

**NASA STS RECORDATION ORAL HISTORY PROJECT
EDITED ORAL HISTORY TRANSCRIPT**

HENRY TAYLOR
INTERVIEWED BY JENNIFER ROSS-NAZZAL
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ROSS-NAZZAL: Today is August 26th, 2011. This interview with Henry Taylor is being conducted for the NASA STS Recordation Oral History Project. The interviewer is Jennifer Ross-Nazzal, assisted by Rebecca Wright. Thank you again for taking time out of your day. We certainly appreciate it.

TAYLOR: Thank you for having me, and I hope I can provide some good information.

ROSS-NAZZAL: I think so. Steve [Steven R.] Nagel recommended you to us.

TAYLOR: I wondered where it came from.

ROSS-NAZZAL: I asked him for the people he thought were the best candidates. I thought we'd start out by asking you to just give us an overview of your career with the Air Force and then at NASA.

TAYLOR: I started my Air Force career in 1971 working on fighter airplanes, F-4s and 111s, and then became a flight engineer on C-141s. Did that for three years or so and then came to NASA in 1979. At NASA I flew on the C-130 Earth resources airplane, the old Super Guppy, the Shuttle Training Aircraft, and then got on the Shuttle Carrier Aircraft [SCA] in 1989.

ROSS-NAZZAL: How'd you find out about the opportunity to work on the SCA?

TAYLOR: Well, I was already here. The guys that were in charge of our operation, as openings came up, they selected people that were qualified and available to fly, because of background experience. It was like just waiting your turn until somebody retired.

ROSS-NAZZAL: Was that one of the nice posts out of Ellington [Field, Houston, Texas], one of the coveted positions, I guess you might say?

TAYLOR: Yes it is, because it's an interesting program. Back when I first started flying on the Shuttle Carrier Aircraft, more landings were at Edwards [Air Force Base, California]. So we got to do it more often. Later on in the program they tried to land at KSC [Kennedy Space Center, Florida] much more than they did in the earlier days.

ROSS-NAZZAL: Tell us about the training that you had to take to become a flight engineer for the SCA.

TAYLOR: At NASA, when I was selected for the airplane, they sent me to two weeks of systems training, and then I went to the simulator for four, five sessions of practicing procedures, especially emergency procedures in the simulator. Every system on the airplane—it's a very complicated airplane because it's so involved—they would create malfunctions in the flight

simulator of every system, and you'd have to learn how to perform procedures. So after that then I just started flying and took a couple training flights and then became qualified.

ROSS-NAZZAL: In that two-week training period were you out at Dryden [Flight Research Center, California]?

TAYLOR: No. Actually the ground school was done up in Dallas at a company called Dalfort which was part of Braniff Airlines back in the days. They had a simulator, and they had instructors that did ground school. In the simulator I had a United Airlines instructor who came and worked at the simulator. There was like five four-hour sessions in the simulator.

ROSS-NAZZAL: Tell us about being a flight engineer for the SCA. What do you do? What are your job responsibilities?

TAYLOR: The flight engineer is responsible for preflighting and managing all the systems of the airplane. Also I do all performance calculations to say, "Okay, can we take off on this runway; how much fuel are we going to need to go from point A to point B?" Because of temperature and altitude effects on the performance of the airplane as you get higher elevation airports like Edwards or El Paso [Texas] or Amarillo [Texas] or anyplace that's higher elevations and temperature gets higher, the performance becomes more limited. You can't take off with as much weight. So that's the calculations we do ahead of time to plan. Okay, we want to go from point A to point B. How much fuel can we get off with, and can we make it from that point because of it? When can we take off? Sometimes we can only take off early in the morning.

We can go somewhere, but we can't get out of there and leave to go to the next point until it's early in the morning. That's why we fly early in the morning, typically. Also to avoid buildups of weather.

ROSS-NAZZAL: I think originally you had mentioned something about the flaps of the airplane as well—the flap retraction speeds.

TAYLOR: In the performance we calculate the takeoff speeds. We calculate what speed the pilot needs to rotate at. What it's going to climb out at. Based on the weight then you calculate when do we start retracting the flaps after takeoff because you use flaps to create extra lift on takeoff so you have to build up speed before you have less flaps because you got less lift. So as the speed increases on climbout, you retract the flaps in different stages.

ROSS-NAZZAL: So you're busy a few days or a few weeks before these missions?

TAYLOR: On a normal Shuttle mission, about a month before, we do what's called a ferry planning readiness review. That's where it's run by the Shuttle Program Office, and one of the things that needs to be done is create a plan based on the weight of the Orbiter at that particular time and time of year and the availability of airports. How are you going to get it from Edwards to the Cape [Canaveral, Florida]; what days are you going to leave; what days are you going to fly on based on the normal end-of-mission landing time; what time is sunrise, because we can only take off during daylight, but we can take off up to 20 minutes before sunrise. We have to land no later than 20 minutes after sunset. So we calculate when we're going to leave from

Edwards; what fuel stops we're going to make; where we might need to spend the night based on the temperature. The heavier the Orbiter, the more stops we have to make from Edwards to KSC. So that's done at that meeting. Also they review the status of what the Orbiter is going to be.

