NASA STS RECORDATION ORAL HISTORY PROJECT
EDITED ORAL HISTORY TRANSCRIPT

ERIC S. RANSONE
INTERVIEWED BY JENNIFER ROSS-NAZZAL
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ROSS-NAZZAL: Today is July 13, 2011. This interview is being conducted with Eric Ransone at Kennedy Space Center, Florida, as part of the NASA STS Recordation Oral History Project. The interviewer is Jennifer Ross-Nazzal, assisted by Sandra Johnson.

Thanks again for meeting with us this morning. We surely appreciate it.

RANSONE: You're welcome. No problem.

ROSS-NAZZAL: I'd like to start by asking you to give us an overview of your aerospace career.

RANSONE: I graduated from college in December of '96, and I guess that's where the voyage started. As an unemployed college student, you send out mass résumés. I think I sent out about three hundred at the time. You try to remember where you sent them all, but sometimes that just doesn't happen. A starving-artist-type situation, you're just looking for anything that comes down the pipe. A month later, things started picking up. I got a few interviews and a few job offers and was about set to take a job offer with a company called Ingersoll-Dresser in Chesapeake [Virginia] doing some marketing engineering-type stuff when I got a call from a Mr. Don Mikuni. He's one of the Rocketdyne legends. He's been around Rocketdyne for a long, long time, and gave me a call and said, "Do you know who Rocketdyne is?"

At the time I did, because I was very interested in the Shuttle as a kid. At eleven years old seeing the first one go up, and that was kind of my goal. I wanted to get into that Space Shuttle Program. So, of course, I was focusing on the space program. He said, "Do you know who Rocketdyne is and what we do?" I did know. "Are you interested in coming out for interviewing in California?"

I said, "As long as you pay, because I'm poor, and I'll go anywhere."

So he flew me out to California, and I hit a homerun in the interview. I knew it. Then he said, "Well, are you interested? I know you're an East Coast boy. We've got a position in Kennedy."

At this time, Ingersoll-Dresser was expecting an answer, so I called them up and asked, "How long do I have to give you a reply?" I had two other job offers, but I was focusing on them and Rocketdyne.

They said, "Well, we'll give you a week."

In the meantime I flew to Kennedy. That was January of '97 and coincided with STS-81 launch. It's almost an unfair advantage for them when you're coming out here interviewing, and you're spending all day interviewing. I mean they really grilled me. I went back to my hotel; I was beat, exhausted, mentally, physically, emotionally drained. I thought, "Man, I hope I got this job, because I really poured everything I had into getting it."

Then I came back later on that evening and saw the night launch. I saw it all the way to MECO (main engine cutoff), to where it was a bright white dot just above the horizon. Afterwards I told a couple of the guys who interviewed me, "I'll work for beans to do this."

They said, "All right. We'll fly you back to Virginia, and if we're interested, we'll give you a call."

A few days after I got back to Virginia, Ingersoll called up and said, "We need a response."

I told them, "I'm sorry. I'll have to decline your offer." I didn't say why.

So then I was back to square one. I had no solid job offers, and just keeping my fingers crossed.

A week or so later Mr. Mikuni called up and said, "We've got an offer for you." It was the best of both worlds. I'll go out to California, work out there for up to two years, learning how the engine's designed and fabricated out at the heart of the factory out there and then eventually transition to Kennedy, which was more than what I could ask for at the time. So that was the day I got my big break, and on April of '97 I hired in and started the journey there, and it's been an amazing ride.

I spent about a year, a little bit over a year, out at the factory. I was mainly focusing on the "Combustion Devices" components, the nozzles, preburners, injectors, main combustion chamber, heat exchanger, and the powerhead. Learning everything about it from the ground up, from the very small component pieces and parts, all the way to the final component, how those things are designed and built I was really getting down to the small first-level component build of the engine, and got to see every one of those components that I was responsible for built from start to finish, which for a Kennedy employee, that didn't happen often.

Most of the people would hire in straight to Kennedy and then cut their teeth there and learn about the engine that way. If they had a chance to go to California, they would. Where with us, it was kind of a pilot program with me and another gentleman named Steve [Stephen] Prescott, who was a turbo engineer, worked on pumps. He hired in and did the same thing, and we both went through the process together and came out here about the same time together. So I kind of got a unique bond with him that we've been through a lot together and learned a lot about the engines together through a unique perspective.

After a little over a year of seeing the West Coast, soaking in what the San Fernando Valley had to offer, and what Rocketdyne taught me had pushed me and pushed the limits on what I thought I could do. You know, you're coming out of college pretty green, not knowing what to expect. So much information is thrown at you, and then you're given a chance to shine and show your skills, and I took every opportunity. Then came the transition to Kennedy just in time to see another launch. On April of '98 I saw my first launch here at KSC, STS-90, and it has been all downhill from there. It was great.

At the West Coast, everything is on the component level. They also did engine assembly where they put all the components and pieces and parts together. They did all that out at Canoga. You come out here to Kennedy, this is where the rubber meets the road. You're literally in a fishbowl; everybody's watching every little thing you do. When you see that first launch go off and you're part of that team that helped get it off the ground, it really, really sinks in how important it is what you do, from the moment that the fires are lit and you reverse all the way back to where those first components were built. The one quote that stands out in my mind is from Wernher von Braun—who was kind of the grandfather of our space program; everybody who works here, he's their grandfather, he's the man—"Success in space demands perfection." It does. Another quote that comes to mind is from another Rocketdyne legend, John Plowden, "Never turn your back on a rocket engine." Every little thing you do is very important because once those fires are lit, there's no turning back.

We do something that's incredibly unique, incredibly demanding at all levels, mentally, emotionally. It takes a toll on your family, because there's times that you're here long hours.

You try to keep the job at the job, but when you go home, sometimes that stress, it takes a mental toll on you, an emotional toll on you. You want to give as much to your family as you do to the program, and you try to balance that out. But it's an amazing journey. It's sad that it's coming to an end, but there's been lot of wonderful memories. There's so much challenge. Every day when you show up here, you don't know what to expect.

I mean, granted, it's the Shuttle. We've had 135 launches, and people seem to think it's like airlines taking off and landing thousands of times a day all around the world, but it's not. There's nothing that compares to it. Anything else out there, nothing compares to what the Shuttle goes through from start to finish: the operating environments, the pressures, the temperatures, the stresses, everything. Everything is incredibly unique and demands an incredibly unique point of view and approach to doing work on it. There's nothing out there, I feel, that is as challenging to work on than the Space Shuttle Program here.

ROSS-NAZZAL: We know that the engine is the most complex engine that was ever built. So walk us through how you process this engine and get it ready and sign off and say, "Yea, verily, I say this engine is ready for flight."

RANSONE: The engine's really not ready to go until the paper stacks up about as tall as I am, and it's all bought off.

ROSS-NAZZAL: And that's about six feet?

RANSONE: Yes, about six feet. The Orbiter, I think you've got to have a mountain of paper before it gets off the ground. Essentially our processing flow for the engine starts as soon as the Orbiter lands and rolls into the OPF [Orbiter Processing Facility]. Once we roll into the OPF, that's our new processing flow of that engine. So the first thing that we have to do within forty-eight hours of wheel stop is there's some bearings on the high-pressure pumps that we have to dry from residual moisture after engine shutdown in space. Moisture does bad things to metals. A lot of this engine is made of materials that are low in iron, but there's still corrosion capability. Corrosion is bad. We all know that. It does some really, really bad things to components, especially with pumps that spin over 30,000 rpm [rates per minute]. So you want to get that moisture out as soon as you can. So we dry those bearings. It usually takes about a day to dry those bearings.

Then after that, we wait for the Orbiter for a little bit to allow us to get access to our engines, and they're usually pretty quick about getting us access to our engines. Then we do some preliminary aft inspections while we're in the Orbiter to see if there's any damage, and then we start the process of getting those engines out. We do a controller power-up for a quick health check on it. Next, the Orbiter hydraulics are activated and we gimbal the engines to a "null" position. The actuators, the hydraulic actuators, we have to lock those in place and null the engines to where they're accessible by the vehicle or the equipment that we're going to use to remove them. Then we get the engines ready to come out. We ask for about six shifts of work to de-torque and demate the joints to allow the engines to come out, and install the GSE [Ground Support Equipment] needed to support the engine removal process.

So after those six shifts of work, Orbiter folks open up the OPF swings and open up the OPF doors, and then we drive over our Hyster, which is what is used to remove and install the engines. The Hyster is essentially a big forklift on steroids that's been modified by the Hyster Company to do what we need to get done. It is another piece of unique machinery here at KSC.

