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Interviews of Gulfstream Personnel (October 2011)

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NATIONAL TRANSPORTATION SAFETY BOARD

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Investigation of: *
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AIRPLANE ACCIDENT *
ROSWELL, NEW MEXICO * Docket No.: CEN11MA258
N652GD *
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Interview of: SHELLY BRIMMEIER

Gulfstream Corporation
500 Gulfstream Road
Savannah, Georgia

Tuesday,
October 25, 2011

The above-captioned matter convened, pursuant to notice, at 9:38 a.m.

BEFORE: WILLIAM J. BRAMBLE, JR., Ph.D.
Senior Human Performance Investigator

APPEARANCES:

MITCHELL GALLO
Air Safety Investigator
National Transportation Safety Board
31W775 North Avenue
---------------------s 60185

WILLIAM J. BRAMBLE, JR., Ph.D.
Senior Human Performance Investigator
Office of Aviation Safety
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

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ALAN J. (JEFF) BORTON
Flight Test Pilot
FAA Aviation Safety
Aircraft Certification Service
Wichita Aircraft Certification Office
--------------------Room 100

THOMAS M. RAMEE, ESQ.
Deputy General Counsel and Risk Manager
Gulfstream Aerospace Corporation
500 Gulfstream Road, M/S B-06

TOM HORNE
Experimental Test Pilot
Gulfstream Aerospace Corporation
P.O. Box 2206, M/S A-12
Savannah, GA 31402-2206

APPEARANCES (Cont.)

JOHN O'CALLAGHAN
Aircraft Performance Group Chairman
Vehicle Performance Division (RE-60)
Office of Research and Engineering
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

-

MICHAEL BAUER
Aerospace Engineer
Vehicle Recorder Division (RE-40)
Office of Research and Engineering
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

E. LORENDA WARD,
Air Safety Investigator
IIC and U.S. Accredited Representative
Office of Aviation Safety
Major Investigations (AS-10)
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

MARIE MOLER
Mechanical Engineer
Office of Research and Engineering
Vehicle Performance Division
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

I N D E X

I N D E X (Cont.)

I N T E R V I E W

(9:38 a.m.)

DR. BRAMBLE: Let's go on the record.

INTERVIEW OF SHELLY BRIMMEIER

BY DR. BRAMBLE:

Q. Could you please state your full name?

A. Shelly Kay Brimmeier.

Q. Last time we spoke with you you mentioned that you had worked for an aerospace company I think prior to Gulfstream?

A. Only as an intern, my full time experience is all with Gulfstream.

Q. No other manufactures, like civil manufactures?

A. No.

Q. In what other areas of G650 flight test besides field performance testing have you been directly involved, if any?

A. I have been a part of data review for the low speed drag testing. Kind of on the outskirts but we are interested in the results of the data. So we have, you know, been involved with those discussions. That's the only one I would say I have, you know, in-depth exposure other than just knowing that the tests are going on and eventually receiving the reduced data from other groups, not directly from Flight Test.

Q. If you could, can you give us an overview of what the Aero Performance group's responsibilities are during the field performance flight test program as distinguished from the flight test engineering group?

A. Do you want me to only highlight the performance group's responsibilities?

Q. I guess what I'm after is sort of what your understanding is of the role of the Aero Performance group during the actual testing portion of the field performance test program and maybe sort of in between major test effort.

A. Okay. Well, the field performance testing was all scheduled in one continuous block of time in a couple different phases. So our responsibility from the performance group side was to provide speed targets and be sort of a secondary look at the data as it was being collected real-time.

As far as the data collection effort, you know, we were just there as an observation and the intent was we were on site in Roswell to help with data review and help with data reduction both of those alongside of the flight test engineering group.

Our primary responsibility is once that data is reduced understand how it was reduced from the flight testing so that we can expand it the same way to use for the flight manual development.

From field performance test we are primarily doing testing for takeoff and landing.

Q. In your role as the lead aero performance engineer for the field performance testing did you supervise anyone or do performance reviews or were just serving as technical lead?

A. Just as a technical lead.

Q. Were you involved in selecting the aero engineers who were going to work on site at Roswell during the testing with you or --

A. I was. We had intended to set up the group that would go out in order to rotate most of our performance group through the flight test experience so they could learn what we do while we are out there. This is a test that we only do once every seven or eight years. So there is not a lot of exposure. So we had intended to have a rotational schedule for the entire department which at the time consisted of nine people.

Q. Who were the other aero performance engineers in the trailer at the time of the accident?

A. Eric Upton and Mobolaji Adeisa.

Q. Were these individuals sort of relatively new and sort of gaining experience?

A. Eric had been with the group for a little while. He had also been in a different department. So this was his first experience with, I say the 650 program was his first experience since he was there in Roswell-1 and in Roswell-2.

Q. First experience with field performance?

A. With field performance testing. And then Mobilaje had worked at another aircraft manufacture. He was relatively new to our group, less than a year with our department and was not primarily working on the 650 program. And really he showed late the evening before the day of the accident. So his exposure was very limited to the testing at Roswell.

Q. What was his role at the time of the accident? Was he just observing?

A. Observing. The three of us were all in the telemetry trailer as observers.

Q. So all three of us were considered observers?

A. I would say that my responsibility was probably a little higher than observation. If there was a request to cross check data, targets, speed targets it was my responsibility to confirm that they were using the right numbers.

Q. Something we neglected to ask last time. When did you arrive in Roswell?

A. I'd have to look at a calendar.

Q. It wasn't the day before?

A. It was not the day before. I had come out right after the St. Patrick's Day weekend. Not after the St. Patrick's Day weekend, a week after that. I think I arrived on March 27th and was there for most of the week prior to the accident.

Q. Did you feel that the team in the TM trailer on the day of the accident was sufficiently experienced to provide full support to the onboard test crew during high risk skill performance testing such as the testing conducted during Flight 153?

DR. BRAMBLE: Do you need to go off the record?

MR. RAMEE: Yeah, let's go off the record.

DR. BRAMBLE: All right. Let's go off the record.

(Off the record.)

(On the record.)

DR. BRAMBLE: Back on the record.

MR. RAMEE: Do you need the question re-read?

MS. BRIMMEIER: Can you, yeah, re-ask the question?

BY DR. BRAMBLE:

Q. Did you feel that the team as a whole in the TM trailer on the day of the accident was sufficiently experienced to provide let's say adequate support to the onboard test crew during high risk skill performance testing such as the testing conducted during Flight 153?

A. Yes. At the time it was understood that the team trailer attendees were there for test support and test conduct was really isolated to the crew onboard the aircraft as for being required.

Q. Who was in charge of the telemetry trailer during testing?

A. The test conductor was Cynthia Townsend.

Q. Was Reece Ollenburg also considered a test conductor?

A. He was the primary test conductor since he was onboard the aircraft, in my understanding. I don't know if there is a set hierarchy.

Q. How are people trained for their roles in the TM trailer?

A. I wouldn't say that there formal training. From the performance group stand point we had discussions about what parameters were we watching, what would be the parameters like speed and pull forces that we wanted to watch for verifying that we were meeting our targets.

Q. Was there a --

A. Actually I have something else to add on that because there is a written procedure of how to act in the telemetry room/trailer. So there are some guidelines and it's basically, you know, how to act, how to be professional that there is not, there is an expectation that you are not distracted by other things while you are in the telemetry trailer or telemetry room. So there is sort of a flight test documented process, list of rules.

Q. Is that a standalone document or is it part of something else?

A. I don't know that it is part of anything else. When I saw it was kind of a one or two pager that was handed to me.

Q. Did you get some kind of on-the-job training earlier or did other members of the team before they actually were in a functional role get on-the-job training like Adeisa was observing --

A. Yeah. We had reviewed flights that were not field performance related, you know, to basically use the IAD software that we were going to be using to watch the data streaming real-time. That's the only training, on-the-job training that I would say that we really did.

Q. Who in the TM trailer was responsible for monitoring maximum pitch, if anyone, to make sure that the airplane wasn't approaching the limit defined by Mr. Ollenburg during the preflight briefing or was that even a TM role?

A. It wasn't necessarily defined. I know me personally I was trying to watch that as one of our key parameters, but there wasn't a defined role of somebody to warn that we were getting close to a limit.

Q. One thing that was observed as we reviewed a lot of the flight test video was that sort of a discussion shifted from discussing angle of attack to pitch angles and it seemed like discussions of angle of attack dropped off somewhere in the eighties of the flights that we had. So I was wondering why did the terminology change from angle of attack to pitch. Is that because they were very close together, near the ground or?

A. I believe for field performance testing it's more of what is indicated to the pilots in the cockpit so in saying that we wanted to target a pitch that was an indication that the pilots had available to them in the cockpit. They don't have angle of attack readily available. I think it's a very small number on a side corner of an indication, but not something that's one of their primary instruments to watch.

Q. Are the two fairly close together during the takeoff rotation?

A. They are during the rotation and as you, as the aircraft lifts off and climbs out then they start to separate.

Q. Would your answer about who was assigned to monitor the pitch relative to limits be the same if I was to ask whether there was anyone assigned in the TM to monitor maximum AOA relative to AOA limits?

A. Yes. There was not one key person assigned. In general I think, you know, several of us were watching but there was no primary responsibility for any one person.

Q. You mean there was no primary person assigned?

A. Right. Yes. Primary person assigned and with that responsibility.

Q. What role does Flight Sciences, I should say Aero Performance in Flight Sciences play in encouraging flight test to meet performance targets?

A. We were defining the performance targets, defining the speeds, working with flight test develop the takeoff technique and understand what speeds were coming out of the results of the testing. I would say or responsibility was to work with flight test very closely to try to meet speed targets.

Q. If you were having difficulty meeting the speed target then how did you know how long to continue trying to meet it and when to stop speaking, I guess we should narrow that down to V_2?

A. Are you looking for a defined procedure?

Q. I guess if there is on or I mean how is that decision made about when you have got enough runs for a particular test?

A. I'd say that we didn't have --

Q. If you can't meet the V_2?

A. I would say that we didn't have a defined procedure and the intent of the testing was to, specifically that we were doing -- the day for Flight 153 was to make a lot of takeoff runs and come back and reduce the data to see where the data was falling. The definition of when to meet a V_2 speed that was not a defined process.

Q. The definition of when to meet a V_2 speed; is that what you said?

A. Yeah, there was not a defined process of when have we met our test criteria other than the speed targets that were lined out in the test plan, which was plus or minus 2 knots. Actually that was V_R plus or minus 2 knots. We were using I think plus or minus 2 knots for V_2 speeds as well.

Q. Was there any kind of plan where if you couldn't -- I mean, so you had that criteria V_2 plus or minus 2 knots, but was there any plan as far if you couldn't meet it, like how many tries you would make without succeeding under which conditions?

A. The plan for that day was to do about three runs for each test condition and that was sort of a global let's collect data and see where the speeds are falling out when we reduce it.

So I don't have a criteria other than we were doing about three runs of each configuration to try to target the target speeds and the performance that we had laid out.

Q. So in reviewing the information that we have it appears that Reece was the cognizant FTE for field performance, that he was the onboard test conductor for the takeoffs, and that he was the data analyst and report writer for V_{MU} and possibly for additional tests. Did you have any concern about whether that was too many responsibilities assigned to one person for the time frame that he had?

A. You know I think that we all had a lot of responsibilities loaded on our plate and I'm not sure that I would highlight any one person as being overloaded.

Q. How did Gulf Stream's flight test organizational structure policies and procedures conform to the 1998 flight test practice manual?

A. I can't really comment on that. I'm not closely, you know, I don't closely know what's in that document.

Q. Are you aware of a test requirements memo that was provided by aerodynamics group to flight test for the free air stall testing?

A. No, I'm not familiar with what would be in that document.

Q. Do you know why a similar document wasn't developed for the field performance testing?

A. During the course of the 650 program we were asked to write test requirement documents for each of the test plans that needed to be written and tests that needed to be conducted. During the course of the development of the 650 program our test requirements document was for field performance I think was drafted not by me. And we didn't get very far into the details before we started just coordinating our requirements of what needed to go into the test plan for field performance with Reece directly. So Pat Connor, myself and Reece primarily just set up meetings to develop the field performance flight test plan rather than writing a test requirements document.

Q. So the field performance test plan sort of took the place of a test requirements memo or document?

A. Yes. We felt that a lot of it would be, you know, we would set up the same requirements that were then going to be written into the test plan and we decided to collaborate on that effort rather than duplicate it. It was just a way of us working together.

Q. As opposed to with applied aero in the stall testing, applied aero developed the document and then handed it to flight test and said now, you do the testing?

A. I don't intend to make any relationship differences between the two groups, just that we had talked about what we are going to write is essentially what you are going to write Reece, you know, why don't we just work together performance DER has a sign off on the field performance test plan, you know, as a signature page. So we said, well, let's work together and get it the way we want it collaboratively. Part of it was, you know, the time it would take for us to develop the test requirements document and then more time to develop the test plan. It just seemed like it was a reduction in time to work together and develop a field performance flight test plan together.

Q. So normally there's a test requirements document and then the test plan is developed by a flight test as a follow-on effort?

A. Yes. We did not have many changes from what we had done on 550 and 450 testing. If you look at the types of tests we were doing we didn't have significant changes so we would rather just collaborate and develop the field performance test plan together.

Q. Is there information in the test requirements document normally for field performance testing that would not be contained in the test plan?

A. Not that I know of. However, I wasn't writing that report and I wasn't real familiar with what needed to go into it.

Q. Who would normally write it?

A. This was the first program that we had been asked to write a test requirements document and I think Pat Connor was drafting a version of it.

Q. Had you ever written one before?

A. No.

Q. What kinds of things would be in a test requirement document?

A. I think just basically what does the test need to cover, what parameters are you looking to record instrumentation wise, what are sort the data requirements. So if there -- for field performance there was data reduction items that, so there was data collection and some data reduction that was part of the responsibility for flight test to deliver to us as part of the company test report or even the certification test report for field performance so that would have been, as far as I understand, documented in the test requirements document and then pretty much reiterated in the field performance test plan with the exception of what the data reduction process would have been.

Q. Before the accident what was your understanding of the reduction in stall in AOA and ground effect compared to free air and how did you come to that understanding?

A. I wasn't extremely familiar with in-ground effect stall predictions other than what I had had discussions with Reece about his estimations and what he was using to set the normalized angle of attack shaker onset to try to predict when we were hitting in-ground effect stall.

Q. Do you know where he got his information?

A. I do not specifically.

Q. Do you know if he collaborated with Applied Aero with Bob Mills?

A. I believe that he did look at past data on G550 aircraft and collaborated with Bob. That's only my understanding.

Q. Do you recall what his prediction of the in-ground effect stall decrement was?

A. I believe that he was looking at 1.5 to 2 degrees as being the margin that he was using to correct out of ground effect stall to in-ground effect stall.

Q. Do you know what factors he took into consideration when he developed that?

A. No, I do not.

Q. Did you expect that this, the IGE stall would be further refined as the field performance testing after?

A. No, I did not believe that we would be doing anything more in the development other than that V_{MU} testing that was defined in the field performance test.

Q. So the IGE stall estimate originated entirely in flight test or in collaboration with someone else?

A. I believe in flight test with, and this is only what I believe I'm not privy to have been listening to conversations or anything. But I believe that Reece had discussed it with Bob Mills in the Flight Sciences Aero dynamics group.

Q. Why did Bob Mills update the stall speeds in late February, or he said it was late January, late February?

A. I believe it was part of the data reduction from the stall speed testing; company stall speed testing that was going on.

Q. The LC speeds that you described last time, you said it was the name of the table, was that just sort of how you happened to label the table or did it have some sort or, was it an abbreviation for something that was known wider or?

A. LC was sort of a version and a descriptor. The L was a version number, so we started with A, B, C, D, went to double L; and C was for a clean uncontaminated wing. We had several schedules. One was clean, no ice, no sandpaper or ice, no ice shape. And then we had a stall speed with sand paper or ice, small layer of ice on the wing and then the ice shape wing. So C was to be uncontaminated wing.

Q. So it went from K to L and then L was -- C meant it was the clean version of L.

A. Yes.

Q. I see. Do you know what the difference was between the two in terms of how it affected the relationship of V_{SR} to aero stall?

A. I know only in relationship that the change was less than 1 knot in certain weight regimes. I don't know specifically what changed in the data reduction for fairing's of the curves to define that change.

MR. O'CALLAGHAN. Can I jump in real quick just for a clarification?

In terms of angle of attack and the speed in Vs, does angle of attack reference stall versus the angle of attack for aero stall; do you recall what the updated K to L change, what effect it had between the margin between alpha SR and alpha stall?

MS. BRIMMEIER: Not specifically other than I have looked at the charts and there was a small change that was not part of the data reduction that I was involved in.

MR. RAMEE: That was kind of an odd off the record question.

DR. BRAMBLE: Let's go off the record.

(Off the record.)

(On the record.)

DR. BRAMBLE: Back on the record.

BY DR. BRAMBLE:

Q. Did you attend a March 24th meeting about stall protection setting in Savannah?

A. In Savannah? No. I did not.

Q. Do you know what was discussed at that meeting?

A. No.

Q. When did you first become aware of inadvertent stick shaker activations or "Nibbles", I guess inadvertent activations is not really an appropriate term, but stick shaker nibbles as the pilots described that were occurring during maneuvering flight?

A. There was, I was not involved in that testing, but I was involved in some of the discussion afterwards that we were nibbling on shaker during maneuver testing. And what I know about that is that we had changed some of our software for the alpha limiter to activate as a result.

Q. What was the nature of the change?

A. Again, this is not really my specialty, but I can I think give an overview. The alpha limiter would activate at a lower percentage of normalized angle of attack if the aircraft was approaching angle of attack at a faster rate than it would if it was at a slower rate. That was the software change that has been incorporated into the aircraft.

