

NASA STS RECORDATION ORAL HISTORY PROJECT

EDITED ORAL HISTORY TRANSCRIPT

ROBERT E. LINDSTROM
INTERVIEWED BY JENNIFER ROSS-NAZZAL
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ROSS-NAZZAL: Today is July 19th, 2010. This interview is being conducted with Bob Lindstrom in Huntsville, Alabama, as part of the STS Recordation Oral History Project. The interviewer is Jennifer Ross-Nazzal, assisted by Rebecca Wright. Thanks again for taking time to meet with us today. We certainly appreciate it.

LINDSTROM: I'm very happy to.

ROSS-NAZZAL: I'd like to begin by asking you if you could briefly describe your career with NASA for us.

LINDSTROM: I was in the Army Ballistic Missile Agency when they transferred to NASA [Marshall Space Flight Center, Huntsville], and worked on the Army space program. I got in the Army through an enlisted draftee program. I was drafted during the Korean War and, like many others, sent here to work as an engineer. I worked here as an engineer in the materials laboratory working on reentry protection [with] the Redstone [rocket]. I worked on Jupiter-C [rocket], did a lot of coordination of that program with Jet Propulsion Laboratory [Pasadena, California]. We did of course reentry work for that and put up Explorer I, the first satellite.

After that I worked on some advanced space programs that we started, never quite approved. Then the Army was asked to develop a large booster. I took on the project engineer

from the original Saturn I booster, stayed with that for a number of years, and worked that for the first three flights. I guess about that time I decided to leave NASA, left for a few years, and came back about five or six years later. I was asked to come back and work on the Saturn V program. I went into the Saturn Systems Office, and I worked on contractor selection for the Saturn.

Eventually I was asked to go into the [Space] Shuttle Office. I worked a couple years on contractor selection before I took over as manager of that. I stayed in the Shuttle Program as the program manager at Marshall until '85. I retired in '85. Since that time I worked on Shuttle to a great extent—I did some consulting. I took over the solid rocket booster program at Thiokol [Corporation], and worked as a division manager there until '92. Then I retired again. I've since worked as a consultant to NASA and to Thiokol, and I worked on the *Challenger* [STS 51-L accident] problem and worked on the more recent *Columbia* [STS-107 accident] problems as a consultant to [Lockheed] Martin [Corporation] and for Marshall at that time.

ROSS-NAZZAL: That's quite a bit. Tell us what your role was as program manager here at Marshall managing those three elements.

LINDSTROM: We had all three elements. Plus we did the dynamic testing here. Also did main propulsion testing at Stennis [Space Center, Mississippi]—we were responsible. I was responsible for the management of that conglomeration. We had sundry program managers at each of those project levels that worked for me, and my overall job was integrating, see that they had the right resources, the right people. Both [at] Marshall doing their job of overseeing and also [at] the contractors. We visited contractors considerably, suggested things for them. My job

here at Marshall was primarily to help these five or six managers see that they had the right resources, evaluate their progress for the center director. We worked with the Johnson [Space] Center [Houston, TX] and the Kennedy [Space] Center [Florida] as well as [NASA] Headquarters [Washington, DC], overall integration of these programs.

ROSS-NAZZAL: What role did you play with the main engines? There were a lot of problems with testing. There were fires, there were budgetary concerns, there were problems with the contractor—what role did you play in all of that?

LINDSTROM: I worked with J. R. [James R. Thompson] and helped him, did several reviews. We brought in some outside contractors to review the program. We brought in Pratt & Whitney because of some pump issues, and we actually got a separate proposal from Pratt for a pump to take the place of the Rocketdyne pumps. We brought in Honeywell. As part of our management of those programs we sent many Marshall people on location, had some up at Honeywell for some time. I was just part of the program. It was a team effort. You don't find much any one person throughout this program [who did it all by themselves]. I'm sure you find the same thing at JSC. They worked as a team. We did too.

We had a very close management relationship to Rocketdyne. Sometimes bringing in additional contractors to look at it doesn't make the contractor very happy. I think JSC has done some of that too. My role was just to stay close. We made changes; we provided as much help to J. R. in terms of the quality and the quantity of the support he got from Rocketdyne. It helped his relationship with Washington.

