcoming Shuttle flights, the administration would face serious criticism with no experienced person in one of the two top spots."

Here is Mr. Bush's reply. "I too was saddened and dismayed. I've always thought the world of Jim Beggs and I still do. I will quietly do some checking on your suggestion. It might be difficult to accomplish given the steps that have recently taken place." That is Jim's stepping aside. "In any event, I'm very grateful for your interest, etc., etc." He didn't do anything.

A month later, *Challenger* went down. Obviously this is something I really have trouble with. I quit. I had a reason, but it wasn't that great. The fact that I knew—well, I knew that this thing should have been fixed. I wrote it down, goddamn it. By the way, I even said, “due date for the formal review May 30th, 1984.” I left NASA, if you look at the books, on the 28th of May. Two days later this was supposed to happen.

What happened of course was that Jim Beggs—I made the announcement long before he had trouble with anybody. He then said—and this was after I wrote this memo—he then said, “Well, you can't do anything anymore,” because [Philip E.] Phil Culbertson I think was responsible for running this thing afterwards. So I could not do anything anymore. I could not organize a briefing, say, for something, and nobody else did. Yet this goddamn thing was in the record. I think I probably should have changed my mind on this. Anyway, that is much water under the bridge.

WRIGHT: Since we're talking about *Challenger*, the important loss was the loss of the people, but we also lost an orbiter. You shared in your book that part of the discussion was, if money should be spent on beginning the foundation of Station or should the money be spent on providing a fifth orbiter—which way should you spend the money? Go towards Station or should you build another orbiter?

MARK: Look, we were building the fourth orbiter at the time. We had the parts; we just weren't building it. *Atlantis* was the last one. *Atlantis* was in the factory. I don't think that was a big deal. The money was already there. Yes, we had to spend money to assemble it and to get it running, but I *never* said that we should stick with three vehicles.

WRIGHT: Didn't some people think that the Space Shuttle Program should be made more robust before NASA started moving towards Station?

MARK: That was always my view. But really we had fought for a fifth orbiter, and we got—I don't know which budget it was—but we did get the parts to assemble a fifth orbiter.

WRIGHT: In the discussions about future Stations, was there a large division about whether they should be permanently manned or should they only be occupied when needed?

MARK: No, no, no, the “occupied when needed” turned out to be not a good idea really. You can do it of course, but no, on the permanence of a human presence in orbit, that was a clear thing that everybody agreed to. The question was just how you do it. My minority view was the one I've told you about. I really think had I stayed in NASA after the *Challenger*—if I'd stayed in NASA just for another year, say, do that briefing of the problem with the O-ring, and fix the goddamn thing, things would have gone all right.

WRIGHT: Certainly would have changed history, wouldn't it?

MARK: Yes, I stopped, I think three flights in the flight readiness review when we had a problem. I remember a hydrogen leak for the tenth flight. We had a hydrogen leak in the back end. Hydrogen is explosive. There were leaks in the tank that sat above it. I said, “We're not going to fly. Come on, guys, stop it.” Then the other one was we almost burned out a rocket

nozzle on one of the solid rockets. Again I said, “We’re not going to fly until we see what happened.” We had a good paper trail, and sure enough, there was a third level contractor who didn’t make this plastic material the right way.

In this room, I was deposed by a guy from the Rogers Commission [Presidential Commission on the Space Shuttle Challenger Accident, 1986]. If you look at the Commission Report, they mention this, the fact that somebody was told, “Hey, fix this.” But they just passed over—it was mentioned, they had to mention it, because it was on the record, but they made nothing about it. I did try to influence the people on the Rogers Commission, and the only one who listened to me was [Eugene E.] Gene Covert, who was a colleague of mine from MIT [Massachusetts Institute of Technology] days. It was one person. You have people like [Neil A.] Armstrong and very prominent people on this thing; well, enough said.

I never again served on a NASA committee after this event. I really never served on any of the advisory committees because I was Director of Ames first. Then I was in the Pentagon, and of course I worked a lot with NASA there. Then I was Deputy Administrator where they advised me rather than the other way around. After that, it was really, there’s no way in God’s world I could have gotten back in. It was bitter, very bitter. I still blame myself. I cannot get away from it, and it’s what, 30 years now? We lost not only the people on the *Challenger*, but we lost the élan, the elitist.

