NASA JOHNSON SPACE CENTER ORAL HISTORY PROJECT
EDITED ORAL HISTORY TRANSCRIPT

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INTERVIEWED BY JENNIFER ROSS-NAZZAL
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ROSS-NAZZAL: Today is July 27th, 2021. This interview with Tom Franssen is being conducted for the JSC Oral History Project in Houston, Texas. The interviewer is Jennifer Ross-Nazzal. Thanks again for spending your morning with me. I certainly appreciate it.

How did you become the project manager for the battery project at Boeing [Company]?

FRANSSEN: Okay. At Boeing I was working in the sustaining engineering world and running that part of it, setting it up. Then we had this other battery project which was the nickel-hydrogen batteries. We had a spares build. I had a manager that brought me in on that just to help out, and it turns out I ended up running the thing. So I ran that for several years, and then we ended up in a very good position where we finished like a year early and were under cost, and it was like great. We ended that, and then I started some side projects, working with some suppliers that I worked with before, and then my manager came and said, "Hey, we got this lithium-ion project coming, are you interested?" I said, "Okay," so they brought me into the POP [period of performance] exercises, where we'd done finance review for a few years before that. Then that's when we got notice of NASA's intent to place the contract. I started working the proposal.

ROSS-NAZZAL: You were there at the beginning.

FRANSSEN: That's one thing about this project. I had it from cradle to grave. We started out with some trade studies before we did the proposal to make sure it was technically feasible. We went through all those trade studies, and then we got into the proposal. I ended up working it all the way through project closeout, which was dispositioning of all the property and closing off the contract after all the deliveries are done.

ROSS-NAZZAL: That seems fairly unusual, I would think, in an engineering position.

FRANSSEN: It is. It would have been like 11 years on the project if we didn't finish early. We finished a couple years early on that thing.

ROSS-NAZZAL: Tell me about writing that proposal. How do you start? What technical details or assumptions do you begin with as a contractor? What information did NASA provide you?

FRANSSEN: They provided us with the high level [information], "This is what we want the battery to do."

ROSS-NAZZAL: Did they tell you they wanted lithium-ion at that point?

FRANSSEN: Yes, it was a lithium-ion battery, because this was a replacement for the nickel-hydrogen. The main reason is it has much more power, so we could have one lithium-ion replace two nickel-hydrogen. We just had to put in the adapter plate to make the electrical connection on orbit. It was to reduce launch cost. That's why they decided to go with the

lithium-ion. They gave us a proposal for what they were looking for in the change, and that's where we went and ran those trade studies, because we're like, "All right, there's a lot of unknowns here." We had to change the software, pretty much because the entire IEA, which is the integrated electronics assembly, its temperature of all the electronics, cooling, was controlled by the temperature of the nickel-hydrogen battery.

ROSS-NAZZAL: Ah, okay.

FRANSSEN: Yes. That triggered everything. Lithium-ion run at a different temperature. So, we had to see if we could redo all the software, all the thermal algorithms, and then we had to figure out whether we could get stuff to fit in the same spot because we got the same footprint on orbit. We had to look at what cells were feasible. We weren't picking the cell but we had to eliminate ones that either the configuration wouldn't give us enough power or they're too heavy. The package had to fit to give us the life we needed, which is I think 10 years or so, at least the advertised life.

ROSS-NAZZAL: Those nickel batteries lasted a little bit longer than they anticipated, didn't they?

FRANSSEN: Oh yes, they were a workhorse.

ROSS-NAZZAL: When you're working on this proposal as the project manager, how closely are you watching all those technical details? Are you working more on the administrative side of the house, the budgetary details, the number of staff you would need?

FRANSSEN: I left the technical as far as how we could accomplish that to the technical folks. But I was working all the budgets with all the teams, making sure they understood what their tasks were, what they needed to do, whether they did it all, putting together a schedule, the master phasing schedule. We put this proposal schedule together, the master schedule. We ended up never changing it all the way through the end of the project. Those were the top-level milestones. Some were early, some were a little late, but all in all once we got that schedule together that lasted for the entire project.

A big part of it was subcontractors, because we subcontracted out some of the battery work on there. It was running those proposals, because we did competitive proposals, and all the evaluations were blind, so it was setting it up to be a good fair competition, where we got all the evaluators making sure everyone's in line and evaluated, making sure the RFP [request for proposal] went out, could be evaluated, and we could distinguish between the suppliers. That was a huge effort going through that, assembling the proposal team, doing all the reviews and the evaluations.

ROSS-NAZZAL: Would you talk a little bit more about that? That's something that we haven't had covered by the other folks that we talked to. Who were some of the other subs who worked on the battery? They talked with us about some of the people but not the proposal stage. How did all that work?

FRANSSEN: Are you interested in who was in the proposal or who was selected out of those?

ROSS-NAZZAL: Who was selected but also even the proposal process. What does that involve? How do you downselect from a variety of contractors? Are you picking from two? Are you picking from a handful?

FRANSSEN: In this case let's use the battery ORU [Orbital Replacement Unit] that we contracted out. We started off with supplier management A runs it all. They run it, and they help select companies that are feasible to do this. Of course, with our input. We'll send out RFIs, requests for information, and intent to bid, and then people will respond to the RFIs.

Based on the response to the RFIs, then we downselect that to a smaller group that would be feasible to produce the battery ORU. With that we get a detailed RFP out with all the requirements and everything that we need, everything we want them to adhere to. We send that out for review.

Before we ever get a proposal back, we set up all the evaluation criteria and how to score it, and that's a lot of what I did. I set up some big spreadsheets that could track everything, because you have a whole bunch of different scores that would use that and do the evaluation.

Then the proposals come in. We actually did blind evaluations. In theory no one knew who was who. Some people could tell by some of the technical writing of the proposal, but nowhere were there any company names or anything like that. We had several groups of people that evaluated different sections of the proposal. We had some technical, we had quality, CM [configuration management]. We had the pricing folks looking at that. We had management type folks looking up that.

Then we'd take everyone's score and we'd put it all together and add up the points and see how they ranked. It's quite an involved process.

ROSS-NAZZAL: Yes, it sounds like it. About how long does that process take?

FRANSSEN: I think it was somewhat about six months for the whole process. When you start out with the RFIs and RFPs and go through the proposal process and the negotiations and things like that.

ROSS-NAZZAL: Would you talk about managing those subcontractors? I imagine that's a lot of what you did as the program manager of this project.

FRANSSEN: It is, it is. You've got to get your relationships set up. I'm a firm believer in going out and visiting them, seeing them eye to eye, and working through issues. With all the subcontractors we had, we had very good relationships. We went out there often. I went out there often. Big or small, see how things were going. A lot of them were in California, so I'd go out there and I could hit a couple of them.