Q. Were these regarded as nuisance activations, the nibbles?

A. Not being part of the test I don't think I can answer that.

Q. How did you learn about that?

A. When we were having discussions about changing the activation of the alpha limiter as you approach higher angle of attacks with the rate turn, so during meetings to discuss that.

Q. Do you know how the decision was made to bump up the activation threshold as a result of nibbles; actually that's not what you said. You said it was a rate turn.

DR. BRAMBLE: Do you want to jump in, John? I've got more questions about thresholds.

MR. O'CALLAGHAN. A clarification here.

I guess we had heard in the past that coming out of March 24th meeting the change to the shaker setting was an increase of activation of stick shaker from a normalized angle of attack of .85 to .90, but I think if I heard you correctly your interpretation of what, it was a change in rate turn that's being applied to that or --

A. We may be talking about two separate items.

Q. Yeah, I think we are.

A. I thought you were talking about the maneuver testing.

MR. RAMEE: Off the record.

(Off the record at 10:15 a.m.)

(On the record.)

DR. BRAMBLE: Let's go back on the record.

BY MR. O'CALLAGHAN:

Q. Ms. Brimmeier, can you just describe briefly an overview of how the stick shaker works, and the various terms that go into the equation to make it activate?

A. Yes, kind of. It's not my specialty. But the stick shaker and alpha limiter are both tied to activation with normalized angle of attack, as normalized angle of attack increases you approach a value of 1.0 that's your alpha for V_{SR}, corresponding to V_{SR}. And I may get these numbers sort of wrong because I am not intimately involved with the development of the shaker and alpha limiter. But the production intention of a stick shaker was that it would go off as you approach V_{SR}.

So alpha limiting turn would happen prior to stick shaker occurring on the direction of the aircraft, it would be an alpha limiting load the pilot would try to pull back and the aircraft would limit the angle of attack from increasing and essentially you should never really see shaker in the correction of the aircraft.

In the flight test mode there was a safety activation of moving shaker down to a point where maybe alpha limiting would start where you would start into an alpha limiting situation. So if the pilot was pulling back on the column and the aircraft would just begin into alpha limiting that's some percentage, .85 percent was 1 percentage. I think it had been bumped up to .90 percent. And the history these I can't really comment on where, why and when that happened.

However, we were using stick shaker as an indication of going into alpha limiting or getting close to an in-ground effect stall predication or something like that. So there is a difference between production aircraft and flight test aircraft in we are using it as a signal to the pilots. And I think that that technique was employed on several flight tests not just field performance.

Q. Now, the relationship between the PLI indication and the stick shaker activation, what was that relationship?

A. I'm not real familiar with that other than I think the PLI indication shows where you would indicate a shaker.

Q. The rate turn that you mentioned earlier how does that affect things?

A. I believe the rate turn really corresponds to up and away performance and maneuvering performance. So as you are approaching stall, let's say like a 3 knot per second approach to stall versus a 1 knot per second approach that rate at which you are approaching stall the alpha limiter was adjusted based to a larger margin. So enacting earlier, the faster you are approaching stall versus a smaller when you are slowly.

Q. So it was a turn that was affecting alpha limiting for the production mode, but did it have an effect on the normalized angle of attack at which shaker would activate the rate turn?

A. No, it should not have on the production aircraft. I don't know if during testing they were using shaker offset to a specific area like, let's say right where alpha limiting would have occurred to show that you use it as an indication that you would have encountered it.

Q. Just to make sure I'm clear on it. So I guess my impression is that there wasn't a rate turn on the activation of stick shaker so whether you were approaching .85 -- let's say the stick shaker was set to .85. So as you were approaching .85 at 1 degree per second or 2 degree per second it would still trigger at .85, it would not lower it to like .8 or .83 just because you are approaching it faster or is that incorrect?

A. You know, I don't know. I don't know specifically how it was set up for shaker. I am more understanding of what was set up for the alpha limiting system.

Q. While we are on the subject do you know what angle of attack in terms of degrees corresponds to normalized angle of attack or .90, just off the top of your head?

A. Not off the top of my head. It would depend on your flap setting.

Q. Flaps 10.

A. Flaps 10. I mean, no, not off the top of my head.

Q. Let me make sure and see if I have anything else in this area. Bill may have asked this already, but regarding the changes to the normalized angle of attack for stick shaker activation the .85 to .90; do you know where that idea was borne or the genesis of that change?

A. No, I don't.

MR. RAMEE: When it is convenient, Bill, I would to take a break, a short one since we are going to be doing this for a long time.

DR. BRAMBLE: Sure we can take a break. Let's go off the record.

(Off the record.)

(On the record.)

DR. BRAMBLE: On the record.

BY DR. BRAMBLE:

Q. Why didn't the change in stick shaker activation threshold from .85 to .90 result in the reconvening of the SRB when it was a change to a less conservative state?

A. I don't know.

Q. Do you know who requested the change in shaker settings? I guess you already said you don't know how that was borne.

A. I don't know.

Q. What kinds of analysis did your group make about takeoff performance prior to Roswell 1 and 2 to determine performance targets?

A. My group, the aircraft performance group has been involved on setting up the speed targets pretty much since very early in the aircraft development program. And we have derived the speed ratios from G550 speed ratios and, you know, I had made those predictions throughout the development of the aircraft program. So prior to Roswell it was our responsibility to provide those targets as well.

Post-Roswell-1 and during Roswell-2 it was our intention to compare the test data to our predictions and see how they lined up.

Q. Was there any desktop simulation done from like first principle physics to try and analyze the airplane's performance before the testing?

A. No. Our tools are not first principles based.

Q. What kind of tools do you use?

A. They are Fortran codes that are developed primarily only by our performance group. They are more focused on using the data as it is reduced from flight test to do the predictions and expansion for the aircraft flight manual.

Q. So there is no other type of performance modeling that goes on prior to flight test other than sort of the ratios for the speeds that are put together?

A. No, not from our group.

Q. How was information from the aerodynamics group used, if at all, to predict takeoff performance characteristics?

A. The information used from the aerodynamics group, the primary piece of information was the stall speeds and, so they have aerodynamics stall speeds and then V_{SR} referenced stall speeds so we use the V_{SR} speed as our basis to ratio, the takeoff speeds. Other data that we got from the aerodynamics group include, you know, drag and lift as the aircraft is in the on-ground configuration, and those pieces go into our model for the takeoff profile.

Q. For creating the AFM?

A. For creating the AFM and for doing our predictive analysis for flight test.

Q. Pat Connor mentioned that there are 3-degree of freedom modeling going on post-accident as part of the renewed field performance testing. Can you talk a little bit about that? What is that modeling and who is doing it?

A. Yes. I know of two separate tools that do a 3-degree of freedom modeling. One of them is in our preliminary design group and I'm not very cognizant of what that tool is doing or is predicting. Another tool is the FSIM model that the stability and control flight dynamics group uses and has correlated to the simulation at the ITF, integrated test facility. So those two models match. And that is the primary 3-degree of freedom tool that we are using to develop the speeds that we will be going back to Roswell with.

The ITF and FSIM model are essentially giving the same results. They are correlated to match each other.

MR. O'CALLAGHAN: FSIM 3-degree of freedom or 6-degree of freedom?

MS. BRIMMEIER: You know, I don't know. I guess it might be a 6-degree of freedom. I know that it is not, you know, our data expansion methodology that we use for performance. So, again, I'm not really intimate with the details of how the codes work, but they are more of an aircraft simulation than ours are.

BY DR. BRAMBLE:

Q. Who is actually doing that? Who is working with those models?

A. Brett Leonhardt and the Flight Dynamics Group, but Brett specifically works with the FSIM models and is working with the ITF data. We have a pilot flying the ITF and he reduces the data from that.

Q. Brett does?

A. Brett does.

Q. Is that kind of approach unusual for a development program?

A. I would say that it is a very useful way for us to look at going back to field performance without using the aircraft. I'm not sure that we had done as much development in the ITF as we are doing now. However, there was testing with the pilots and flight test engineers that I know of that happened before Flight 153 specifically Reece and Vivan had gone to the ITF to test techniques in the ITF before they went to Roswell to do the CTO testing out there.

Q. That occurred the week prior to the accident?

A. Yes.

Q. A couple days before?

A. Yes. I'm not sure exactly when, but during that week before the accident.

MR. RAMEE: Can we go off the record a second?

DR. BRAMBLE: Yes.

(Off the record at 10:44 a.m.)

(On the record.)

DR. BRAMBLE: Let's go back on the record.

BY DR. BRAMBLE:

Q. The 3-degree of freedom modeling that you were talking about that you said was being worked after the accident for 650 by, was it Brett Leonhardt?

A. Brett Leonhardt is part of the flight dynamics group which focuses primarily on stability and control issues.

Q. That is sort of a more extensive analysis preceding the field performance testing than was done, has typically been done in the past here at Gulfstream?

A. Yes. The preparations we are doing now are much more detailed than what we had done before.

Q. Is it also more detailed and extensive than other manufactures would do for a new airplane development program?

A. I can't really talk to other manufactures since I have not worked anywhere else.

Q. What's the advantage, I mean have you seen any, why have you gained from doing that after the accident as far as setting up for the next round of field performance testing?

A. I think we are looking at more key parameters this time and basically as a result of in-depth analysis after the accident we have learned more about in-ground effect stall, and we have learned more about how we want to margin from in-ground effect stall. So right now the intent is to stay more than a degree at least a minimum of a degree away from in-ground effect stall during our testing.

One of the ways we are doing that is increasing our speeds, target speeds so that as the aircraft accelerates down the runway and rotates the aircraft will liftoff prior to reaching a target max pitch attitude. So the aircraft will continually rotate throughout the liftoff and approach to 35 feet.

Q. It will continually increase pitch?

A. Increase pitch, yes.

Q. So there won't be a target pitch that's held until 35 feet, it's a dynamic pitching maneuver?

A. Yes.

BY MR. O'CALLAGHAN:

Q. And the margin from stall is obtained by just having the speeds be higher from rotation onward?

A. Yes. We are looking at analysis of both the normal all-engine CTOs, the single engine CTOs and in all of the abuse cases doing detailed analysis on those prior to going out and testing.

Q. So without the benefit of all the ground effect analysis that has been done since the accident and all you have learned there, that aside, would the 3-degree of freedom tool or the 6-degree of freedom tool have been useful for Roswell-2, even without the benefit of what you are talking about ground effect?

A. I mean I think it might have.

Q. In what way?

A. As having, you know, a secondary check of do we think the aircraft can meet our predictions. I'm not sure that any of us really thought, you know, that we needed cross checks prior to going back to Roswell, to going to Roswell.

Q. So do you have a feel about what the tool might have lead you to conclude regarding the maneuvers for Roswell-2?

A. No. I haven't been involved with the use of that tool for several years now. The last time that I was involved with it was when we were doing some tail resizing studies for the G650 and when we were doing those we were using it to dynamically predict where rotation could occur given the aerodynamics of the aircraft.

Q. For tail power--

A. For tail power studies. So that was the last time that I really was involved in comparing those results just something in our tools. And I have not been deeply involved with the data that reduction has been or analysis has happened after the accident personally because I just wanted to remove myself a little bit from it.

Q. You mentioned the increased speeds, is that just for -- those increased speeds is that visualized just for the next entry, re-entry into testing or is that sort of seen as a production final, closer to the final production numbers as well?

A. That's seen in something that we will be targeting for the testing and what we envision production, the production aircraft to have.

Q. So it will be faster. Do you have feel for what impact on the field lengths that's going to be?

A. It will make them longer; it will make the field length longer.

Q. Care to venture a guess by how much?

A. Right now we are looking at something like 500 feet increase.

Q. How much faster are the speeds compared to the schedules

that were in place --
A. I think in air approximately 5 knots faster.
MR. O'CALLAGHAN. Thanks.
BY DR. BRAMBLE:
Q. For the speeds that were developed as ratios, was there a build down process in the flight testing to arrive at the minimum ratios for a speed such as V_2?
A. There was not so much a build down process. I think we were more focusing on what is the technique and using a consistent technique throughout the testing. Earlier in Roswell-2 testing we had a slightly different technique which I think I have discussed with you guys before.
Q. In Roswell 1 or 2?
A. It was there primarily in Roswell-2 because that's where we were targeting the V_2 speeds. In Roswell-1 the testing that we did were, we did some pitch attitude development and some pitch rate development and there we weren't necessarily targeting a speed by the end of a takeoff run. So there was the testing in Birmingham and testing in Roswell-2 early on in March where we did the CTO testing with a technique and then when we came back for the second round of CTO testing which was Flight 153 was where we changed the technique slightly and so this round of testing was with the refined technique.
It was intended that technique would be refined and consistent throughout all pilots and that would give you the

target speeds, that would give us the speeds that ended up being reduced from flight test. We were to compare those speeds to our targets.

Q. Did you, overall considering the level of preparation prior to the, let's say, the second round of CTO testing, Roswell-2 did you feel that the preparation for the testing was adequate?

A. Yes. I felt like Reece had discussed changing the technique, had tested that in the ITF with Vivan. We had a meeting when the team arrived on Friday afternoon to talk about the new technique and discuss, you know, anyone's questions, concerns.

Q. We'll come back to the rotation technique a little later. But in terms of analyzing data during, sort of throughout the field performance testing program how were the data supposed to be periodically analyzed, presented and decisions made about whether the airplane was meeting field performance goals and who made the decisions about how to resolve potential obstacles to meeting performance targets such as meeting V_2 during controlled takeoff testing?

A. Okay. First I would kind of like to lay out again just to be clear the roles of the performance group and the flight test engineer group. The performance group was on site to help with data reduction and help with data analysis. And the responsibilities of doing the data reduction and reviewing the tests and deciding whether to proceed really was on the flight test engineer.

Q. The test conductor?

A. Test conductor. So to go back to your question, there really was discussion once we started looking at the data of kind of how does the data fall compared to our predictions, there was intended to be an effort from the performance group side to say how does the test data line up with what we would expand to show in the flight manuals, to show for guarantee predictions and that was all intended to be kind of, it was a loosely defined process, but it was a process where the performance group and the flight test engineers would be there on site looking at the data sort of hand-and-hand and we didn't have a defined process of this is your responsibility, this is our responsibility, those kinds of things. It was essentially the on-site teams working out what to look at, what did they want to see, what did they want to reduce between us and, the performance group and the flight test engineers.

Q. Did you participate in meetings amongst group heads or managers to discuss how the flight test data from Roswell was comparing to performance targets?

A. Yes. I was involved in discussions.

Q. How often did those kind of meetings occur?

A. Do you mean during the flight testing?

Q. Yeah, I guess I would say, let's say during the month of March?

A. During the month of March. Yeah, I can't actually put a number because I don't know that we had even maybe one meeting during March.

Q. How about earlier in the year like January/February?

A. Yes, in January/February that was when we had been looking at the Birmingham data and trying to compare that to what we would have derived from a -- for a guarantee, you know, weight and airport altitude. When we did that, the numbers showed that we were very close to meeting our guarantee point as a result of the Birmingham testing that was done.

Q. Who participated in those reviews, the sort of reviews with managers and group heads?

A. Pat Connor, I believe Paul Donovan and Reece were most likely there. You know, probably Tom Lavrisa from G650 Flight Sciences side and Barry McCarthy from G650 flight test.

Q. So is it fair to say that at that time based on the Birmingham data you came to the conclusion that you were getting pretty close and with a few minor revisions of technique you might be able to shave off the extra couple knots that it was --

A. Yeah, we felt pretty confident that if we could continue then we would have -- be very close to our guarantee conditions.

Q. Okay. Was that just --

A. And I would like to specify that our guarantee condition is a flaps 20 configuration.

Q. How often in January and February did you have those meetings? Was it just one to review the Birmingham?

A. No, I think that I had sat with Pat and maybe Reece once before we took it to management. There probably was a review with director-level management and the pilots. I think that's probably the only meetings that I can remember being at. There may have been another meeting where we actually said the number to higher than the director-level. This is our number we predict, but I don't think I was there for that.

Q. Do you know what number you were thinking about at that time?

A. We were very close to 6000 feet.

Q. Then who was analyzing the takeoff performance data coming out of Roswell-1 and 2 on a day-to-day basis? Was it all real-time in the trailer and the airplane or was there more going on in the afternoon and evening each day?

A. The real-time in the trailer was really just a quick look at do we think we are meeting our targets and, you know, very quick once over, you know, continue or give feedback.

The data reduction, you know, was intended to happen in the office in Roswell in the afternoons and one of the things during Roswell-1 we were still working on getting our tools to work on site. We had some computer issues on site.

MR. O'CALLAGHAN: Those are tools for pulling data?

MS. BRIMMEIER: Yeah, mat lab scripts for pulling data from IADs software and processing the data for the CTO runs.

So we were doing some debugging of the process during

Roswell-1 there was not as much on-site data reduction I think that as had been intended. And for Roswell-2 the process was a little more defined and we had some kinks worked out so the testing would go on in the morning and then in the afternoon we would be reviewing the data and even so we still seemed to be lagging the testing that had been that day. So we were still looking at data from a couple of days ago rather than what had just been flown.

BY DR. BRAMBLE:

Q. What type of analysis were you doing in the evenings during continued takeoff testing portions of the month?

A. What we were doing was basically plotting out time histories of our key parameters, and using those to identify, you know, rotation, liftoff 35 feet, evaluating the distance during the run. What we were going to do is pull those definition and start the data reduction process of laying all of our data out to a composite curve to develop our speed ratios, our air and ground acceleration factors and time delays.

DR. BRAMBLE: Did you want to ask any clarifying point on that, John?

MR. O'CALLAGHAN. I have a do have a question and it might be a little bit detailed or run into several questions. Is that all right or do you want me to wait until the end?

DR. BRAMBLE: Does it relate to this particular --

MR. O'CALLAGHAN. Well, it's a general question about data reduction.

DR. BRAMBLE: Okay.