So that plan is kept until they land at Edwards. After the Orbiter lands at Edwards, then we go out to Edwards a couple days before the actual time we start the mission. We review the plan, get new weather forecast, and then update it as we go. Frequently the plan you've put together a month before launch is no good when it comes time to actually leave because the weather is going to keep you from going to a certain airport. So you have to do it on the fly and replan it real-time like a day before you leave from Edwards. You frequently, as you stop, have to change the plan because you may have gone from point A to point B but you can't get to C so you go from B to D and on from there. You have to change your route based on weather.

ROSS-NAZZAL: You mentioned something that I thought was interesting. You could basically only fly during daylight hours. Why is that?

TAYLOR: It's because of seeing and avoiding weather. We can't fly through thunderstorms. We can't fly through clouds. We can't fly within any more than light turbulence. Because the Pathfinder airplane, which is out in front of us by about 100 miles, is scoping out the route, they can tell us that we need to change our route or deviate or climb or descend. We're limited on altitude with the Orbiter to eight psi [pounds per square inch] and minus nine degrees centigrade, which is 15 degrees Fahrenheit. So sometimes we have to deviate on our route. Seeing clouds at night is much more difficult when you're flying. So unless it's absolutely clear—we have got a

couple waivers a couple times to complete a flight at night when we knew it was absolutely perfectly clear and there was no chance of any problems, but normally we only fly during the daytime.

ROSS-NAZZAL: Is that because of the thermal protection system [TPS]?

TAYLOR: The TPS system, the tiles on the Orbiter, any rain just erodes them like all get-out and causes significant damage, or can cause significant damage. So we don't fly through rain, and we can't be near thunderstorms. So it's just much easier just to see and avoid during the day than at night.

ROSS-NAZZAL: When you're working at these plans a month in advance, you have an idea what the Orbiter weighs. Does that weight ever change? Do you weigh the vehicle once it comes back in case they brought something else?

TAYLOR: No. They don't weigh it at Edwards. What they do is the Orbiter mass properties folks keep track of what the Orbiter is weighing based on propellant uses during a mission and cargo offloaded. Before the mission they have a pretty good idea, approximately, what it's going to weigh if they land at Edwards. Once it lands at Edwards they give us an updated weight that we can use for the final planning. This is just a best estimate of what it's going to be when we do the meeting a month ahead of time.

ROSS-NAZZAL: Tell me where you sit during the ferry flight itself.

TAYLOR: In the cockpit of the 747 you have the pilot's seat, the copilot's seat, and the flight engineer's panel. The flight engineer's panel is on the right side of the cockpit. The seat that the flight engineer sits in swivels and slides such that I can turn sideways and face the panel, which is right behind the copilot's seat, or slide it right up in between the two pilots' seats because when we get ready to take off the pilot just calls for me to set the engine power settings. So I'm pushing the throttles up. He's got his hand on the yoke, and he rests his hand on the throttle so if we have to abort beforehand then he pulls it back. But otherwise he just tells me what power setting to set during the takeoff roll and then on initial climb out and during climb. So typically I sit between the pilots and turn so that I can still see my panel, but it depends on the phase of flight.

Now once we get up in cruise I usually slide my seat back and face mostly my panel. My panel is the size of that board [about 4 ½ feet wide x 3 feet high]. It's full of gauges and switches, which I have to constantly monitor. As we burn fuel I have to burn fuel out of certain tanks at certain times. So I'm maneuvering switches and valves to burn the fuel out of different tanks.

ROSS-NAZZAL: How many tanks are there on the SCA?

TAYLOR: There are four main, one center wing, and two reserve tanks. We normally only use fuel out of the mains and reserves. We don't use fuel out of center wing mainly because the Orbiter just takes up too much weight. The airplane can only weigh 710,000 pounds at takeoff.

So with a 200-and-something-thousand-pound Orbiter we can't put a full load of fuel on. So we never get fuel in the center because you make it too heavy.

ROSS-NAZZAL: Tell me why you would burn fuel out of different tanks. How does that work?

TAYLOR: It's just to manage the load on the wings, to keep the wing loaded right, a certain weight. Certain types are bigger than others. So you start out burning out of all the main tanks. Then you get down to a certain amount, and then you switch over, burn out of the inboards. When you get towards the end of the flight you get lower on fuel so you have to use the reserve fuel and dump it into the tanks to use.

ROSS-NAZZAL: Sounds like a lot of juggling.

TAYLOR: It is a little bit, but it's not too bad.

ROSS-NAZZAL: What are some of the challenges that you might face when you're flight engineer working on the SCA?

TAYLOR: Biggest thing is a lot of performance calculations: the balancing of flap setting for takeoff versus climb limit, because with more flaps for takeoff you're limited by takeoff climb weight more than with the less flaps setting. But with less flaps you need more runway to get off. So it's a balance between what can you climb with versus what can you get off the runway with. That's the biggest pretakeoff challenge. In flight the main thing is just monitoring the

systems, keeping track of what's going on. During Orbiter ferry mission the SCA provides power to the Orbiter, and we have to keep track of that. Every 15 minutes we record the voltage and the amperage of the transformer rectifier [T/R] output to the Orbiter to make sure that the Orbiter doesn't lose power. If part of the Orbiter loses power, then some of the circulation systems and coolant loops become affected. Depending on what the temperature is and where we are, if we lose too much power to the Orbiter, they will say, "Go land," because we don't want to damage the systems on the Orbiter.

ROSS-NAZZAL: That would damage avionics in the vehicle?