Initially, when the Space Shuttle was first flown and designed, they weren't thinking of taking any of these engines out. The engines would stay in. We'd do our maintenance on the Orbiter and fly them so many times a month, just like aircraft or an airliner. But, again, falling back to how crucial or how critical the components are and the demands that space imply upon them, the wear and tear, we realized pretty quick that we got a lot more to do to those engines to get them ready for flight than what we originally thought. Eventually a few Rocketdyne KSC legends devised a method to remove those engines from the Orbiter, using that Hyster, so that we can process them on our own and get essentially the engines out of the way of the Orbiter folks so they can process in parallel without us being in their way. It benefited both parties, the Orbiter folks and us.

Getting back to the process, once the Hyster removes the engines and takes them back to the shop, that's where our shop processing starts. We unload the engines from the Hyster, put them in the horizontal orientation. Then we do some more external inspections, looking at the thrust chamber and at the exterior components of the engine, such as the nozzle, some of the lines and ducts, insulators, harnesses, electrical harnesses and things like that. You become the eyes for the engine. You have to see what it is trying to tell you that is wrong.

Then we get into our early diagnosis of internal problems. The visual inspections that we do, of course you're looking for wear and tear. That's primarily what you're looking for, bouncing what you see against your acceptability pass/fail criteria. Then, like I say, we get into diagnosing the engine. We do some internal leak checks of the major systems, the fuel, LOX [Liquid Oxygen], and hot gas systems. What we're looking for is just gross leakage of the systems to give us an indicator of what we might be looking for problematic-wise later on in the processing. Sometimes we have data from flight that are indicators of internal issues also. So we have a pass/fail associated with the data and these internal checks, and if anything is outside of that, then we know there might be an issue in that system. We'll get to what we do with that later on down the line.

Then we also do our nozzle coolant tube leak checks. The nozzle is comprised of 1,080 stainless steel coolant tubes that are coated for corrosion resistance, and those tend to spring leaks because that nozzle goes through a lot during launch startup and gets beat on as far as pressures, temperatures, and other operating parameters. So we do our nozzle tube leak checks to see what we have to repair since it is reusable.

After we do the initial leak checks, we dry the engines. We did a bearing drying while on the Orbiter. In the shop we dry the rest of the engine components, the rest of the engine systems, with heated GN_2 [gaseous nitrogen] and run that for almost a day, a full day. There's a two-hour purge and then an eight-hour purge, and then we do our drying dew points, where we measure how dry those engines are.

Once those engines are dried, we get into the bulk of the processing. We rotate them up to the vertical orientation. We do some more system leak checks, such as a mass spectrometer leak check of the engine heat exchanger. Next we remove inspection ports and perform borescope inspections of internal components of the high-pressure pumps, preburners, heat exchanger, main injector, and powerhead. It is amazing what an experienced person can do with a borescope, what they can see. Then any component that needs to be removed or replaced for whatever reason, we do it at this point. We do track a lot of components of the engine for life based upon its history and design. We know how long they're going to last. In this vertical orientation any of those components can be more easily removed and replaced. After components are removed, we also do a lot more of our visual inspections, inspections of the pumps, inspections of the pre-burners and injectors and internal components.

After all those inspections and component removals are completed, we put the engine back together, bolt it up tight. Then we do some more system internal and external leak checks to make sure all those disturbed joints—because there are over three hundred joints on this engine—make sure any of those three hundred joints are tight and they don't leak at all, just using helium and bubble soap. Sometimes a mass spectrometer is used to try and catch small leaks on specific joints in conjunction with the bubble soap leak check.

Then after those leak checks, we get into what's called flight-readiness testing in the shop, or FRTs. The external leak checks, we're testing the system integrity, if the engine is tight and put together properly. The internal leak checks test integrity of internal components and seals, as well as overall integrity of each system. The FRTs, they judge the operability of the engine, if everything's functioning properly. We go through several tests basically checking every system on the engine. We power up the controller and perform a health check on it. Then we pressurize various engine systems, and do some additional leak checks of some of these pressurized systems. There is a command and data simulator (CADS) room, similar to the LCC [Launch Control Center] firing rooms, where we can monitor data and send commands to our engine controller. We monitor the sensors, making sure the sensors are functioning properly. Then we cycle the hydraulic and pneumatic systems and run several more tests. For example, we make sure the actuators that rotate the valves on the engines are actually doing their job, and valve position sensors are reading the percent open that they're supposed to be open when they're supposed to be open. The goal of FRTs is to judge the functionality of the engine and all of its systems: fluid, electrical, or mechanical.

So after all those FRTs are completed, we know that the engine is functionally sound. We've gone through a staged process to make sure the engine is visually acceptable with wear and tear. We've made sure the engine, as far as the components, the joints, the system integrity is tight. The FRTs is a big milestone in the overall engine processing, so when we say FRTs are complete, we know that engine's functionally sound. At that point, you're probably about three-quarters of the way through engine processing, with the completion of FRTs.

Then we rotate the engines back down to the horizontal orientation, and then our last thing that we do is an engine encapsulation leak check. Now, the engine encapsulation leak check is designed to check anything that is in the Orbiter aft compartment. From where the nozzles stick out of the Orbiter, all the way up to the gimbal, where it attaches to the thrust structure of the Orbiter, all that's encapsulated in this "big can" piece of GSE. We pressurize the major systems, and then we use a mass spectrometer leak check to test to see if there's any leakage in that can, and that's a pass/fail of one SCIM, or standard cubic inch per minute, leakage, which is very, very, very, very incredibly tiny.

So when we pass that engine encapsulation test, that is our final check that that engine is 100 percent tight and leak free. It's functional; the wear and tear is acceptable. So when we pass the engine can, we know that when we install it in the Orbiter, up to that point of installation, nothing's wrong with that engine. We know that with reasonable certainty that we're going to give the Orbiter folks and our customer a good, sound engine.

Then after engine encapsulation, we do some visual inspections to see if anything was damaged during our processing in the shop. Then that's it. It's ready to go, ready to install. We put it back on the Hyster, take it over to the Orbiter, and install it.

ROSS-NAZZAL: How long does that whole process take from the moment the Orbiter lands until you put it back in the vehicle?

RANSONE: Well, that depends on how bad those engines are needed. We've turned engines around between thirty to forty days if there's been no issues, no LRUs [Line Replaceable Units] that we have to take off. There's been cases where the Orbiter was really, really hot and heavy for an engine, had some issue, whatever, so we've had to process one real quick. On average, I think we quote around sixty-day turnaround for an engine. That's average with tube repairs on the nozzle, and if we have a small LRU, that's what we quote. Like I said, if the Orbiter folks, our customer, really, really needs an engine quick, we dump everybody we have on that engine, and it gets done real quick.

ROSS-NAZZAL: Do you work with other engines, or are you primarily just working with three constantly, or do you have maybe six or twelve here at Kennedy that you can work with?

RANSONE: Right now we have fifteen engines at Kennedy. We have all but three in our engine shop, and those three are up in space on *Atlantis*. At any given moment, the number of engines we work on is really primarily dependent upon the people we have. Right now, we kind of are winding down. We've cut heads. So right now we can handle about three or four engines at a time. In our heyday when we had over a hundred people here, it wouldn't be uncommon to work on six engines at a time in the shop, if we had six engines to work on.

The number of engines that we'd had at KSC had a roller coaster over the years due to various issues. At one point, if I remember correctly, around 2000 or so, we lost several engines because we phased a certain model out, so our number of engines got cut nearly in half. Right now we have almost a completely full shop. On average, we like to say we can work on six engines, but now we're down to about three or four due to people constraints.

ROSS-NAZZAL: How many people typically work on a single engine at a time?

RANSONE: Again, that goes back to how important or how needed a certain engine is, but it's really constrained by how many bodies you can get around that engine without getting in each other's way. We can have anywhere between three to six people working on an engine, depending on where they're at, what component they're working on. You get more than that, then people start getting in each other's way.

Now, we do have certain instances where we are doing component removal and replacements, where just due to the criticality of that component R&R [Removal and Replacement], we're going to put a lot of eyes on that. So we'll have up to eight people or so running that operation to remove and replace that component, just because you don't want anything damaged, run into anything, check and clears, and make sure that that component goes in properly or is removed properly.

ROSS-NAZZAL: Who finally signs off on the paperwork that says the engine is ready to go? Is that your assignment?

RANSONE: I have a small part in that. We have several checks and balances all through this engine processing. Prior to FRTs in the shop, we do have one of our "passport processes," what we like to call it here in our company. It's called a passport process, but it's basically a decision-making point that makes sure that everything is okay. We have what's called an open-item review prior to FRTs, where the engineer who's in charge of those FRTs basically goes through everything that we've done on that engine up to that point to make sure that he or she is ready to proceed with checkout, that the engine is assembled properly, nothing's been missed as far as configuration-wise, that the engine is configured the way it should be, and that there's no open work. That's our first passport. Once that passport is properly met, we can proceed with checkouts. That's the start of all these checks and balances.