BY MR. O'CALLAGHAN:

Q. I'll just ask since we are on the subject. The term data reduction, data review, data analysis, to expansion to the AFM, I have asked some other folks this too because, you know those things mean certain things to me but I may be fooling myself they may mean different things to other folks. So can you just describe a little bit about what each of those terms means to you, if there are distinctions between review, reduction, analysis, and expansion; and sort of the depth of analysis that's involved? I know you just mentioned things like extracting segments of interest from a, you know, volume of data and then plotting the relative parameters versus time, so a presentation of the information and then picking points off of there; so that would be sort of one level.

I can imagine there are other levels. For example, probably a more sophisticated analysis would be actually trying to extract lift and drag coefficients in building C_L versus alpha curves and drag pullers from the data and, you know, is that something that was done as well.

So just to give you an idea of the universe of things I can think of, you know, when one talks about data reduction and if you could just maybe clarify and help specify what exactly you guys mean by that and what do the terms encompass?

A. Okay. So I'll start with sort of what I see the process, there's a data review which in my mind is when the first look at the data, the time history which happens in the telemetry trailer during and just post the test run. So a quick, you know, what were the targets and did we, how close are we to them. And sometimes that would then be, you know, communicated back to the aircraft, other times, you know, we did not communicate how well they meant. The communication process to get to the aircraft from the telemetry trailer only the test conductor has a microphone to talk to the aircraft. So the other engineers, the three performance engineers in the trailer have mics in the telemetry trailer so we would have to hit a button, talk to the test coordinator. The test coordinator would have to process that, hit a different button and talk to the aircraft.

BY DR. BRAMBLE:

Q. You mean talk to the test conductor in the trailer?

A. I have to from my station hit a button to talk to the test conductor. Then they have to talk to me, you know, we confirm our statement whatever it is. And then the test conductor if they need to communicate to the aircraft would then have to hit a different button to communicate to the aircraft test conductor on board the aircraft. But really it goes to the whole aircraft, I think, everybody on the aircraft can hear it.

Q. So that's data review.

A. So that would be data review. Data analysis --

MR. RAMEE: How about reduction?

MS. BRIMMEIER: Yeah, I think I'm --

MR. RAMEE: Reduction, analysis, expansion, as you use them.

MS. BRIMMEIER: I might just jump to analysis and then reduction.

MR. RAMEE: Okay.

MS. BRIMMEIER: So data analysis in my mind is that taking on the data from the aircraft, data stream and developing the time histories and pulling those key speeds, column forces, pitch rates, pitch angles, sort of the data analysis from the day and looking at it, you know, on paper the first time in the office. And then each of those data analysis chunks from each test card in my mind really comes together and you plot it all up on a, you know, chart that compiles all of those runs into one scatter of data.

BY MR. O'CALLAGHAN:

Q. What variables would you plot against each other in kind of a composite plot?

A. Well, one of them is the speed ration so the V/V_{SR} where you have a rotation, a liftoff and 35 feet or V_2 speed for single engine or continued engine, a twin engine continued takeoffs.

Q. So it would be V/V_{SR} versus takeoff over thrust to weight?

A. Thrust to weight ratio at liftoff.

Q. At liftoff, great. Okay.

A. So that really is sort of the production phase where you have taken all of these pieces of data analysis, in my mind taken all of these pieces of data tests from the tests, put it together into one data radiation scatter plot. And then that is the data reduction piece that goes to the flight manual expansion. The V/V_{SR}s are what we use to expand the data for the flight manual and that's true for the V/V_{SR}s the air and ground acceleration factors, time delays, braking MUs, rolling MUs.

Q. So when you say expand the AFM, sort of build the AFM for all different altitudes and temperatures and all that kind of thing is what --

A. Uh-huh. Weight, altitude and temperature combinations.

Q. So, let me be clear then, so that expansion, sounds like, it's based on data that's already in the form of V/V_{SR} versus thrust to weight as opposed to extracting lift and drag and then building it up through those terms; is that accurate?

A. Yes. There are lift and drag components to our expansion models. And it's the lift and drag in the ground attitude on the runway. And then there's a delta lift and delta drag when you deflect the spoilers for a rejected takeoff. But the continued takeoff portion really is just the in-ground attitude lift and drag for the acceleration portion just prior to rotation.

Q. Then as the data is collected is it used to correct whatever estimates of CO and CD are used to generate the predictions?

A. Yeah. Essentially that flight test correlation factor breaks down into your rolling R/rolling MU and stopping MU. So if there is an offset in our predicted lift and drag values it would get captured in the rolling MU or the braking MU at per configuration. So sometimes our rolling MUs and braking MUs are different, you know, different flaps configuration. That's because it's more of a flight test correlation factor than a true stopping coefficient for only the energy that goes into the brakes.

MR. RAMEE: Rolling MU, can we spell that out?

MS. BRIMMEIER: M-U. The Greek letter MU.

BY MR. O'CALLAGHAN:

Q. So rolling MU and braking MU that gets to the acceleration and deceleration portion if you have an abort. So then but for the dynamic rotation and then the climb out -- well, climb out is free air. Is any of the data used to determination correction for free air or in the air estimates of lift and drag?

A. That's where we use the ground an air acceleration factors. So the ground acceleration factor is the phase from rotation to liftoff and the air acceleration factor is liftoff to 35 feet. So those are what is derived from our CTO testing to use for the expansion to correlate.

Q. Let me characterize it and see if I'm clear about it.

A. Okay.

Q. So it sounds like it's mostly intermediate stuff or maybe I simplify stuff, but rather than going back to the raw lift and drag and building up forces and moments and integrating those one sees well, we estimate it's this. We tested. We got something slightly different. We apply this, multiply our factor we can correct the prediction to the actuality and the basic physics is taken care of; is that fair?

A. Yes.

Q. What I'm not exactly clear yet is how that gets expanded to different weights and temperatures and altitudes but without going through lift and drag.

A. So the testing is conducted at our range of takeoff weights for the aircraft. So we cover the weights with testing and demonstrating throughout the weight range those air and ground acceleration factors. And the atmospheric altitude and temperature is the part that is expanded for the flight manual, I guess. So the air and ground acceleration factors really are derived from that actual range of weights testing. And the expansion parameters really include the altitude and temperature effects.

Q. So altitude and temperature will affect thrust and so that's your entry into the thrust to weight table and then you go off and you find out what --

A. Yes.

Q. -- V speeds would be and all that?

A. Yes.

MR. O'CALLAGHAN. I think I'm clear. Thank you.

DR. BRAMBLE: All right. It's 11:22 and is anybody going to need another break? I think, because we didn't start until a half hour after 9:00 I think we may need to go until 12:30 if that's feasible.

MR. RAMEE: We are fine. We are clear until 1:00. I'd like you to fully mine what Shelly has to provide to you. If you want to take a break now and organize for a few minutes we can, or we can continue for another 15 minutes, it's your option.

DR. BRAMBLE: Why don't we go to 11:30 that's another seven, and then we will take a break and then we will have a full hour. Maybe we can finish it in that next hour. We will see.

MS. BRIMMEIER: Okay.

BY DR. BRAMBLE:

Q. So if you are doing hazardous envelope expansion testing and deciding whether to proceed to the next point, whether it's safe to proceed to the next point, who is responsible for sort of presenting the available data to the team so they can make the decision about whether to proceed?

A. I guess I'm not sure what you mean by hazardous envelope expansion.

Q. If you are going to a new point that is not within the bounds of the parameters that you have already tested. If it is high risk and you are expanding that to a higher pitch perhaps, or I guess that would be an example.

A. I guess I don't know that there is a defined process on how to make that recommendation or who decides.

Q. Is it more of an everybody is monitoring it and just decides in real-time from looking at the data and calls out a concern if they have one?

A. Yeah. I believe that, you know, everybody has an option during brief or any test set up to highlight any concerns, talk about the testing that's going to happen. So I believe it would happen during a brief, you know, if not prior to that.

Q. On the day of the accident the air plane was parked and Mr. Ollenburg had to get the IADS terminals rebooted in the airplane. It seems from the video that the flight crew got out and that Kent had a discussion with you and that Vivan had a discussion with Reece during that period while it was parked. Do you recall talking with Kent during that period?

A. Was this just prior to 7A1 test point?

Q. It was, it went 6C1s break, then 6C2, 6C3, 7A1, 7A2, I believe. I think there was a 6C3. So, do you recall when the airplane parked?

A. I remember that the aircraft did park outside the telemetry trailer and Kent did come into the telemetry trailer and was talking to me about the runs.

Q. Can you tell us more about the discussion?

A. Sure. He had come in saying, you know, something to the effect of: Is this good? What are you seeing? I want to know what to do if I need to correct something? So I had shown him a couple of the runs that we had just done on the IADs time history traces and, you know, said these are the runs where we were further away from V_2 than these ones and showed him the traces.

He and I had talked about instead of focusing on targeting the pitch, trying to target the speed at 35 feet. And, I'm trying to think if there is anything else that we really talked about. But he did kind of a quick check of, you know, where do you think we are? What do you want me to do? At that time I had recommended if you are lifted off, you know, just target your V_2 speed rather than looking for a pitch and then trying to switch to speed. That's the basis, general basis of the discussion.

Q. What did he say in regards to that?

A. I think he pretty much was: Oh, okay. Let me go back and talk about it. This wasn't anything new as far as how we were discussing targeting the speeds; it just was kind of a reiteration of things that we had talked about before.

Q. How about the 11 degree limit that Reece had briefed the day before? How did that factor into this?

A. To be honest we didn't talk about it one way or the other when Kent came to talk to me in the trailer. It wasn't intended to remove that as a limit or we didn't discuss it.

Q. What was your impression of when that 11-degree limit should be in effect and when it should not, was no longer in effect?

A. I guess my understanding was that it was in effect as an in-ground effect stall protection, a spoken limit rather than any kind of a feedback on the aircraft. And as it climbed out to 35 feet it was always my understanding that we should not be limited as we climb out. But as far as where in altitude that transition occurred I don't think I ever had a feel for it. I don't know that we had ever discussed it formally.

Q. So what was your impression during the briefing when Reece said I don't want to exceed 11; when did he mean that?

A. My impression was that he meant throughout the takeoff maneuver.

Q. What are the boundaries of the takeoff maneuver in your head?

A. The key, you know, you would begin the rotation and throughout liftoff, through 35 feet I think the test point was called complete beyond 100 feet. So I would have assumed he would have held 11, 12 degrees as a limit through 100 feet.

Q. During the previous CTOs that day, did you notice whether or not the airplane was exceeding 11 or 12 degrees prior to 100 feet?

A. No. I was watching the traces but I don't recall specifically if any one trace went beyond 11 or 12 degrees.

Q. Was anybody sort of, I mean, if that was the limit discussed in the brief who was supposed to be watching for it?

A. I know that Reece was, you know, watching it as the test conductor on the aircraft.

Q. What lead you to the understanding that Reece was watching the maximum pitch on the aircraft?

A. During the runs just after a CTO run oftentimes Reece would call out the targets that he noticed, or not the targets. I should say the comparison to the targets that he noticed throughout the last run, previous run. So in the couple of, in the, let's say, one or two minutes post that test point he would repeat back and reserve, you know, this is what I saw VR, this is the peak pitch or the pull force that I saw and would kind of reiterate those parameters to the pilots and us in the trailer.

Q. So did you feel like you were supposed to also monitor those things or were you responsible for an entirely separate suite of stuff?

A. I felt I was monitoring those things, however, there had been at least one time where we had discussions about the telemetry personnel in the trailer were not required to be there during the test for conduct of the test.

Q. During high rates test?

A. During performance tests in general. It was an additional set of eyes, several eyes watching the data. We were set up to be there every day. If for some reason something happened at the telemetry trailer, didn't have power, wasn't working, wasn't set up, the aircraft was still going to conduct tests while we tried to get the telemetry trailer ready. And that was communicated to me by Flight Test. It was not the intent to run that way, but it was their operation.

Q. Who told you that?

A. Paul Donovan had talked about it.

Q. If you wanted to monitor those parameters on every high risk trial, and call out if they were approaching or exceeding 11 or 12 degrees, would you have been able to given your other responsibilities or was it feasible?

A. I was watching each trace and I was marking how we met the targets on the test cards while we did each of the test points. If I was to have to communicate something to the aircraft I would have had to activate my microphone, communicate it to the test conductor in the telemetry trailer they would have had to communicate that to the aircraft. So as far as the time frame of being able to alert the aircraft to an issue that I saw there was quite a delay.

Q. How about between runs, like after a test and into the next one?

A. Between runs that was when I would have been able to communicate that feedback. At times there were requests to not continually feedback that information that they wanted to continue testing without too much information.

Q. Even if they were exceeding the 11 degrees for the brief?

A. I wouldn't say that.

Q. Did you feel like you could have spoken up if you felt --

A. I feel like, yes, we could have.

DR. BRAMBLE: Should we break or do you have an urgent follow-up?

MR. O'CALLAGHAN. Since we are here.

BY MR. O'CALLAGHAN:

Q. Do you recall or have a feel for what the trim pitch angle for V_2 would have been during the climb out?

A. No, I don't.

Q. Do you know if it would have been above 11 degrees?

A. No.

Q. Oh, and one other thing. In that discussion with Mr. Crenshaw and yourself about going for V_2 at what point did Reece get involved or briefed on those decisions on that strategy?

A. Well, I don't think that was a departure from discussions we had had earlier. And I don't know that I can say specifically that Reece was brought into the loop other than, you know, when Kent got back on the aircraft. I'm not sure.

Q. Did you hear them talking about it?

A. You know it has been quite a long time and quite a lot had happened since then so I can't say that I even remember what was being said.

MR. O'CALLAGHAN. Right. I understand.

DR. BRAMBLE: Need a break?

MR. RAMEE: Yeah, let's break for a minute, take five.

DR. BRAMBLE: All right.

(Off the record at 11:48 a.m.)

(On the record.)

DR. BRAMBLE: Let's go back on the record.

BY DR. BRAMBLE:

Q. So, Ms. Brimmeier, you mentioned in your past interview that you had some difficulty on site during testing analyzing the data between each day's testing and was that what you were referring to today when you were discussing how you sometimes get a little behind day-to-day, be analyzing the data from two or three days back?

A. Yes.

Q. How could the situation have been improved or did you feel it needed to be or do you now feel that it needed to be improved?

A. I do feel that, you know, we actually have made a new definition of our process so that we will be looking at the data before we proceed for the next day's testing. So we will have looked at the data from previous day's testing or that day's testing, you know, before moving on. So that's a good step in my mind that we are going to be reviewing what we had just tested.

Q. Was that feasible with the level of staffing that you had during Roswell-2?

A. I believe it might have been feasible with the level of staffing. There were probably some things that we needed to work out as far as maybe doing alternate shifts or something like that, dividing up responsibilities a little more definitively in order to get through a lot of the data analysis and data review.

Q. Why do you think that wasn't done prior to the accident, or wasn't done that way?

A. To be honest, I think that some of those kinks that I had talked about on getting our tools set up and running and doing the analysis that we wanted, we were just getting to the point where everything was running smoothly. We were excited about being able to keep up with the testing at the point that the accident had occurred. So a lot of that work had been ongoing throughout our time in Roswell. We were just to the point where the team that was on site could keep up with looking at the day prior or that day's testing.

Q. If that system, if the current procedure for analyzing each day before you move on had been in place during Roswell-1 would the, do you think the V_{MU} data would have been reduced prior to Roswell-2?

A. The tools that I am talking about I'm not sure if they were actually used to reduce the V_{MU} data. I was not involved in the V_{MU} data reduction. I believe Reece pretty much did that all on his own and Paul Donovan has looked at it since then. So I'm not sure if the tools that I am talking about are specific to looking at the V_{MU} data.

Q. Were you on scene during the V_{MU} testing in the trailer?

A. Yes.

Q. So could you have developed similar tools to support the V_{MU} data analysis?

A. I believe we could have. I believe that Reece may have used the tool that we were using for CTO analysis. I'm just not positive on his process. The tools were jointly developed between Flight Test and Flight Sciences, performance group of Flight Sciences.

BY MR. O'CALLAGHAN:

Q. Just really quick. Could you describe very briefly what the inputs and outputs of this tool are?

A. The tool basically was to look at the telemetry data from the test run. So it was using -- there was a lot of them, but essentially day conditions, weights and altitude temperature, speeds, for the CTO analysis the rotation liftoff, 35 feet, speeds and distance along the runway from DGPS of data.

Q. So this is the same thing we were talking about a little earlier I guess when we were talking about reduction and et cetera?

A. Yes. I'm just not sure how the V_{MU} data ties into that tool or if it does at all. If Reece used that same tool to come up with some of his V_{MU} analysis I'm not sure.

Q. So it doesn't spit out the coefficient, for example?

A. I don't think it does.

BY DR. BRAMBLE:

Q. What data could the team in the telemetry trailer have analyzed, if any, to determine that V_2 was unattainable given the test cards as written and stop the takeoff testing prior to 7A2?

A. I guess the only thing that I could say that we have learned since the accident is that we changed our target pitch angle for flaps 10 and in doing so may have become V_{MU} limited. In that case I would say that that would have been the tool that we could use whereas the limit of V_{MU} to determine our liftoff angle, liftoff angle and point.

Q. So is there a way by analyzing the preceding runs that the team in the telemetry trailer could have determined that, in real-time that you were V_{MU} limited with this new target pitch or?

A. To be honest what I know is all sort of hindsight being much clearer. I don't know that there was a tool that we could have used on site at the time to prepare, you know, for that, to determine whether V_2 was attainable.

Q. Could you have just said, well, hey, Run 7A1 was done according to the test card instructions and the airplane was unable to hit the V_2 speed?

A. Yes, I think any of the test personnel could have said that. The decision to repeat the test point was made by the test crew.