Big thing was the relationship with the contractor. Now this was a different type of contract. Most contracts you put in place you got a base fee and then some type of incentive fees. But for the main contract, the battery ORU, we actually did 100 percent award fee.

ROSS-NAZZAL: Is that because you wanted this battery to be available earlier?

FRANSSEN: No, we wanted an award fee so the supplier would be responsive. You set up award fee criteria so they adhere to what is important to be done. It does give you a little bit of a lever if they're not performing, to help encourage them.

We ended up with a supplier that was 100 percent award fee. Took a while to get the concept of it, but then they got it, and we worked very well together. We kept cost of changes down to a very minimum on this program.

ROSS-NAZZAL: How did you do that? Can you talk about that?

FRANSSEN: We had a good set of requirements up front. Another thing is scope creep. We really paid attention to scope creep. It's different between you got an option to do it this way, this way, what's the best way to do that. We only had two cost of changes on the contract with NASA. One was for some additional hardware, just additional builds. The other one was the result of 787 battery issues, but we had to add a radiant heat barrier into our battery, and it was to add that. That was the only two cost of changes.

Working with the sub, we tried to work open with the sub, and we worked out issues together. The last thing you want to do is start doing changes back and forth, back and forth, back and forth. That just drives the cost of it. As long as it was within the scope of the contract, we worked things out, we got things done.

ROSS-NAZZAL: Can you give an example of something that you went back and forth on that ended up getting resolved that didn't result in what you call scope creep?

FRANSSEN: It could be the approach to some of building the battery and some of the tasks that they did to do that. I'm not the expert in this area, but technically they had to hit this certain threshold to optimize it, and they didn't want to go there. We had to work back and forth to make sure what was best for the battery was the way to do it, because it took a little bit of extra analysis and things like that. Bottom line, you work back and forth and you get a good working relationship. There's give-and-take all the way down the road. I don't have a real specific example to give at this point.

ROSS-NAZZAL: You also said that the master schedule really never changed once you had set that, which I thought was pretty amazing.

FRANSSEN: Once we got through the proposal we went through and did an execution review. At Boeing this is called gate five. This was really the first major project to go through gate five at the Houston site. We were like the guinea pigs going through it.

We must have done a couple hundred pages of presentations about defining what all our baselines are. The schedules, we got margin in them. What are the costs? What are the suppliers? And that the schedule is executable as is. We went through standard reviews, requirements review, PDR [preliminary design review], CDR [critical design review]. We also added an SDR, which is a system design review, before PDR, just because we wanted to make sure everything was working well together.

Went through that, we set up the major milestones, and then we just put in everything after that to flow into the major milestones. Yes. It stayed for the whole project. Now I think SDR was on time, PDR was early, CDR I think was on time, but then we had some issues with

the qual [quality] unit that we discovered. I don't know if they talked about the cracking baseplate.

ROSS-NAZZAL: Why don't you talk about it? I always love to get other people's stories.

FRANSSEN: Okay. To me, there's some other causes, the root cause of this. We had weight restrictions for launch that we were following the ICD [interface control document], so we had to keep the weight of the battery down, the mass of the battery down. We were always scrimping for weight, trying to get it as light as possible. When the manufacturer was building the baseplate, they milled off. The baseplate sits on the bottom of the battery, and it has fins for cooling, and all the cells sit on it.

They milled that down to as thin as it could possibly be, taking the bosses where the cells sit and making those as minimal as could be, and still pass all the miles. What happened is the cells are fairly heavy, the bosses that they sit on didn't go all the way to the edge bosses, they ended early. That was part of the weight saving thing.

You look at their model, and it showed a high stress point, but they put it off as this is just one little dot, it's no big deal. It turns out we were going through qual, which we shake the heck out of the box at qual, and then someone noticed some cracks on the baseplate right by these bosses that were a couple inches long.

We said, "Holy cow." We had two qual units. One of them was at the IPL [International Space Station (ISS) Power Lab] here in Houston. They opened that up and took a look at it and said, "Yes, we got cracks in this one too." Turns out we started doing a detailed study of that little high stress point where normally they say they averaged this out and it goes away. Sure

enough, it was that bending and flexing right at that little point that caused the crack. If the bosses would have went all the way—like a half inch more is all they would have had to go.

ROSS-NAZZAL: Oh, wow.

FRANSSEN: It would have went all the way, it probably wouldn't have been an issue. We ended up doing a lot of analysis, and we determined that okay, although not ideal, the crack in the baseplate is just a crack, it won't fail, really doesn't hurt its functionality. It's got a certain amount of life on it. They did a lot of great analysis. The crack could only grow a little bit over an inch, they found out by doing their vibe [vibration] and their normal vibe and the launch. It cracked a little bit, wouldn't go any more.

We used eddy current and things like that trying to find out what the size of the flaw would be. Some didn't have any. Some had little flaws. They weren't really visible in these units. As I said they showed up on qual units because we shook them so many times and at such a high level.

ROSS-NAZZAL: But this didn't require you to go back and redesign or redo.

FRANSSEN: No. It could have, but it turned out that the crack was okay. Pieces weren't going to come off of it. Just in case we also put some Kapton tape, in case a piece would ever free up on it. Did not hurt the functionality. As I said it couldn't grow a little bit more than an inch. These things are 3 feet wide. Almost none of them are visible on the actual flight. That's when you started doing it. As I said you had to use eddy current, things like that trying to find it.

I still put root cause as us trying to scrimp, get down the weight of the battery. It turns out there was plenty of margin that we never knew about. So we did a lot of scrimping where we probably really didn't need to do, when it comes down to the end of it.

ROSS-NAZZAL: Why do you think you didn't need to scrimp as much?

FRANSSEN: Because when we started working through the launch stuff on this one, we found out there was a lot. What they had in the document about what you were allowed was extremely conservative. Sure, you need another 10, 15 pounds? Yes, no problem. What? Actually, as we got down the road and there were some minor things we had to look at, like when we added the radiant heat barriers, it was like adding some weight. That's where we really started to find out that number they gave us really wasn't that firm.

ROSS-NAZZAL: When you found out about the cracks, as project manager, what was your initial thought?

FRANSSEN: Oh, no, here we got to go scrap everything, redesign. We just lost a year. But everyone was very open. One of the things we always did is as soon as we found something we brought it forward. Every time we brought it forward right away, because if there are repercussions, we needed to get to it and address it right away. We got our chief engineers we go to; we have management to make sure they knew, NASA counterpart, let him know right away. We have a great working relationship. They didn't hang you for bad news, it was like

here's the bad news and here's what we're doing about it. Or don't know what we're doing about it yet because it just happened today, but we'll let you know.