When I was Director of Ames, there were half a dozen people on the staff of the NASA Administrator who were members of the National Academy of Engineering. We don’t have a single one today, not one. It’s that kind of thing. I should say that I am a consultant to Ames. I have been a consultant since I left NASA. We have done some great things there, as you well know.

WRIGHT: When you were showing me the picture of the *Challenger*, I was reading the text and noticed [John W.] Jack Boyd's name, and I know that's a very strong friendship that goes back.

MARK: He's going to be 90 on August 19th, and we're going to have a major bash for him. Jack joined me here when I was chancellor. He was vice chancellor for—no. He joined me earlier. He joined me in Washington when I was [NASA] Deputy Administrator. He was Associate Administrator for Management. Then he came here for a while; he was vice chancellor for—yes, research support. He spent—well, I spent eight years as chancellor, but he didn't stay all the eight years.

Let me get out of my blue funk here. Look, every time I think about this or talk about it, I just get very upset. The worst of it is that I knew a lot of people who knew about this thing. In fact they told me. [L. Michael] Mike Weeks came to see me in March of—I think I even wrote it up. That was on the second flight. Yes, here it is [*The Space Station: A Personal Journey*], in chapter 14, the previous chapter, no, two previous chapters. Mike Weeks, yes. I'm repeating this from a previous chapter. It says, "I also mentioned the conversation I had concerning this problem with Deputy Associate Administrator for Space Flight Michael Weeks about a waiver required if any fail-safe (which means redundant) system turned out not to meet the requirements." He came to me and he said he wanted a fail-safe permission. I said, "Mike, you don't—[James A.] Jim Abrahamson has the responsibility for that, not me."

But then I made another real mistake. I think I said it here. "Mike, who was the Acting Associate Administrator at the time, had the authority to waive the requirement, but he came to ask for my opinion. I supported Mike's position to waive the fail-safe requirement for two

reasons, one technical and one operational. The technical reason was that the Titan IV launch vehicle had a solid fuel rocket just as the Shuttle, but it had only one O-ring for the seals in the same position where the solid rocket booster had two,” on the Shuttle. “At the time Titan IV had a sterling launch record with more than 100 successful launches.” That was one reason I said. We got two, they got one. The operational reason was that I had insisted the seal to be fail-safe. It would have taken a year or more to redesign and rebuild. Once again I screwed up. I should have said at this point, “Hey, we got to fix this.”

I was wrong about the technical matter regarding the solid rocket booster with the Titan launch vehicle. There were actually very significant design differences between the boosters on the Shuttle and on Titan IV which I had forgotten. What’s next?

WRIGHT: When Shuttle was being developed, there were a lot of discussions with the military. Were those same discussions used about a potential Space Station? Were the uses by the military at all discussed?

MARK: Let me talk a little bit about this. First of all, the Space Shuttle had money in it. That is the second stage was paid for by the Pentagon, because they wanted to launch very heavy vehicles. In fact the size of the Shuttle payload bay was determined by the size of the largest spy satellite we had, the Hexagon. It’s declassified now. We actually launched a number of classified payloads. So the Shuttle was always—both NASA and the Air Force had something to do with it. We had a mission support element in fact in Houston, about 100 people, and they ran that part of it. The Space Station was never considered by the Air Force; they had a program

called the Manned Orbiting Laboratory. But Nixon said, “Look, we’re going to have one Space Station, certainly not two,” when in fact we had two, one classified and one unclassified.

The thing that happened is that when the generals looked at the Space Station they said, “Look, we know the Russians can shoot down space vehicles, and we don’t want any casualties in space.” They just said, “Look, we’ll do this with robotic things.” Hell, I was the Under Secretary of the Air Force, and I was Director of the NRO [National Reconnaissance Office] and I went along with them. I said, “Of course, but the Shuttle has one thing that the Air Force doesn’t have, and that’s payload capacity. So our largest satellites have to go on the Shuttle.” We didn’t have a rocket that could carry—well, we had to build rockets that we used to carry the biggest spacecraft. Now I don’t remember whether—no, I can’t talk about it, because there are things that are still classified, I’m sorry.