Q. On the air plane?

A. On the air plane. The intent was always that we would repeat each of the runs a couple of times. So that wasn't necessarily a go, no go, decision. I think it was always sort of in everybody's mindset that we were going to do a couple of runs on each card that day.

Q. If the V_{MU} results had been processed before Flight 153 and used to model how the airplane would takeoff, to your knowledge, would it have indicated that it was a waste of time to be targeting 1.13 V stall for V_2 during Flight 153?

A. It's hard for me to comment on that because I have not been involved with that comparison. There are some aspects of things we have learned after the accident that I have not been involved in.

Q. A big question in our mind has been why the Aero Performance group wasn't involved in the analysis of V_{MU} takeoff data until after the accident but was involved in some of the other field performance testing. Can you shed any more light on why?

A. No, I don't know that there is a specific "this is the reason," but there, our past history with doing all the field performance testing has been that Flight Test really is the responsible party for reducing a lot of the data. And this time for the G650 program the performance group had offered and Flight

Test accepted our offer to be a little more involved in the data reduction on site.

The V_{MU} analysis was not historically something that our group had done so we did not expect to be involved in reducing the data other than doing a crosscheck that the analysis methods matched what we would have done ourselves. To my knowledge, that did happen after the accident. Pat Connor did look at the V_{MU} data reduction that Reece had done in his draft report to just verify that the process that he would have used matched what Reece had used.

It's my understanding that Gulfstream Flight Test Group has more responsibility for data reduction than some other flight test groups in other companies. It's just a feel I get from communications with other people that our group does have more data reduction responsibilities rather than just data gathering.

Q. What were your primary, what was the focus of your activities between Roswell-1 and 2 flight test activities?

A. We were looking at the data that we had collected. A lot of the data reduction we were still leaving to Flight Test. We had loaned at least one, maybe two of our engineers to Flight Test to help with some of the data reduction that Reece was doing, they were working alongside with Reece for a couple of weeks.

Q. What time frame was that?

A. Probably just before, in December, probably a couple weeks in December before the holidays.

Q. So to be perfectly clear, there was no expectation that Aero Performance would be analyzing V_{MU} test results in parallel with Flight Test?

A. It was not my understanding that that would happen.

Q. Did Aero Performance perform any analysis of the Birmingham test flights dedicated to refining the rotation technique?

A. Yes.

Q. Who worked on that?

A. Pat Connor was involved with that.

Q. What discussions took place between you, Pat Connor, Reece Ollenburg, and Ken Obenshain that lead to the decision to attempt to reduce the V_2 overshoots through modifying the rotation technique rather than increasing the V speeds to match the obtained results?

A. I'm trying to think if I was even involved in those discussions. I may have heard the results of those discussions after the fact.

Q. Do you know how the strategy was established to try and solve that problem?

A. No.

Q. If, and this is the million dollar question, but, you know, if the airplane was repeatedly unable to meet the test criteria, whose role was it to maybe notice and suggest that there was a deeper issue than technique that might need to be addressed or was that realistic to expect anyone to done in hindsight or without the benefit of hindsight?

A. I guess my understanding would have been that during, you know, a debrief we would have discussed this is the results we are seeing. Reece and I would have most likely had a conversation about what do we do, where is this falling -- where is the data falling and is that exactly everything that we can achieve.

Q. If it was everything you could achieve --

A. That would be the limit.

Q. -- technique or --

A. Well, with -- I think with technique was the way that we were evaluating the performance of the aircraft.

Q. Was the rotation technique used on the day of the accident expected to be acceptable to the FAA during certification?

A. Yes. I believe that we stepped away from our rotation technique of being a very abrupt 75-pound, 70- to 75-pound pull force. That was our previous technique. The revised technique was going to something more like a 60-pound pull force at a slower rate. And we believed that that was more comfortable for the pilots, would be something that the FAA would have been more agreeable to. So we thought it would have been certifiable and agreeable to the FAA.

Q. Prior to the accident -- I think you have already answered this. Why was V_2 not increased prior to the accident when there were repeated exceedances in the range of 48 knots and based on your previous answer for saying that we thought we could solve this through technique; is that the bottom line basically?

A. Yes.

Q. With the 4 to 8 knots exceedances if the speeds had just been adjusted up, what kind of -- how would that have been impacted the takeoff field length?

A. I think that it would have increased our ballast field lengths for the flaps 10 configuration it would have driven the lengths a little longer but it wasn't as much of a concern since we don't have a guarantee condition to meet for flaps 10.

Q. How much were the V_2 overshoots for flaps 20, if any? I can't recall.

A. You know, I can't recall without looking back at my notes either. I think that we were a little closer to our V_2 targets on flaps 20 than we were for flaps 10.

Q. I think our big question to this point in the investigation has been was Flight Test or Flight Sciences feeling a lot of pressure to try and meet performance guarantees from upstream in the management chain or was this a case of intelligent dedicated people trying to solve the problem and trying to meet their goal?

A. I don't think you have one without the other. I mean I do believe that there was focus from our engineering standpoint understanding how close we were to our guarantees and trying to get the best performance out of the aircraft that we could.

There was a focus, you know, from management wanting to know how; well, did we think we were meeting those targets. And I think from the beginning of the program we have known a 6000 foot, flaps 20 ballast field length was a target. It has been there for more than five years. I think it was a visible target to be I-rating.

BY MR. O'CALLAGHAN:

Q. This question might shed some light. Did somebody from Flight Sciences or from Flight Test look at the data and say you know we think we need to move up the V_2 speeds; brief that to somebody higher in the company, and then return from that meeting saying, well, let's try a little harder or was that or did that such a meeting ever take place?

A. I'm trying to remember if a meeting like that had taken place. When we did look at the Birmingham data the speed, the V_2 speeds were slightly higher. I think maybe two knots higher than our target predictions. And even with that we were still able to just meet 6000 foot ballast field length. So from that standpoint Pat Connor was one who had reduced that data and kind of evaluated it for some of the, I'm not sure how many meetings, how far that data went. I'm sure at some point it was briefed to management that we might be two knots faster on our V_2 speeds but we are still within our 6000 foot guarantee. We probably are good to go back to Roswell on the second trip and proceed with the target speeds that we started with.

Q. So then with Flight Sciences or Flight Test was there a perception that this is really a big problem or not?

A. I don't know that any of us thought that hitting that V_2 speed was going to be unattainable. As a result of the Birmingham data we had tested several increments on rotation speed and I think it was V_R from the target speeds V_R, V_R+2, V_R+4 and going back to Roswell for Roswell-2 testing we used the V_R+2 database to do the CTO testing at Roswell-2. So there was some speed development, some discussion about changing the speeds at that point.

BY DR. BRAMBLE:

Q. Were you aware of touchdown speed overshoots the week before the accident? Somebody had mentioned something about that occurring in the days prior to the accident, I think difficulty meeting the touchdown speeds.

A. I am aware that we were doing some landing data collection and I don't specifically know if touchdown speed overshoots, but in our light weight alternate flaps configuration for landing so anything not flaps 39 in the lightweight conditions pilot feedback was that it was hard to control glide slope at the target VREF speeds that we were giving them. The intention going back for field performance this time is that we will do some development testing to see what kind of speed increase we may need to put as a minimum speed for your alternate flap configurations for landing in order to hold a consistent glide slope and be able to, you know, approach the runway with controllability, enough power from the pilot's perspective.

Q. Do you recall there being a certain point during the performance landings where Paul Donovan or the flight crew might have said, or you might have asked for more testing and they might have said, ah, we are done with that, that's the best we can do?

A. I do recall something similar to that.

Q. How did that conversation go?

A. You know, I can't even remember the specifics of where we were or when we had the conversation. But -- and I don't remember what was said. But I think I was trying to say oh, we are not meeting the targets for the glide slope that we wanted to meet. You know, can we run a few more cases? And the response back was, no, let's keep stepping through the testing and get done.

Q. Who said that?

A. That was from Paul Donovan.

Q. Was that contentious at all or was it just sort of like no, just move on?

A. You know, I kind of took it as, you know, he didn't want to talk about it at moment and that I would bring it up again when we had data in hand saying this is what we said we were going to try to target. This is where the data ended up. You know, can we justify repeating those test points to collect the data that we said we were going to in the test plan.

MR. O'CALLAGHAN. Can I ask something?

DR. BRAMBLE: Uh-huh.

BY MR. O'CALLAGHAN:

Q. Just for clarity on what the difficulty was. We talked to some other folks and my understanding had been that it was, the difficulty sort of in the flair portion they were going from the 50 foot point and then -- speed off and touching down at a target speed. But when you just mentioned flight path control and power you made me think that it was something higher up on the approach. Can you clarify it a little bit please?

A. I'm not familiar with the speed, not getting the speed bleed off in the flair. I do know that some of our test points did not meet the speed bleed off that we were expecting. But I don't know that that's necessarily a bad thing. I don't know that we over sped at touchdown point more than we thought was acceptable.

Q. So the difficulty you had in mind was what?

A. When you are coming in on an alternate flaps configuration, so like flaps 10 or zero where you have got less drag on the aircraft, the low idle setting of the aircraft and coming in on the 3-degree glide slope the pilots had commented that they didn't feel there was enough residual power to adjust glide slope to keep on that 3-degree approach. So --

Q. You mean they did go to -- they were at idle --

A. They felt like they weren't fast enough to keep the power high enough to be able to adjust to keep you on the steady glide slope. And this is a phenomenon that we do have on the 550. For the lower flap settings for landing at light weights we have a minimum speed that you don't go below. And so our intent returning to Roswell is to set a speed and as a minimum do not go below on a light weight alternate flaps condition test that, get pilot feedback if that's acceptable maneuvering capability during an approach to hold a consistent glide slope and that sort of thing, to write that into the procedures for the flight manual.

Q. I guess I'm still confused. I mean the combination of speed and power will dictate your flight path angle. So the only point you're constrained then is when you are back at idle and you can't reduce any further. Was that the problem?

A. Yes. That was -- the feedback was that they felt they were already back at idle couldn't risk glide slope.

Q. So they are still going too fast --

A. -- didn't have enough drag.

Q. They were still going too fast essentially?

A. Yes. And the intent there would be just increase your speed and get the drag up a little bit.

BY DR. BRAMBLE:

Q. How was the touchdown speed predicted or modeled prior to that, performing landing testing?

A. Oh, what we had predicted was that there was an 04 percent reduction from 50 feet to touchdown that would happen during the flair. It's just a straight 96 percent of the 50 feet, you know, VREF was our predicted touchdown speed.

Q. How did you predict that?

A. That was just based on, you know, looking at our previous aircraft and using 650 parameters lift, drag and thrust.

Q. Cynthia Townsend mentioned that she recalled you saying something about, or that you guys were discussing how the takeoff tests were working out that morning and that the test criteria might have to be changed. Can you elaborate on that discussion whether that agrees with your recollection and can you recall anything about that?

A. I don't recall having that conversation. So I'm not sure exactly what we were talking about.

Q. Do you know how many times the -- what's a maximum number of times that the landing test was repeated in a particular configuration when you were having those difficulties, when you guys finally decided to stop?

A. I'm not sure how many times were we repeated those tests.

Q. Were there any that were done more than three times you think?

A. No, I don't think there were any that were done more than three times.

Q. The decision to stop was just made unilaterally by all?

A. Yes.
Q. Did you object?
A. You know, I think I tried to request that we stay out a little longer and continue the testing at that point. With his response I think I decided I would just bring up the discussion later and revisit it with future testing.
MR. O'CALLAGHAN: Again to be clear, this is having to do with trying to achieve the combination of flight path angle and speed for the alternate flap setting and running up against idle thrust?
MS. BRIMMEIER: We also were looking at the flaps 39 condition and there are test points that I would recommend that we repeat there as well.
MR. O'CALLAGHAN: Same problem?
MS. BRIMMEIER: No, they are not the same problem. Just meeting test criteria and were we, you know, we weren't within our test criteria laid out in the flight test plan.
MR. O'CALLAGHAN: Which were those?
MS. BRIMMEIER: There was a V ref speed. I don't remember what totally. V ref plus or minus 2 knots glide slope up to 3 degrees. We were really targeting 2.5 to 3 degrees and many of our points did not meet 2.5 degrees glide slope. I'd have to look at the plan to see the other criteria.
BY DR. BRAMBLE:
Q. Moving on to flights 88 and 132; what was your

understanding of the cause of the roll offs that occurred during those flights?

A. What was my understanding at the time?

Q. Prior to the accident, yeah.

A. So I'll address them individually I think because I have a slightly different understanding. I had at the time a slightly different understanding for both of them.

Q. Okay.

A. Flight 88 was a V_{MU} test condition so that test procedure was to hold the nose off the ground at low speed and continue accelerating until the aircraft just lifted off to define the minimum unstick speed. And my understanding with that flight as I was there witnessing it was that the pilot onboard, which was Kent, recognized that he over rotated the aircraft beyond the pitch target that was set up for the test card.

Q. What angle of attack did he reach?

A. I don't know without looking back.

Q. Did you perform an assessment of the AOA at which the roll off began?

A. No, I did not.

Q. And Flight 132 --

MR. RAMEE: She wants to add something.

DR. BRAMBLE: Sure.

MS. BRIMMEIER: No, I was going to go to 132 but you were asking it too.

BY DR. BRAMBLE:

Q. Okay.

A. So for Flight 132 that was a continued takeoff test and I believe in that case as well we had been working at least one run prior to that where we had missed, where we, the pilot had missed the target rotation speed and for the Flight 132 run that specifically had a roll off event the -- I don't remember the specifics of the run other than it was I think an early rotation and a high rotation pull, over rotation again. It went beyond the targets of the test condition.

Q. I guess I'll ask again. Do you know what angle of attack he reached and did you or did anyone else that you know of perform an assessment of the AOA at the roll off, when the roll off began?

A. I did not.

Q. Do you know if anybody else did?

A. I don't know.

Q. How were these events analyzed to evaluate the cause?

A. Do you mean prior to Flight 153?

Q. Yeah.

A. You know I don't know that anyone really dug into the details of what happened during Flight 88 or 132 other than the people that were there doing the test, doing the debrief. We definitely had discussions about here is what we think happened. The aircraft was over rotated. The discussion then went to the crews talking about how this was limit and we might be under our limit. That's as much as was --

Q. What was the limit?

A. That we went beyond our pitch target and that was the reason I guess, not formally that there was a limit. But we went beyond the pitch target and that was the reason for the event.

MR. O'CALLAGHAN: Was that on both or one or the other?

MS. BRIMMEIER: I believe on both of them we talked about how we over rotated the aircraft and that was highlighted as, you know, being an incorrect maneuver.

BY DR. BRAMBLE:

Q. Were you involved in the debrief after each of those flights?

A. I was.

Q. Who else was present?

A. All of the onboard test crew, all -- most likely all of the telemetry data trailer crew. I'm not sure if I could say exactly who else would have been there.

Q. This is on scene in Roswell?

A. On scene in Roswell.

Q. During that debrief did anyone present data from the runs?

A. Not that I know of. Typically our debriefs happened immediately or very closely following the test flight. So I believe that people did end up looking at the data but it was post the debrief before anyone really did reduce data and look at time histories and that kind of a thing.

MR. O'CALLAGHAN: Which people?

MS. BRIMMEIER: I believe Reece was doing a lot of looking at that data to try to understand what had happened and what -- to understand what had happened on the aircraft.

BY DR. BRAMBLE:

Q. This is slightly a different topic but regarding your relationship with Reece do you feel that if they were proceeding on a task and you felt like there was a risk to continuing, would you have felt comfortable telling Reece I think you should discontinue the test or do you think that Reece was sort of maybe more senior more knowledgeable?

A. I do feel that I would have felt comfortable talking to Reece about my concerns and he would have been receptive to that.

Q. What analysis was done to determine the root cause of the wing drops during the 88 and 132?

A. Are you talking about post-accident?

Q. No, not post-accident, after the incidents but sort of later on in subsequent days prior to 153. I mean in 88 it was in November so it was a long period of time and 132 not so much. But with I know Kent did a presentation but from an aircraft performance side I guess the question is like, who analyzed the aircraft performance during those events?

A. Yeah, so Flight 88 was a part of the V_{MU} test. So I don't think anyone in performance really was involved in looking at that data analyzing what happened. And for Flight 132, you know, we kind of just dismissed that point as being an over rotation and a point that we weren't going to use to put into our CTO data reduction.

MR. O'CALLAGHAN. While we are on this subject.

DR. BRAMBLE: Uh-huh.

MR. O'CALLAGHAN. Do you have some more on this subject?

DR. BRAMBLE: Yeah, I could ask these follow-up questions unless you want to jump in.

BY MR. O'CALLAGHAN:

Q. Since we are talking about causes are aware of any conversations that Reece might have had with Gary Freeman about 132 and the role of YAW damper?

A. Yes, on Flight 132 I do believe that we had an IFR in effect that was to keep the YAW damper off during the testing. It was an IFR for the entire 650 fleet at the time and I don't have history on why it was enacted. But that was one of the software configurations for our tests that day. We were doing light weight CTO testing and feedback from the pilots was that the airplane felt a little, I don't remember what term they used, but something wobbly and like a little bit unstable and that they didn't prefer to do any further CTO testing with the YAW damper inactive. So we did have discussions in a debrief about that.

Q. So was it your impression that the IFR and the YAW damper and its absence and the wobbliness or wiggliness of the airplane; was that attributed as the cause of the roll of 132, to your knowledge?

A. I believe the crew felt that that could have been a contributor and I don't know that any of us said that this was a cause and that we knew a definitive cause other than we knew that we had over, that the aircraft had been over rotated.

Q. In those discussions, for example, in trying to make an argument for the role of YAW damper or lateral directional issues as contributing to the roll off were plots of slide slip or rudder input or these sort of things examined to sort of say, ha, here we see these parameters behaving this way which confirms or gives weight to the concern about the YAW damper, that level of analysis?