ROSS-NAZZAL: What did the ISS Program say, do you recall, when you told them about these cracks?

FRANSSEN: Yes. We had to bring it through safety reviews in the program. They understood how it happened, and they wished it didn't happen, but there was no repercussions for it, like an award fee or anything like that. It was all okay, we got an issue, how do we address it. Is the crack really an issue? That's where we had to look into yes, it's okay to fly this way, it is an issue, it's not an issue. It wasn't an issue whatsoever.

ROSS-NAZZAL: You did mention something that I wanted to ask about, because we talked about it with Tim [Timothy R. North] and Eugene [R. Schwanbeck], which was the 787 battery incident. Tell me from your perspective what impact that had on your efforts moving forward with the project.

FRANSSEN: A, it put a microscope on you, especially from the safety community, because GS Yuasa built the 787 battery and they're building our cells. Everyone quickly made the assumption they were the same, and they are nowhere even close in design and qual. I'll give you an example. The batteries we use, the terminals are like $2,400 apiece just for a single terminal. The cost of a cell was almost the cost of an entire ORU building it. There was a big difference of structure.

The big impact was Tim was actually part of the team to help out with 787. He was our battery expert. They went through all their root cause analysis things and listed several things that they needed to deal with on 787. We just came back, and from what they had we looked at what we needed to address on our battery that we weren't already addressing. Spaceflight is a much different environment. So we paid a lot closer attention on JSC requirements for spaceflight to make sure we were safe. Because if these things go it's not a pretty story.

Turns out the one thing we weren't doing was the radiant heat barrier. So that was the one change we mentioned. We said, "You know what? They're recommending this be done. So we need to go with that." We designed a radiant heat barrier, and it went between cell two-packs. That's just in case a cell goes into thermal runaway. The two-pack may burn up but it won't go to the adjacent two-pack and then start a cascade.

ROSS-NAZZAL: What sort of impact did that have on your budget? Was that a huge increase?

FRANSSEN: The change covered the cost that we had, because they wanted to add that in. We had the new requirement to have that. The change covered the cost of that.

ROSS-NAZZAL: Oh. So NASA had insisted on it.

FRANSSEN: Yes. Because it was a change in requirements. They gave us a requirement change, which the solution would be a radiant heat barrier. Now the cost of the residual impacts from all the inquiries and questions and going off and studying, yes, I'd say it was a little bit under $500,000.

ROSS-NAZZAL: Oh, wow. That much.

FRANSSEN: There really wasn't much of a delay. But there was a lot of analysis we had to do. Something like that, that's one of the unknown unknowns that you get on a project.

ROSS-NAZZAL: Did you get any media inquiries about what was happening? Since you were the battery project manager, were people asking you to weigh in publicly?

FRANSSEN: I did not. No. Not really. Not on that subject. The main subject was 787. I'm not very knowledgeable what they did on that. So the focus was on that. Tim was there just because he was an expert in batteries, and we were there because we wanted to incorporate anything lessons learned that would make our battery safer.

ROSS-NAZZAL: What about weight? Did that increase? You mentioned you had to scrimp quite a bit. Did that add to the weight of the battery?

FRANSSEN: It did. It didn't add that much, 5 to 15 pounds, somewhere in that ballpark. But that's where we found out about how much weight margin we really had on the battery. We were able to change the battery weight requirement to allow you to put these in. We were okay to fly that way.

ROSS-NAZZAL: You guys sound like you were master planners when you were working on this project. You seemed to have a lot of experienced people. This wasn't their first rodeo I guess is the way people describe it.

FRANSSEN: No. Space Station has been around a long time now. I remember a comment we had when we had a meeting. We were meeting with the Orion [Program] people. One of the guys came out of the meeting. He says, "Boy, they're awful young on that thing." On Orion. They're so young. I was like, "Yes, you mean like we were 25 years ago working Space Station?" We have a lot of good, experienced people working.

ROSS-NAZZAL: It sounds like you had other experiences that you could draw from, and clearly had used it to your benefit, that you were able to design a battery, keep to a schedule, and seemed like everything really fell into place quite nicely.

FRANSSEN: It did. We had our challenges. There are things we did that helped. We changed suppliers a few times. That's one of the things you can't be afraid to do when you're seeing trouble with a supplier and an issue. Actually, our subcontractor did this. He changed his major assembler after the qual unit, just because of the experiences they had. They saw where this was going.

ROSS-NAZZAL: Is it because of the crack?

FRANSSEN: No. They had one subcontractor to do the assembly of the qual unit. They assembled both qual units. They gained a lot of experience with the subcontractor. They were getting into a lot of issues with the subcontractor, and they were getting ready to do flight production. Excuse me. EM [engineering model] units. Not the qual units. This was before the qual.

They started evaluating other subcontractors and they took the schedule hit and the cost hit to switch subcontractors for the qual and flight contract, because they saw trouble coming down the road. Everyone was not happy at first, but it's like sometimes you got to do that.

I did the same thing. We built the enclosure for the battery, and we were actually having Boeing build the enclosure for the battery. When we started out with the contract, we did a bunch of make/buys. Make this, put this out. I revisited those every year for a while just seeing what was going on. We had HPSC [High-Performance Spaceflight Computing], the Houston production facility, making the enclosures.

Again, I gave them the EM enclosures. Go prove yourself. They ran into some issues. They couldn't meet expectations. So we ended up changing that from a make to a buy. We went through another competition on that to build that. The adapter plates we were going to build in the same facility, but you sit down and you look at the cost, you look at where you're running, you extrapolate it out, going, "This ain't going to work." So we did another research in the market out there, and then we did another competitive proposal, and we found another supplier, very good one right local here in Stafford, [Texas], Atec, [Inc.] to go ahead and build, manufacture the adapter plates for us. I think they were also JSC supplier of the year one time.

We were their first space contract to get to work. We gave them the adapter plates. Much different. They're your firm-fixed-price contract. You reduce your risks that way. But

again, you got to watch it so you don't grow that where they can give you a lot of changes. We did very well. Again, we had a very good working relationship.

ROSS-NAZZAL: Did you have a chance to go out to Stafford and monitor how things were going?

FRANSSEN: All the time. Yes. I say all the time. We'd definitely get out there every quarter or so. More often if needed because they were just down the road. My major supplier out in California, I was there monthly.

ROSS-NAZZAL: That's Aerojet?