After the engine has gone through engine encapsulation and is ready to install, that's where I come into play. Prior to engine installation, I have what's called an engine installation review. I have one review with Rocketdyne in-house where basically I go through everything that we've done to that engine, every variant of paper or every variant of driver of work, whether it be nonstandard or standard work. We go through check by check and say, "This was done, and we're okay with that. This is done, we're okay with that. It's complete or it's not complete. And why is it not complete? If it's not complete, are we okay to install the engine?"

Once I do my in-house review, then I actually take that to our customers. Everybody's a customer. Anybody you work with that asks you to do something, that's your customer. Well, our primary customers are NASA and United Space Alliance, and ultimately the taxpayer.

They're our biggest customer. They're paying for everything we do here, so we want to make sure we do it right and that they get the best value for what they pay us to do.

So once I take the engine installation review to our customers, I basically verify that when we go to install those engines, they're going to be what you asked for and that everything was done according to all your standards and according to all of our standards and that nothing's been missed. And if so, why, and is it okay to proceed if we have some open work. That's our next check and balance in signing off these engines. There are others throughout the engine's travels here at KSC.

Then you fast-forward to just before launch. In the month before launch, we have what's called flight readiness reviews [FRRs], and that's where you get a lot of people together from all across the nation at various levels of various programs, whether it be the contractors and also the customers: NASA, United Space Alliance. We have two FRRs that we primarily bless the engine for launch. One, we have our own internal program FRR dealing with the Space Shuttle main engines [SSMEs]. That's our first signoff internally that those engines are good to go, where we as a company, Pratt & Whitney Rocketdyne [PWR], go through that entire set of engines up to that point of the FRR—what was done on those engines, if there's been any other issues on any of these other engines that might affect that upcoming launch, how we've addressed it properly, and how do we prove that we are okay to launch those engines on that coming mission.

We have three people from our company that sign off. You have a Safety and Mission Assurance Manager for Rocketdyne Rob Sobieski; you have the Chief Engineer for Rocketdyne Doug Bradley; and then you have the Program Manager for Rocketdyne Jim Paulsen sign off on our behalf at the SSME-level FRR; and then you have our NASA counterparts from Marshall

[Space Flight Center, Huntsville, Alabama]. You have the NASA Marshall Safety and Mission Assurance John Thompson. You have NASA Marshall Chief Engineer Katherine [P.] Van Hooser, and then you have NASA Marshall Program Manager Jerry [R.] Cook. Now, once those six people sign off on our program-level FRR, they know that those engines are good to go; we're good to launch.

Then the next FRR is the big one where you're talking NASA [Headquarters] Washington, D.C., Johnson Space Center [Houston, Texas], Kennedy Space Center, all the sites involved with the Space Shuttle program. All those guys get together and the launch director, the Shuttle Program manager, all them get together and at that top-level FRR, and they go through every system, Orbiter, ET [External Tank], main engines, etc, and bless everything for launch. And that's your final signoff. Once that final FRR is complete, then you know we're good to go. There's a lot of checks and balances.

ROSS-NAZZAL: Tell us about your relationship with all these partners. You've got Marshall in Alabama; you've got the Program Office in Houston; you've got United Space Alliance out here and also Houston. What's the relationship like with all these different groups?

RANSONE: I really have no issue with any of them. I think we have a great working relationship. Everybody knows that you're in it for one common goal, to get that Shuttle and those astronauts off the ground safely. In the case of *Columbia* [the STS-107 accident], they bring back to light that once the launch is over, you're not done, so you do have to get them back down to Earth safely. So everybody knows that that's your common goal.

As far as individual groups, whether it be Orbiter or external tank, MPS [Main Propulsion] Systems, everybody has their own goals as far as their own operating means and standards, their own program-level goals, and things that they have to look out for. Sometimes there is a little conflict because when the vehicle is completely integrated, everybody's fighting for schedule time to get their work done.

And taking that into mind that everybody's got their own things that they have to do and their own worries, still you've got to remember that, (a), we're all people. You've got to treat each other like people. There are some people out there that seem to miss that point. They don't like to treat others as they like to be treated. I don't subscribe to that mentality. I like to make sure everybody gets treated as humans first and then look out for your own component. Then also keep in mind, (b), we're all in it for the same goal. You're here to launch the Space Shuttle safely and land it safely. Those astronauts are your number one priority, to get them up and down safely.

As far as working relationships with the various Centers, I think it's great. There are some misunderstandings on certain levels as to what each group understands what each other does. Not everybody at Marshall knows everything we do here, but I don't know what everybody does at Marshall either. I don't know what they need to do to get their job done to where they can interface with me, and I don't want to assume that.

Then as far as working on the component-level—the folks here—I think it's great. Working here at Kennedy, I've had also the opportunity to work at California with the factory and then travel to various Centers, it's a great group of people that work on the Shuttle Program.

That's probably what I'm going to miss the most, their level of professionalism, their dedication, their skill, their knowledge, I mean, you name it. Plus you've got quite a lot of personalities out there, a lot of jokesters. You've got to have thick skin to work on this program sometime. If you can't take a joke, you might as well walk out right now. It's hard to find all those ingredients in one job. I feel like I'm truly blessed because I work at a job that's incredibly unique, with a group of people that are incredible, any and all of them. It's not just within Rocketdyne, because we are a very tight-knit group, almost like a family atmosphere here, but it's also the rest of the Shuttle Program. Like I said, everybody's got their own personalities and everybody's got their own way of doing things. You say tomayto, I say tomahto, but you take that into consideration and respect them for who they are and things just go a lot smoother when you have that mentality.

ROSS-NAZZAL: You told us about your training out in California. Tell us about the training for some of the technicians out here. Are they specialized in a particular component like nozzles or turbopumps, things like that?

RANSONE: A lot of the technicians, most of them have an aviation background or aerospace background. Some of them have military background where they gained that experience there. So they do have some previous expertise on highly technical and mechanical systems. A lot of the guys who are here at Kennedy came from old space programs. I don't want to say "old" space and make them sound old, but you know what I'm saying, historical space programs.

ROSS-NAZZAL: Yes, from Apollo, for instance.

RANSONE: Yes, the Apollo days and stuff like that, Santa Susana field labs [California], Stennis Space Center [Mississippi], where they worked on hot-firing the engines, the various engines, and so they transitioned here. It's almost like a one-to-one. Where at Stennis the engines don't go anywhere, they stay in the stand; here it's a mobile test stand that goes up in space. Some of us like to joke around that the Orbiter is our mobile test stand, because the engines have been run for years before they got on an Orbiter.

That's the one thing we have to benefit from, is that these main engines from the very get-go have been running at Stennis Space Center testing, up until 2009. So we literally would run these engines till they break. Sometimes they were meant to be broken, sometimes we didn't expect it, and in either case the goal was to learn from whatever happened at Stennis and apply it here.

Those technicians, they're a great group of guys, great group of people, guys and gals. There's been women technicians who work here, and they held their own. They're no different than any of the others. I would like to say that for the record I think Rocketdyne has probably the best group of technicians out there, and I'm going to gloat, because I don't think there's anything that they're incapable of. I would trust them with my life.

ROSS-NAZZAL: Tell us about the work that Stennis Space Center would do on the engines before they came to Kennedy.

RANSONE: They would beat on them, in a good way.

ROSS-NAZZAL: Interesting picture.

RANSONE: Yes, get on there with a big hammer, [demonstrates].

Essentially what Stennis' goal is, when they're not testing development engines, when we would send them a flight-ready engine, they would basically make sure that engine is good to go on an Orbiter. They put it through its paces. The engine would be assembled. In the past, it would be assembled in the Rocketdyne facility in Canoga Park. Recently, the past five engine assemblies were done here at Kennedy.

After the engine is assembled and goes through all the checks and balances that we do here, we send it to Stennis and they put it in a test stand and essentially fire it up, light the fires, kick the tires, and run it through the whole flight program. If it's a flight motor, it just goes through the flight profile, up to 104 percent, same throttling and everything that the Orbiter folks would do when it's in the Orbiter on the way up.

After the hot-fire, they essentially do what we do here. They pore over that engine with a fine-toothed comb, looking at every little nook and cranny, checking every system, system integrities, functionalities, and operation parameters. These engines produce a mountain of data, pressures, temperatures, shaft speeds, stuff like that, and they pore over every ounce of data to make sure that that engine functioned the way it was predicted to, because, again, it goes back to development of those motors. These engines have over a million seconds of hot-fire time, which is incredible, given the fact that it's a reusable motor, that it's essentially what they would consider a booster motor or a first-stage motor. All that history allows us to very closely predict what each engine, each component is going to do during flight and/or test.