A. I didn't do any of that. I'm not sure if anyone else has.

Q. So you are not sure that Reece presented to Gary plots of slide slip or things like that?

A. I don't know.

MR. O'CALLAGHAN. Okay. Thanks.

BY DR. BRAMBLE:

Q. Who was responsible for analyzing aircraft performance during those flights, the incident flights 88 and 132?

A. I guess ultimately those were part of the Flight Test data reduction and that would have been, 88 would have been part of the V_{MU} data reduction and 132 would have been part of the CTO data reduction. The V_{MU} would, as we previously understood it would not have fallen under the performance groups' purview other than just a review of the data analysis and how it was determined.

Flight 132 most likely would have been more of an area the performance group would have been involved in looking at the data and reducing the data.

Q.   Do you know why it didn't receive a thorough analysis?

A.   To be honest my impression from the debrief of both of those flights, was coming from what I interpreted of the crew's communication of oh, we know what happened. We over rotated. End of story.

There was not a whole lot of conversation about us needing to look into it or needing more data review and that just kind of comes from my observations of being there during the debriefs of both of those flights.

Q.   Given the combination of responsibilities that you had between Flight 132 and 153, could you have led an analysis of that? I mean did you have time if you had been asked to to do it or did you have too much going on?

A.   I think it would have been something that would have been -- I would have highlighted as this is going to slow, you know, us down in the further testing and we will need to stop and analyze this and understand what happened.

Q.   Did that play into the fact that that was something you didn't look at or was it more just a fact --

A. To be honest -- I'm sorry. I cut you off.

Q. That's all right. I'm just trying to figure out -- I know you weren't sort of -- your perspective is you weren't really expected to look at those it seems, and that may be the case. But I'm just trying to think like from the standpoint of the environment and the workload and everything like (a), could you have and it sounds like you think you would have needed to pause the testing to do that. And so the second thing would be did you consciously weigh that and then decide, no, we shouldn't stop or was it just it stopped earlier at we are not going to analyze those because they don't really fit the test protocol?

A. So my interpretation of: we know what we did, that we over rotated the aircraft, in my mind that was sort of the decision made by the crew and to be honest I think everybody sort of understood, yeah, we did go beyond where we were targeting. We understand that. Let's not do it again. And it didn't occur to me at that point to say, hey, should we launch off into looking at this data.

To be honest, I'm not sure that I could have identified what exactly had happened myself. I would have had to call in some other people from other areas in Flight Sciences to help look at the data. And it just wasn't one of those things that we had talked about with the on-site testing about having to go that route.

Q. So looking back why do you think that neither Flight Test nor Aero Performance recognized 88 and 132 were stall events that occurred below the expected, the predicted IGE stall angle?

A. Because I don't really know why.

MR. RAMEE: Bill, could you break that into two questions. One concerning the Aero Performance Group and ground effect because it's not clear to me that they have a keen understanding what the in-ground effect stall limit was. And then a separate question for Flight Test. You kind of combined the two of them. You might get a different answer if you separate it.

DR. BRAMBLE: We are off the record.

(Off the record at 12:43 p.m.)

(On the record.)

DR. BRAMBLE: Let's go back on the record.

BY DR. BRAMBLE:

Q. So let's break that question into two parts. One is why do you think that Flight Sciences Aero Group didn't recognized that the Flight 88 and 132 stall events were, 88 and 132 incidents were stall events that occurred below the predicted IGE stall angle?

A. So Aero Performance, there is an aerodynamics group and there is a performance group. So when you say aero performance I assume you are talking about the performance group specifically.

Q. Uh-huh.

A. To address the question why do you think, why do we think we didn't realize that that's an in-ground effect stall that had occurred, I don't think we had gotten to the point of really reviewing that data and reviewing the time history and, you know, part of that might have been from my understanding of during the debrief not having the crew highlight that as a major concern.

Q. Is there another part to that?

A. No. I think that eventually we would have been able to look at that data as sort of the, these are all the test points that we had done, you know, as far as CTO and what happened during each of these. But there wasn't a priority on looking at that run specifically because of the way it was communicated to me during the debrief from the crew.

Q. How about for Flight Test, why do you think Flight Test didn't recognize it?

A. I don't know. In some respects maybe they did understand what was happening when they said, we over rotated the aircraft. I don't know if that was, if it is too much of a jump to say and they recognized that we were in a stall condition. But to be honest we had not talked about the word stall during the debriefs.

Q. Was it implied?

A. I mean I think that's what I interpreted it as. But I don't know that I made the step of and we need to go and look at it from that.

BY MR. O'CALLAGHAN:

Q. I think another point of clarification is here, because I think the way Bill originally phrased the question about three minutes ago, he said recognition of stall that was below the predicted value. And now we are talking about recognition of stall period. And I think what you have just expressed is something that's probably intuitive to us as well. If one says, well, we over rotated; that there is implication that we had the beginnings of a stall and that's what caused the roll; is that fair to say that much?

A. Yes, I think so.

Q. So then the second half or the clarification point is then okay we stalled, but was it actually below where we thought it should occur, and that would have required an analysis, a deeper look that was not done. So is it fair to say that probably the assumption was that it occurred where it was expected without necessarily looking at the data?

A. Yes, without really reviewing the data we I think in my own estimation I think I believed that we were at the limit that we had expected it to be occurring. So we didn't know that it had occurred early. I didn't know that it occurred early because I hadn't looked at the data to suggest that.

Q. So then my question would be: Was there a discussion of perhaps eventually looking at that data to confirm the in-ground effect stall expectations?

A. I can't think of a discussion that had actually happened to have said this is what we need to do.

Q. Using it as a data point to build the lift --

A. I don't know. That could have been something that Reece may have had in mind for doing V_{MU} analysis, but I'm just not sure. I really was not involved in discussions like that.

MR. O'CALLAGHAN. Okay. Thanks.

BY DR. BRAMBLE:

Q. Were you ever aware that the roll offs that occurred during Flights 88 and 132 occurred at .86 and .87 normalized AOA prior to the accident?

A. I'm not sure that I knew what the normalized angle of attack was when they encountered it.

Q. Why do you think 88 and 132 didn't result in the reconvening of the SRB?

A. I think, again, I would go back to the communication during debrief. I feel that if the crew had maybe mentioned more that this was something we needed to look into, this was something other people needed to be involved in, I believe it may have triggered a reconvening of the SRB and understanding of what happened. In some aspects I think that communication didn't relay a strong enough feeling that that was an event that needed to be reviewed.

Q. Do you have any sense that maybe this event, maybe there had been prior wing drops in prior programs and there were two on this one, do you get the sense that people sort of were becoming less afraid of this and starting to view it as less of a major event or --

A. I guess I don't think so. That kind of contradicts what I was just saying, but I don't think that anyone really was desensitized to it. I think that it was more of an indication that the way the wing stalls is from the wing dip and that the wing would drop. I don't know that -- I don't know that we were desensitized to it or if we just were more focused on what is our limit and let's stay away from our limit to keep safe.

Q. What processes were in place to encourage the sharing of information about G650 performance issues at cross relevant sub-disciplines within Flight Sciences such as ensuring that the analysis of Flight 88 and 132 were shared between performance, aero performance and aerodynamics or ensuring that these two groups collaborated when making estimates of IGE stall?

I think; correct me if I'm wrong, but I think you are going to say that these analyses weren't done so they weren't shared and that it was really the estimate of IGE stall was done more on the Flight Test side.

A. Yes, I believe that a large part of the in-ground-effect stall estimation was done in Flight Test by Reece Ollenburg with probably communication with Ken Obenshain and I'm not sure who else. I do believe he shared that with the aerodynamics group. And as far as sharing the data from Flights 88 and 132 with other disciplines in Flight Sciences that definitely has happened after the Flight 153 accident. I think, again, I would go back to it wasn't highlighted as a major concern until the accident.

Q. Do you know anything about a conference call that Reece had in the afternoon Thursday, March 31, a couple days before the accident?

A. No, I don't. I was in Roswell and he would have been in Savannah.

Q. My last couple of questions are. Can you outline for us what you can recall about your sleep history in the three days or so leading up to the accident? Like do you recall when you went to bed and when you woke up? I know it was a long time ago.

A. Yeah, it was a long time ago. I kind of like my sleep so I imagine that, you know, I was probably going to be around 10:00 at night, getting up around 5:00 in the morning, getting to work around 6:00. There was a time change in there at some point. No, maybe that was in November. Anyway, our target time to be at the airport was just before sunrise so that we could get the airplane ready to go and be out on the end of the runway as early as we could.

Q. So you were getting about, if you had to estimate, maybe seven hours a night?

A. Yeah, probably. There may have been times when I was going to bed at 9:00 and getting eight hours, seven or eight hours is pretty normal for me.

Q. Then you had been working for how many continuous days by the day of the accident?

A. Probably seven.

Q. So eight days prior you had a day off?

A. Yes, actually the week prior I was on a business trip and I had the weekend off. I believe I flew to Roswell on Sunday before the accident.

Q. So you had --

A. Probably six days.

Q. So you had Saturday and part of Sunday off. What dates are those?

A. March 26th was Saturday, and March 27th was Sunday. I believe I flew to Roswell on Saturday or Sunday, but I just don't know for sure.

Q. What was the topic of the conference?

A. I was at Penn State for an industry advisory council meeting.

Q. All week?

A. Yes.

Q. That was the week of the 21st to 25th?

A. Yes.

Q. Then typically when you were not participating in field performance testing how many days a week did you work?

A. Typically 4-1/2 to 5 days.

Q. How many hours per day?

A. We work four tens, Monday through Thursday, and then

Friday I would usually work a half day or a full day, 10 hours. So five to 10 hours on a Friday.

Q. Then in Roswell you would work how many days in a row before returning to Savannah?

A. Pretty much every day that I was there and if we were taking a break because of flying for 13 days straight then that would have been the day off that I would have taken. I'm not sure that I ever met a continual 13-day workload while I was there though.

Q. Your company flight duty rest policy was something, was the same for people on the airplane and you in the trailer or --

A. No, I'm not sure that I understood any limits for us in the TM trailer or doing the data reduction in the office other than the 13-day limit.

Q. So the 13 days was the only limit that applied to you as a --

A. As far as I understood.

DR. BRAMBLE: That's the end of the complied questions. So it's already 1:00. I imagine there's probably at least a few follow-ups and since this is an important one could we delay Paul half an hour?

MR. RAMEE: They will wait out there for us.

(Off the record at 1:00 p.m.)

(On the record.)

DR. BRAMBLE: Let's see how this goes then.

All right, John, go ahead.

MR. O'CALLAGHAN. I'll try to be quick. I just have a potpourri of smattering things going on.

BY MR. O'CALLAGHAN:

Q. Back to stall in ground effect. You mentioned early on that you think Reece's estimate was one half or two degrees and you may not know specifically for that particular estimate but just in general from a theoretical point of view, what sort of uncertainty bans around that would you draw, that kind of a number?

A. I don't know.

Q. Okay. That's fine.

A. I know that we had a, we had an uncertainty tolerance that we were applying to the normalized angle of attack build up with the in-ground effect stall plus a tolerance of the accuracy of the air data system to reading AOA.

Q. That's a .34.

A. Is that the one you are talking -- yeah, .34 is the total.

Q. Yeah, I understand that. But we think from -- that reduction in stall angle of attack is going to be X. How much confidence, what kind of a ballast margin around that X would you draw, percent or absolute values of degrees or anything?

A. I don't know. I wasn't involved in those discussions really.

Q. A question about the program or the Fortran program that's used to build up the V schedules you mentioned. Was this something that sort of when you arrived on scene is already in place and something you inherited in your group?

A. The program is the program that we use to predict takeoff every day. In the performance group it is one of our key tools. The buildup of the V speeds and the speed schedules is an input into the program and that was something that we had developed prior to going to Roswell and would then have reduced the data from Roswell and substituted that in place of the speed schedules that we had developed for predictions. So the results of the data would have driven a new set of speed schedules for development of a flight manual.

Q. You say it's an input. So if you could describe what goes into the program and then what comes out before you test, I guess, in preparation for going to test?

A. We have a prediction database, which includes stall speeds for V_{SR} and ratio tables, which define the V_R, V rotation over V^{SR}, V_{LO} over V_{SR}; V_2 or V_{35} over V_{SR}. Those are input tables which are a function of the thrust to weight at liftoff. We also input thrust tables and aerodynamic lift and drag coefficients.

The output that then comes out is a prediction on your takeoff field length, speeds, times for each segment.

Q. What about pitch angle?

A. Pitch angle is not an input nor an output.

Q. So for example, you say the V speed schedule is an input versus thrust to weight so basically you choose well, we want it to be 1.13 V_{SR} at V_2. We want V_2 to be that. So the program will say, well here -- based on the stall ratios here are the actual numbers and that --

A. Yes.

Q. Got you. Thank you. Were you on scene for the Birmingham testing?

A. No.

Q. Maybe you know the answer to this anyway. I think I understand that those tests were conducted with symmetric thrust to model to match one engine out?

A. Yes, I believe they were.

Q. Do you know why it was done that way as opposed to the true engine out or idle chop?

A. No. I don't know. I would assume that it was just as a safety concern rather than simulating an engine out and have symmetric power.

Q. That makes sense. A little bit back on the communication and collaboration within Flight Sciences. You mentioned that since the accident there is a lot more, but in general even before the accident can you just, I know you are sort of under the same management structure, under Tom Lavrisa, but do you sit close to each other, do you see each other, do you have meetings together in common, how much do you, you know, see each other and communicate during the week or, you know, in the office, over the water cooler? I mean give me a general sense of, you know, how often you talk to Bob Mills and say hi?

A. Okay. Our group all does fall, the G650 analysis does fall -- and Flight Sciences under Tom Lavrisa. And logistically we are seated in three different buildings. I said the performance group now is in the building across the parking lot. The Flight Dynamics Group is here in this building with Tom. The Aerodynamics Group is permanently located in another building across the road. So we do have weekly meetings with 650 Flight Sciences staff. So --

MR. RAMEE: Before you do that will you go back and do that based upon before the accident please because we weren't in the three buildings then?

MS. BRIMMEIER: We weren't?

MR. RAMEE: We weren't.

MS. BRIMMEIER: Where were those guys? I guess they were in RDC-2.

MR. RAMEE: If you are still separate there is no need to correct it.

MS. BRIMMEIER: There are a couple different locations. There would have been two separate buildings. So I'll go back. I'm trying to think where Bob sat though.

DR. BRAMBLE: Let's go off the record.

(Off the record at 1:07 p.m.)

(On the record.)

BY DR. BRAMBLE:

Q. Let's strike the pervious answer and just say. The question was. How did the communication between different subgroups in Flight Sciences go and how do you see, not only the director of Flight Sciences Tom Lavrisa, but also other people in different groups such as Bob Mills and where were you, Tom and Bob located prior to the accident, your offices in Savannah?

A. Okay.

Q. It's a multi-part question. Let's just stick to where the three of you were located.

A. So Tom Lavrisa is located in this building, RDC-1 building. And the Flight Dynamics and Control -- group of Flight Sciences are also in this building. The aircraft performance group and the aerodynamics group we are both located in the RDC-2 building in an area designated off for Flight Sciences. So essentially there were two locations separated by a parking lot.

Q. And now back to the original question, how often did you see Tom and Bob Mills, when you were back in Savannah in the office?

A. (No response.)

BY MR. O'CALLAGHAN:

Q. Specifically, your interaction with Bob, not necessarily Bob individually but specifically with his group in Flight aerodynamics and you are in the same building I understand now,

but separate floors --
A. No. Actually we are on the same floors. And my interaction with Tom Lavrisa was at least weekly, if not more than that because I would walk over and talk with him. But my interaction with the other groups was probably limited to maybe weekly, but depending on what we needed to talk about and how often one of us approached the other.
Q. Thank you, that's good.
A. I guess I should add that we also have a 650 Flight Sciences weekly staff meeting. So weekly that would have been a representative from each of the departments in Flight Sciences, meaning having a program update, here's what's going on, that kind of stuff.
Q. How many people would be in that?
A. It would be about ten.
Q. Ten, okay. Thanks. Getting back to some history. So, if I heard right you have only worked for Gulfstream, you came to Gulfstream after --
A. Yes. I started with Gulfstream as an intern and then started full time when I graduated.
Q. You graduated from?
A. From Penn State.
Q. In aeromechanical?
A. Aerospace Engineering.
Q. Bachelor's, Master's?

A. With a Bachelor's, in December of 2001, is when I graduated.

Q. And then came here, okay. Fantastic. The folks you work for either in your own group or in Flight Test do you know how many are private pilots?

A. There are a couple of people in my group that are private pilots or had their license at one time. Two of our performance engineers, Pat Connor did have his license at one time I doubt he flies anymore. Within Flight Test I guess I'm not real familiar with who would have had their flight, private pilot's license.

Q. This brings me to the last question that I have asked everybody. We have been asking everybody. Number one, thank you so much for all your time. Both last time and today, I know it is an ordeal so thank you for that.

As you know we are drawing sort of to the end of our fact gathering and we will be going back to Washington and doing processing all this during our analysis and ultimately the end of the process is the most useful thing I think for why we are here is to generate safety recommendations to the industry to hopefully, you know, improve things. So two questions really, one is you have kind of gathered what we are looking at, what we are focused on based on our questions, but if there is something you think we are missing or something else we should be looking at that we haven't kind of mentioned, or don't seem to be aware of, please share that and then secondly, I know that everybody here has, this accident has been on their minds and hearts, obviously for many months now, and that you yourselves may have some ideas as to things to offer the industry, things that we can maybe bring to light through our recommendations, and so, if there is anything in either of those areas you would like to share with us, please do.

A. Okay. I don't know that anything comes up right now.

Q. Well, if anything occurs to you just approach through Tom or anybody. Thanks, appreciate it.

A. Okay.

MR. O'CALLAGHAN: That's all I have.