FRANSSEN: Aerojet Rocketdyne. Yes. I used to go out there monthly. Sometimes you have an agenda that you needed to cover, sometimes you didn't. Even when you didn't you would fill up the entire time you were out there because everything starts coming up ad hoc when you're out there. That's one of the things I learned on the old nickel-hydrogen program. When you're out there they don't have any questions. But when you're there come all the questions and issues to go work. Every trip was very productive.

ROSS-NAZZAL: Can you give some examples of things that popped up that you weren't aware of here in Houston that you found out about Aerojet when you made that trip? Anything stand out in your memory?

FRANSSEN: It's nothing technical. It's mainly running the contract and how they're doing on the schedule and budget issues, risk they have, and how they're going to spend the money. Evaluating how many test sets they need. Things like that. And there's stuff we did to help them. They actually ran the cell selection. We had a lot of experience on doing competitive proposals and stuff like that. We spent a week or so out there. It was for them to run, but we would give them suggestions of how to look at things and how to evaluate. Look at ways to evaluate it to make sure they could have crisp clear criteria for evaluation.

ROSS-NAZZAL: Did they ever come back and reach one decision where you said, "I don't think this is the right decision, you might need to reconsider this"?

FRANSSEN: I avoided that because that would be contractual directions. I could tell them I don't like a decision, but I'm not going to tell them to change it. But they were pretty good. I think my technical guy was more of a no, you need to do it this way type thing than I was.

ROSS-NAZZAL: Were you spending any time out at Glenn [Research Center] working with Penni Dalton at that point?

FRANSSEN: I did not. She was the technical part. Tim and Penni worked together.

ROSS-NAZZAL: I thought I would ask about that. Were there any major budgetary issues that you encountered? I know towards the end I want to talk about the cost underrun. But it seemed like I guess things seemed to work well.

FRANSSEN: One of the biggest hits we had was two of the flight units Aerojet was running through thermal test, and there was something wrong with the script, and it ended up lowering the temperatures of the batteries too far down. It was too low too long. Basically froze the cells. We had two battery ORUs that we had to replace the cells in. Not only do you have the cost of the cells but you have the cost of the labor of disassembly. These things aren't made to disassemble. You had to disassemble them and reassemble them and retest them. That was a major budget hit.

Early on in the program NASA had their independent reviewers reviewing our schedules and reviewing our budgets. We just kept, "Trust us, we're fine."

They kept coming back, "No, you're going to be two years late first delivery, and you're going to be $25 million over budget."

We're like, "No. No. We're okay." One of the things that made it hard to manage this is because it was such a long contract, or effort to go through this, the prime contract that we were under ended in the middle of it.

ROSS-NAZZAL: What contract was that?

FRANSSEN: That was NAS15-10000. It's because they do it in extensions. I think it was like September of '15 was when the contract ended. Of course we go all the way out to 2020. So you have no baseline for any of that work out there. You have no money for that. As we're working for it, you have this artificial cutoff date that you have to do all your cost and schedule performance metrics.

One of the things I did through this project is anything I could move to the left I moved. If we got deliveries that need to happen five years out in the future, but if I got the design done—I'll use flight interface hardware as an example, which is pieces of metal that we use. If I got the design done and I got the manufacture on board, I'm going to build it all and deliver it all, get it done early. If there's any analysis I can get done early. Because trying to build as much margin as I can. Anything I can do early I deliver it early.

In fact, it turns out that the mod [modification] kit for this—when we first put it together and we knew we had to have a mod kit, and a lot of times a mod kit consists of hardware and the paper to do on-orbit installation. Come to find out in our case you did not want to marry sets of hardware together because you wanted the option to move things around. So the mod kit was generic, and it was just use one of these batteries, one of these, one of these. They weren't married. So we went and we could do our mod kits. I delivered them like five years early.

That was a paper product, but it was still a DIL [deliverables items list] end item. But it was all getting that stuff done as soon as possible. What happened is I'm doing effort where I'm contracted to do, but we have no budget or baseline to do it, so I'm working that effort back here. Of course, my cost indices is red. Really quite bad. It was like 0.8 or something like that. I just said, "Trust us. When we get the new contract, everything will go green." Sure enough, we got the new contract, everything went green, because we got credit for everything that we did. Of course, then we still ran into the problem with qualifying the ORU and the cracked baseplate. There's all sorts of little things that you run across, and qual, where you have to rework some things.

We were over a year late on getting qual. The first unit was really late. We definitely missed delivery of the first few units. But we made delivery the need date for flight. It meant

we got past our qual issues and manufacturing was a big focus. I actually ended up going out to Rocketdyne for three months working them. I'd look at things a little bit different than they would doing day-to-day. I'd set up a daily board. Here's the units we got to get done. This is when we need to do them. This is what needs to be done. It's just crunching through it day by day to make sure we made the flight. Which we did.

First few units were late, they were six months apart, were supposed to be. But it was within a couple months we got all the deliveries done. Then once we started rolling, we just kept rolling and there was no sense slowing them down. We were able to get the deliveries moved in by well over a year, completing all the deliveries. That's where a lot of the underrun came from because when you finish early you don't have the infrastructure to pay for. You don't have the program managers, the finance, the schedulers, the CM, the quality. That's where you're saving.

Technical, you still got the same amount of scope to do. You still got to build the things. Still requires the same amount of man-hours for that. That and contract closeout helped. One of the things we did on contract closeout is we started working it a couple years before we were going to do our last delivery.

ROSS-NAZZAL: How can you start doing closeout several years early?

FRANSSEN: The biggest thing is property disposition. Step one, making sure you know all your property and where it is. I know you do property reporting. But you do verification and check and make sure okay, we know what property we've got to dispose of. There's a process to go through for disposition. We started running cases. We bundled and packaged them differently. We started running cases through the process to get disposition before we were done building.

We knew what we were going to do with those. Then once we got to the end of the contract, we needed to execute the dispositions, so we executed the dispositions. That's how you got through the property closeout very quick.

Now when you get into contract closeout, we did what we could from our side, but then there's the cost side, DCAA [Defense Contract Audit Agency]. That may take three years or whatever. But we did everything we could to get that done and people off the contract, people off the charge line both from Boeing and Houston.

I did a similar thing to the nickel-hydrogen battery. We did all that prework for property closeout and that was a firm-fixed-price contract, so we didn't have to wait for DCAA. We had our last delivery on a Thursday. On Friday we had the trucks there to pick up all the property, and by Monday all the property was delivered at KSC [Kennedy Space Center] and we had a zero property report.

ROSS-NAZZAL: Wow.

FRANSSEN: You could do that on a firm-fixed-price contract. But cost-plus you got to go through all the evaluations and things like that. But yes, it's going through all that disposition ahead of time, saves a lot.

ROSS-NAZZAL: That's a good lesson learned I think when the program manager is reading the transcript and wanting to learn more about that.