With a million seconds on those motors, that's a lot. With those million seconds, you have all kinds of learning opportunities, little golden nuggets of learning. This engine is constantly talking to you, constantly, constantly. Whether it's during operation or when it's sitting still, it's constantly telling you what's going on with it. Whether or not you're listening is key. Whether it be a piece of data that's out of the norm or whether it be a piece of hardware that doesn't look normal, it's up to us and the folks at Stennis and also the people at Canoga and Marshall and other sites, everybody as a team, to say, "What is this engine teaching us and how can we improve upon that?" Stennis—that's part of their key role. After they hot-fire that engine, they work together as a team with Canoga Park, Marshall, and others and say that, "Okay, this flight engine has passed the rigorous hot-fire, the green run of that engine, and it's okay to go on an Orbiter." So they mirror a lot what we do here, just at a different site and that their test stand stays on the ground.

ROSS-NAZZAL: Do you have to check the engine once it comes back from Stennis?

RANSONE: Yes. Once they send it to Kennedy, we do some visual inspections and pump torque checks, among other things, just to make sure that it didn't get damaged during shipping, and that's the main thing. After we do that, it's pretty much good to go. We don't really second-guess their work that often. There might be something that comes up data-wise in transition or in hindsight that, after looking with a larger magnifying glass, that, "Oh, well, we might not be comfortable with that." Then so we might be tasked to do something off nominal or unusual here. But for the most part when Stennis does their job and they sign off on that engine, they have a review that they do prior to accepting that engine into the flight program. They have another passport-type review that essentially accepts it as a flight motor. We don't like to second-guess that. That's enough of a passport process and enough scrutiny to say that once that engine is delivered to us, it's good to go.

ROSS-NAZZAL: Tell us about what role you might play after you've installed the engines. They're ready to go for flight. The Orbiter leaves the OPF and goes into the VAB [Vehicle Assembly Building] and it rolls out to the pad. Do you ever have to do any sort of processing or watch the engines as it moves through these various stages?

RANSONE: Yes. If we could, we'd like to put bouncers with a big stick around the engine and tell people, "Don't touch them. Don't touch them. Don't touch them. Hands off." But we have to trust that anybody and everybody who is around those engines would respect those as flight components on the Space Shuttle, just like we wouldn't go up and poke the Shuttle. There's that degree of trust that every group out here on the Orbiter has with each other, that when you're going to be doing work around somebody else's component, you're going to treat it just like you treat yours.

Yes, in a nutshell, we do a lot of functionality checks. After the engines get installed, one of the first things that we do, we check the pump torques, the low-pressure pumps that get bolted to the interfaces of the Orbiter. We want to check those torque checks to make sure the shafts and the various internal components of those low-pressure pumps haven't bound up for whatever reason.

Then we do our interface leak checks on the joints that interface with the Orbiter. We pressurize those and make sure those don't leak. That's obviously very important. You don't want any leaks in the aft. Then we do quick engine controller checks. We do hydraulic checks of the thrust vectoring system of the Orbiter that gimbals our engines. We make sure that everything is functional there. That's all in the OPF after we install. We do that work in the OPF. We also do some visuals and just kind of "mother" the engines, look over them while they're in the Orbiter's hands.

Then when we go to the VAB and the Orbiter gets mated to the rest of the stack, or the vehicle, the tank and boosters on the MLP [Mobile Launch Platform], we do some system integrity checks there and do some visuals there. Not much work in the VAB. The Orbiter's only in VAB, on average, a week, but now since we're winding down and due to personnel constraints, the Orbiter was in the VAB for about two weeks.

After the Orbiter rolls out to the pad, then we do a lot of work out there to the engines. Once we get out on the pad, usually the first thing that we do within a few days of rolling out to the pad is we do another FRT, a flight readiness test, similar to what we do in the shop. But since we're integrated with the Orbiter and the Orbiter systems, we're bringing more people into play, so it's not just us "playing" with our engines. There's the Orbiter folks and the MPS groups, among others, that are in on these FRTs. So, again, it falls back to making sure all those systems, the MPS systems that feed the engines, and the engines themselves, are all functional and operating the way they should and that none of those systems leak.

We also do what's called a helium sig test, in essentially the aft compartment. Everything that's in the aft compartment as far as propulsion systems that feed the engines is pressurized, and then we run a mass spectrometer and we check to make sure there's no leakage in the aft, because any leakage in the aft is a bad day. Potentially you can lose the Orbiter and the crew, so you don't want any leakage in the aft. After our helium sig, we do some other system checks also.

Then we're kind of playing a waiting game before we can go in to get the Orbiter ready and the aft compartment ready to go up in space. We do what we call aft closeouts. They're inspections of the entire aft of the Orbiter, and we also do some inspections of the external areas of the engines. We do some minor processing of the engines, what we call MCC [Main Combustion Chamber] polishing. The Orbiter, while out at the launch pad, is exposed to a very corrosive environment since it is right on the Atlantic Ocean. The MCC thrust chamber of our engines is made of a primarily copper-based alloy that in the past used to oxidize; you can get some surface-level oxidation that would slightly affect the performance of the engine as far as the boundary-layer flow and coolant of that chamber. If you have any interruptions of that, you can get flow turbulence causing hot spots on those chambers and affect the life of that component. Repetitive hot spots can also lead to material cracking where liquid hydrogen used to cool the MCC leaks out. So we go in there and we polish off all that oxidation to ensure that does not happen. Recently we developed a purge of the entire thrust chamber, the nozzle and MCC interior spaces, that has nearly eliminated the oxidation of the MCC surfaces. We still polish the MCCs, but it goes a lot quicker now.

Then we're marching towards putting that aft door on. We do a lot of visual inspections in the aft compartment, some where we bring in offsite folks from California and take photographs of everything, in parallel with the rest of the Orbiter folks who are in the aft, like the aft compartment; the MPS groups, all them guys are in there doing the same thing. It's coordinated chaos, if you can call it that. It's like a ballet where people are not as graceful as they would like to be, but they're all dancing together, and, like I said, with the main goal of everybody making sure their components are good and we're respecting what you do as long as you respect what I do.

Once all those system inspections and aft closeout checks and everything are complete and signed off, then we put the aft door on. That's usually, we like to say, within a week of launch, but it all depends on our evolved schedules, when they want those doors on. We put those aft doors on and do a last system check of that aft compartment and the doors, and then we're done. Then we march towards launch countdown.

ROSS-NAZZAL: Are you in the firing room the few days before launch?

RANSONE: Only if I have to be. I'm not one of the folks who light the fires. I'm there only if something bad happens, which if I don't have to go to the firing room, then that's a good day. Because what I would be there for is if something were to happen, if we abort on the pad or we have a return to launch site [RTLS] or an abort to one of the overseas sites, then I would have to be part of that team that would coordinate what we would do and when we would get it done. I'm there during launch; I'll be sticking my head in and out, but I'm not sitting at console. It would have been nice to do that, but my career path took me elsewhere. I don't mind that. So if I'm not needed on launch day, that's a good day.

ROSS-NAZZAL: So you get to go to the river and watch?

RANSONE: Yes. I'll have to pack my bags. There's days I'll have to pack a big suitcase in case we have to go overseas. If we have to go overseas, I'm on the plane within twenty-four hours. The first time I had to pack for that, the gravity of that responsibility really sunk in. I'm like, "Man, if I'm taking this bag and throwing it on a plane, then chances are I'm probably going to be coming home looking for another job after that, too."

ROSS-NAZZAL: That's interesting. Why would you have to go over there? To inspect engines?

RANSONE: If they have to abort to a transatlantic or a TAL site, transatlantic landing, usually that means we didn't do our job. If we have return to launch site, that means, okay, something happened prior to the solid rocket boosters coming off, and we can theoretically land back at Kennedy. So it could be an engine problem, it could be whatever, an Orbiter issue for RTLS.

Well, when you get to the point of transatlantic landing, in my opinion, that means there's something that we as main engine group, as a main engine team, didn't do, because one or more of those engines are not going to allow that Orbiter to get to orbit. It could also be an Orbiter issue that they felt they can't get up there or they don't want to go up there, but my personal opinion is, it's something that we're responsible for. It could be a tank issue, but that has much lower probability in my opinion.

If it goes over to transatlantic landing and lands at Istres [Air Base, France] or Moron [Air Base, Spain], your main goal is to try to find a way to get that Orbiter back on United States soil, because it's not like you can just light the rockets and fly it over here. You've got to find a way.

ROSS-NAZZAL: There's not another launch site over there.

RANSONE: It's going to be a logistic nightmare to get it back over here. So that's the prime goal. When we land over there, more than likely we would have to take the engines out. It all depends. They have plans, but I've been told that our goal would be to take engines out, so we would have to ship the Hyster over there and somehow get all that back over here, because they don't have a way to get that Orbiter on top of a 747 over there. They don't have the means. But you never know. You never know what can happen. Thankfully, we've never had to deal with that, and with the last launch up, we never did. So we all did our jobs to avoid that.

ROSS-NAZZAL: Your résumé indicated that you were streamlining a lot of chronic processing issues. Can you tell us about some of those issues that you worked and how you helped to streamline that?