TAYLOR: I believe so, yes. We have two gauges. You can either select volts or amps. We have four T/Rs. So keep track of the volts and amps that they're putting out. That tells us the Orbiter's power being used. You can see over flight time. You can see the load on those going up as the Orbiter cold-soaks in altitude. Their systems have to work harder, their coolant loops and pumps work more. So you can see an increase in load.

ROSS-NAZZAL: How many people end up flying a ferrying flight? Is it just the two pilots and the one flight engineer?

TAYLOR: Normally during an active ferry mission, it's two pilots and two flight engineers.

ROSS-NAZZAL: Do you switch off at some point during the flight?

TAYLOR: Sometimes we do. It depends how many legs we're going to do. If there are enough legs so everybody's going to get a chance at the seat then one flight engineer will take a leg from point A to point B. Then the other guy will take it from B to C. The pilots will do the same thing. They'll switch legs. It depends on how many they're going to get. If there's a very limited number of legs, then sometimes people will switch in flight so that one guy will get the takeoff and one guy will get the landing.

ROSS-NAZZAL: I've been in the SCA, I think, once. If memory serves, there's a lounge where there might typically have been seats in a 747.

TAYLOR: In the SCA we retain the seats in the first-class area, downstairs, but nobody rides down there during the active ferry missions. When we go from the Cape back to Edwards without an Orbiter, the mechanics who had been riding on the Pathfinder sit down there. Now upstairs behind the flight deck in commercial 747s there was a lounge area. We have four seats up there, but we don't really use them for day in, day out operations. Everybody's in the cockpit. Also it's very noisy in the airplane aft of the first-class section and in the lounge area where the structure has been modified for the forward support upstairs and then for the other supports in the back of the airplane.

Because all the insulation and all the galleys and all the lavatories, everything's been taken out to reduce the weight, it also gets very cold in the back. So there's a curtain that's put up to try to keep the air temperature not so cold.

Now usually what happens is after takeoff the other FE [flight engineer] goes back and walks through the cabin and looks out at the wings and the engines. When you get to the back of

the airplane you can look out the windows and see the wing of the Orbiter on either side. So look and see if it's still there. I'm just kidding. We just look over it, make sure that there's not something leaking or something going on. We call it a scan. We just go out and walk around, walk through the cabin. Look and make sure everything's okay, because normally you just stay in the cockpit.

ROSS-NAZZAL: That's a cool job, I would think. Have you ever taken anybody on an active ferry flight who wasn't part of the crew? Say the [NASA] Administrator or other visitors.

TAYLOR: We used to take Orbiters from KSC to Palmdale [California] for their OMDP which is Orbiter Maintenance Down Period. We had four vehicles. Because of space at the Cape, they wanted to get work done in California. We'd take them out there, and they'd be out there for like nine months to a year. Sometimes on those missions because those Orbiters were inert, they did not have any toxics on board, they would allow a couple people to go along who were involved in the management of the program. But we just didn't take tourists or anybody who wasn't officially involved in the thing. In other words maybe the ferry manager or the KSC ground operations manager or somebody like that would ride in the airplane. But we don't carry extra people on active ferry missions.

ROSS-NAZZAL: You mentioned the fact that there were toxic substances on board. Are you trained in hazardous materials and things like that?

TAYLOR: We are. In the SCA they used to give us what was called these Scott Air-Paks. It's like a scuba tank that you put on your back. It had a face mask, I don't know if that's the right term, but a mask where you could breathe air from the tank. They gave us this thing called a Draeger checker. It was a sniff checking device that had tubes, and you'd break off the tip and stick it in this pump, and it was for ammonia or hydrazine or whatever.

Normally the Pathfinder lands ahead of us. We land, pull into a remote area, and with binoculars they look to see if anything's leaking, and also they go around and sniff, just like after landing. If you've seen at the Cape, they go around and sniff and make sure there's nothing leaking out. Then they give us the okay to turn the air conditioning on and taxi into the parking spot. If we land without the Pathfinder somewhere, divert the Pathfinder, something happens or whatever, then the other FE has to be capable of putting on that Air-Pak and going out and doing a sniff. I have done that one time before. I know another guy has had to do that because we've landed somewhere without the Pathfinder.

Nowadays they use a small ten-minute breathing supply which is just a hood and a little small tank. It's not as big as it used to be. It's called ELSA [escape pack]. It's just a little breathing pack, but they put enough on for everybody so that you can get off the airplane in case there's a problem, if there's toxics.

ROSS-NAZZAL: Have you ever encountered that other than that one time?

TAYLOR: Only one time I had to go out and do it. I know other guys that had to do it once or twice. But there were never any toxics leaking. We had to do it because we landed. So we take off without the air conditioning, turn it on, and we turn the air conditioning off just before

landing so that if there's any leaks—when you're flying they're all getting blown away, but when you land and you slow down, to make sure that there's no chance of any toxics leaking before we get to safety check, we just keep the air conditioning off. It doesn't take very long after we land for them to check the airplane over.

ROSS-NAZZAL: I didn't know that. Learn something new every day. You told us about the training that you undertook before you became a flight engineer. Tell me about the training that you participate in on a regular basis to keep yourself up on equipment.

TAYLOR: Every six months we all go to the simulator and spend three or four days getting refresher training on systems and also practicing emergency procedures. They'll give us a scenario where they'll give us problems starting engines, systems fails, engine failures on takeoff, aborted takeoffs where you get up to where it's time for takeoff, they fail an engine, then you have to stop and evacuate the airplane. Electrical problems, flap problems, gear problems. All the different problems that can occur on the airplane, we practice every six months.