FRANSSEN: Yes. Doing that early is key. If you wait to the end, you got at least another year left, just because of the amount of time it takes for screening and to get directions and dispositions on all that stuff.

ROSS-NAZZAL: You were talking about how there was this attitude that you were going to be overrunning your budget by like $25 million and you weren't going to meet any of these schedules, from NASA's perspective. What was Boeing's perspective, given how you were handling the contract? What did they think of NASA's reaction to what was happening, do you recall?

FRANSSEN: They had some doubts too. You show them the data, "No, we are really okay." They were very supportive of me. It was like they would say, "No, we think we're okay." We had all the projections and everything out there on how things should go. Things could have easily gone the other way. But we were lucky.

We had some things. I bought these pictures. I bought three extra pictures that we could use just in case we needed them as a risk reduction thing. Speed up production. It turns out two of them had some defects, so we ended up putting together just one picture out of it that kept us alive. Otherwise we would have been shut down for six, eight months. It's things like that.

We had test sets. We had four test sets out at Rocketdyne, and to help do the acceleration, the production, we went and did a fifth. Did you really need it? It was like, "Ah, we need it in case things go wrong." You build five identical units, five identical software, and sure enough, you have one that just keeps glitching and blue screen. You ended up using that

one a lot of times for parts for the other ones. Could never figure out why it operated differently. But it operated differently.

We bought extra things when we could. We looked at our risks as the project was going on, and we actually spent some money. Some of it was management reserve, some of it was just regular contract money because we needed to get it done. We spent the money to help mitigate those risks. That was money well spent.

ROSS-NAZZAL: Yes. I heard you say that some of it was luck. Do you really think it was luck?

FRANSSEN: You get in with the intent of doing that. But it's also backup in the back of your mind. Because I ran into issues with pictures before. So it was like no, let's get the extra ones and see how that works out. The test sets that we got an extra one, because that was a much more expensive item, I want to say it was luck. We could still use it for things. But a couple units were full up, had to do absolutely everything. That unit couldn't have been used for that. Some of it is luck, some of it is no, something tells me we need to invest some money here.

ROSS-NAZZAL: Tim had talked about all these, and I think you alluded to it at least, there were a lot of independent reviews that came on that people wanted to look at these batteries. As program manager how did you handle that when all these groups came through? NESC [NASA Engineering & Safety Center] and other folks questioning what you've come up with and trying to find that one gotcha I guess, that malfunction that's going to throw a wrench into everything.

FRANSSEN: Some of the NESC reviews didn't impact us directly, because we just kept on going. They were just evaluating design. We chose to bring in people for several independent reviews during our design process, and whenever we had a major issue, we would bring in an independent team, where we would reach out to experts within the company and experts within NASA, they're nonadvocates, they don't deal with the project. We'd go through and present the information and the ideas. We'd have to respond to all their suggestions.

We would invite a lot of these folks to our reviews just to have them there. SDR, PDR, CDR type thing. But when we had a specific topic, we'd bring the experts in, and then go through. Those were self-inflicted. Those paid off. It really helped when we brought the NASA people into the reviews too so they had a word as we're going on.

ROSS-NAZZAL: Can you give an example of one review that you thought was helpful?

FRANSSEN: Actually, one was a safety review with the battery, and we brought them in. This again is probably related to 787, but we had to evaluate all of our safety practices with the battery and the ORU. We brought in NASA safety, we brought in NESC, we brought in Boeing experts where we went through everything that we were doing, and the different suggestions on that.

Some of these guys are amazing. During one of the reviews, we had an issue with one of the circuits where we had some leaky transorbs that were draining the battery cells when they weren't supposed to be draining power. This happened to come up during the review, and one of the smart guys gets up on the whiteboard and goes ch ch ch ch ch, little sketching, and lo and behold, there was the circuit that resolved our issue. Again, the reviews paid off, because I think

that one was actually from a design review we were going through that we brought people in on design, and that was one of the issues we had. It was real-time resolution of the issue. Of course, we had to look into it. But they did the redesign of the circuits, and that fixed the issue we had. It turns out that we were leaving an ORU sit, and they just keep discharging, and they just charge too low, which would damage the cell.

ROSS-NAZZAL: That's great that you were so forward-looking in all of those things. Talk about the manufacturing of the batteries. We haven't talked about that. I know you mentioned going out to Rocketdyne and saying, "Here's the schedule, guys, we're going to meet this for three months." But I wonder if you would talk about your recollections of how everything transpired to move everything forward.

FRANSSEN: Are you talking like during the time when we were at the big press trying to get the batteries out?

ROSS-NAZZAL: Yes. That would be a good time to talk about.

FRANSSEN: Rocketdyne had a supplier. I believe the company name was NATEL [EMS, Natel Engineering] who did the manufacturing. When I was out there what we did is we started watching every step of the process. Then you find some ways to get things done.

NATEL, they're the ones responsible for just assembling the battery and doing some very high-level tests to make sure yes, it's functional, and then they would bring it to Rocketdyne who would do all the detailed final tests on the battery ORU. During this crunch we were going

through, we came across a few issues that we had to fix. One of them was called the hook splice. This is one reason we got out there. We started to get into a lot of issues where we had to reopen some batteries and fix things. The hook splice was they did a splice, and sometimes a little wire would pop out.

It would short against the side and would take out a circuit card. That's a very expensive thing. We identified what was wrong and we had identified what rework we had to do to get these built. You'd have to ship the battery back to the manufacturer where they would work it. One of the things we were able to do is get the manufacturer to come into Rocketdyne where the batteries were, because luckily they're only like two miles away. We had some union issues to deal with and things like that, but we were able to deal with those issues and bring them in. We had to stage all these batteries, keeping track of what all needs to be done on all of them to make sure we systematically go through it.

Then it's sort of ironic. When a lot of these issues were coming up, like the splice thing that would be shorting out of the battery that would cause an issue, management stopped manufacturing and wanted to do a safety stand-down.

ROSS-NAZZAL: Boeing or—

FRANSSEN: Boeing did. They said, "Okay, let's stand down for two days." We were in a press to get these batteries out, and they want to stand down for two days. We said, "Okay." We were trying to get this one battery done, trying to meet a delivery date. They called us, and we had the people in-house working on it. We had the chief engineer and the head safety guy online, and said, "No, you need to cease and desist." It was like all right, everyone, hands down.

We stopped the manufacturing process. Turns out the one-day safety stand-down which was supposed to be on a Thursday, didn't get planned till the following Tuesday. So, we were down about a week. Of course we missed some delivery dates. Missed some incentive dates, which our program management wasn't happy about, and we started up again.