RANSONE: There's processing issues and then there's hardware issues. As far as processing in the engine, everything you do on that engine is a process. You can make that process as long as you want, depending on the scope of your view. So the process of overall engine processing or the step by step, that's rather long, forty to sixty days or whatever it is we quote. But then you also have small processes as far as each little test you do, each little inspection. Each one of those is a sub process.

At Rocketdyne we've been pretty proactive as to not wait for something to happen to make us do it better. You know what I'm saying? We've been pretty proactive to find out how we can always improve. Listening to the engine. Again, when the engine tells us something, well, then we sit back and think, "Well, what did we do wrong? Did we do something wrong as far as Kennedy here, or was it a design issue, or fabrication issue?" As far as Kennedy processing, it's about looking all around at what we do. How can we trim time and do it better, not necessarily faster, but mainly to do it better and safer and increase the quality, because it's all about giving your customer the best value. So you're always looking at how you do it better.

Now, an example of that, it kind of is process, but it also is hardware-related. The engine nozzle, can be a thorn in our side at times. Out of all the components, it doesn't move, it doesn't spin, it's a stationary nonmoving component, but it gets beat a lot. During the engine startup, there's a shock transient that runs the whole length of the nozzle, and as that shock transient reaches the end of the nozzle or the exit, that nozzle really, really just gets distorted and that puts a lot of stresses and strains on it. It's an incredibly lightweight nozzle for its size. It goes through a lot of temperature changes. The fuel comes in that cools the nozzle at cryogenic temperatures less than or colder than negative-400 degrees Fahrenheit, but by the time it actually gets done with cooling a nozzle, it's incredibly hot. So the outside of the nozzle theoretically is cryo [cryogenic]. You could touch it, but the temperatures that the inside of nozzle sees are over 5,000 degrees Fahrenheit. So it goes through a lot of temperature changes. Over 3,000 psi [pounds per square inch] running through that nozzle, a lot of pressure, through very thin materials.

Due to all that combined, the tubes spring leaks all the time, all the time, and it's not something that we're proud of and it's not something that it was meant to do. It's not a design flaw. It's just inherent to how that nozzle operates. So we're constantly, constantly trying to find out ways to fix those nozzles better, quicker, and make sure that those repairs are better.

So one of the things I was involved with post-*Columbia* was we looked at all of our leakage criteria on that nozzle, pass/fail criteria in certain zones in certain areas of the nozzle, what can we live with, what can we not. One of the things I did is every leak check of every nozzle of every flight, I compiled.

ROSS-NAZZAL: Fun work.

RANSONE: Literally a needle in a haystack is what you're looking for, tedious, but it was part of what we wanted to do. The goal was to further refine our leak check criteria, our pass/fail criteria of these nozzles to preserve the life of them and operability and repair ability. In a sense, it would help you accept and/or repair these leaks better with a better pass/fail. So that was one way, refining our criteria.

Another thing that I was part of a team was a nozzle thermography. It's what we call a nozzle thermography leak check. It's kind of hard to explain, but the thermography leak check system uses an infrared camera to try to find leakage on a nozzle, because when you're looking at the coolant tubes on the hot wall side or where the thrust is, where the actual fire is, those are easy to see. They're right there. But on the other side, where those coolant tubes are bonded to the structural jacket on the 'coldwall' side, you can't see that leakage. Based upon some of our engineering science, shall we say, that we employ, you can kind of get an idea from the area where it's at, but the goal of the thermography was to use that infrared camera and find out where that leakage was that you can't see. So in a sense, you're using this infrared camera to look through that coolant tube material to look for a spot, a signature, that says, okay, you've got a leak there. I was part of that team that helped develop that process.

In the past when we would have to find those coldwall leaks, we would have to cut open tubes, and cut and cut and cut, and isolate that tube. "Oh, the leak's still there." Okay, cut another one. Isolate that tube. "Oh, leak's still there." There've been times we've cut over thirty tubes, and that repair would drag on for weeks, weeks, and weeks. There's been times that we've never found that leak, and we've had to buy it off or find some way to accept it, and there's been cases where we've lucked out and we cut a tube once and found it and fixed it.

Now, the whole idea of the thermography was to eliminate all those tube cutting. You're still searching, seeking with this camera, but you're not cutting tubes. It's real quick to just take a shot. "Oh, it's there." Cut it open. "We got it."

I think that was a pretty interesting process, and I was proud to be part of that team. It was with Marshall and Canoga Park, and with us folks here at Kennedy and Stennis, all of us worked together, engineers and technicians, we all worked together and fine-tuned that process with the goal of making these tube repairs a lot quicker so we could get that engine back on line, that component back to being a flight asset. So that was just engineering science. It was pretty cool.

Another example of a processing problem I had a part in resolving is how we deal with contamination. Contamination in a rocket engine, or in any other fluid, mechanical, or electrical system for that matter, can be deadly. It can block coolant passages, interrupt fluid flows, short electrical systems, and just generally do very bad things. You try your best to control contamination or FOD [Foreign Object Debris] from its source, using a preventative measures and procedures. No matter how hard you try, internal systems can get contaminated, whether it be from external or internal sources. This is where reactive or passive measures come into place; how well can you find it and get it out after the fact? After you find something, document it, remove it, and verify the system is clean, you have to get back to active means of approaching the problem. Where did it come from, how did it get there, and can it be prevented? Can we do what we have been doing better? It's the idea of continuous improvement; do not wait for a problem to happen. I was part of a team that helped improve and expand our active approach to contamination or FOD. One measure was to borescope inspect components and/or systems after a component or joint is demated, before its replacement is installed or mated, and after the installation or mate is completed if possible. Our new active approach greatly reduced the occurrences of unacceptable contamination or FOD noted in the engine. I was proud to be part of that team.

Finally, there is the risk assessment process we use at PWR. Everything we do here is a process. There are generally two types: a nominal process, or something you do regularly, and often and an off-nominal process. These are processes that are done very rarely, on a contingency basis sometimes, or new processes altogether. I was part of a team that helped develop an Off-nominal Risk Assessment Checklist, or ORAC. The ORAC is a VERY comprehensive list that is meant to be a mind-jogger of sorts, forcing you to look at that off-nominal process from all aspects and "outside the box:" tooling, ergonomics, hazards, actual work steps, everything. What is it, how is it done, why are we doing it, what are the results of actions taken in the process, what are the risks that may hinder achieving 100% success? We look from start to finish of the entire process. If there are any issues, constraints, risks, and so forth, the ORAC drives you to address them and put any fixes, mitigations, or such in place BEFORE you start any work. This way you give the people who will be performing these off-nominal tasks the best chance of success, you do not set them up to fail. The new ORAC process has worked very well, and I am glad I had a part in developing that.

ROSS-NAZZAL: There were a number of improvements made over the years as you've worked on the program to the engines, like the Block II engines, the advanced health management system. Can you tell us how those changes impacted processing or the work that you do here at KSC, or if it did at all?

RANSONE: Primarily the modifications to the engine that we've done ever since the engine was first designed and built back in the seventies and first flown in '81, all the way up to now, all those phases of modification of the engines were primarily based upon reliability and safety of the engine. So as far as processing, how it affected our processing, in most cases it helped us. In some cases, we went backwards, but it really didn't matter because you're not really worried about the processing, you're worried about the safety. That was our ultimate goal.

Again, it falls back to these engines were constantly, constantly, constantly tested, and when they broke, we did find out why. We didn't leave a stone unturned if it didn't give us that answer. We would search and search and diagnose, and when the engine would break or something would happen, if we would have to take a component offline and cut it apart to look at cross-sections of welds or look at grain structures of pump blades, we did it. Because, again, the ultimate goal was you wanted zero failures because you didn't want anything to happen to those astronauts. It's not so much you're worried about the company reputation. That's a byproduct of worrying about the astronauts. Your goal is what your customers ask you to do, and you fulfill it to the best of your abilities, and if you can't fulfill it, then you keep doing it until you can. You keep working at it until you can. Failure is not an option, you know. We want nothing but 100 percent success.

So, going back to the modifications of the engines, as something would break and we would learn about that, we'd say, "Okay, we need to modify that to fix that," and that's what we would do. Primarily some of it was based upon manufacturing ability to get those engines built quicker and the components built quicker, but mainly it was reliability and safety. So we would phase that in as we would learn.

So the first engines that were flown, I've forgot what they were called. I called them Phase Ones, but I think they were baseline or FPL engines, full power-level engines. I forgot what they officially called them. Those we flew up to the *Challenger* [accident, STS-51L]. After the *Challenger* incident, all the lessons that we've learned at Kennedy, at Stennis, at Marshall, at Canoga, at West Palm [Beach, Florida], at the Honeywell facilities, all the people that contributed to that final product of an SSME, we had a lot of things we wanted to improve upon, so we did a phased approach after *Challenger*.

The first modification was after *Challenger*. It was a Phase Two engine. That was primarily controller software and controller reliability, taking into consideration some of the things were learned from *Challenger* and other lessons learned. We also did some minor improvements to other components, mainly how they were built, not how they functioned or how they performed. Flew those a lot.