But they just said, “Look, this is not something that we want to do.” I agreed with them. If you got an opponent who can shoot down—just at the beginning of the [James E.] Carter administration the Russians shot down one of their old satellites. Then we promptly did the same thing so it wasn’t—that was never considered. It was never considered.

But let me talk about the Space Station now. What happened was, first of all, Houston had no supervision in the two years that Jim Fletcher fixed the Shuttle. In that period, they put together the current Space Station. They abandoned every other thing. There was nobody at Headquarters to do anything else, so the Space Station we have now is the result of that. They had ups and downs, and they are still the world’s best space engineers. There’s no question in my mind about that; so they built this Space Station.

It was not exactly designed for what I had in mind or what I wanted to do, which is to first of all do biological experiments without the background of a big Space Station. God, what

was his name? Bruce McCandless [III]. First one to walk without a tether. I loved that mission, that was marvelous. It was about the same time we did the Solar Max.

Now what happened to the Space Station? Why am I really in a very bad mood about the whole thing? When President [William J.] Clinton came in, just as with the Apollo-Soyuz [Test Project] in the [Richard M.] Nixon administration, let's do something with the Russians. By the way, I should say that in the part of the Reagan's State of the Union message in '84—by the way, he took the model of the Space Station. I should show you that too, because Reagan, after we got it done, after we pushed it through the Congress, there was a meeting of the G5 [Group of Five Countries], the big countries, big democracies. He took the model of the Space Station with him. I have a picture with Margaret Thatcher [Prime Minister, United Kingdom] and Reagan standing around the table with the Space Station. The thing that was most interesting is that we also had—I was still in charge, so we also had the satellites that would go with the Space Station, only he didn't take them to Europe. That was in the Cabinet Room where we got his decision. Then we had little figures. A little figure was tied to the model by a wire, so they didn't take that off. This Space Station is sitting on that chair with a little man in a white suit sitting next to it. That was great fun really.

What happened in the Clinton administration again was “let's do something with the Russians,” which I strongly supported. So what do we want to do? It turns out that we were interested in having backups. We were interested in certain things that the Russians did that we didn't do. The big problem is that the Russian spaceport is at 50 degrees north; in other words it's at the same latitude as Anchorage, Alaska.

What that meant is that we could not do equatorial orbits with the Space Shuttle. When we work with the Russians we had to put the vehicle into a 50-degree orbit. What that means is

that you can't use it as a staging base anymore. I fought a bitter bitter—I was here, I wasn't anywhere. I didn't have any—I was out as chancellor already. I was just sitting here.

I said, "Hey, guys, why don't we pay the Russians to launch their payloads into an equatorial orbit so that we can use this thing as a staging base? We're going to throw it away. There's no real reason for keeping it. We'll learn a lot more about people, and people want to pay for it, fine. But I don't think we need that much. I think we know what we need already."

The only experiment today that has any importance on the Space Station is [Samuel C.C.] Sam Ting's high energy physics detector [alpha magnetic spectrometer]. That could very well bring in something new. They haven't done it yet, but it takes years and years to do these things. I'm very very unhappy with the current situation, that the Clinton administration made this mistake. It would have cost a lot of money, but.

WRIGHT: During those early discussions when you were there as Deputy, you knew the Russians had space stations and the Soyuz. Were there discussions then of possibly partnering with them to either use their stations or have an international partnership?

MARK: In his State of the Union message, Reagan said that we want to work with our friends and allies. I vividly remember at the end of the meeting Reagan didn't say, "We're going to go do it," during the meeting, but about two days later Beggs got a telephone call and he called me into his office and said, "Reagan is on the phone, I want you to listen." And, so I listened. What Reagan said was, "Can we do this thing internationally?" Jim said, "Of course." That was the only discussion.

WRIGHT: In your book you talk about STS-9 and about the importance of working with the Germans with Spacelab. It set that stage for an international partnership?