ROSS-NAZZAL: Where's the simulator located?

TAYLOR: We have been using the simulator at Denver [Colorado]. In the years that I've been on the airplane we went to Seattle [Washington], to Boeing, to the simulator. Went to Pan Am in Miami [Florida] to the simulator. We've been going to the United [Airlines] simulator in Denver. We've used the Evergreen simulator in Denver. Before I got on the airplane they'd use American Airlines simulator. So we've used different simulators. We now have a couple of

guys who do all of our ground instruction and sim [simulator] instruction. They used to be United pilots and flight engineer instructors, and now they work for CSC, which is our contractor. They just lease the simulator for us to use.

ROSS-NAZZAL: For some reason I thought maybe there was a simulator on site or over at Ellington. You also fly the plane on a regular basis too, do you not?

TAYLOR: Yes, we fly the airplane about once a month, three weeks to a month. We go out and do a training flight so that everybody can get their landings and proficiency. We have to fly every 60 days to be current.

ROSS-NAZZAL: How do you simulate a Shuttle being on top of the SCA?

TAYLOR: Through software, the simulator folks created the drag. You can adjust the weight in the simulator. You can change the weight and cg [center of gravity]. So we tell them what weight we want to be at, 710,000 or 600,000 or whatever weight we want to be. Through the software they can change the way the simulator responds because it simulates that we're heavier or lighter. The Orbiter drag is a math model that was created back in the '70s and passed from simulator to simulator. It's a program that we own to create the drag simulation.

ROSS-NAZZAL: When you're not flying an active ferry flight where do you normally take the SCA just to practice?

TAYLOR: Normally we take off from Edwards and sometimes we go up to altitude north of Edwards and just check the pressurization. It all depends on what's been done to the airplane in the last month. A lot of times we just go over to Palmdale and just shoot touch-and-gos and full stops so that each pilot gets an instrument approach, a couple touch-and-gos, a full stop landing and a takeoff. Then they swap seats and we go do it some more. It depends. Sometimes we have just a couple pilots on the airplane, sometimes four or five. Because of people's schedules everybody tries to fly whenever they get a chance.

ROSS-NAZZAL: It must be a dream job for a pilot or a flight engineer.

TAYLOR: Yes, after doing it for a long time, it gets windy and bumpy out there in California. So we try to fly early in the morning before it gets too hot and bumpy. As you can imagine, it's the desert. In the summertime, it's bumpy.

ROSS-NAZZAL: It's hot out there all the time.

TAYLOR: At lower altitude, because we're just a couple thousand feet over the ground as we're in our patterns.

ROSS-NAZZAL: Now that the program has ended, what's happening with the SCA? Do you continue to practice and do simulations?

TAYLOR: We continue to fly the airplane, and we will keep flying the airplane about once a month. Next spring in April is when *Discovery* is scheduled to go to the Air and Space Museum. Once it gets delivered to Dulles [National Air and Space Museum Steven F. Udvar-Hazy Center, Virginia], to the Air and Space Museum, we'll pick up *Enterprise* and take it to New York. Now the equipment that they're going to use at Dulles after it gets loaded has to be torn down and shipped to New York. So it'll probably be four to six weeks with *Enterprise* sitting on the 747 in New York before that equipment gets there to take it off. After *Enterprise* gets taken off in New York, then the airplane will go back to Edwards. Then in the summer *Endeavour* will go. We'll take the airplane back to Florida, pick up *Endeavour*, and then fly it out to LA to deliver it to California Science [Center]. That's it. Then after the Shuttle Program is done delivering all the Orbiters to museums, the airplanes are scheduled to be transferred to the SOFIA [Stratospheric Observatory for Infrared Astronomy] Program.

ROSS-NAZZAL: What is the SOFIA Program?

TAYLOR: SOFIA Program is an airborne telescope in a 747 that is a different model. It's called an SP; it's a shorter model. It has a telescope in it. It's an infrared telescope. I've flown on it some too. It's operated by Dryden out at Palmdale Airport, which is just around the corner from Edwards. They take off in the evening and fly for ten hours all night and go up and look at whatever scientific investigations they want to do. It's a large infrared telescope. You can Google SOFIA, and you'll see lots of pictures about it. It was bought from United Airlines years ago and took many years to modify. It's starting to do its science flights now. They're doing more and more flying with it.

ROSS-NAZZAL: Will the SCA have to be modified again?

TAYLOR: No, they're not going to modify the airplane. They want the engines as spares for their program. Use the same engines as we do and any parts they may need. So the airplanes probably won't fly anymore, but they may find use for one. Now they may use one for currency, because they can't go fly currency flights in that airplane because of the very, very expensive telescope and the cost to operate that airplane. They don't want to take any chances just doing touch-and-go landings with it. They only want to do mission flights. There are people who call from time to time that are interested in possibly using the 747s to carry something or to do something. They call us up, or they write us an e-mail. I tell them, "Okay, it's going to cost you this much to operate the airplane," and they say, "Oh, okay, thanks."

ROSS-NAZZAL: Never mind.

TAYLOR: So we get calls from time to time, people wanting to do projects. As far as I know, unless something changes, after the Shuttle Program is done delivering, everybody says, "Yea verily we're all done," and [NASA] Headquarters [Washington, DC] put out a memo a couple three years ago says the airplanes will be transferred to SOFIA to reduce their cost so they won't have to go buy more engines or anything like that.