The next phase, if I remember correctly, after Phase Two, we did a Block I. Block I was first flown in 1995. We brought in a new high-pressure oxidizer turbopump. The high-pressure oxidizer turbopump spins at over 30,000 rpm and delivers a very dense fluid, liquid oxygen, to this engine, and it goes through a lot to get its job done, a lot of stresses. It takes its toll on that pump. Through the years of flight and development, they found out a way to make that pump better, one of which was using different bearings, an improved bearing material on that pump.

It's also with manufacturing ability of the pump. Overall, the goal was for that pump to improve its reliability and safety and make sure that it did what our customer asked it to do. The new pump had increases in safety, reliability, and life or useage.

Also with the Block I engine, we incorporated a new powerhead design where it went from five ducts that transferred the gases from the pumps, the turbine ends of the pumps. It delivered the gases from the pumps to the main injector to be burned for combustion. It went from five ducts to four, three ducts on the fuel side down to two; mainly reduced turbulence, and with the reduced turbulence you had reduced pressures and temperatures. That helped the life of the engine and reliability of the engine, and also helped things kind of upstream of those ducts with the pumps, mainly with the pumps, allowed them to increase their reliability and lower their operating parameters and less stress on them.

Then if I remember correctly the final major thing that we incorporated in the Block I is a single-tube heat exchanger. The heat exchanger is a component on the oxidizer pre-burner where the high-pressure oxidizer turbopump is, and what that function of the heat exchanger does is it turns liquid oxygen to gaseous oxygen so it can pressurize the external tank. The single-tube heat exchanger design eliminated a lot of welds, thus increase in safety and reliability. Again, all the modifications of the engine go to safety and reliability of the engine.

Some of the modifications, we're trying to squeeze more performance out of the engine. The thrust-to-weight of this engine is incredible. The reliability, the efficiency of the engine is incredible. The Isp [specific impulse] is a function that measures basically the overall performance of the engine. It's pretty high for that engine. It's one of the highest of all the rocket engines out there. So with all the modifications that we do to this engine, we are trying to squeeze performance out as much as we can, it's like trying to wring out a dry sponge, but all these mods [modifications] mainly revolve around safety, reliability.

1998 we went to a Block IIA. What we did is we incorporated a large-throat main combustion chamber. The main combustion chamber is part of the thrust chamber. You have your injector that combines and burns the gases to produce thrust, and then it converges to the main combustion chamber throat, whereas once you get past the throat of that combustion chamber, that's where your acceleration of your hot gases start to product thrust, and then downstream of the throat you have your diversion region to produce thrust and rocketry science takes over from there.

We increased the throat of the main combustion chamber I think around 10 percent from the small-throat to the large-throat configuration, and what that did is, again, reduced your operating pressures and eased the load, so to speak, of everything upstream of that. So your pumps, your powerheads, everything, it reduced all the stresses and strains on them. Again, all these mods are going to safety, reliability, helping the engine do its job better. I think that was it that we did in the Block IIA was just the large throat.

Then, finally, we did a Block II mod, which is what we're running now. Everything we're running now is Block II, and that is incorporating a redesigned high-pressure fuel turbopump. Those are made by us—we are now part of the Pratt & Whitney Rocketdyne West Palm Beach campus, and the folks down in West Palm Beach are the ones who are designing and fabricating and assembling those pumps. With the redesigned high-pressure fuel turbopump, it borrowed a design cue from the redesigned high-pressure oxidizer pump with a new bearing, a silicon nitride bearing. It's a ceramic material, harder and lighter than the older material, more reliable, less wear, so your safety and reliability of that pump does get increased.

They also redid some methods on how they've produced the blades of that pump. They noted over the years that they had some issues with grade structures, and they went to a casting. It was actually primarily around dealing with eliminating welds of those blades. Again, when you can eliminate a weld or how things are joined, it increases reliability and safety again. Again, it all is around reliability and safety of the component in the engine.

Those are our mods, so that's what we're flying now. We've been flying them since 2001. It all revolves around lessons learned throughout the entire thirty years of the program and everybody listening to what the engine is telling you. If there's something wrong and you can't find why, then you're not listening hard enough, you're not looking hard enough, so you don't stop till you find that last stone that tells you that answer.

ROSS-NAZZAL: Well, you've been highly successful.

RANSONE: Thank you. Thank you. It's not just me, it's everybody, but, yes, thank you. On behalf of Rocketdyne and the main engine team, I thank you.

ROSS-NAZZAL: Tell us about the Space Shuttle Main Engine Processing Facility. I understand that was built, I think, in '98 or so. Tell us about what it contains.

RANSONE: It contains a lot of good people and a lot of good hardware. That's our baby. We used to process engines in the VAB. That's when I hired in. We were still processing in the VAB when I transitioned to Kennedy. It was interesting. We didn't have quite the space we needed. Everything wasn't as ergonomically sound as you would like, but we got the job done.

So, prior to ’98 we pitched the idea to NASA that we would like to have our own standalone facility. Mainly we needed some space, but also primarily to get us out of the VAB where there’s a lot of ordnance, the boosters and stuff like that that are stored, basically for the safety of employees and everybody involved, just get us out of the VAB, let the people who do work in the VAB just be the booster and tank folks, and when they mate the vehicle, let that happen at the VAB. So we did.

After a few years of building and troubleshooting the shop, they opened it up in ’98, and all the lessons learned from Stennis Space Center and the Canoga Assembly Facility, where they would assemble the engines back then, were incorporated in the shop. So what we have there is roughly about a 35,000-square-foot facility that can process rocket motors, specifically designed for processing rocket motors. We tailored it for the main engines, as far as crane height for example, but we can process other motors there.

As far as what the shop contains, we have our drying ovens there to dry the entire engines after flight and the control panels and fluid hookups and everything there, and then we also have floor space to do horizontal processing and a huge high bay to bring in our giant steroid tractor, the Hyster. Then we have vertical stands where we can rotate up to six engines into the vertical and process six engines at a time vertically. Then we have a lot of floor space to use as we please. We have pressurization panels where we can pressurize any system of the engine, whether it be in horizontal or vertical orientation. We have electrical interfaces to where we can hook up the engine avionics and electrical systems to power up the avionics and electrical systems and troubleshoot as necessary and also simulate how those electrical systems would be used during flight to make sure they’re functional.

Also we have areas to process some of the GSE that we use. There's fifteen engines here in Kennedy, but there's hundreds of pieces of GSE that we use to process the engines, and without the GSE we wouldn't get anything done. So we've got to maintain our GSE just as stringently as we maintain the engines. That's about it. We've got a couple cranes in our shop that can pretty much lift a house off the ground if needed and, like I said before, a lot of characters running around looking at engines and doing their job as best as they can.

ROSS-NAZZAL: Are there any hazardous materials that you handle out in that shop?

RANSONE: Not as hazardous as some of the stuff that the Orbiters work with, like hypergols, but we do have a lot of hazards. In the case where the engine's in the vertical and we have to pressurize an engine, that thrust chamber becomes oxygen-deficient atmosphere, so you have to treat that accordingly. That's a hazard you have to take into consideration. Then you're running pressurization, so you have to handle your pressurization lines accordingly, because if one of those fails, it could be a bad day for somebody. You have heavy lifts, so that's another hazard we have to contend with, so you don't want anybody under suspended loads. Then you also have electrical hazards, fluid hazards. So there are plenty hazards in there, just different from what the Orbiter deals with.

Then you have hazardous waste, byproducts of what we do. We do use various chemicals, adhesives, and various materials that you just can't toss in a trashcan to go to the dump. You want to make sure those are disposed of properly. We do have procedures and processes for those, and storage and disposal of your various hazardous commodities that we have throughout the shop. And everybody's trained on hazardous waste disposal and hazardous waste handling and all the various hazards we may encounter. Everybody's trained on that, so if you're going to work in the shop, you're going to know what to look for and you're going to know how to deal with it.

ROSS-NAZZAL: You talked about some of the work you did after the *Columbia* accident. Was there other work that was going on that impacted the engines themselves?

RANSONE: As far as the *Columbia* investigation, we had a small group of folks, including myself. Our goal, our primary responsibility, as debris was brought into Kennedy, we just identified it. "That's main engine's. That's ours," and we'd get it out of the way because they knew pretty quick we had nothing to do with that. Although we were part of the Orbiter, we did what we could do to help that Orbiter team, that investigation team, get their job done. It was primarily just to get out of their hair and let them do their job. So really our only responsibility, was just to identify debris that was ours and get it out of the way.