If you want to describe it as something in private industry, it's a general management role where you're managing some managers. You do what's necessary, spend a lot of time in reviews of the engine program. It really depends [on] what kind of problems they were having. I'd participate in the technical review and provide my own thoughts to both the Center Director and to J. R. It was a team effort. I can best describe it by saying I was a general manager of some very good managers. Sometimes you didn't have anything to do, but sometimes you were really busy.

ROSS-NAZZAL: What was the biggest challenge while working on the main engine before STS-1 flew?

LINDSTROM: I think the biggest challenge we had was the pump reliability and life. I think that's what we worked from a technical standpoint. We had a number of problems but the high speed pumps were most difficult and took the most effort. We brought Pratt in for that, getting enough testing off. Rocketdyne did a good job. They had a great deal of expertise. One of the advantages here in NASA, also at JSC, is when we started the Shuttle Program we had the propulsion background of the Saturn Program, Saturn-Apollo. So we had some very competent, qualified people. Our program managers and our chief engineers on each of these programs, whether it be J. R. or George [B.] Hardy or Jim [James B.] Odom—they were as competent as the engineers; they were as competent as the contractors in all cases.

We knew what they had to do. These people were very well qualified. And a lot of, I think, our success was we had the expertise. The people who had been through the Saturn-Apollo—they had been to war so to speak, and they were able to do so. Same as JSC when Chris

[Christopher C. Kraft] was there. We had strong technical leadership at the Center level and engineering level, and that gave us the right kind of reporting. Our management understood what we were doing and what we were saying.

ROSS-NAZZAL: The engines themselves were one of the pacing items for the orbiter. What sort of heat did you take from Headquarters and from the program office itself at JSC?

LINDSTROM: We'd take a little heat from Bob [Robert F.] Thompson, but really I don't think you can call it heat. They wanted to know what we were doing and understand what we were doing. Bob Thompson evaluated us the same way he evaluated everyone. John [F.] Yardley in Washington was a very strong technical individual, a good manager. We used to have to call him up in the middle of the night every time we were having a little glitch on the engine, and John called directly to J. R. probably once a day, or quite often.

I don't really think I'd call it heat, but they were watching what we were doing. The fact that Yardley was a very strong individual technically and managerially—you had a lot of respect for him, as we did for JSC people, R. F. Thompson, and the people that were there, Chris. We just had a lot of respect for those people. Worked with them, and they worked with us. I think they respected us too.

ROSS-NAZZAL: Was your role to protect J. R. from some of that heat or some of the discussions from Houston and DC, as the manager?

LINDSTROM: I would provide answers to these people too. I'd work with J. R. and ask him questions [about] making technical decisions, evaluating as much as anything the Rocketdyne people. We changed some management people at Rocketdyne. We were talking to Rocketdyne. We went through Rocketdyne corporate office to make changes at Rocketdyne, as we did with Martin in the external tank.

ROSS-NAZZAL: Tell me a little bit about the testing program for the main engines. What are your recollections of those events at the time?

LINDSTROM: I witnessed a few engines blow up. We did most of the engine testing down at NSTL [National Space Technology Laboratories, later renamed Stennis], and we would have a group of people down there. First half, we would go through a test readiness review with Rocketdyne on each of the engine tests. They had some very good test people down there who later worked in development. We had our druthers, but we were very happy when we got a good test. It was a struggle I guess you'd have to say. I used to say when we'd have a test that we'd have a little problem, the engineers would start working on the problem, then by the time we got back to Rocketdyne they'd already figured out what we were going to do next, how we were going to fix it. We didn't know how to fix it.

ROSS-NAZZAL: Was there ever a point where you thought that maybe this fantastic wonderful engine might not work and might not be ready for the first flight?

LINDSTROM: We didn't say it was ready till we thought it was ready. We had enough testing for the first flight.

ROSS-NAZZAL: How did you determine that it was ready for that first flight?

LINDSTROM: You listen to your people, you listen to Rocketdyne's people, and you make a judgment. There'd be some that think it's ready; some that don't think it's ready. In many cases you just have to set a goal. You achieve these goals. That's one part of the puzzle that you consider. We brought in expertise from other Centers, other contractors to look at our project too. You just try to get the best people you could get, both from the contractor and JSC. A lot of JSC people helped us. Dick [Richard H.] Kohrs helped us a lot; Aaron [Cohen] helped us. Max [Maxime A. Faget] did. A lot of people did the review. A lot of this only on the SSME [Space Shuttle main engine]. We got Pratt & Whitney in. We had some problems with the handling of the motors and the tank. We brought Boeing [Company] expertise into that. Technical reviewers came from our contractors. If you thought you could get some better, extra expertise to help when you really didn't know what you were doing, you would bring them in.