MARK: That's right. That was very, very important. If we ever get to Mars, it's going to be international for sure. It's a big deal. I've got a bunch of students working on doing some designs. I won't see it but they will. The only other things of interest that I've really done with NASA after I got out is to work with Ames. Ames is very vibrant today because we have a quantum computer, which is the next step in computational work here.

WRIGHT: Share with us what you believe to be some of the most memorable times, or those times that you believe when you were Deputy Administrator, those events that pushed the Station forward. I know one that you've described was on July 4th, 1984 when Reagan uses that most important phrase about "establishing a more permanent presence in space."

MARK: Permanent presence in space, that's right. Oh, that was funny, that was really funny.

The Shuttle was up [in space], so I was at my spot at the MOCR [Mission Control] in Houston. We had the speech in which Reagan said, "I'm now charging NASA to build a Space Station." We knew that wouldn't fly. At the very end we put this statement in about the permanent presence in space; then what we would do is what the President really meant—a permanent presence in space. What happened was that I was sitting at the console and I guess Chris [Kraft] answered the phone and Beggs was on the line. So I took the phone and Jim says, "Guess what? OMB [Office of Management and Budget] has already taken out the Space Station [from the speech]. They saw it the first time." I asked, "Did they take out permanent

presence?” Jim said, “Nope. They kept that.” I said, “Well, you goddamn better keep it for the whole trip.”

So, that was the first thing that happened. Then somebody on that flight, one of the Headquarters people, saw that “permanent presence” thing, and knowing that the other one was taken out, he took that one out too. And so, Jim calls again and says, “They’ve taken out the permanent presence.” I said, “Look, that’s one thing you really got to get back in.” At the ceremony where we had the President put the third star on Abrahamson’s shoulder, Beggs was there of course, so he took the President aside and said, “Did you mean to have somebody cancel out this thing?” “Hell no, I’ll say it.” So we managed to get it back in, but that’s what happened.

WRIGHT: Then around two years later in the State of the Union message, he calls for the building of the Station. There was a lot of work in between there, wasn’t it?

MARK: You mean between—

WRIGHT: July 4th, 1982, was the STS-4 flight when he first uses that phrase; the State of the Union message was in [January] 1984.

MARK: Yes. The July 4th was earlier, that was in ’82. We had no money; the money didn’t come until ’84.

WRIGHT: Yes, because you had the FY ’85 budget proposal in—

MARK: A hundred fifty million dollars.

WRIGHT: I'm sure that raised a lot of pushback.

MARK: Yes, the first dollop.

WRIGHT: What were you hoping to do with that first installment?

MARK: We had to first of all agree on a design, and if I had stayed there, we would have built, what in the book we called, the baseline. Look, Jim was so good at this. I remember when we talked about the Space Station for the '85 budget, and he did this at several hearings when the Space Station was mentioned. The first one was at our confirmation when [Harrison H.] Jack Schmitt was in the Senate at the time. He said, "What are you going to do with all this money?" Beggs says, "We're going to do a Space Station." Schmitt says, "It's too expensive." Beggs says, "We'll buy it by the yard." I thought that was just beautiful. He said that again in the Cabinet when Reagan was there, that the baseline had this business with a central Station and then the other parts; it was just like buying it "by the yard."

By the way, the first plan was only for \$8 billion with the reason that the central Station plus one of these things that would fly in formation with the Space Station – those two things were only \$8 billion. What would happen later is that every time we put another satellite for the Space Station together, we'd spend more money, so in the end it would have cost as much as this one did, but we didn't have to say that in the beginning. That was something that made it easier for the people in the Congress to buy it.

I don't think Mr. Reagan really cared very much how much it cost. He really wanted to have it. I remember a meeting in the Pentagon when I was already Deputy Administrator. It was about the Space Station, and of course the military guys were against it.

The President had this system; he didn't want to have big Cabinet meetings. He said, "I can't hold myself to that." He invented this system of Cabinet Councils. He had about five Cabinet Councils. The one we were in in NASA was Commerce and Trade, but the Cabinet Council on National Security, namely the military, also had a meeting about the Space Station, because they wanted to shoot it down. It turned out that Jim was out of town for that meeting, so I had to represent NASA. I got to sit at the table, not in the chair in the back.