As far as results or follow-on from the *Columbia* investigation and incident findings and the stand-down during the *Columbia* prior to Return To Flight, we pretty much were proactive. We were actually very proactive, and we looked at everything we did here. We have paper that allows us to work on the engines and tell us to do certain things during our processing of the engine, and we stood down every piece of that paper, and "stood down" meaning that we looked at every page, every step, every word, every buy, every warning, everything. Made sure that, okay, are we happy with that? Well, why not? Could we do that better? Well, how so? Well, if we implement a change, how do we know it's going to work? So it's around this whole plan, do, check and act type thing. Whereas, okay, you have some requirement that tells you to do something that our customer wants us to do, and it's reflected in all the standard work paper. Well, you have that requirement. Well, then how do we document that requirement? How do we satisfy that requirement? How do we do it? Then once we do it, how do we know we did it correctly? How do we verify that we did it correctly?

So it's a constant loop, and that loop is never really closed. It's never really done. Once you satisfy the requirement, you're always looking at how to do it better. During that *Columbia* stand-down, we went through every inch of that paper, everything, to find out how we can do it better, how we can document it better, how we can plan it better, how can we do it more safely, because we have a kind of a mentality down here, of course. Safety, it's not just a procedure, it's a culture. You've got to live it, you've got to breathe it, just as easy as you can walk and talk at the same time. You don't think about it; it's just in your blood. You're always trying to figure out how to do it safer. So we did some of that after *Columbia*.

We also looked at things using this mentality of "we don't want to set people up to fail." That's key, because everything here that we do is a process, and everything has a procedure attached to that process or a requirement attached to that process, or basically paperwork. If we're putting this piece of paper out on the floor and telling somebody to go do it, we take stamp warranty very, very seriously here. When you stamp off that piece of paper, that in a sense goes back to what we were talking about earlier. How do you know that engine's ready to fly? Well, when you put that stamp on that piece of paper that says you did that step correctly, that's one little step towards ensuring that engine's ready to go.

So we looked at "are we setting people up to fail?" When we tell them to put that stamp on that paper, are they going to do that job right that properly reflects all these mountain of requirements? We stood down all of our paper. It wasn't just engineers. It was the technicians who do the work; it was the quality folks who verify the work; it's the safety folks to make sure that it's being done safely; it's the configuration folks who were making sure that when that engine's back together, it's the way it's supposed to be. So all these people stood down all of these pieces of paper.

We also looked at not just individual pieces of paper, but the overall processing of the engine too. How could we do it better? How could we do it safer? We were just very proactive. We didn't wait for somebody to tell us. We did it on our own. So by the time we did Return To Flight, we improved things. I wouldn't say considerably, but we did our job better. We gave our customer more value, so that was key.

ROSS-NAZZAL: According to your résumé, you've implemented quite a few significant ideas or techniques to help improve processes like the Lean principles, reducing process steps, lead time. Can you tell us about some of those things that you've implemented?

RANSONE: Well, I can't take 100 percent credit for a lot of these things, because we do everything as a team here.

One of the things, our nozzle encapsulation, I can't really take the credit for this. One of our technicians had an idea. Instead of using the old method that we would do that would employ basically taking a big—it's kind of hard to say—just a bag, and attach it to a certain area of the nozzle that we can't see the coolant tubes and leak-check it. He came up with the idea to use a hard fixture with a known volume and attach it to the side. I was part of a small team that kind of got that going, but that mainly is his credit. I don't want to steal his thunder.

Another thing that we do as far as looking at Lean principles is we're constantly looking over processing data and looking at if we have repetitive issues, well, what can we do about that? We have Corrective Action Boards, Preventative Action Boards, again, paper stand-downs and stuff like that, so it's all just kind of part of a team environment where we're working towards that type of stuff.

Another thing, I wouldn't say it's not necessarily Lean principles, but it's a byproduct of our operating system that we use here at Pratt, is using some of these Lean tools to look at data. We looked at, again, our nozzle. We kept getting leaks in certain areas over and over and over and over and over and over again throughout the recent history, and, again, keep looking until you find that one stone that you overturn that gives you the answer. We used the various Lean tools, analyzing the data that the engine's giving you, whether it be operational data, inspection data, or nonconformance data, in this case.

We did some trending and noticed that it was in a certain area. We asked, "Well what do we do in that certain area of that nozzle that might cause that?" We narrowed it down to some processing that we thought was helping that nozzle, and it turned out it was hurting it because of a sponge. It was all revolving around a sponge that we would use to put a corrosion inhibitor on that nozzle to prevent corrosion. In fact, it was accelerating corrosion. Eventually we found out that when they packaged it and sent it out to whoever would buy it, they would treat it with something that was incredibly high in chlorine content, and chlorides and metals don't like each other. Chlorides tend to accelerate corrosion rather rapidly, and it turns out the chloride levels were like more than one hundred times the concentration of the ocean saltwater. So what we were doing was putting corrosion accelerant on the nozzle.

So through the Lean principles and our various tools that we employ here at Rocketdyne, we found that it came down to, like, a $5 sponge. We eliminated that sponge and things got better, and we eliminated our leakage that would happen over and over again. So that was an example of the use of one of the Lean tools.

Another thing that I kind of helped as part of the team to employ is a tracking system. Our customer has, per engine, over around two hundred OMRSDs (Operational Maintenance Requirements and Specifications Document), or OMRSD requirements. Those are basically what they want per contract done to this engine and prove that we've done it, to say that they want that engine to fly.

Well, we had a way to track those, that we internally would track them. I was part of a team. One of the things that I helped do was implement a web-based system that's a lot more user-friendly, to allow us to personally, as our Rocketdyne group, to go in and say, "Yes, we did this. We satisfied that requirement," before we would get to our engine installation review and take it to the customer. The final tracking of that, the official tracking of those OMRSDs, is done by United Space Alliance. They're the ones who go off into their database and say, "Yes, Rocketdyne did it. We are okay with that engine." This was kind of our own check and balance to make sure that we did that. Then any nonstandard processing we would do to that engine would add on more requirements, and that's what one of my jobs is, is when we go to do nonstandard processing, I would make sure those requirements are added to our processing list and then verify it as done.

I'm not going to take credit for any one thing, because there's really not much that we do here individually. It's always a team effort. I've been part of several teams that do a lot of good work to help this engine and help us do what we do here. So I don't want to just raise a flag.

ROSS-NAZZAL: You mentioned the last, I believe, five fabrications of engines occurred here rather than in California. Would you tell us why the switch, why suddenly move across country?

RANSONE: Primarily they wanted—"they" as in our Canoga Park team, wanted to shut down that facility where they did engine assembly. Since a lot of what we did here at that time and also at Stennis is very similar to almost doing a complete engine assembly from the ground up, because there's not a single component that we can't remove and replace here at Kennedy. We can tear an engine down to where all the components are off and rebuild it if needed. So in a sense, when Rocketdyne program management wanted to shut down that facility, we raised our hand and said, "We can do it." We went over there for the last couple of engine assemblies and also watched what Stennis did, as far as development engine assembly, and tried to figure out how to do it better, how we can do it better, as far as within our means. And then we started.

We ended up building an engine faster, less man-hours and less time and money than what Canoga would do. I don't want to implicate anyone at the Canoga Park facility. It's not that they did anything wrong. It's not that they were not looking outside the box to improve their processes. It's just that they were operating within their own means to do what they had to do. And we got down here and certain things freed up for us and we had a little bit more control of our own destiny down here as far as what we can do. Be proactive, again, to figure out, implement new ideas, and that's what we did. It was quite an experience.

ROSS-NAZZAL: When did that take place?

RANSONE: Oh, jeez. I was afraid you were going to ask me about that one. I can't remember exactly what year the first engine assembly was. I would like to say it was around 2001, 2002 timeframe, but don't quote me on that one. I'll have to double-check my resources on that one. Turns out it was in 2005 when the first engine assembly at KSC happened.

We did build five engines here, and four of those engines did get flown. The last engine that we built here, Engine 2062, was the last engine ever assembled for the Space Shuttle Main Engine program. Unfortunately, prior to that engine being completed, we didn't have a test stand to green-run it at Stennis. They shut down a test stand at Stennis in 2009. So it's an engine that is built, ready for a test stand and ready to fly on whatever they're going to bolt it up to.

ROSS-NAZZAL: So what are you going to do with all these engines that are here at KSC? Are they destined to go to museums, or is Rocketdyne going to use them on some other system?

RANSONE: I don't have a garage big enough, so I'll guess they'll have to stay here or somewhere else. That's a good question, a very good question. We are still waiting for that decision. We've heard they're going to stay here. We've also heard they're going to go to Stennis Space Center and stored there. Don't know. We're still waiting for that decision. Still waiting on a lot of decisions. And it's not so much Marshall making their decisions. They're bound by Washington, D.C. So that decision chain goes about as far up as you can go, waiting for it to happen. So that's about all I'm going to say about that. I'm not very happy at the lack of decision, but I'm not going to blame any of my Rocketdyne teammates and I'm not going to blame any of the Marshall folks, because I know they're bound by what they can do. So you know where that blame is going; it's Washington, D.C.