ROSS-NAZZAL: How many people used to work on the SCA as pilots and engineers? And how many have you retained now that you're done?

TAYLOR: Right now we have two pilots at JSC [Johnson Space Center, Houston, Texas]. We used to have six pilots and four flight engineers throughout many years, four pilots at Houston and two pilots at Dryden. All four flight engineers were in Houston. Now with retirements and this and that and the other there are two pilots at JSC that are civil servants, and there are two qualified flight engineers at JSC. There's one ferry-qualified civil servant pilot at Dryden and one civil servant pilot who can fly the airplane but is not certified yet for ferry operations. We have one contract flight engineer who used to be a civil servant, and one guy in training. Within the last few months, they hired as a part-time contract pilot one of the former civil servant pilots from JSC, who's now retired. He's also going to be flying SOFIA part-time. Then we hired another guy part-time to be an SCA pilot.

The one guy who used to work at JSC and retired, he was on the airplane for a number of years, probably 20 years before he retired. We had two people retire within the last year and a half or two years from JSC that cut into the pilot pool significantly.

ROSS-NAZZAL: You all work on other planes and other projects.

TAYLOR: Everybody flies something else and has multiple things that they do. So it's not just the only thing to do.

ROSS-NAZZAL: You're the chief flight engineer for the SCA. Can you tell us about that?

TAYLOR: Basically I provide the standardization for all the flight engineers. I administer the evaluations to determine when somebody's qualified. I just manage the flight engineer part of the operation. I do just about all the performance planning for these ferry mission readiness reviews. Just a point of contact for all the FEs.

ROSS-NAZZAL: You had talked earlier about the ferry readiness reviews and how long in advance you had started working on those. Can you tell me who else is involved in those ferry readiness reviews besides the pilots and flight engineers?

TAYLOR: Well, there's a guy who works in the Shuttle Program Office named Don [Donald L.] McCormack, which I think you've talked to or answered some questions. He has been the ferry manager for the last number of years. He runs the ferry planning readiness review. He has folks from all different parts of the Shuttle Program Office that answer to him about the Orbiter configuration. He has DoD [Department of Defense] folks that respond to him for the status of our approved airports to go to. He talks to the KSC processing folks to say they're ready to support. Basically it's just a review of what the status of the Orbiter is. Is everybody ready to do a ferry if we have to? What is the configuration of the vehicle? He's the manager of that program.

Now once we get out to Edwards to start a ferry mission, then he's coordinating with the weather folks. He's coordinating with all the processing folks to say when we're going to be ready to go. Then we as the SCA crew provide him with plans on how to get there and how we recommend going. Also the weather folks who are saying, "Yes you can go from point A to

point B but then you're not going to get any further than that until three days from now when this weather system gets out of the way." So he's taking a lot of inputs to manage the ferry mission.

ROSS-NAZZAL: You mentioned that things change, things are moving along on the fly, if you encounter weather for instance. Have there ever been times when you've just really had to go way out of the way, very far up north, out of the way from KSC because of weather?

TAYLOR: Well, recently—I say recently—within the last probably two, three, four years, on a ferry mission we went from Edwards to Amarillo to Nebraska to Fort Campbell, Kentucky, to get to KSC, because there was a big blob of weather. It was just constantly staying and evolving over the Texas, Louisiana, Alabama, Mississippi area. So we had to make this big circuit. Plus the Orbiter was quite heavy so we could only just make short hops. So we've had to go all that way to get around to get to KSC.

One time from KSC back to Edwards we flew from KSC to Missouri and then from Missouri to California to get around weather. You can imagine the Gulf Coast, which is the shortest way to get from Edwards, typically in the summertime or sometimes in the spring you can have a lot of weather issues with thunderstorms. We try not to go anywhere where it's going to be any bad weather while we're there. In other words if we can fly from point A to point B today, but it's going to be bad after that we don't go because we don't want to go somewhere and get stuck without being able to get out of there.

ROSS-NAZZAL: What's the typical flight path that you might take from California to Florida? Or is there one?

TAYLOR: Depending on the weight of the Orbiter and how many stops, typically it'd be from Edwards over the Southwest part of the country over the El Paso area and land somewhere in Texas, either San Antonio, Fort Worth. We used to go to Abilene to Dyess Air Force Base or to Oklahoma, and then go in.

Now that's for the Orbiter that's like less than 200,000 pounds. We can usually do that and make two legs: one from Edwards to someplace in Texas and then on to Florida. But with a heavier Orbiter you're going to make at least three stops, three legs, and sometimes even four. We try to stay further south, if we can, just to cut off distance and cut down stops. We try to do it as safely, as efficiently, and as quickly as possible to minimize the time that the Orbiter is not protected.

In other words it's not in the building at KSC or it's not at Edwards. It's not protected by a building at Edwards, because it's in the mate/demate facility out there. Generally the weather is pretty decent out there. It's dry. It's not going to get rained on very much. They really don't like to get rain on the Orbiter. That's what we're trying to avoid. The goal is to do it as quickly as you can, as safely as you can and as efficiently as you can.

ROSS-NAZZAL: You primarily land at DoD sites?

TAYLOR: Military bases, just about all the time.

ROSS-NAZZAL: Why is that the case?