DR. BRAMBLE: All right. Let's go to Mitch.

MR. GALLO: I have a couple of questions I'll try to make it fast.

BY MR. GALLO:

Q. During the 088 and 132 roll off events that was attributed the pilot technique, was there any concern that those two events were due to a pitch up tendency due to high rotation rates?

A. I guess I can't speak to that other than we did identify that it was an over rotation.

Q. Did you ever hear that issue coming up though?

A. No. Not that I can remember.

Q. Are you aware of the Gulfstream the GIV in-ground-effect stall that occurred during that test program?

A. I am aware of a wing tip strike during the GIV program.

Q. Do you know the circumstances behind it, what was done afterwards?

A. No. Not enough to talk about it.

Q. So going to today or currently or before the accident did any of the pilots, and this is during field performance testing, did any of the pilots ever talk you before deployment or after deployment regarding giving either their feedback or just trying to ground effect additional knowledge?

A. You know it was not rare for us to have a pilot involved in our discussion about setting up for the test and the test technique and those kinds of things. And anytime we were having those meetings, you know, pilot feedback was welcome. I can't think of a time when, you know, pilot specifically came to me and said, hey, I want to talk to you about what we are proposing or anything like that other than the discussion that we had about Kent coming into the TM trailer during Flight 153.

Q. Did Mr. Jake Howard or Mr. Gary Freeman ever tell you that a capture of V_2 was impossible to do or that the V_2 speed should be increased during your performance testing?

A. I don't remember anything, you know, directly being stated that way. You know, it may have been that we had discussions that said, you know, our speeds may fall out where they are going to fall. But I'm not sure that anyone was specifically adamant that, you know, this is it. This is all we are going to get, anything like that.

Q. Did Mr. Kent Crenshaw prior to deployment to Roswell for 153B ever contact you directly to talk with you about the upcoming tests?

A. Not that I know of.

Q. How about Mr. Vivan Ragusa?

A. No.

Q. In the last, and I'm assuming you participated in the last 7:30 a.m., call in before Flight 153? Did you participate?

A. 7:30 call in?

Q. Yeah. 7:30 a morning call in to Savannah?

MS. MOLER: It would have been 5:30; 7:30 Savannah time.

BY MR. GALLO:

Q. The morning call in?

A. No, I don't think I did participate in a morning call. Was it to Flight Test?

MR. GALLO: Let's go off the record.

(Off the record at 1:18 p.m.)

(On the record.)

BY MR. GALLO:

Q. So you didn't participate in the 7:30 a.m. call-in?

A. No, I was not involved.

Q. During the Flight 153 briefing, was there discussion about the change in the shaker settings?

A. I can't remember us discussing changing the shaker.
MR. HORNE: Can I follow on, Mitch?
MR. GALLO: Go ahead.
MR. HORNE: You were out there for the 132 also, right?
MS. BRIMMEIER: Yes.
MR. HORNE: Do you remember any conversations, the same question for 132, anything after Flight 125?
MS. BRIMMEIER: Not specifically.
BY MR. GALLO:
Q. Going to the there was a Fortran model that you indicated that involves your V speeds that were used, do you recall when that was originally written, during what program?
A. The code has kind of evolved over the years and has been adapted as we make changes in certification rules and those kinds of things. So the program when it was initially developed I couldn't say, but it was quite a long time ago.
Q. Because I notice it's in Fortran. So you don't know when it would have been developed approximately?
A. No. We had used a version of the same program, with maybe not as many updates as we have for the 650 program for, you know, GIV certification, for GV certification and 450 and 550.
Q. During run 7A1 on Flight 153 did you notice a, did you note the time between liftoff and rotation?
A. I did not.
Q. Did you feel that it was longer than other time

differences from previous takeoffs?

A. I don't know that I did any kind of a detailed look at that run.

Q. Do you recall how significant a change, the speed changes were between the speed table LC and K1?

A. I don't believe that the changes were significant. I believe they were less than a knot, maybe a knot at most.

MR. GALLO: That's all the questions I have.

MR. BORTON: I just got a couple quick ones.

BY MR. BORTON:

Q. The flight test plan certification, flight plan for field performance have you gotten any feedback maybe post-accident as you are progressing towards doing this from Atlanta ACO on the use of telemetry specifically, and whether it needs to be there?

A. I can't talk to the feedback from the FAA, but we do have a different plan going out from, you know, Gulfstream engineering standpoint. There will be more disciplines watching the testing in the telemetry trailer and, you know, the roles and responsibilities are going to be defined as to what parameters is each person watching and what will be an evaluation of each run and so there will be a different updated process for field performance this time.

Q. So it sounds like TM release parameters from TM would be required to do the test at least from Gulfstream?

A. Yes, I believe the feeling going forward is that it is required.

Q. The other question is on the takeoff rotation technique, you talked briefly about how it has changed. Could you just describe in a little more detail what you all are looking at?

A. Yes. The technique that I am talking about here is not necessarily how the pilot flies the point, but the way that we are generating our prediction speeds. So what we are intending is that the aircraft will accelerate to a faster speed on the ground and as it begins to rotate because you are at a faster speed the aircraft will lift off the ground before you hit our peak pitch attitude and as the aircraft climbs through 35 feet, you know, if you keep rotating and pitching up when you hit your peak pitch attitude, let's just say, it's 10 degrees then you would essentially be at your V_2 at 35 feet.

Q. So there's a pitch target but it sounds like you intersect it all a lot quicker than previous?

A. The intent is that you are not in a high attitude configuration on the ground before you liftoff. So the intent is to rotate later at a faster speed and the aircraft as soon as it rotates will liftoff shortly after rather than getting to a higher pitch attitude.

Q. And you are still trying to certify 10 flaps for Gulfstream?

A. Yes.

MR. BORTON: Okay. That's all I have, Mitch.

MR. GALLO: Just one more question.

BY MR. GALLO:

Q. Can you describe in the rotation technique the differences between a step input and a ramp input and the effect in capturing V_2 with those two techniques?

A. The step input would be sort of an incremental no column force to an incremental pull of, let's just say, 70 pounds because that was our target previously. So it would be a very quick, essentially step input of no column force a full 70 pound column force technique.

The more of a ramped technique that we went to for Roswell-2 just for Flight 153 essentially was to pull that column force over still a short period of time but it had lengthened from instantaneous pull and the technique was reduced from pulling 70 pounds to 60 pounds.

Q. So how does each one affect the capture of V_2?

A. You know I think that the intent was with the ramped pull the pilot would have a little more sense of how fast the aircraft was responding to the pull forces and so that would give him better judgment of where pitch targets, being able to meet our pitch targets and not go beyond and fly the maneuver. So I'm not sure that it necessarily drives a V_2 capture. It just would drive the technique to be repeatable and predictable by the pilot.

Q. And one more question, I'm sorry. Who conceptualized those two types of inputs?

A. I believe that was coming from Flight Test Engineering and the pilots in coordination.

MR. GALLO: That's all the questions I have.

DR. BRAMBLE: All right, Marie, do you have anything?

MS. MOLER: No.

DR. BRAMBLE: Mike?

MR. BAUER: This is just to clarify some statements you made earlier. Was it your understanding that TM was not necessarily essential for this testing or required for the testing?

MS. BRIMMEIER: It was my understanding that if there was a reason that TM may not have been up and ready and running that the test on the aircraft would still proceed.

MR. BAUER: That's all I have.

DR. BRAMBLE: Lorenda?

BY MS. WARD:

Q. I was just curious. You may have it three hours ago. But what is your role when you are back in Savannah? So you are not conducting a test and now you are back in the office. What would you consider to be your daily duties?

A. The aircraft performance group covers a lot, a large range of analysis. In effect with do the predictions for takeoff and landing and climb performance. We also develop the flight manual so once we finish this testing, you know, we will be developing the flight manual for the 650. But the group has responsibility for other certification efforts that have to do with how the aircraft flies. So we will do cabin decompression analysis and how do the flight profiles match, you know, what was tested during flight test. We will do trade studies on, change one variable to this or to that, how does it affect takeoff or landing, air climb or, you know, how the aircraft cruises. We do mission analysis as well, so predicting the range and cruise as ultimate cruise altitudes and ceiling data, a lot of that stuff.

So our focus is mostly on the, how the airplane flies and some certification reports that would be required for a 650.

But the group also is responsibility for the whole fleet of Gulfstreams. So even though my responsibility was G650 there are some people in the group that are responsible for the fleet that is out there flying right now, answering customer questions about how to get in and out of airports and that kind of stuff.

Q. Is there any overlap from the Flight Test side as far as the Flight Sciences or flight test engineer, like if you are doing data reduction, who would be that additional second set of eyes when someone is doing that reduction to make sure that it is done correctly?

A. Typically it would be someone from our group. We have taken the DERs as sort of that cross check. So Pat Connor and myself are both, we were DERs on the 650 program, now we are ARs for the same role essentially. So in something like the V_{MU} reports or the field performance tests, company test reports we both would, one of us would have validated that the process was similar to what we would have used or matches what we had agreed on before we reduced the data and that we understand it. And that we would have expanded it the same way. So there would be a cross, there would be a sign off of one of us on those reports.

Q. Is there a time frame for that?

A. No. I mean I think there are target, you know, sign off and review these report target dates. But I don't know that there is any, you know, time frame of test end to report written like that criteria.

MS. WARD: That's all I have.

DR. BRAMBLE: Tom, anything else?

MR. HORNE: Yes. I'll follow on your questioning.

BY MR. HORNE:

Q. Would it be fair to say that there is a time line that the reports have to be signed before you submit them to the FAA for certification?

A. Well, that is true as far as if we have a target certification date in mind, all of the certification reports are required to be submitted at least 30 days prior to that for the FAA to have time to review them to grant certification on a specific date.

Q. A couple other questions. At Birmingham development you mentioned they did several different speed increments. And from what I can tell it was flaps 20 only?

A. Yes, I do believe we only targeted flaps 20.

Q. So when you went to Roswell and we were doing Flight 153 I think is the first time we did the flaps 10, what were we using for the speed increment for the flaps 10?

A. We did VR plus 2 on the flaps 10 and the flaps 20 speed schedules based on a few back from Birmingham only on the flaps 20 data. But we added the increment to both flaps 10 and 20.

Q. Which leads to my second question at Birmingham we were doing two engine takeoff testing, so we kind of built up little bit in the takeoff development and speed schedule development. But when we did the flaps 10 we were doing an actual engine pull. Was there any discussion about maybe doing the two engine build up points for flaps 10?

A. No. Not that I know of. We did it in lay out the test cards so that we did twin engine flaps 10 takeoffs prior to doing a single engine flaps 10 takeoff.

Q. I forgot that on Flight 153?

A. On Flight 153. So the order of the test cards did reflect that we were doing twin engine, but not a reduced power twin engine like we had done in Birmingham.

Q. Mitch asked about the speeds. Was the crew aware of the changes between the LC and K1 speeds, did they get briefed on the speeds have changed slightly?

A. I can't remember specifically, but we always had --

Q. They were just in --

A. We always had target speeds available prior to the testing.

Q. We were asking about the debriefs. Here we typically have a telephone call in number, where other people call into the debrief. Was there anybody from Savannah that called in to debrief on Flights 88 and 132?

A. No, unfortunately that process really wasn't something that we set up for in Roswell. So there wasn't a regular phone call to do pre-flight brief or post-flight brief.

Q. In the flight test plan there was a section that talked about rotation rate development.

A. Uh-huh.

Q. Was that done? Was that part of Birmingham, I didn't see specifically?

A. it was part of the Roswell-1 testing that we did. It was somewhat limited. We didn't do a lot of test points on it. It was more to get a feel for how the aircraft was responding. We did some targeted pitch attitudes, so set straight to a pitch attitude and see what speeds develop as you climb out. And then also pitch rate. And the pitch rate test points I think we did, you know, maybe three or four different pitch rate development tests, but not too many.

But after Roswell-1 that was the only time we did that.

Q. I'm going from memory here, but in the Flight Test plan I think in the CTO testing it's to rotate at the average pitch rate or, you said rotate at a pitch rate of 3 to 5 degrees per second, average pitch rate?

A. Yeah, I think that was guaranteed.

Q. And then when I looked at the cards for Flight 153, and 132 that was not on there. Do you know how that got changed, or why that got changed?

A. No. I don't.

MR. HORNE: That's all I have, thanks.

DR. BRAMBLE: All right. John, anything else, Mitch, Chuck, Brenda? Okay. I think we are done.

MR. RAMEE: Let's go off the record for a minute.

DR. BRAMBLE: Okay.

(Off the record at 1:37 p.m.)

(On the record.)

DR. BRAMBLE: John, you want to ask it?

BY MR. O'CALLAGHAN:

Q. Ms. Brimmeier, do you know whether folks in Flight Test including Mr. Ollenburg or Captain Crenshaw were aware of how the V speeds were developed coming out of aero performance?

A. I would guess that Kent was not directly involved in discussions about that and if Reece was aware it would have probably been based on just discussions with myself and Pat Connor. I'm not sure that either one of us had done a formal presentation of here is, when I say, us, Pat Connor or myself, had done an informal presentation of here is how the speeds we are using were developed. But I do know that we had conversations about the V_2 speeds being at the minimums, you know, for certification and that we were trying to target those minimum speeds in order to target our guarantee performance for the aircraft.

So if anybody was informed I would say Reece would have been better informed than Kent on how our speed schedules were developed and how we were trying to match those with our flight test program.

Q. Question kind of inspired another one. Are you aware of folks within Gulfstream kind of rotating through disciplines like people who may have worked in Flight Sciences, aero performance, aerodynamics, going over to Flight Test or vice versa and spending a tour of duty, anything like that?

A. Yes. I do know that that has happened in the past and did happen on the 650 program. Are there people that you would want me to identify?

Q. Sure specific folks that you know have worked in both places?

A. John Lewis, and Michael Brinley both spent time and Michael Brinley is still in Flight Test kind of on loan from Flight Sciences. Both of them are from the acoustics group, but have extensive knowledge about how, about airplanes in general so I think that's why they were both on loan.

Pat Connor had spent time in Flight Test during the GV program doing work, you know, there. I myself spent two weeks helping to reduce data at one point during the G450 program. But that was pretty limited. That's all I can think of now.

MR. O'CALLAGHAN. Thanks.

DR. BRAMBLE: Anybody else need to follow-up on that?

I think we are done. Let's go off the record.

(Whereupon, at 1:41 p.m., the interview was concluded.)

CERTIFICATE

This is to certify that the attached proceeding before the

NATIONAL TRANSPORTATION SAFETY BOARD

IN THE MATTER OF:	AIRPLANE ACCIDENT ROSWELL, NEW MEXICO N652GD Interview of Shelly Brimmeier
DOCKET NUMBER:	CEN11MA258
PLACE:	Savannah, Georgia
DATE:	October 25, 2011

was held according to the record, and that this is the original, complete, true and accurate transcript which has been compared to the recording accomplished at the hearing.

Letha Wheeler
Official Reporter/Transcriber

UNITED STATES OF AMERICA

NATIONAL TRANSPORTATION SAFETY BOARD

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Investigation of:                 *
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AIRPLANE ACCIDENT                 *
ROSWELL, NEW MEXICO               * Docket No.:  DCA11MA076
N652GD                            *
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Interview of: PAT CONNOR

Gulfstream Corporation
500 Gulfstream Road
Savannah, Georgia

Monday,
October 24, 2011

The above-captioned matter convened, pursuant to notice, at 8:10 a.m.

BEFORE: WILLIAM J. BRAMBLE, JR., Ph.D.
Senior Human Performance Investigator

APPEARANCES:

MITCHELL GALLO
Air Safety Investigator
National Transportation Safety Board
31W775 North Avenue
---------------------s 60185

WILLIAM J. BRAMBLE, JR., Ph.D.
Senior Human Performance Investigator
Office of Aviation Safety
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

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ALAN J. (JEFF) BORTON
Flight Test Pilot
FAA Aviation Safety
Aircraft Certification Service
Wichita Aircraft Certification Office
1801 Airport Road - Room 100

THOMAS M. RAMEE, ESQ.
Deputy General Counsel and Risk Manager
Gulfstream Aerospace Corporation
500 Gulfstream Road, M/S B-06
Savannah, Georgia 31407

TOM HORNE
Experimental Test Pilot
Gulfstream Aerospace Corporation
P.O. Box 2206, M/S A-12
Savannah, GA 31402-2206

APPEARANCES (Cont.)

JOHN O'CALLAGHAN
Aircraft Performance Group Chairman
Vehicle Performance Division (RE-60)
  Office of Research and Engineering
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

-

MICHAEL BAUER
Aerospace Engineer
Vehicle Recorder Division (RE-40)
  Office of Research and Engineering
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

E. LORENDA WARD
Air Safety Investigator
IIC and U.S. Accredited Representative
Office of Aviation Safety
Major Investigations (AS-10)
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

MARIE MOLER
Mechanical Engineer
Office of Research and Engineering
Vehicle Performance Division
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

I N D E X

I N T E R V I E W

(8:10 a.m.)

DR. BRAMBLE: Let's go on the record.

INTERVIEW OF PAT CONNOR

BY DR. BRAMBLE:

Q. Mr. Connor, thanks for joining us today. We talked before, and today it is our effort to sort of fill in the gaps and also ask about things now that we have had more of a chance to review the investigative evidence that we have collected over the last few months. So if I seem to be jumping around a little bit it is because we have already asked you a lot of things. And so I'll try not to ask too many questions we have already asked before.

You mentioned during your last interview that your prior employers included Lockheed. Did you work for other manufacturers as well?

A. No, that was right after school I had 4 years in the Army but then went directly to Lockheed. Worked there as an aircraft performance engineer for 13 years prior to coming over here in '88 and working as an aircraft performance engineer ever since.

Q. All right. In what other areas of the G650 flight test program have you been directly involved other than field performance?