ROSS-NAZZAL: What are some of the more memorable missions that you helped work on or witness?

RANSONE: Well, the first launch, STS-81, when I was a green college kid that was broke and eating Ramen noodles. It was a night launch, and it was in January. STS-81, saw it go all the way to main engine cutoff, and it was a bright dot about an inch or so from the horizon. That was incredible. I mean, it's night sky. I think it was like four a.m., so it's still pitch dark out. When our main engines lit, you saw a glow. The boosters lit, you saw a bigger glow. When that vehicle lifted off the pad, it was like somebody turned on the lights, and it was amazing, amazing. Then the booster separated and you saw this ultra, ultra white dot of the main engines still kicking strong, doing their job, pushing all the way to main engine cutoff, or MECO. I was sold. I was sold.

Like I said, I told a gentleman named Jim Tibble, who was sitting in this firing room and he ran me out—he was one of my first managers here—I told him I'd work for beans, and told my other manager, my other boss there that gave me my opportunity, Mr. [Eric P.] Gardze, "You guys can just low-ball me. I ain't going to care. I'm signing on. You're going to have to kick me out if you don't want me." That was one.

Shorty after I first transitioned to KSC, I attended my first top-level FRR, where representatives from the astronaut office attend. This was back in 1998, 1999 or so. John [W.] Young was the astronaut representative at that FRR. Another hero I looked up to. Well, during a break I approached him. Before I could ask him for an autograph, he very politely asked me if I could print out a certain chart from the last presentation. I told him, as politely and courteously as I could, that I was not responsible for the charts. He lit up his astronaut legend smile, laughed, shook my hand and apologized for thinking I was the "chart boy." He signed my FRR program after that. I made the mistake of telling some coworkers what happened, so then I became John Young's "chart boy." I could think of many worse things to be. I have the program in my memory books.

John [H.] Glenn's launch, STS-95, that was one, because that was a really, really good moment for the program, gave us a lot of good publicity. People started remembering what the Shuttle was about, because you had a national hero going back up to his home in space. He has a home here on Earth, but his real home's up there. That's where he belongs. We sent him back up there, and we were in a big-time fishbowl here for that. The stress, the tension, you wanted to get this 100 percent perfect. You want to get every launch 100 percent perfect, but this is an icon that I looked up to when I was a kid. I got a chance to meet him and shake his hand. He's going on the Shuttle, the engines that I worked on. I was just like, "Wow, that's super cool."

When that got off the ground and he got back down safe, that was quite an accomplishment. Like I said, it was a fishbowl here. Your manager was saying, "Hey, just do your job. Just do your job. But get it right. Get it right. We want it to go right. We want it to be perfect." Like I said, no different than any other launch, you want them all to be perfect and all safe, but it's John Glenn. That was one memorable launch from a positive aspect.

Then there is STS-93. Right after engine start and liftoff, several of the cockpit warning lights lit up. Eileen [M.] Collins was the commander for that mission. The Orbiter was screaming that something was wrong, and very wrong, potentially deadly wrong. It seemed to me that her voice broke only for a fraction of a split second, as I am sure it would happen to anyone when they first realize they may be meeting their maker, but then she was solid as a rock, a real "Cool-hand Eileen." The Orbiter got into orbit safely, but not without issues. There were two big issues that mission. Orbiter wiring that caused a short, which knocked out some of our abilities to monitor and control our engines, and a little metal pin that hit our nozzle coolant tubes causing a major fuel leak resulting in a low-LOX engine cutoff, before expected and planned MECO, of all three engines. If the engine runs out of the fluids it pumps and uses during operation, that is a real bad day. Well, that little metal pin, only about a half inch long and pretty narrow, was knowingly installed in one of our engines as part of a planned engine maintenance procedure. I installed that pin. Even though the SSME Program accepted a small risk that the pin may come out during operation, because the program felt the probabilities of that happening were slim to none, and approved its installation, it still made me feel horrible because I installed it. Well, after that mission we discontinued use of those pins and any engine that may ever need them. So not only did my loose pin put the astronauts at risk, it took engines out of the program as flight assets. Great. Those were very solemn days after that happened. That was a memorable launch from the negative aspect.

Another one, I think it's STS-101, if I remember correctly. That one was a morning launch in May. Because there's the unique differences of STS-101 and STS-108. 101 was a morning launch, if I remember correctly. Yes. The sun was thinking about coming over the horizon right when we were getting ready to launch, so you get the gradients of colors when you're looking at the eastern horizon, when the sun is starting to warm up and telling you it's getting ready to come over the horizon. You have the darks and then it gets your sunset colors. The backdrop prior to T-zero was just amazing, it was gorgeous, just a whole spectrum of vibrant colors.

Then you have liftoff and it lit up the sky, but since the sun wasn't over the horizon, you're still kind of dark and the plume had a dark tone to it. Then as it got up after a certain point, that plume hit the sunlight and lit up. It just went from the dark, dark gray of the plume being not lit, as if it were like an evening or night launch, and then it just suddenly got lit up as white and as brilliant as you please. And you can just hear the crowd go [gasps], "Wow!"

Then you had the shadow effect streaking towards the west of the plume. So the lower half is dark, not lit. The upper half is lit. The Orbiter's lit. Keep in mind you have that beautiful spectrum of your purples and pinks and everything, and then it's lit in shadowing.

STS-108 was kind of just the opposite as far as time of day. It was an evening launch. The sun was setting. Sun was already behind the horizon or under the horizon, so in the west you had the sunset colors. In the east it was dark, getting dark, getting black, and the Orbiter was cloaked in darkness. As it lit up, it lit up the eastern sky. As it went up, it was cloaked in darkness minus the plume, and then got to a certain altitude where that sun that was over horizon was able to light it up. Again, it was the crowd moment, [demonstrates], and this time you had the plume and vehicle shadow pointing to the east. It was amazing. Those were two of the most visually amazing memorable launches. I probably burned out my camera taking pictures of those.

Then you have Return To Flight, STS-114, all those years of post-*Columbia* work, a lot of emotions, a lot of emotions. I'm getting a little emotional now. Those were the most memorable missions.

And then, of course, this one. I wasn't here onsite for the launch, because I wanted my family to take part in it. I took them to Kars KARS [Kennedy Athletic, Recreation, and Social] Park, an employee park nearby. We went camping in an RV and was able to have my wife and two boys, one going on three, who just loves rocketry, loves his dad; my enthusiasm has kind of infected him. He's all about rockets. He's been to the Visitors Center several times. He's seen launches from Orlando [Florida], which is where we live. But we wanted to be closer than Orlando, so brought them here. Memories of a lifetime right there. All thirty years of the program and then fourteen years of my life went up with that launch, and it was quite an amazing time. Quite an amazing time. I'm sorry; I got a little emotional here.

ROSS-NAZZAL: That happens to all of us. I think it's a sad moment.

RANSONE: Thank you. Thank you. I think that would be it.

ROSS-NAZZAL: I was going to ask you if you had anything else that you had written down. I think we've gone through my set of questions.

RANSONE: I was going to talk to you about my first Dryden [Flight Research Center, California] trip. When the Orbiter can't land at Kennedy, it lands at Dryden, and I was able to go out there. It was kind of like the cradle of aviation out there, one of the cradles of aviation out there, and see the Orbiter where it first used to land. STS-1 landed on that lakebed. To go out there, because I was really geeked-up to go out there and see that. Then you do your job, and a week later the Orbiter is heading home to Kennedy, but just to be part of Dryden history and processing the Orbiter and seeing the desert, going from lush green to brown barrenness and just everything. It was February when I went out there. People think, oh, desert in February, no big deal. I didn't have enough clothes. I felt like I was naked on the runway out there. It's cold.

You're out there in Antelope Valley near Palmdale [California]. I got introduced to desert wind out there, and I didn't like it, and it was cold. It's all just wonderful memories. That's about it.

ROSS-NAZZAL: What do you have to do when it would land out at Edwards? For main engines, what's your responsibility there?

RANSONE: Mainly we do some basic inspections, some real, real cursory inspections to see if there's anything wrong with the engine that would not allow it to go back to Kennedy, and then it's just mainly we're tucking the engines to where we can put the cone on and allowing those engines and the MPS systems and the fuel-feed systems and oxidizer-feed systems and all the internal systems of the Orbiter, they have to be pressurized on the way out. So we have to make sure that our engines can hold that pressure, that the integrity of those engines are where we want them to be. So those are our main priorities out there, to make sure we are configured for the ferry and that the system integrity is there for the ferry, and that's it.

The Orbiter folks have got the lion's share of the work out there. They have to get that Orbiter configured. There's a lot more configuring for them to do to get it to work and go back on that 747 and come out to Kennedy. We just try to stay out of their way.

ROSS-NAZZAL: Sandra, do you have any questions for Eric? All right.

Thank you so much for your time today. We appreciate it.

RANSONE: You're welcome. No problem. I enjoyed it.

[End of interview]