TAYLOR: Security, support capability. There's a lot of people on the Pathfinder. There's probably a team of 30 people or something on the Pathfinder, or more. So if we spend the night, everybody's got to get vehicles, hotels. The military provides security, because the Orbiter has to be roped off. It has an entry control point where they have armed guards, and nobody can get within 200 feet of the 747, unless they're on the access list. The only people on the access list are the 747 crew and some of the ferry team members that have to do stuff with the airplane or the Orbiter.

ROSS-NAZZAL: Who is on the Pathfinder? Tell me a little bit about that.

TAYLOR: You'll have weather officers. You'll have a ferry manager. You'll have all the KSC support personnel. You'll have the 747 mechanics. You'll have the Pathfinder flight crew and maintenance crew. You'll have safety folks. You'll have security folks. It's a big crowd. It's typically 30, 35 people on an active ferry mission on the Pathfinder.

ROSS-NAZZAL: As you're coming into a landing, who needs to be there? What are your duties as you're landing the vehicle?

TAYLOR: The Pathfinder is there ahead of time, so they have things set up. The airport or the base knows where they're going to put us, because it's all been coordinated. When we land of course we have safety vehicles like fire trucks and ambulances standing by. We land, and we go to the spot where they're going to check and make sure we're safe with the sniff checks and then we go to our parking spot.

The mechanics are there. They're ready to marshal us into the parking spot and put chocks around the gears so that we know it's secure and won't roll once we park and shut down the engines. So we really don't have anything to deal with, other than just getting to the spot.

ROSS-NAZZAL: Once you've landed are you greeted by press? Do the media want to do interviews?

TAYLOR: Yes, media wants to do interviews. Of course any base we go to, the commander of the base always seems to have an entourage he wants to bring out. Once we've declared that the vehicle is safe, and it's okay with the ferry manager, then they'll let select people come inside the 200-foot rope for tours. So we sometimes have to hang around to give tours of the airplane, just short ones. If we're on a turnaround mission, there's not a lot of time. If we land somewhere, going to just refuel and leave, we're only on the ground a couple hours. So we're busy from the time we land to the time we're ready to leave. There's not a whole lot of time for show-and-tells. If we spend the night somewhere, depends on how long our day has been too, and when we have to leave the next day, how long we can stay out there and provide tours and show-and-tell for people to come see. It's just an empty airplane but people like to walk up the stairs to the doors and that way they can get a closer look at the Orbiter. Of course everybody wants to take pictures.

ROSS-NAZZAL: It's a cool thing. When you're not around it every day, I think that that's pretty cool.

TAYLOR: It's an iconic symbol. It's an American icon, the Orbiter on top of the 747. When we land at bases, there are so many people around, on the highways nearby, to watch us come in, it's just amazing, especially if it's been well publicized in advance that we're coming in there. It's released to the news media, and they start putting out the information. Here comes the herd of people. Of course a lot of them can't get on the base, but they get as close as they can to see. Some bases it's much more receptive to people being able to get close by and see. Others are out in the middle of nowhere, and there's not that many people anywhere. Go to Abilene, there's not many people that get close to the base, because it's out, it's way away. Versus you go to Fort Worth, to what used to be Carswell Air Force Base, and there are just people everywhere around there. Thousands of people parked on the sides of the roads. Depends on which way we're landing.

ROSS-NAZZAL: Has the SCA ever flown into Ellington?

TAYLOR: Yes. We have never brought an Orbiter that landed from a Shuttle mission, because of the weight and the toxics, but we have brought inert Orbiters through. *Challenger* came through on its first flight in 1982. After STS-4 [*Columbia*] landed, it landed in California, [President Ronald] Reagan was there to greet the crew. He gave a big speech at Dryden. *Challenger* already was loaded up on the 747 and took off from the lake bed over the crowd at Dryden and then came to Houston and stopped and then left and went to KSC on its initial delivery flight to KSC. We brought *Endeavour* on its maiden trip when it came from California. We brought it through Ellington. *Atlantis* came through Ellington also when it was new.

We've had other vehicles. We brought *Columbia* through. I'm pretty sure *Discovery* has been through. I'd have to look at my records to see which ones have come. *Enterprise* came through when it was being flown around to go to KSC for testing. Of course it never went to space. But *Enterprise* has come through back in '78 or something like that, '79.

ROSS-NAZZAL: That's exciting for people who work on spacecraft here.

TAYLOR: A couple years ago on the way from Fort Worth we did a flyover of the JSC area in December.

ROSS-NAZZAL: I remember that.

TAYLOR: But we couldn't land because of the weight. We did a couple circuits around the JSC area and a couple flybys at Ellington. We did a flyby at Intercontinental Airport on the way to Louisiana. It just worked out to where we could route it that way. Any time we're flying a ferry mission, we get lots of calls to try and do flybys. That has to be approved by the Shuttle Program, because they control the Orbiter.

We don't decide where to do flybys, the SCA crew. We get told we'd like to do a flyby here or there, because they manage that risk. We just fly it when they tell us to. Now with the JSC flight, we worked out a little route. They just say, "Do a flyby at JSC."

ROSS-NAZZAL: That was neat. I do remember that, going out, getting that e-mail. How many missions have you flown from Edwards to KSC? Do you know offhand?

TAYLOR: I don't know. I'd have to look, but I would think probably 40 or more just guessing. That includes some KSC to Palmdale flights too so probably 40 plus missions total since '89.

ROSS-NAZZAL: What was your final ferry flight that you did?

TAYLOR: Last one, let's see. I don't have my records here to know the last one I did. When was the last time we landed at Edwards?