Ironically, the ORU that we just about had ready, they started working on again, and they took out a little teeny setscrew. You can't see my fingers, but it's a couple millimeters long. Little setscrew, real small. And they lose it.

There's some things they should have done that they didn't up front. When something like that happens you just should say, "Everyone stop, hands down, everyone away from the ORU." Bring in, and then start doing inspections on people to see if you can find this thing, see if you can find the screw.

The guy said, "Oh, we saw it go into the ORU." It went through this little, teeny hole where a cable goes through on top.

ROSS-NAZZAL: Were they shaking it?

FRANSSEN: Taking it, shaking it, turning it upside down, seeing if they could find the thing, instead of just backing off and doing the systematic. It turns out we don't know where the screw was. What we ended up doing is taking this battery, and this had to go through all the review boards and everything like that, and we had to look at everyplace this little, teeny screw could float into—it's a little setscrew—where it could float to. And then make sure we put Blue Goop [Thread Lubricant], which is so nothing would short, in all those areas. We went through every

inch of the battery with a borescope. That battery was out of commission for a good four, five months.

ROSS-NAZZAL: It took that long?

FRANSSEN: Yes. You're taking a very small borescope and going through every location in this three-by-three box trying to find it. And then when you can't find it, you got to do the analysis to see if this gets in space, if it breaks loose, where could it float to and cause a problem. Yes. You also had to look at "Okay, if you have this in here and it's going into space is this going to become a projectile?" and things like that. Turns out nothing ever happened. We Blue Gooped everything up.

ROSS-NAZZAL: But you never found that screw?

FRANSSEN: Never found the screw. It could have been in someone's pant cuffs or in their shoe or something when they walked out. Or in the pocket of a lab coat. But no one stopped to say, "Inspect all of that stuff." They all left the lab and started walking around. Then of course the next day he's like, "Well, I think it went into the ORU."

ROSS-NAZZAL: Wow.

FRANSSEN: Yes. You have some things that happen that aren't ideal.

ROSS-NAZZAL: That's a major challenge. What did Boeing say when they heard about this unit being down for four, five months? Did you take any heat for that?

FRANSSEN: No, it was like, "Well, you need to do what's right. What can we do to make sure this doesn't happen again?" We put in processes to make sure that doesn't happen again. They weren't pleased, but they understood. We had other lines in production, or other batteries in production, that we could still meet our delivery schedules. That was the key. Just like the two units that they froze. We call them FN numbers, FN one, two, three, four, all the way up. That was units four and seven. They were very early in the production cycle.

If I remember right, those were already delivered to the government when we discovered the issue, so we had to ship them back.

ROSS-NAZZAL: It sounds like you did have some challenges definitely.

FRANSSEN: Oh yes. There were several challenges. Even in Houston, we did a lot of the thermal analysis we needed to do for Houston, and a big thing was if this goes into thermal runaway what happens to the Space Station, what happens to the IEA, what happens to the entire heat loop. They actually did a first-time analysis of modeling a thermal runaway inside the battery ORU. It took a long time, it took a lot of analysis, but this is what says we're good with the radiant heat barriers and we're watching whether we cascade or not. They wanted to make sure they didn't melt the IEA and destroy the thermal loop on orbit.

ROSS-NAZZAL: Were you out at White Sands [Test Facility, New Mexico]? Tim told me about a test out there that people were very disappointed. They wanted to see some major propagation on the test unit, and things just went "boop." I don't know how to describe it.

FRANSSEN: If I'm not mistaken, that effort out at White Sands was a separate NESC type thing to do. Although they were evaluating our battery, it didn't directly relate to the project. So, I didn't get to go play. Eugene and Tim got to go play. They were helping out with that. But I wasn't involved with that aspect of it. What they were trying to do is they were trying to get propagation. It turns out one cell would go, and that was it. I know one cell in the lab was. I believe that's what it was out there too.

ROSS-NAZZAL: Yes, I think Tim said that the guys that were there were expecting fireworks and were pretty disappointed that that did not happen.

FRANSSEN: I guess what happened with the cells, when it goes into thermal runaway, part of the material sits in it and keeps burning and heating, which goes to the next cell, and then it goes, and it has the same thing. What was happening with these cells is they'd set them off, and the cell would just spew all its guts, so there's no material sitting at the bottom to sit there and heat up. It'd go all over the ORU. But they would not get the cascading event that we were looking for.

To me it was still a successful test because it says, "Look, our ORU design works."

ROSS-NAZZAL: Yes. You guys were doing the thermal analysis here in Houston, but that was primarily computer-based?

FRANSSEN: Yes, that was a model simulation.

ROSS-NAZZAL: You were pleased then with what you were finding here.

FRANSSEN: Yes. We had a vent in the enclosure, so in case there was a thermal runaway the gases could escape. I'd say it was like a half-inch vent that we had there. Part of this analysis said, "Ah, we need little bit bigger vents." We ended up putting in two 6-inch vents, and we had to design a baffle system so the flames wouldn't exit out, just because of the amount of gas and everything that's being released from these in a thermal runaway event. That was actually, yes, a redesign of the enclosure and a design of a new vent.

ROSS-NAZZAL: How far into the design of the battery was that thermal analysis, do you recall?

FRANSSEN: That was one of the earlier thermal analyses that we needed to do to verify our requirement. The enclosure was already designed. The E enclosures were built. We were getting ready to build the qual enclosures. We already had all the parts. That's where we went, "Ah, time out, we need to redesign a new vent system for it." Luckily, we hadn't manufactured any of them yet.

ROSS-NAZZAL: That's always a good thing.

FRANSSEN: Yes.

ROSS-NAZZAL: Did you spend any time out in Japan?

FRANSSEN: Yes, I did.

ROSS-NAZZAL: Would you talk about that?

FRANSSEN: Yes, that was very interesting going out there. GS Yuasa, very good host. Got to study the culture before going out there. When we first started going out there, they were very reluctant for information. We have a U.S. contingent GS Yuasa and we'd go there, and so they would be the primary interface, we were there, we'd be asking questions. Up front they were very reserved on the information, but as time went on and we started working with them and working through any questions, issues, and things like that, they figured out we weren't there to steal their design. We weren't there to do anything like that, we were there to make sure we got a good product, the best product we could possibly get, and that they were adhering to all the Space Station rules and configurations. Every time we went out there, we did a configuration audit that says, "Okay, let me see this information here, let me see how we're doing this process." By the end they were open enough, every process that we went into. We went into the filling of the cells, the manufacturing, the welding, the mixing.