ROSS-NAZZAL: Did you start thinking about how you might redesign the engine after that first flight? Or were there any problems with the engine?

LINDSTROM: I don't think we had too many problems, not on the first flight. We had a problem I think about the fourth flight or so. Only two problems that I can recall. On an injector, if we'd gone much longer we probably would have burned up the engine, and then we also had a

problem with shutting down an engine prematurely. Temperature gauge was bad. Biggest problem we had there for a few flights was just the correct temperature gauge and controller. Fortunately the [flight] controller down at JSC shut down the chance of shutting two engines down. If we had, we'd have dropped it in the Atlantic Ocean, and she disabled the second shutdown, which was the right thing to do. On that one we worked that very good detail. We were trying to find the sensor to use on that flight. I spent about a month at Rocketdyne just trying to help select the right sensor for it. The whole thing is a team effort.

In fact we had three parties remembering our first flight. We had one just two or three weeks ago now. We had over 100 people. We got the same group back together to talk about the old times, talk about our problems, and some of our successes. That team still sticks together. In fact we also have a Shuttle buddies breakfast together once a month, all together. We have 35, 40 people there too. I just mention this as a way to [point out how] you really develop a team. Work on these things, work together. There's very little individual success—somebody coming up with a brilliant idea, “Man I can fix that engine or fix that.” A great deal is left to the project manager really building their team. We had George Hardy and Jim Odom.

ROSS-NAZZAL: How did you build your team of these project managers?

LINDSTROM: Just work with them, try to help them. Most any manager tries, regardless [of] what they're managing, to build a team to work together. You try to help them. You don't really direct these people. Some people may think being a manager is direction, but you're really there to provide the resources to help them and help their relationship with the next level. We'd try to protect our managers, often giving them the resources to evaluate their people, and giving them

new people, different people. You do a certain amount of things, rewarding them the best you can. In government, [there's] less chance for reward. You select managers first, that's your first job, then you help them get a chief engineer. Works pretty good.

ROSS-NAZZAL: Tell us about your work on the solid rocket booster [SRB] and solid rocket motor [SRM] when you were manager of the Shuttle Program Office.

LINDSTROM: It was much the same. We had two failures. One was the nozzle almost burned out on one flight. We struggled with a solution to that. George Hardy and I went out to Thiokol. I lived at Thiokol for about a month while they worked that problem. And we've done the same thing with J. R., a couple of us at Rocketdyne, the chief engineer also. We believed very much in getting our technical and our management team on site to really work close, know what's going on.

ROSS-NAZZAL: Could you tell me the difference between the project manager and a chief engineer?

LINDSTROM: They're entirely different jobs. They work as a pair really, but in the end the manager makes the decision. Chief engineer provides his evaluation, and he overviews the total program. The manager, at management level or a looser level, he makes the decision. Many times his decision is based on what the chief engineer says, what he recommends. The chief engineer also brings the resources of our engineering organization to bear on the programs. He manages all the engineers [and provides an] engineer support level.

ROSS-NAZZAL: Can you tell us a little more about the testing program or the qualification of the SRBs and SRMs?

LINDSTROM: On the SSME they set out initially to test every component before they put the system together. Then they had a lot of pump testing and had to build a new stand. They tried to take each component of the engine—primarily the pumps, the injectors—and they tried to build test capability to do that before they put them all together as a system. We had a fair amount of trouble on building the pump unit component test stand out at Rocketdyne. It took a long time to get that facility going, had some cost overruns on it. For the first testing of some of the systems on the SSME we put a system together. We put a test engine together and that's one of the first [tests] we had on some of the components that were on that engine. We did a lot of testing on the engine, and we had an engine here at Marshall that we tested certain aspects of the engine. We had to use the stands down at Stennis. On the engine testing we tested a fairly low thrust level, then eventually built up to 109% of the engine thrust.