A. We got started early on with the design of the 650 in working up performance estimates for what the takeoff performance would be, what the range would be, et cetera. As the program matured a lot of that got passed off to Shelly Brimmeier, who I believe you will be meeting with later on. So she was more the day-to-day point of contact on G650 performance efforts. As we got closer to flight test for the 650 I did meet on and off with flight test and flight operations personnel to discuss preparation for the 650 flight test program.

As a principal engineer I did not have primary responsibility for 650. Instead my responsibilities were split between new airplane programs, the G280, G550; existing airplane programs, 450. So I have overall general responsibility, as Shelly Brimmeier was assigned specifically to G650 performance issues.

Q. We noticed on the organization chart for the Flight Sciences Group that you and Shelly were both the head of the Aero Performance Group; is that correct?

A. I was put as acting group head. As a principal engineer they don't officially want you to serve as a formal group head, but in the absence of an appointed head I was acting group head. But then probably 2 years ago Shelly was elevated to be the official group head of Performance Engineering.

Q. Do you know how she was selected?

A. She started to work for us right out of college, Penn State, in about 2000, 2001, a very good performance engineer, good leadership and good personal skills. So she subsequently went back, got her MBA, and so she is an up and coming star, I think, within engineering.

Q. And if you could briefly describe the Aero Performance Group's responsibilities during the field performance flight test program for 650?

A. As I mentioned, when we started getting close the time when we went out to Roswell, and actually going back probably a year before that, Shelly and I were meeting periodically with flight test personnel on some of the key parameters that we needed to get from field performance testing to then turn around and expand our AFM takeoff and landing performance.

So we were providing them guidance based upon past programs of the sort of information that we needed and how it was collected previously. Particularly in Reece's situation -- he had previously come from Lockheed and did not have a lot of background on how things were done here at Gulfstream. So we probably met and discussed that more regularly with Reece than we would have had there been another flight test engineer assigned that had familiarity with past aircraft programs and what data we were collecting.

Let's see. As we got closer we had a number of meetings and then during the actual conduct of the flight test we would provide estimates on what sort of field lengths to expect, if it was an engine outrun where we wanted to cut the thrust, cut the throttles in order to be fully spooled back by the time that we got to rotation speed. One of our big functions was what target speeds we needed to have while we were out there.

So we would provide a lot of pre-test guidance and then post-test we would participate in the post-test reviews just to see how things were conducted, the pilot's perspective comments, that sort of things.

Q. What role does Flight Sciences play in encouraging flight tests to meet performance targets?

A. We made some guarantees on the 650. In particular, the guarantee is at max takeoff gross weight, our takeoff distance would be 6,000 feet plus or minus 8 percent. Similarly we made a guarantee on landing performance, 3,000 feet plus or minus 8 percent. So we were monitoring our performance relative to those guarantees.

Q. How did you interact -- how did you or Ms. Brimmeier interact with the flight test engineers on that issue?

A. We had an initial round of testing in November 2010 out at Roswell. Most of that testing was sort of parametric in nature. We would go out and try a couple different pitch attitudes, a couple different rotation speeds. Following that testing we came back and looked at our results. What we were finding is that in many instances we were quite a ways away from where we needed to be; our field lengths were coming out quite a bit longer. So we did have a meeting with Flight Test after we -- this took place in January 2011 after our initial cut assessment of the November testing, and we mentioned that some of the techniques were not going to get as close to our guarantee distance that we needed to see if we couldn't improve the techniques to get our takeoff field length distance down.

Q. Do you know how the takeoff and landing guarantees were established in the first place?

A. Generally what we do is use estimates from previous airplanes with regards to braking coefficients, time delays. We also use the best assessment we have of stall speeds to govern our takeoff speeds and landing speeds. So we put all of that into the hopper and come up with our best guess at what the performance will be for a new airplane prior to actual testing.

Q. What stage of the program like, you know, generally time frame-wise, when those targets were established?

A. The guarantees actually go back to very early in the PD, preliminary design, effort before the initial design was passed over to Flight Science. I know the takeoff guarantee was established. I'm not sure about the landing guarantee. Both of them did not get formalized, I think, until 2006 or 2007 when we put together our first product specification. That's a document that we provide all customers that says this is your guarantee. This is what your range is going to be. This is what your takeoff distance is going to be. This is what your landing performance is going to be on this new model airplane.

Q. So where did the estimate of stall speeds come from that early in the program?

A. Early in the program you use empirical methods. You know what your wing design is going to be. There are existing methods, prior data that give you an estimate of where you think your stall speeds are going to be. So you use that information initially to work up your guarantee.

As time goes on and you actually go off and flight test, particularly on the 650, we did some cryogenic testing over in Germany which allowed us to get full scale Reynolds number. That's probably the most difficult part of estimating what your CL max is going to be or scale effects when you have a model with a small Reynolds number and you are trying to extrapolate that up to full. But with the cryogenic testing we were able to essentially test at full scale Reynolds numbers.

So we were able to determine CL maxes for our airplane at essentially full scale Reynolds numbers. So we felt fairly comfortable with the data that we were getting out of the cryogenic tunnel, and subsequent flight testing on the 650 I think verified that we were, in fact, getting very good CL max data from the cryo testing.

Q. Mr. Ollenburg's duties included cognizant flight test engineer for field performance, on-board test conductor on the airplane, data analyst, and report writer. Did you have any concerns prior to the accident that he may have had to many roles or responsibilities?

MR. RAMEE: Would you repeat the question please, Bill?

DR. BRAMBLE: Did you have any concerns --

MR. RAMEE: The preamble to the question.

DR. BRAMBLE: Oh, Reece's duties included -- off the record.

(Off the record.)

(On the record.)

DR. BRAMBLE: Back on the record.

BY DR. BRAMBLE:

Q. So my question is did you have any concern prior to the accident about whether this was too many responsibilities assigned to one person?

A. I think a number of us had a number of responsibilities. I was not overly concerned that his plate was too loaded up, possibly in retrospect maybe so. At the time, no, I did not feel like he had any more responsibility on his plate than a lot of other people.

Q. Moving on to another topic. How were the GIV and GV wing drop incidents that had occurred in the past reported and analyzed and what lessons were learned from these events?

A. The GIV events took place before I arrived at Gulf Stream. I think that was the 1986 time frame, possibly '87. As a result of that incident they did do some wing treatment to the leading edge of the wing, border line stall strips to improve the stall characteristics of the airplane.

I was at Roswell, I believe, it was in March '97 when we had a V_{MU} incident where the airplane pitched up, rolled off, touched a wing tip to the ground. I think -- I can't recall whether it continued the takeoff or aborted the takeoff.

Subsequently they did an analysis, and as memory serves me, they determined that it was not a stall, but rather some fairly high crosswinds that were prevalent that day that was the major cause of the accident or incident. They subsequently for V_{MU} testing -- we reduced the crosswind limits that were allowed in order to do V_{MU} testing.

Q. What was your position at that time in 1997?

A. I was a performance engineer, probably the main performance engineer on site at Roswell for GVI, GV testing. There was one other performance engineer out there with me at the time.

Q. Did you help with the postings and analysis?

A. No, I was not directly involved in that. That was more of a flight test issue.

Q. Do you know who did it?

A. Ken Obenshain, I think, was one of the main people involved in that assessment. John O'Meara was the flight test pilot in conjunction with the FAA pilot Dave Gollings; they were both part of that incident.

Q. How do you spell Gollings' name?

A. G-o-l-l-i-n-g-s.

Q. How many of the key players from the GIV/GV days were still around for the G650 program in flight test or Flight Sciences?

A. Ken Obenshain probably has among the longest duration of anybody in the company and has excellent familiarity, background with flight test related issues going back actually to the probably GII at Grumman.

Q. In the flight test plan for G650 in Section 8.1, there is a section describing GIV incidents. Do you know who developed that section of flight test plan?

A. I don't -- let's see, this is the flight test plan for the 650?

Q. Uh-huh.

A. It was probably a combination of Reece Ollenburg and Ken Obenshain, possibly Paul Donovan as well had some input.

Q. At the time of the accident what policies and procedures did Gulfstream have in place to manage the safety of the flight test program?

A. The main one that I'm aware of is a SRB that is held prior to actually going out and conducting the testing. At that point you bring everybody that has a stake in the testing together, present the plans for how the testing is going to be conducted, make sure you have met all the prerequisites and then ask to see if there are any concerns, reservations, issues that need to be explored. Typically you will have that anywhere from a couple weeks to a month in advance of the testing so that if you do identify any issues/problems you can then -- you have time for corrective action prior to the test beginning.

Other than the SRB, you know, we have preflight, post-flight briefings where people can bring up issues. As the test is ongoing you discover items that have come up; people are encouraged to speak up and indicate if there are any unsafe operations. I think that's all I'm aware of.

Q. Do you know why the SRB wasn't reconvened as a result of the 88 and 132 wing drops?

A. I can only speculate that people did not --

MR. RAMEE: Do you want to speculate?

DR. BRAMBLE: Off the record.

(Off the record.)

(On the record.)

DR. BRAMBLE: Back on the record.

MR. CONNOR: I have my ideas but I'm not sure they are just strictly ideas.

BY DR. BRAMBLE:

Q. Well, one of the things we are interested in is sort of people's perceptions of the culture and how decisions were made. So that's of interest to us if you feel comfortable telling us your thoughts on it.

A. I'll venture a guess at what was going through people's mind. I think we had had, as you have noted previously, some issues on prior tests when they had -- in going to those conditions they had exceeded the conditions that were specified for those particular runs. In particular, they had gotten to too high of an attitude.

So, I think, the assumption was you did not conduct those runs according to plans. There was some sort of roll-off, but you had exceeded the limits that we had established for testing and so there was a decision made to go on with the testing, that the reason there had been a roll-off is they had exceeded the target limits for those tests.

Q. What policies and procedures did the company have in place for reporting and investigating perceived hazards or safety-related incidents that occurred during flight testing?

MR. RAMEE: Can we go off the record for a second?

DR. BRAMBLE: Uh-huh.

(Off the record.)

(On the record.)

DR. BRAMBLE: Let's go back on the record.

BY DR. BRAMBLE:

Q. What I am wondering is if there's something separate from the SRB process, some sort of policy that sort of specifies how concerns or events should be reported. Is there anything other than the SRB process?

A. Not that I'm aware of.

Q. Changing topics to stall characteristics. Before the accident what was your understanding of the reduction in stall AOA in ground effect compared to free air and how did you come to that understanding?

A. During the subsequent accident investigation I became aware that an estimate of about a degree-and-a-half of reduction in stall angle in ground effect had been estimated as providing some guidance into what would be safe target attitudes to use during particularly V_{MU} testing.

Q. Were you aware of that before the accident or just afterward?

A. I can't recall if I had some familiarity beforehand. I think I was briefed by Reece that they had made some estimates. That was an area that Reece and Shelly were more involved with than me. But I think I did have some basic knowledge beforehand that they had made an estimate of what the reduction of in-ground-effect stall angle would be relative to setting target attitudes for the V_{MU} testing.

Q. Do you recall if there was any discussion of this change in stall angle during the SRB meetings for ground effect versus free air?

A. I don't recall specific discussion about that at the SRB.

Q. Did you expect that that difference would be further refined as part of field performance testing or was that kind of more Shelly's bailiwick being the 650 person, or Reece's for that matter?

A. No, I think actually that was probably going to -- provided we did not get into any problems or issues, that was probably going to be a final estimate.

Q. Who provided the information about the reduction in stall angle in ground effect to flight test? How was that information communicated to the Flight Test Organization?

A. That may be a better follow-up question for Bob Mills. My understanding is that it came from the Aero Group. Shelly may also have a little bit more background on that issue.

Q. Did you attend the March 24th meeting that was on Reece's lotus notes calendar about stall protection settings?

A. No, the 24th I was still in Roswell as the principal performance engineer for field performance testing. I had gone out on the 15th to relieve Shelly and I stayed there from the 15th to the 25th. So I was not in attendance at a meeting back here on the 24th.

Q. You didn't participate by phone?

A. Not that I recall.

Q. When did you first hear about stick shaker nibbles that were -- they were described as nibbles by the pilots -- that were occurring during the field performance test program?

A. I don't recall a specific date or time. I was aware that it was an issue, but when I became aware of that I can't say whether that was early March, late March, just when.

Q. Were they regarded as nuisance activations?
A. That was my understanding.
Q. Do you know how that determination was made?
A. No.
Q. Do you know how it was decided to bump up the shake activation threshold as a result of the nibbles rather than increasing the V speeds?
A. Clearly increasing V speeds carries with it an increase in distance. I think the feeling was that it was a safe operation to bump up shaker. I believe it was previously at .85 normalized angle of attack. It got bumped up to .90 sometime just prior to Phase 2 testing.
Q. Do you know who was involved in the decision to increase the shaker threshold?
A. Not off hand. I would assume that that was Ken Obenshain, Bob Mills, Reece Ollenburg, among others.
Q. Did you participate in program status meetings during the field performance testing program and how often were they held and who else specifically attended?
A. I don't recall that there were regular status briefings during Roswell-1, which was November of 2010, and Roswell-2, which essentially was March of 2011. Shelly and I both prepared daily logs that we put together and sent back.
So we were up-to-date as far as test activities from that. I don't recall any other sort of formal debriefs that were

companywide. You know, within the test community out at Roswell we had our preflight and post-flight briefings.

Q. During which of these meetings were concerns expressed about difficulty meeting the field length performance targets?

A. The first meeting that I recall where that became an issue was January 2011. We had just looked at the results from Roswell-1 and concluded that we were quite a ways away from where we needed to be to meet our guarantee. So we discussed what other options, techniques could be employed to get better performance.

Q. How were the data supposed be periodically analyzed and presented and decisions made about whether the airplane was meeting field performance goals?

A. There was no formal plan that as data got reduced we would attempt to look at that and see where we stood relative to the guarantees. In particular when I was out there at Roswell from the 15th to the 25th we were actually doing a lot of engine lapse rate testing at that time. And so while we were doing nonperformance type work, I and two other performance engineers that were there basically took a lot of the CTO (continued takeoff) data that we had already collected and put them on a chart of V/V stalls versus thrust to weight, which is probably the key thing which gives us insight into how well we are going to meet our guarantee. That information was completed just before I left, and subsequently I did meet with Reece Ollenburg on the 27th, Monday, the 27th of March to show him how we were doing relative to our guarantees.

Basically, for the flaps 20 configuration, which is where the normal takeoff flap setting, which is where our guarantee is located, we were tracking pretty much on the 6000 feet. We were just a little bit above the 1.13 V_{SR}, which is FAA minimum, but we were still tracking right at about 6000 feet.

Q. So was it your feeling at that time that the effort to revise the takeoff technique had succeeded at that point?

A. Correct. It looked like we had -- at that point it looked like we had had the set of takeoff speeds that we needed to have a viable 6000-foot capability. We had not yet fully reduced brake coefficients and time delays, which are also critical to that assessment. But we felt pretty good about being able to meet our guarantee at that point.

Q. Who initiated the meeting between you and Mr. Ollenburg on March 27th?

A. I believe it was myself. I had just come back from Roswell. Mr. Ollenburg had been out there. He had been back in Savannah for about a week at that point. I had just completed reducing the V/V stalls so I wanted to meet with him and show him those results, which he was not aware of previously. I also wanted to talk to him about -- there is a requirement that the normal liftoff speeds be a certain percent above the V_{MU} speeds. So I wanted to talk to him as well to see how we stood relative to meeting those margins. So that was the main purpose of the meeting on March 27th.

Q. You explained during your last interview that you told him that you were kind of on the ragged edge of -- was it meeting those requirements, the percent above the V_{MU} liftoff speed?

A. Correct. Yeah. We were marginal. For the normal engine out liftoff speed needs to be 5 percent above your demonstrated V_{MU} speed. The all-engine speed, the liftoff speed needs to be a full 10 percent. We looked at the data and we were just right on the ragged edge of meeting both of those margins.

Q. What implications did that have for the remainder of the takeoff testing?

A. It didn't affect the immediate takeoff testing. I think we were going to gather, finish gathering the data and then once we had all of the data assessed, at that point we still hadn't collected all of our CTO performance. We were still doing testing. So this was just the results that we had up to that point.

So the plan was to go ahead and finish out the full set of test conditions, put them on the plot, see if we needed to refare any of our lines, and then look at the margins relative to V_{MU} and decide whether or not we would shift up the takeoff speeds to meet the V_{MU} margins if we did not have them or one option in my mind was to possibly go back and test for higher V_{MU} targets, which would lower the V_{MU} speeds to provide the margin. But the first thing was to get all of the test data and assess whether we met the margins or not.

Q. By going back and testing for higher V_{MU} targets that would mean -- how would you do that?

A. When we were there -- For V_{MU} typically you start out with a buildup process in that you target fairly low pitch attitudes initially and build up. So we started out flaps 20, 7 to 8 degrees, and went 8 to 9 degrees and finally 9 to 10 degrees. We wound up with a maximum flaps 20 V_{MU} target of about just a little bit short of 10 degrees. At that point we were not aware of how close we may have been to in ground effect stall, so one option was to possibly bump up that angle by another degree, which would lower our V_{MU} speeds and provide more margin relative to our normal operating speeds.

Q. Who were the key decision-makers who would sort of decide how to deal with obstacles meeting the targets, which was choosing among these options?