You go observe and you look for things. You look for sources of possible contamination, because if you get contamination into the goop in the mix, that could lead to a short of the cell

and thermal runaway. That's the type of things that we did. We just observed, see what they did, made sure they were following their processes as they documented them.

ROSS-NAZZAL: How long would you stay out there for when you would go?

FRANSSEN: It'd be a week at a time.

ROSS-NAZZAL: It's a long plane ride over just for a quick trip.

FRANSSEN: It is, it is. It's 13, 14 hours.

ROSS-NAZZAL: Long days.

FRANSSEN: Yes. Going out there not an issue. I could go out there, land, get to our hotel, wake up the next morning ready to go. Coming back the jet lag just killed me going the other direction. It'd be two weeks to recover to get back to normal.

ROSS-NAZZAL: Oh, wow. You mentioned that you studied the culture before you went over there. Did you take any sort of cultural training from Boeing or NASA?

FRANSSEN: No. I just reached it online, got a little bit out of books, just to see how to interact with some of the people there. Of course, whenever you're there we went and did a lot of

sightseeing. Kyoto, that's where GS Yuasa is located. Just a beautiful place. That was probably my favorite place that we were there. So many temples and things to do.

ROSS-NAZZAL: Did you pick up any Japanese while you were working on the project?

FRANSSEN: I did not. I am terrible at languages. I try and I fail all the time. I went through three years of high school Spanish and got As all three years and got out of it and couldn't speak, read, or write a word of it.

ROSS-NAZZAL: You're just conjugating verbs, right? I remember those classes.

FRANSSEN: Yes.

ROSS-NAZZAL: Did it pose any challenge that you didn't know Japanese? Did the folks there know English or were you working with translators?

FRANSSEN: Most of them spoke English. We did not have a translator. There would be times where they'd go off and caucus in Japanese and we had no idea what they were saying. But we did not use translators. There'd be cases where we'd have to address questions in many different manners to make sure they understand what we're actually looking for. And the same when they'd give us an answer. They'd have to change it to [make sure] we understood what they were saying.

ROSS-NAZZAL: I wondered about that, because the technical is very different than a social conversation one might have.

FRANSSEN: Yes. A lot of them spoke English, and when I was there you could get around pretty much. English was spoken a lot of places. One of the first places we went to eat, we went out there as a group. We sat down to eat, and this was a small little place, it was like a noodle place or whatever, and you could tell there wasn't a word of English anywhere, no one spoke English. We all got the menus, we had no idea what they said, this was before you had Google Translate where you could just take your phone over and read it.

One of the guys that was with us was very inquisitive about what all these different things were. He goes to the lady and he asks a question. We're like, "Uh, you just ordered that." So, he had some issues on that trip. Him and chopsticks did not get along.

ROSS-NAZZAL: Oh, that's kind of a problem.

FRANSSEN: But even in a place like that you could look at the pictures, or you just order something and see what you get.

ROSS-NAZZAL: Right.

FRANSSEN: You got to watch out for some of the things you have. I think on our last trip out there a group went out, and they had several entrees, and one was a raw duck. There are two

different tables, now I didn't go on this dinner that night. One of the people was like, "Oh, in U.S. we cook our fowl." One table was just fine, the other table seriously ill.

ROSS-NAZZAL: Oh no.

FRANSSEN: Oh yes. They were ill even to like a month afterwards. They were still getting night sweats. They all lost 10, 15 pounds. So, stay away from the raw fowl.

ROSS-NAZZAL: I will follow that advice as well.

FRANSSEN: I always tried the different foods that were out there. Very different.

ROSS-NAZZAL: I can imagine. Did you get a chance once HTV [H-II Transfer Vehicle] was getting ready to launch your batteries into space? Did you get a chance to go out there as well?

FRANSSEN: I did not. My job was to manufacture them and to design and build them, and not to launch them. Eugene tried to get me out there, but it didn't work out. So, I never got to deal with any of the launch stuff. Tim did. Tim was able to do that.

ROSS-NAZZAL: Oh, that's too bad.

FRANSSEN: Yes, I would have liked to have been involved with that a little bit.

ROSS-NAZZAL: Yes. Were you watching the launches of HTV? Or were you pretty much okay, we've manufactured them, we've delivered them, our job is done? Or did you still have a role to play until they actually physically were put on Station?

FRANSSEN: No. My role ended with here's the battery. Whether it flies or not, not my issue. We did that very on purpose, because when we were doing the change on the contract for this, it was like you want us to bid this, we need a real no kidding cutoff date, what ends our effort. The end of the effort was we qualify it, we build it, we deliver it. Then down the road they worked out launch integration activities.

ROSS-NAZZAL: Did you watch any of the launches though? Were you interested in what was happening at that point?

FRANSSEN: I was interested. I think the first one I followed more than any of the rest of them. Plus I had Tim that was involved, and he'd tell me what was going on.

ROSS-NAZZAL: Things have gone pretty well as far as I can see.

FRANSSEN: Yes. The project had its challenges. But as I said, being there from day one to the end makes a big difference. Even when working the proposal, once we got our schedule laid out. It was walking through every team's bid. Throwing their man phasing against all the project milestones, and does this pass the giggle test, does it look like they're going up and down when they're supposed to, do they end when they're supposed to, do they have enough there, or are

they too much, are they too heavily bid. Must have been 20 or so teams that you'd be going through that type of detail with.

Then one of the things I did, and a lot of the guys I talked to afterwards said they wished they would have had this insight on other projects, is I kept track of what everyone bid, and I kept track of their spending every week. Number of hours, who's working on it. To where I could go in and see okay, here's what you're spending, here's what you bid. You're way out of whack, what's going on? Or you're way under, are you not getting something done that you're supposed to be getting done?

I was actually able to provide feedback to a lot of teams for bidding other changes in the future of stuff they discovered here that they just didn't think of when they were bidding. One was the MMOD for an example, which is micrometeoroid debris. They were probably double their budget on what they ended up spending. But it was like well, we haven't done a new program like this in so much time, we've forgotten how much of the testing and all the effort it really takes to prepare with this. Because they're used to just testing existing assets that are out there, but was able to provide that feedback, track everything.

Software was always a bad one. They were like double, things like that. Yes. Then we get some areas that are under. Again, what probably saved us at the end from schedule and budget-wise was finishing early and getting things done early.

ROSS-NAZZAL: How did you keep track? Were you just using a spreadsheet? Or did you have a database or some finance person?

FRANSSEN: I had lots of spreadsheets. I use Excel for almost everything. It was spreadsheets, lookup tables. I'd import data from weekly charging. I can take that; I can look at it. You can see overtime, you can see who's doing what, you can say, "Why are these people charging?" I used to call a lot of people up. Welcome to the project, and what are you doing for me?