ROSS-NAZZAL: I was trying to think about that this morning.

TAYLOR: 2009?

ROSS-NAZZAL: Probably, yes, it's been a while, because they try to land at the Cape.

TAYLOR: We did that *Endeavour* flyover in 2008, December '08 I think it was. Then it was the following year. So it's been a couple years.

ROSS-NAZZAL: What are some of the more memorable ferrying flights that stand out in your memory?

TAYLOR: The first one that I did, when I walked out to do the preflight on the airplane at Kelly Air Force Base [Texas], I walked around and said, "Wow!" So to get to do the first one that you

did. Then the one where we flew *Endeavour* flyover was special because of getting to show people. One time we went to Salt Lake City [Utah] on the way to Palmdale, and there were just thousands and thousands of people lining the roads. We got there a little late because of some Pathfinder issues. Military airplane had problems. It was late in the afternoon, and people were using their flashes as we flew over at 1,500 feet, trying to take a picture of this airplane flying over. We circled the area quite a bit. There was just thousands of people.

Then the next day we delayed taking off for a while. They had a bunch of schoolkids come out, gave tours, TV and stuff. They're all special. The first one, and then each one is unique, and each one has some special stuff to it. It can be very tiring because you're getting up very early in the morning. You typically have a long duty day, because we show up for briefing two hours before takeoff, and that's 20 minutes before sunrise. So when you leave Dryden, it's 45 minutes from town to Edwards. So you're looking at a pretty early getup.

ROSS-NAZZAL: That's like 2:00 in the morning? If you're on Houston time, that's four. How long would your day typically be after you flew?

TAYLOR: Our duty day is 14 hours. So from the time we show up to the time we leave the airplane can't be more than 14 hours.

ROSS-NAZZAL: How many hours does it take to fly from Edwards to the Cape?

TAYLOR: Well, it depends on how many stops we'll make. If you just make one stop, it's about—I'm going to round it up—it's about seven hours. It's about three and a half hours from

Edwards to Kelly, and then about three and a half more from Kelly to the Cape, depending on the tailwinds. So you got two, three hours on the ground at Kelly. You got a couple hours on the ground at Edwards. Then when you land you've got to stop on the runway. They got to do the safety check. Then they got to tow us in the mate/demate facility. We get off right before they tow us into the facility. So it can be two plus seven plus three plus an hour. So easily 12 hours, if the weather is good. Now that's if we just land and refuel and go. If we have to spend the night, then you add a couple more hours onto that each way.

ROSS-NAZZAL: How many gallons of fuel does the SCA use typically on a flight?

TAYLOR: Depends on the weight of the Orbiter. The airplane, the lighter it is, the less fuel it uses. On a typical end-of-mission ferry weight it averages about 38,500 pounds per hour. Now divide that by 6.7. I'm not going to do that in my head with the recorder going. If you divide 38,500 by 6.7 that'll give you the gallons per hour. It burns about 130 pounds per nautical mile of flight. So it's burning 20 gallons every mile, something like that. Is that right? If it's 130— I'd have to do the math.

ROSS-NAZZAL: That's a lot of fuel. That adds a lot of weight too.

TAYLOR: It's not fuel-efficient. We're flying low because the Orbiter has altitude temperature restriction. So if we could fly higher with the Orbiter we could use less fuel. Eastbound is 15,000 feet typically, and we average about 38,500 over a three-and-a-half-hour flight. That's a good round number.

ROSS-NAZZAL: Tell me just in general how the 747 was modified.

TAYLOR: The airplanes were modified by Boeing. Inside the airplane, where the aft attach point is, there are two bulkheads that go down into the belly of the airplane that support the weight where the Orbiter is mounted, both in the vertical mounts, and then there's a horizontal mount that goes forward of that. So there's a bulkhead there. There's also one for the front mount. There's also extra layers of skin added in various stress points throughout the airplane. Two and three layers on the outside of the airplane in places where the engineering decided that's where the stress is going to be.

ROSS-NAZZAL: That skin, is that extra aluminum?

TAYLOR: Yes.

ROSS-NAZZAL: Now NASA has had two SCAs over the years. I think in your notes you had mentioned you went out to Wichita [Kansas] to oversee some of those mods [modifications].

TAYLOR: The second airplane, the modification started in '88. It was finished in late 1990. I was also working in quality assurance. So I spent some time at Wichita, as did other people, monitoring that contract, and looking at the work that was being done. Its first time carrying the Orbiter was when we carried *Endeavour* on its maiden flight out of Palmdale. I was on that first

takeoff. So that was interesting. The first time we used that 747, and the first time that Orbiter had flown, that was a memorable flight too, that first time with that one.

ROSS-NAZZAL: Does NASA still maintain both of those SCAs?

TAYLOR: Both airplanes are currently maintained, although probably in the next few months we're going to have one just in final storage because we just will need one to take Orbiters to museums.

ROSS-NAZZAL: Is the SCA used for anything else besides the SOFIA program and the Orbiters? Is there anything else that NASA uses the SCA for?

TAYLOR: It's not currently used for SOFIA, but it's supposed to be transferred to them for use. Now we a couple years ago, actually a year and a half ago, we carried an unmanned vehicle called a Phantom Ray from St. Louis [Missouri] to Edwards for Boeing. We did a flight test to determine how that vehicle would respond. Because it was unmanned, they were not allowed to fly it from St. Louis to California over the populated US on its first flight. They didn't have the flight facilities in St. Louis where they could do it. They wanted to do it in California. So over a many-month period they designed an adapter to mate to our mounting points. Then they mated their vehicle to that adapter, and we flew it nonstop from St. Louis to Edwards for them.