The engine program was set out to do this testing by component. Same as if you'd cook a meal if you could test each one then eventually put them together. Hope it'll still make a cake rather than just half a piece of pastry or something. That was done really between Marshall. It was actually part of the program, I think, for the bidding of project. We specified that type of program I believe. I was not involved as such with Rocketdyne. Pratt & Whitney protested the selection of the engine with Rocketdyne but it was upheld for Marshall.

All the programs, we tried to use proven technology. On the SRB, the cases were similar to what we had built before. We made some large cases. Propellant was a propellant that was

used on Minuteman [LGM-30] and Peacekeeper [LGM-118 nuclear missiles], Minuteman primarily. We had a lot of experience with the propellant.

We had a lot of issues both with Martin [Marietta] Company and with Thiokol. In both cases size gave us a lot of difficulty. Martin Company had welded these components together. They'd built a lot of engines, but they hadn't built one as big as the external tank. And the same way with the solid rocket motor. Each segment was so big, we mishandled a few segments, dropped them or something. Those two things were size, whereas in the SSME it was primarily technology and development.

ROSS-NAZZAL: Were there any complications with the testing of the SRBs or the external tank that you recall?

LINDSTROM: No.

ROSS-NAZZAL: Things went pretty smoothly compared to the main engines?

LINDSTROM: I don't know if you'd say they were smooth. We had a lot of problems with the tank. Not so much in the testing, we had a very extensive test program on the structural testing on the external tank. The idea was if we would really do a good job testing then we'd know all the load situations. When it comes to redesigning the external tank, which eventually we had to do, we'd know what's going to happen.

The solid rocket motor we didn't have as much. We had some test cases, primarily some insulation problems. We had some nozzle problems. They were not technology problems; it

was getting it done correctly. In most cases size affected that, whether it be in the tooling, how you put it together, or whether you're putting insulation on the inside. Again it was the nozzle primarily. We really had very good luck with the propellant at Thiokol.

ROSS-NAZZAL: What role did you play in the decision to build the lightweight tank?

LINDSTROM: I was not even out there. I had retired before that.

ROSS-NAZZAL: What about the decision not to paint the tank white? Were you involved in that decision?

LINDSTROM: Yes, I think that was before the first flight.

ROSS-NAZZAL: Can you tell us about that decision?

LINDSTROM: We took the paint off to save the weight. Initially designed was white paint, then we just made it that muddy color.

ROSS-NAZZAL: Were you involved in that decision at all?

LINDSTROM: I'm sure I was.

ROSS-NAZZAL: I thought I would ask you just a couple questions about management. Were there any decisions that were made by the [NASA] Management Council that impacted the elements that you oversaw?

LINDSTROM: I think most of the program decisions at that level were made by Yardley. I'm sure the Management Council, which was the Center Directors, were involved and made decisions for their own programs, but I don't know if they were specifically Council decisions. They basically overviewed the program, they made certain funding decisions. Basically the program in those early years was in the hands of John Yardley.

ROSS-NAZZAL: Would you tell us about your relationship with him and working with him on these components?

LINDSTROM: We had a good relationship with John. He wanted you to keep him informed, and he expected you to call him if something was wrong or something wasn't right. I had a good relationship with John. He was a good guy; I think he made friends with everyone.

ROSS-NAZZAL: What about your relationship with Bill [William R.] Lucas [Marshall Center Director]? How did that work when you were manager of the Shuttle Program Office, and he was overseeing the site?

LINDSTROM: I had a good relationship with Bill. We had worked together in materials, and we'd been friends for many years. He was a good strong technical [engineer]. I think we had a good

relationship with all our contractors; we had a good relationship with JSC. Although some people don't believe that, we had a good relationship with them, with KSC. We had a good relationship with Headquarters. All in all everybody tried to help each other.

ROSS-NAZZAL: I read somewhere that you were in charge of 20 Shuttle missions when you were the Shuttle program manager. Would you tell us about the role that you played when missions were getting ready and when they were in flight?

LINDSTROM: I just managed what was going on, primarily by reviewing and understanding the results of what was going on. We had flight readiness reviews, and we required that they have a flight readiness review with the senior management at the contractors. One thing we specified is exactly how they would conduct the review. We knew all the big problems but we required that they go back and review all changes for everything that had happened all the way back to day one. That they re-review them each time because you want to make sure that the change which was approved some time ago all of a sudden wasn't one of the problems. We had a very formal specific review. We would then review with JSC, and we had a review of our last review with the Center Director. Then I guess it was the Management Council and John Yardley.