Understand what they're doing, that's how you got to keep control of the charges. You want to make sure you don't have anyone just putting 20 hours in a week just because.

ROSS-NAZZAL: That's something that I would not have considered. But yes. You definitely have had that experience.

FRANSSEN: It turns out that the project manager is responsible for everything, budget, schedule. All the teams out there who are doing all the work, there's no repercussions if they go over budget. They're not responsible for the hours, they just get the work done that they need to do. So, it makes a difference when they're not accountable for what they spend. That's why you got to keep on them so quick. You end up getting good relationships with everyone you're dealing with too. Got to know your people.

ROSS-NAZZAL: Yes. That's a good lesson learned. We have talked about challenges. Were there any other major challenges that we haven't addressed for the project that stand out in your memory?

FRANSSEN: Let me see here. We talked about the thermal. Those were the biggies that we had. You always have subcontractor performance and working with that. But you get by that by working with the subcontractor. Having a good relationship with them.

ROSS-NAZZAL: You mentioned Atec and they had worked with JSC to provide stuff, but it was really their first Station contract. How did you help them working in a space environment? Because I imagine that's quite different from what they were providing originally.

FRANSSEN: Yes. We put the proposals out there to evaluate. They came back with their response. We said, "Okay, this is clearly the best choice based on the scoring." They were not a proved supplier for Boeing space work. So A, we had to go through the process of getting them approved. Their property system, their quality system, all their processes that they do. We went through that process, and then we started working with them addressing their concerns. We were still somewhat in the design phase with that, so we could take their feedback while we were doing some tweaks in the design for manufacturability. They said, "Hey, can you consider doing this way or this way?" To help the manufacturing part of it.

We ended up with a very good relationship with them. We were doing the testing of the batteries out at JSC. Thermal testing and vibe testing, where they would truck them over and get them done. We kept the vibe testing at JSC but we ran into an issue with the thermal testing. Some of the chamber capabilities didn't meet our needs, and then they had some issues with contamination on one of the thermal chambers.

We worked together with the supplier. The supplier's solution was I'll buy my own thermal chamber. It ended up being a contract change because I got a contract change, you're no longer going to do the testing here, you're going to do the testing there.

They were willing to help out and invest where they needed to. They got the milling machines they needed that produced the hardware. They ended up a very good supplier to work with. They turned out to be a very good supplier. Being down the road certainly helps.

ROSS-NAZZAL: I bet. Looking back over your time, what do you think was your greatest accomplishment while working on this project?

FRANSSEN: Working with the folks and managing to get it done early. It was accomplishing all the requirements but working with everyone to finish early, to keep it within the box. At the end having a piece of hardware that is now 24 of them flying on the ISS, powering the ISS, is a great, great way to get towards the end of my career.

ROSS-NAZZAL: Yes. A nice little crown for you.

FRANSSEN: Yes.

ROSS-NAZZAL: Did you get any pushback from people who said, "Hey, what's the rush? We can take more time, we can do more"? I assume engineers really like to test things.

ROSS-NAZZAL: Yes, yes. Nothing against the thermal guys. But the thermal engineers I think are the worst of all of them, because they can continue to analyze and analyze and tweak tweak tweak tweak tweak forever. You got to get to a point where "All right, did we meet it, yes or no?"

"Yes, but I could do this to—.

"No. Did we meet it, yes or no?" To get done with. And it's time to move on.

We had some mechanical design that was going on where we had to do some redesign. The enclosure was supposed to be very similar to the last enclosure we did for the nickel-hydrogen. This was my mistake, I should have dug in deeper to the design, and I didn't. I asked a designer, "Is this the same as the last one?"

"Yes."

I'm like, "Okay." Sure enough, there was a few little tweaks here and there that changed things. One real simple thing was there's an MLI [Multilayer Insulation] blanket to help keep this thing warm for thermal properties. The old design had MLI blanket going underneath the bumpers that go on the outside of the battery. The new design didn't. It just had the bumpers right up against it with no blanket. I didn't realize that. Couple other guys didn't realize that. We went into thermal characterizations out at the supplier, and they're like, "We just can't get this in the box, we don't know what's happening."

That's when we said, "Oh, we need blanket there." So we took the bumpers off, cut some blanket material, stuck it there, and sure enough everything matched up into the miles. We had a couple redesigns like that.

ROSS-NAZZAL: Redesigns on the fly, I guess.

FRANSSEN: Yes. We went back to the old design is what it ended up being really.

ROSS-NAZZAL: Were there other moments, those kind of aha moments, that you remember from the project?

FRANSSEN: Not right off the top of my head that we haven't already discussed.

ROSS-NAZZAL: I only had one other question for you because a lot of the material that I keep reading, at least what Eugene gave me, said that these are the largest lithium-ion batteries ever utilized for a human-rated spacecraft. I wonder if you would explain in your mind why that is so significant.

FRANSSEN: Early on when I was working batteries they'd be talking about lithium-ion. Everyone was so afraid of the effects, if there was a thermal runaway, and the physical damage that could happen to the aircraft and the people. I found some old presentations on this from way back in the late '90s that some people put together, and was glancing over some of the information, and that was one of the things that was always killing it.

It was very significant that we were able to get a safe battery assembled to protect the astronauts, the launch vehicle, and the ISS. Having that much energy in such a small little box—I think there's 30 134-amp-hour cells in this thing—and have it be rated safe to operate on ISS is a huge step forward from where we were.

ROSS-NAZZAL: That makes sense.

FRANSSEN: Everyone was always very hesitant. You've seen all the commercials with little cell phones or stories of the cell phone burning. It is not a pretty sight when one of these things go, any of these things go. It's a very traumatic event.

ROSS-NAZZAL: I've been out at White Sands, and they were doing testing of lithium-ion batteries for laptops, and they had all these laptops where they had propagated. It was like whoa. You don't think of that, turning on your computer on an airplane. But whoa.

FRANSSEN: Yes. Those are just little 18650.

ROSS-NAZZAL: Yes, your battery is a lot bigger. Lot more power.

FRANSSEN: Yes.

ROSS-NAZZAL: I think we have covered all the questions that I had drafted, and I can't think of anything else. But I wonder is there anything you wanted to talk about today or address about the batteries.

FRANSSEN: I think I covered most of the things I wanted to, which was the subcontractors, about from a project management standpoint getting through the project from beginning to end.

ROSS-NAZZAL: Okay, well, I sure appreciate you coming out today, I know you've got other more enjoyable things to do now that you're retired.

FRANSSEN: Yes, yes.

ROSS-NAZZAL: All right, well, thank you very much.

FRANSSEN: All right, thank you.

[End of interview]