First of all we did an hour flight test with a photo-chase airplane to see how it would handle, because there's some unknowns. Then we did some inspections to make sure it hadn't caused any problems. Then the next day it was like a 5.8-hour flight from St. Louis to LA,

because we did it low at altitude and reduced speed. You can Google that. It looks like a little mosquito on top of the airplane. It was like 30-something-foot wingspan. With the adapter it weighed like 30,000 pounds. But it's an interesting picture.

ROSS-NAZZAL: I'll have to go out and look at that.

TAYLOR: It made the national news on the day we did the flight test. Flying around St. Louis. It's interesting-looking, it's like a little bug.

ROSS-NAZZAL: Not quite as big or as heavy as the Shuttle.

TAYLOR: We've had requests to do other things with the airplane. Mostly it's just been used for carrying Shuttles.

ROSS-NAZZAL: It's been that workhorse for all these years.

TAYLOR: That's its job. Don't want to take any chances on anything happening while doing something else. They agreed to use it for that Phantom Ray project, because we still had two airplanes. There was a time period where we could do that.

ROSS-NAZZAL: I guess I do have one other question that I hadn't thought about. Obviously the Shuttle, you didn't always know where you were going to land because of weather. So were you

ever working on the possibility of it landing at Edwards, and it didn't end up landing there, but you had to be prepared in case there was that contingency landing?

TAYLOR: Right. Every mission we would put together a plan just in case. The Shuttle Program would be looking at the weather ahead of time and trying to decide whether to activate Edwards, to have it ready just in case, because the forecast at the Cape was bad. So we would be actively working on plans, especially sometimes during a Shuttle mission. To say it's looking more and more like they might go to Edwards so we'll sharpen our pencils.

ROSS-NAZZAL: How far in advance do you have to be out at California? Or do you wait a couple days?

TAYLOR: We usually go out at least a couple days ahead of time. At least one day before they're scheduled to ferry we have the part B of the ferry readiness review. That's when the ferry manager gets all the people from KSC and all the folks at Edwards that are—of course KSC folks go out to Edwards to process the vehicle. He gets everybody together and has a big long meeting about the status of the Orbiter, when we'll be ready to ferry. He gets a weather briefing from the weather folks to talk about okay if we're ready tomorrow we'll plan to take off at this time, and this is where we'll go. We, the SCA, are all involved in that decision process.

Frequently the weather briefing says ain't going to happen. Or the folks processing the Orbiter say, "Well we were supposed to be ready tomorrow, but we're not going to be ready tomorrow," or "We're not going to be ready for an early morning takeoff, but we'll be ready in the afternoon." Well, what does that do? Do you decide well, we're just not going to try to

leave late in the afternoon because it really doesn't buy us anything. We'll wait till the next morning.

ROSS-NAZZAL: If you have to delay do you just come back to JSC?

TAYLOR: No, once we go there we stay there till we leave. I have gone out and spent anywhere from one or two days to a week waiting to leave. Once you get out there there's no reason to turn around and come back. You just stay until you're ready to leave.

ROSS-NAZZAL: Well, I tried to be pretty thorough. But is there something you think I may have overlooked about ferrying operations or the SCA or any anecdotes or stories that you would like to share?

TAYLOR: This is a personal one. It's a very sad time for me, to see this come to an end. To me, it's such a wonderful program. I just hate to see it come to an end. There has been a lot of discussion about as we take them to museums should we do any touring around, make several stops on the way to each museum. Yesterday there was a meeting at Headquarters, and they decided not to do any extra flying around for a variety of reasons although the White House may push back on that. I'm not sure how much I should really say about that, because the Headquarters, White House, there's going to be going back and forth about that.

What they call the Executive Council, which is the Administrator and all the wheels and all the Center Directors, they have this NASA team. They decided they didn't want to expose the vehicles to any more hazards than necessary as they take them to museums. Plus there's

some cost issues which are not trivial. It'll be great for people to see them in museums, but I don't think it's time. My personal opinion, not an official NASA opinion, my personal opinion is we shouldn't have retired them this early. That's how that goes. I sure wish they were still flying.

ROSS-NAZZAL: A lot of people we've interviewed for this project have talked about that.

TAYLOR: It's bittersweet. It's a sad time. I spent my whole life. I came to work a year and a half before the first Shuttle launch. I'll be here probably for a year and a half after the last landing—it won't be the same.

ROSS-NAZZAL: It's changing the Center, that's for sure.

TAYLOR: Well, it's changing not just the Center but the agency.

ROSS-NAZZAL: Did you get a chance to see the launch of STS-1?

TAYLOR: First launch I went to was STS-3. First landing I watched was STS-4 at Edwards. Then I've been to a lot of launches and landings since then. One of the other airplanes I've flown is the Shuttle Training Aircraft, which is a modified Gulfstream II which has half the cockpit like the Orbiter, half like a regular airplane. We used it to train Shuttle pilots to land the Shuttle. So I started flying with it in 1981.

ROSS-NAZZAL: So you trained Steve Nagel, I guess.

TAYLOR: Took a lot of bananas but we got him trained.

ROSS-NAZZAL: I think he talked to us about that a little. Well, I thank you very much for your time today. I certainly appreciate it.

[End of interview]