I remember that I'd just gotten out of being Secretary of the Air Force; it was about six months to a year, and the exact date is in that book, so you can look at it, because I wrote that one with aplomb. What happened was that [Caspar W.] Weinberger [Jr.] had all his generals there and of course I knew all those guys, I was on a first name basis with all of them. Oh, and by the way, the other thing that President did was also very unusual. He never chaired those meetings. He was a guest. [Robert C. "Bud"] McFarlane was the National Security Advisor, so Bud was in the chair. Of course, I knew him very well from Pentagon days, and so Bud gave the first, "Here's what we're going to tell you." Then he said, "This is General So-and-So and he's going to go talk about it." So General So-and-So starts to lecture and each of them is on for, I don't know, 10 minutes or something. McFarlane at the end says, "Any questions?" The general had said something wrong, and so I piped up and I said, "You know, Bill, what you said about that isn't quite right." I deliberately used his first name, which was really interesting.

So Weinberger looks at me with this stare and then says, "We have other things to tell you; don't answer." So I did it a couple times just for the fun of it. Weinberger was just all over

me. At one point the last time I did this, Reagan looks at me and he winks. What do you do if the President of the United States winks at you? I got the message; he said, "Shut up." I kept quiet.

Here's what he does, which is really interesting. At the end of the meeting he had a habit. I probably went to four or five meetings during my Pentagon and NASA thing when Reagan was President. He said, "Okay, all this is very interesting," and thanked everybody around. Then he gets up and walks up to the door, and he's got his hand on the doorknob, turns around, and he says, "What do you guys think we're going to be remembered for 100 years from now? Think about that one." I got that message loud and clear because that was when I knew we could get this, and that the President really wanted it.

Something similar happened in the Cabinet Council. The Secretary of Commerce was in the chair on this one. I forget his name.

WRIGHT: Was it Secretary [Malcolm] Baldrige [Jr.]?

MARK: Yes. Baldrige, thank you. What happened was that Beggs was the presenter, and in the Cabinet Room you can't use electronic stuff; you can't use viewgraphs or PowerPoint. You have these easels with painted pictures on them. It's good. I don't know whether everybody gets that, but we did at that time.

Beggs really does a fantastic job of selling this thing. Again, he was superb. The President then at the end says, "Why don't we go around the table and take a vote?" So, Baldrige starts naming the people. David Stockman, the head of OMB, voted yes first. The attorney general in the Reagan administration [William French Smith], he votes yes. Then the

guy who did commerce and trade voted yes, Baldrige himself. That was out of 13. So we lost by a large margin.

I walk out the door with Beggs and I was downcast after all this. I said, “Jim, I guess we didn’t quite make it.” “Oh, no, no, no,” he said. I said, “We only got four votes out of the 13.” Well, he winked at me a couple times.

WRIGHT: Why was it important to the President to establish the Space Station?

MARK: He had vision. I worked with Jimmy Carter too. It was totally different; totally different. Look, we had two presidents in the twentieth century, [Franklin D.] Roosevelt was one and Reagan was the other. The rest of them were good people but not historical; these two guys were historical.

WRIGHT: That’s interesting. One of the other elements that you mentioned in the book was the potential for commercial use for the Station. Could you share with us some of that discussion or some of the reasons why people believed back in the early 1980s that the Station could be used for commercial basis?

MARK: Some companies did experiments both on the Shuttle and on the Space Station, and there was always a segment of American industry that was interested in commercial applications. But this was nowhere near enough to pay for it. What you have—and even today the only really successful commercial space program are the communication satellites. That’s a multibillion-dollar enterprise. Actually, the commercial imaging systems are also now profitable. The

French, the Japanese, everybody has one now. But the Space Station is still in the situation where we have to do things that look good commercially and gosh, it's been up for what, 20 years now? Fifteen. Nothing's come out. We thought that it would be easier to do many chemical processes. If you want the purest metal, then you don't put it in a pot and heat it, because the pot has walls.