I think the reviews were very thorough. Both we and JSC at that time had strong technical people in management when Chris was there and Bill Lucas here and John Yardley. They're three pretty tough guys to get through a review. Max participated a lot, and so did Jim [James E.] Kingsbury here at Marshall. Each organization had strong engineering capability, so each of them conducted a review. You tried to make the review as thorough as possible. We established what each project would do for each review, exactly what they would look at, what

they would report on, and how they'd have to certify that was okay. We had some good reviews. I think to a great extent the fact that we had the Center Directors in our reviews—normally the contractor senior management would come in too and present to us in the Center. Any big problem, like whether a pump was going bad, you knew that was an issue.

We required that each program carry their ten top problems, and they would have to report on that each time we had a review. We had a lot of intermittent reviews with the Center Director. He reviewed what we were doing, which was his own in house as well as the contractor. I think the Center Director reviews were very important to us. In recent years I know they've cut way back on the Center reviews. I don't know exactly why.

ROSS-NAZZAL: Can you pick one or two of your most favorite flights from the Shuttle program? Any that stand out, maybe STS-1 for instance?

LINDSTROM: Well, the first one did because we didn't know how it was going to go. We knew we could fire the engines, get them started, get the solid rocket booster. But we didn't know how that thing was going to fly, whether it was structurally capable. I remember the first one.

ROSS-NAZZAL: Were you at the Cape [Canaveral, Florida] when the mission flew?

LINDSTROM: I went for the first flight, yes. I've been there for a lot of them, 50 of them or so. I remember when I left the flight control room. It was about 10:00, 11:00 in the morning. I went over on US [Route] 1 and stopped and bought a six-pack of beer. I told that at one reunion back here and Crip [Robert L. Crippen] came up to me and he says, "Bob, that's what I did too, I got

in my truck and headed back and had a six-pack of beer.” Mine was Budweiser. I don’t know what Crip’s was.

ROSS-NAZZAL: One of the interviews that I had read, you had talked about the issues with the external tank insulation. You knew even before *Challenger* that that was an issue, that it was falling off. Can you talk about that and what ideas you had come up with to resolve that issue and how it was being worked before *Challenger*?

LINDSTROM: We really hadn’t worked it a great deal. The issue really was we didn’t realize that a piece of foam, which was pretty lightweight, would hurt the orbiter. We assumed that much of the damage on the orbiter was due to stones and rocks out at Edwards [Air Force Base, California] and also down at Kennedy, that a lot of the damage we saw was just dirt. We didn’t really have any damage on the tank to my recollection that would indicate some loss of tile such that we’d overheat the thermal structure of the orbiter.

We didn’t really consider, at least when I was still there—we had some come off after first tanking test. It was an integration question primarily; it was a question between ourselves and the orbiter. We never put the two together, that it would cause damage or catastrophic failure. I don’t know exactly why. I’ve never gone back and looked at the testing of it, but basically an integration question.

ROSS-NAZZAL: Are there any other technical issues with the various components or issues about testing that we might not have covered that you thought we should discuss?

LINDSTROM: I think it was pretty thorough. I think you'll find many of the issues, much like the external tank foam with the orbiter flight, was an integration issue. To some extent I think some of the other issues they had with the solid rocket motors coming off would have been an integration issue. The two big issues were the orbiter brick or the TPS [thermal protection system] and the engine. They were the two controlling problems.

ROSS-NAZZAL: What do you think your biggest challenge was while working as manager of the Shuttle Program Office?

LINDSTROM: Just pulling everything together. The total program was a big issue. I worked hard on the engine. We may have to change people; sometimes changing people is not a lot of fun. Just keeping abreast of what's going on.

ROSS-NAZZAL: If you had to pick one greatest accomplishment while you were the program manager, what do you think that that would be?

LINDSTROM: Getting the team pulled together and getting that job done. We made some good management decisions. We changed some people in some of the contractors. They were tough decisions to make—you really can't consider that an accomplishment. Just getting the whole team to work together, getting it all done.

ROSS-NAZZAL: Rebecca, do you have any questions for Mr. Lindstrom?

WRIGHT: I think he's covered it all very well.

LINDSTROM: Glad I was able to help you.

ROSS-NAZZAL: Yes, well, thank you very much for taking time to meet with us.

[End of interview]