The idea that in zero gravity you can heat something with radio waves, say, microwaves, like you're cooking stuff, and get all the bad stuff out of it, and then have a pure sphere of metal, it turns out not to be terribly important commercially. The other thing we thought—and this is why some people talked about curing cancer—we also thought it would be easier to make these very complex molecules like DNA, and that didn't work, they really are subject to gravitational forces, no matter how small. I think commercially it's a failure, but so were the first railroads.

That we're going to have a commercial space system is clear. We have one which I call "commercial," namely SpaceX. Eighty-five percent of the money for SpaceX comes from NASA, so it's just like Boeing [Company], but I'll tell you what the difference is, and this is important. The average age [of the workforce] at Boeing is 54, the average age at SpaceX is 32. That's why I visited SpaceX. It's near Los Angeles, and we have a SpaceX [test facility] right up here in McGregor, near where [George W.] Bush had his ranch. That's the big difference—we got new people here. The students here are falling all over themselves to work there. I was very much involved in getting that.

Brownsville [Texas] is going to have a [SpaceX] launch site. I gave the commencement address two years ago at [University of Texas at] Brownsville and I mentioned that and I said, "I'm going to fix that and get it done and you have my promise on that." It got fulfilled. I sicked

all my students on the management. I don't know any of the managers, but I have 25 students there at SpaceX now. I don't visit the management, I visit the kids.

WRIGHT: It's great to hear they're excited about space.

MARK: Oh yes. Look, the constituency now is just right, because our best students go into it. That's really I think a good thing.

WRIGHT: Looking back, are there any other aspects of the Station that you'd like for us to know?

MARK: I never got into the actual engineering. I think it was bungled. I really think it was not well done. Ames has projects compared to Space Station (big satellites, small things), but every one them, every single one of them worked. The reason for that again is Stanford [University, Palo Alto, CA] was next door; you hire interns, you hire graduates, and things work.

Probably the thing that has most impact is the tiltrotor airplane, the Osprey. That was developed at Ames. We went through a lot of problems with it. The U.S. Marine Corps now has about 250 and the orders are up to 400 from everywhere else. You're going to be riding in it someday, because we're going to get rid of all the small airplanes on the big runways; it's just a matter of time. In fact the FAA [Federal Aviation Administration] is already certificating a Learjet type that is not a commercial airplane, but one that uses the tiltrotor principle for anybody. They don't have the same high standards of certification for helicopters they have for—and the reason is that they had forbidden to have—we have no commercial helicopters. There are no commercial helicopter services. The reason is there are too many accidents. We

killed about 20 people in Los Angeles about 30 years ago. That's when the FAA stepped in and said no.

WRIGHT: Thank you again for your time today.

[End of interview]

[The review I requested on March 30, 1984, was never held. I made the decision to leave NASA sometime in May [1984] and Jim Beggs (correctly) took me out of the decision loop. What happened afterwards is described on the next few pages. My intention in calling for the review was to stop flying and to fix the O-ring problem. As you can see, the review was held on August 19, 1985, and in spite of the problems, they kept flying. Hans Mark.]

STS 41-C PROGRAMMATIC ACTION ITEM
(OUTSIDE THE FLIGHT READINESS REVIEW)

NUMBER: 3-30-4-2
INITIATOR: DR. MARK
ACTION: PERFORM A FORMAL REVIEW OF SRM CASE-TO-CASE AND CASE-TO-NOZZLE- JOINT SEALING PROCEDURES TO ENSURE SATISFACTORY CONSISTENT CLOSEOUTS.
ACTIONEE: MSFC/L. HULLOY
DUE DATE: MAY 30, 1984
CLOSEOUT:

SUBMITTED: _____

CONCURRENCE: _____

CONCURRENCE: _____

Clynn S. Lunney
Manager, NSTS Program

APPROVED: _____

J. A. Abrahamson
Associate Administrator
for Space Flight

JMW 5 Apr 84

[These charts show the final "Close Out" of the "Action Item" about the review of the seals and joints on the Solid Rocket Motors (SRM) of the Space Shuttle. The review was held on August 19, 1985, fourteen months after the due date that I had specified. Between May 30, 1984, and August 19, 1985, eight Space Shuttle missions were flown and four of these showed significant O-Ring damage. The recommendation to fly is highly qualified and the requirement that joints are "free of contamination" is impossible to verify after the assembly of the seals and joints. Another copy of my original "Action Item" is attached. These pages come from Appendix H of the Rogers Commission Report. Hans Mark.]

Chart 189

STS 41-C L-1 ACTION ITEM.

NUMBER: 3-30-4-2

INITIATOR:

ACTION: PERFORM A FORMAL REVIEW OF SRM CASE-TO-CASE AND CASE-TO-MOZZLE JOINT SEALING PROCEDURES TO ENSURE SATISFACTORY AND CONSISTENT CLOSEOUTS

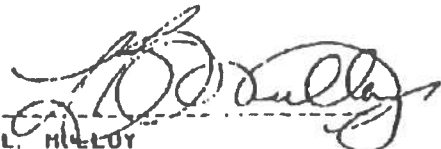
ACTIONEE: L. MULLOY/MSFC

DUE DATE: MAY 30, 1984

CLOSEOUT:

MSFC PERFORMED A REVIEW OF SRM CASE-TO-CASE AND CASE-TO-MOZZLE JOINT SEALING PROCEDURES AS DIRECTED BY LEVEL I ACTION 3-30-4-2. AN SRM REVIEW IN PROCESS HAS EXPANDED AND FORMALIZED WITH A DETAIL PLAN OF ACTION, TWP-14359, DATED MAY 4, 1984. THE PLAN AND REVIEW WERE DEVELOPED AND IMPLEMENTED IN CONJUNCTION WITH MSFC SCIENCE AND ENGINEERING PERSONNEL. THE RESULTS OF THE REVIEW WERE REVIEWED PERIODICALLY WITH NASA-HQ PERSONNEL AND A DETAIL REVIEW WAS PRESENTED TO THE DEPUTY ASSOCIATE ADMINISTRATOR ON AUGUST 19, 1985.

SUBMITTED:


L. MULLOY
Manager, SOLID ROCKET BOOSTER
PROJECT

CONCURRENCE:

S. R. REINARTZ
Manager, Shuttle Projects Office

CONCURRENCE:

Arnold D. Aldrich
Manager, National Space
Transportation System

APPROVED:

Jesse H. Moore
Associate Administrator
for Space Flight

Chart 187

General Conclusions

- **All O-ring erosion has occurred where gas paths in the vacuum putty are formed**
- **Gas paths in the vacuum putty can occur during assembly, leak check, or during motor pressurization**
- **Improved filler materials or layup configurations which still allow a valid leak check of the primary O-rings may reduce frequency of O-ring erosion but will probably not eliminate it or reduce the severity of erosion**
- **Elimination of vacuum putty in a tighter joint area will eliminate O-ring erosion if circumferential flow is not present - If it is present, some baffle arrangement may be required**
- **Erosion in the nozzle joint is more severe due to eccentricity; however, the secondary seal in the nozzle will seal and will not erode through**
- **The primary O-ring in the field joint should not erode through but if it leaks due to erosion or lack of sealing the secondary seal may not seal the motor**
- **The igniter Gask-O-Seal design is adequate providing proper quality inspections are made to eliminate overfill conditions**

Chart 188

Recommendations

- **The lack of a good secondary seal in the field joint is most critical and ways to reduce joint rotation should be incorporated as soon as possible to reduce criticality**
- **The flow conditions in the joint areas during ignition and motor operation need to be established through cold flow modeling to eliminate O-ring erosion**
- **QM-5 static test should be used to qualify a second source of the only flight certified joint filler material (asbestos-filled vacuum putty) to protect the flight program schedule**
- **VLS-1 should use the only flight certified joint filler material (Randolph asbestos-filled vacuum putty) in all joints**
- **Additional hot and cold subscale tests need to be conducted to improve analytical modeling of O-ring erosion problem and for establishing margins of safety for eroded O-rings**
- **Analysis of existing data indicates that it is safe to continue flying existing design as long as all joints are leak checked with a 200 psig stabilization pressure, are free of contamination in the seal areas and meet O-ring squeeze requirements**
- **Efforts need to continue at an accelerated pace to eliminate SRM seal erosion**