A. That would clearly be a Flight Ops, Flight Test and Flight Sciences decision.

Q. So these decisions we made in a sort of group setting?

A. (Non-verbal response.)

Q. What kinds of analysis did the Aero Performance Group in Flight Sciences do to make predictions about takeoff performance prior to Roswell-1 and 2? Was there a process where Aero Performance makes predictions about what the airplane, what speeds the airplane is going to hit and then Flight Test goes out and

tries to see whether it matches it, or --
A. We had worked up some preliminary V/V stalls as a function of thrust to weight. We used those predictions to work up a set of target speeds for operation at Roswell for both flaps 10 and 20 configuration; those were the target speeds that the flight test crew was using on a daily basis during the conduct of the test. Depending on the gross weight of the airplane they would come down and the flap setting, they would come down and get their V_1 speeds, V_R, liftoff and V_2 speeds.
Q. Was there also modeling of the airplane's performance sort of from the first principle physics with sort of what was known about the various curves?
A. For the ground portion we used first principles F=ma analysis. For the rotation and air segment phases we simply used estimated V/V stalls that we had gotten from the GV and shifted them down to the target speeds that we were trying to hit on the G650 but we had also adjusted those schedules slightly based upon some experience that we had gained during Birmingham testing in February of 2011.
Between the initial testing in November and the second round of testing in March we had a 1-day test over in Birmingham and that was a result of the January meeting where we had talked about missing our guarantees what other techniques could we employ after coming up with techniques. We then went out to Birmingham and tested that in February. So based upon the Birmingham

experience we also adjusted our target speed schedules a little bit to account for those results.

Q. How was -- I think I may know the answer based on what you have said. But in terms of how V_2 was predicted for Roswell, what was the process on which you arrived at the V_2? I understand there are ratios, but was it refined through that process you were just discussing?

A. The V_2 speed criteria was basically to try and hit the FAA minimum V_2 criteria of 1.13 V_{SR}. So our goal was to be at that V_2 speed the lower your V_2 speed, the lower your distances are going to be. So that was our goal to get our V_2 speeds down to that level. So where did rotation and liftoff have to occur in order to get down to that target V_2 speed.

MR. HORNE: Bill, can I ask a clarifying question?

DR. BRAMBLE: Okay.

MR. HORNE: When you say V/V stall is that essentially V_2/V stall?

MR. CONNOR: Yes, the V/V stalls refer to either rotation, liftoff or V_2 speed. But specifically, if we are talking about V_2 it would be V_2/V_{SR}.

Q. Over V_{SR} is 1.13?

A. Yes.

BY DR. BRAMBLE:

Q. Who was analyzing the -- thank you -- performance data coming out of Roswell-1 and 2 on a day-to-day basis, like the end of one day's flights to the next day's flights?

A. It was a joint Flight Test and Flight Science activity. Cynthia Townsend was principally looking at the braking coefficients. I think the on-site performance personnel were doing more of the CTO data reduction, continued takeoff V/V stalls as a function of thrust to weight.

Q. So that would be Shelly, Ms. Brimmeier primarily?

A. Yeah, Shelly Brimmeier, myself and we were taking this opportunity to also rotate in and out a number of our other performance engineers to get some experience on data reduction. So Adam Hart, Eric Upton, Mike LeMieux, Chris Cambric (ph.) were all other performance engineers that rotated into and out of Roswell.

Q. Was it typical for the aero performance people at Roswell to analyze the day's data and then brief the data with their findings the next morning?

A. No, I would say that was atypical. We were reducing data as time permitted. Our first responsibility was to make sure that we would proceed on with the planned activities for that day as opposed to ensuring that we had reduced the prior day's flight test data.

In fact, it was only because there was a break in performance flight test testing in the middle of March that allowed me and the other two performance engineers that remained there from the 15th to the 25th time to go ahead and reduce particularly a lot of the CTO data that we had already collected.

Q. And Ms. Brimmeier said that she had some discussions during Roswell-1 and 2 with aero performance people and flight test people but it was difficult to analyze the data as they were going along because of the pace of the testing. Did she have any conversations with you about that?

A. I don't recall specific conversations but that clearly was what was happening, just keeping pace with the normal flow of flight test activities precluded a lot of in-depth data reduction during the testing itself.

Q. Would it have been helpful to have additional personnel available to analyze the data as you were going along, you didn't also have to be conducting the test?

A. You know, in retrospect one of the big items that did not get reduced in a timely fashion was the V_{MU} test results. Had that information been known at an earlier point it may have given us some insight as to how target speeds might have been impacted when in late March we opted to reduce the target pitch attitude for the flaps 10 configuration from 10 degrees to 9 degrees. So that clearly was a situation where not reducing the data in a timely fashion was detrimental to us.

Q. How could that have been avoided, or how in the future could that be avoided if were to look at solutions?

A. I think we have been looking at that as well and clearly there are some prerequisites that need to get reduced, looked at before you do any follow-on testing. And as a result when we return to Roswell currently predicted for sometime late in late November, the first order of tests will be V_{MU} tests. We identified that we had not done a full range of thrust to weights. So our first order of business will be to go out, do that test, spot those on a curve with all of the other V_{MU} test points before any additional testing proceeds.

Q. Before any additional testing?

A. Right.

Q. Take off testing?

A. Correct. We may go ahead with some landing testing that we have not yet completed and actually have to repeat prior to even the takeoff testing depending on what's decided there.

Q. I'm skipping questions.

A. That's fine.

Q. What data, if any, could the team in this telemetry trailer have analyzed during the earlier test runs on the day of the accident to determine that V_2 was unattainable and they should stop takeoff testing prior to run 7A2?

A. In the TM trailer we do attempt to mark the critical items that we are getting from the testing, the rotation, liftoff and V_2 speeds. We do that as quickly as possible after the test and, in fact, the Flight 153781, the test prior to the fatal accident, they had noted that our V_2 speed target was 136. They wound up hitting 144.8, so about 8 to 9 knots higher than what our target speed was.

That was identified, to respond to your question, and at that point I think a decision was what was happening, what could we do differently to get that V_2 speed down but without the realization apparently at that point that the, with the new pitch attitude that had been adopted just -- that was the first day with the flaps 10 configuration that we were now testing with the 9-degree pitch attitude limit as opposed to 10-degree pitch attitude limit. And, so, there wasn't this realization yet, even after that first run, that the 9-degree pitch attitude was impacting our ability to hit the target V_2 speed. What else could have been done? I'm not sure.

Q. Would it have been possible to look at the fact that the target pitch hadn't been attained and the V_2 speed had been exceeded and, therefore, the airplane couldn't do it or was there a belief that there was still some wiggle room in there between the initial target pitch and V_2 where they could make it happen?

A. Hindsight it would have been good to look at the data and see that the airplane on 7A1 got to the target attitude and simply did not have flying speed at that attitude and had to maintain that attitude for another 4 or 5 knots until it finally had sufficient flying speed to liftoff. Had there been a break after that first run, to scrutinize the data maybe, that would have jumped out at folks. I think at the time it was just mentioned that, okay, we missed our target attitude by a significant margin --

Q. Target attitude or V_2?

A. Excuse me. We missed our V_2 speed by a significant margin. Let's go back and repeat that run to see if that's valid. And I'm speculating because I was not there onsite at Roswell. I was not part of the TM trailer, but I do know that between the runs the airplane pulled up in front of the TM trailer, the results speed V_2 overshoot were mentioned to the Flight Test crew and then they repeated the run with 7A2.

Q. If the V_{MU} results from November had been processed and used to model how the airplane would take off would that have indicate prior to Roswell-2 that it was a waste of time to be targeting the 1.13 V stall during Flight 153?

A. For Flight 153, yes, but remember that was the first flight after a decision had been made to reduce the target angle from 10 degrees, flaps 10, to 9 degrees. Prior to that we had actually during Roswell-2 done a number of flaps 10 tests using the 10-degree target and there we were seeing about the same level of V_2 overshoot just a couple of knots relative to our target speed not 8 to 9 knots that we were seeing on Flight 153 where we reduced the target pitch attitude to 9 degrees.

Q. So you felt that generally the sense was that the 1.13 might work out because you were only a couple knots off with the 10-degree pitch target?

A. With the 10-degree pitch attitude we were coming as close to our V_2 target as we were for the flaps 20 configuration and it was just a couple of knots in excess.

Q. Why wasn't the aero performance group in Flight Sciences more involved with the analysis of the November V_{MU} takeoff data until after the accident?

A. V_{MU} I think was always set to be a flight test data reduction item, and so we deferred that to Reece Ollenburg. I think the reason they proceeded on with the V_{MU} testing basically what you are establishing is that here are some safe maximum pitch attitudes that we can go to. In the case of flaps 20 it turned out to be about 10 degrees. In the case of flaps 10, about 11 degrees. And, so, as long as we stayed below those pitch attitudes for the remainder of our CTO testing then we should be on firm ground and that was the criteria that was specified under the test technique, was to pitch up to typically flaps 20, I think a 9-degree pitch attitude and that would give you about a degree margin relative to the V_{MU} test attitude.

So even though the data had not gotten reduced in a timely fashion I think the decision was made to proceed on with the test because we knew essentially what the safe pitch attitudes were already. In retrospect by reducing the data what we are able to -- and that was done incidentally by Reece. I think a good portion of that data reduction was done, the V_{MU} data reduction was done during the one week he was back in Savannah before he went back out for the final found of testing.

Q. In March?

A. In March. And so he had come up not only with the maximum angles but more importantly what the in-ground effect CL alpha data was. There were estimates on what that was previously, but this was finally flight test data to show what those estimates were and it was that information from that draft report that Reece had prepared that after the investigation I went back, looked at that data and determined that with a 9-degree pitch attitude or flaps 10 our target speeds were not viable.

Q. Do you think Reece had any idea about that before the accident?

A. Apparently not. Having reduced the data he probably should have been as aware of anybody of implications of reducing the target pitch attitude but apparently he, myself, and others failed to realize that it might impact our target speeds.

Q. Between November and March what were you and Shelly primarily working on, you and Ms. Brimmeier? I'm sorry.

A. We got involved in continuing to plan for going back to Roswell but there are also just all sorts of miscellaneous G650 issued. I think one of the things we were doing a lot of flight testing. One of our other guarantees was what's your range going to be on this airplane. So we had taken a lot of long distance flights to see whether or not we had the 7000-nautical-mile capability.

So we were spending a lot of time evaluating performance from the crews to see whether or not we had a bona fide 7000-nautical-mile capability there. So there were a number in addition to planning for Roswell there were a number of non-Roswell type G650 issues that were coming up on a daily basis that we needed to attend to.

Q. Both and Shelly?

A. Correct. I said in addition to my 650 responsibilities I was also working new airplanes, existing airplanes. I was having to limit my time on 650 activities.

Q. How did it come to be that you did analysis on the March CTO testing but not the V_{MU} work? Was that a decision that you and Reece made or you and Ms. Brimmeier?

A. No, I think that was just a general understanding that flight test would assume responsibility for the V_{MU} and we would assist on most other data reduction. And we, quite frankly, hadn't worked out who was going to have primary responsibility on some of the other issues. But I think it was fairly understood between Reece, Shelly and myself that Flight Test would have the lead in reducing the V_{MU} data. And that's why Reece had taken it upon himself to work up that draft report late March.

Q. Did the aero performance group perform analysis of the Birmingham flight test data from February?

A. Yes, we did. In conjunction with Flight Test as well. I remember Reece had worked up his own assessment. We had worked up ours. We compared notes and they were pretty close to one another as far as V/V stalls that we were seeing as a result of that testing.

MR. RAMEE: Can we take a quick break when you get a chance?

DR. BRAMBLE: Yes.

MR. RAMEE: Can we do it now?

DR. BRAMBLE: Yeah. Let's take 5.

(Off the record.)

(On the record.)

DR. BRAMBLE: Let's go back on the record.

BY DR. BRAMBLE:

Q. Do you know whether Flight Sciences or Flight Test did the V_{MU} data reduction and analysis for GV or was it similar to the way things were worked out here?

A. On the GV it was primarily a Flight Test responsibility to reduce not only the V_{MU} data but also a lot of the performance data. This time around due to lack of manpower in Flight Test we were taking more and more responsibility for assisting Flight Test with reducing some of the field performance data, but not the V_{MU} data.

Q. The reduced manpower in Flight Test was that primarily people that had been performing analysis functions during the prior program?

A. Previously they had a team of people working data reduction in addition to conducting the test. This time around on the 650 program they did not have as many people dedicated to data reduction as they have on past programs.

Q. Do you see that as playing any kind of indirect role in how things turned out?

A. I'm not sure that even in the past we had immediate turn around in data reduction. Typically a lot of that did not get sorted out until after flight testing, field performance testing was complete and we had collected all the data, we had brought it back and started reducing it.

We would do some data reduction as time permitted, but it was not whole scale data reduction during the actual conduct of the test. Historically that did not get done until after the test was complete and people had a chance to focus on data reduction.

Q. Was the aggressive rotation technique, I wasn't characterizing it as aggressive, but the rapid 60-pound pull during the CTO testing was expected to be acceptable to the FAA during certification and, if not, why would the team continue to use that technique?

A. Actually, it was felt that it should have been very acceptable to the FAA. The FAA allows up to a 75-pound pull force on column pull. So we were actually operating below that. On the G550 we were typically hitting right at 75-pound pull force and going back even earlier to the GIV before a 75-pound limit had gotten imposed I have heard, I have not looked at the flight test data, but column pull forces were in excess of even that.

Q. This kind of repeats some of the earlier stuff and if you don't have any more light to shed on it that's fine. But in general why was V_2 not increased prior to the accident when there were these repeated exceedances of V_2 in the range of 4 to 8 knots?

A. Prior to Flight 153 we were seeing some exceedances but particularly at the guarantee point it was more like just 2 or 3 knots and it was not considered to be excessive from my perspective. So I think that's why we did not feel a need to increase V_2 speeds. It was just a target. Let's see where we wind up given that target to see what the impact is going to be to performance and then it will have to be a management decision do we want to go back and test to get lower speed still to get lower distances or are we good with where we are at?

Q. How would increasing V_2 by 4 to 8 knots have impacted the takeoff field length?

A. This was the flaps 10 configuration that the accident occurred on. It's not our primary takeoff configuration where the guarantee was based. So when we made a conscious decision to go with a 9-degree pitch attitude as opposed to 10 for flaps 10, I wasn't overly concerned that our performance might suffer a little bit. This was only the secondary takeoff flap position and primarily you would only incorporate flaps 10 takeoff performance if you are limited by the second segment climb gradient limit of 2.4 percent or you have an obstacle that is limiting takeoff performance. If you are field length limited, which happens most of the time, then, normally you would want to use the flaps 20 configuration.

So if we had to bump up the flaps 10 speeds that would have had no impact on our guarantee condition and just a small impact on our competitive posture.

Q. How much was V_2 being exceeded in the flaps 20 condition?

A. At the guarantee point we were getting to 1.15 V_{sr} instead of the target of 1.13. So that was probably 2 to 3 knots.

Q. So if the, what you are saying for the flaps 20 condition is that if you hadn't had to bump up the V_2 speeds by 2 to 3 knots it would have been minimal impact on the field length?

A. Correct. We were still at 1.15. We were just meeting out guarantees as best we could determine and checking the data prior to Flight 153 for the flaps 10 configuration the data was showing us at 1.15 V_{SR} as well when we were employing the 10-degree pitch attitude.

Q. And that was resulting in V_2 over shoots of 2 to 3 knots as well?

A. Yes.

Q. So if the 10-degree pitch target had remained the standard and the V_2 speeds had adjusted up 2 or 3 knots, do you have any sense of what that would have done to field length in terms of hundreds of feet?

A. A couple of knots are probably worth 100 to 200 feet.

Q. And the margin in the contract was 8 percent of 6000 or 480 feet?

A. Correct. Essentially we could go almost as high as 6500 feet and still meet our guarantee.

Q. Mr. Donovan mentioned during his last interview that they had some touchdown speed exceedances during the performance landings and we were wondering if that was somehow related to the V_2 exceedances and we don't really have a good understanding whether those are completely separate or related problems.

A. I personally am not aware of touchdown speed exceedances for landing to the what we were targeting at 50 feet is 1.23 V_{sr}, which is the minimum allowed by the FAA. Typically you will at 50 feet you pull your throttles back to idle. You will bleed off a couple knots prior to touchdown. So looking at the touchdown of the landing data that we collected, our touchdown speeds were just like 1.20 or 1.21 V_{SR}. I think we were seeing about a 2 percent loss in speed between 50 feet and touchdown. So I'm not sure what these touchdown speed exceedances were that Paul Donovan was commenting on.

Q. What was your understanding of the causes of the wing drops on Flights 088 and 132 and how did you come to that understanding?

A. I found out about them after the fact. I think the flight --

MR. RAMEE: After which fact?

MR. CONNOR: Well, let's see. The Flight 132 had taken place I think on the 14th of March. As I mentioned I arrived at Roswell on the 15th. So I did hear at that point that the prior day or the day before there had been a wing drop event and it was assessed to have resulted because they exceeded the pitch target during takeoff and that was the end of it.

BY DR. BRAMBLE:

Q. Why did Reece say during -- no, you weren't present for the pre-flight briefings that Reece gave on April 1st and 2nd I guess.

A. No.

Q. Do you know from prior discussions with Reece why he had decided to stay away from 12 degrees during rotation?

A. My understanding was the V_{MU} event of Flight 088 and also 132, those were two data points that they weren't sure what was happening but did not want to get back into that area.

Q. I guess in retrospect it's clear that they were stalls, but trying to imagine it without the benefit of hindsight you wonder if they didn't understand what was happening why they didn't look more closely at the aero data.

Do you have a sense of why they just stopped that it must have been an over rotation or?

A. Can't venture a guess as to why nobody decided to dig into the data and better understand it before proceeding on.

Q. Do you know what analysis was performed on those wing drop events?

A. I'm not aware of any special analysis that was done.

Q. Who was responsible for analyzing aircraft performance during those flights?

A. The V_{MU} event from Flight 088 I think Reece at Flight Test as I've mentioned previously was responsible for data reduction. The Flight 132 event was a CTO event after that occurred I think they decided that they had just gone to high of a pitch attitude. I think they wound up repeating that test point and that test point subsequently got reduced by us and used as a valid data point. Not the one with the roll off, but the subsequent test point was used to establish V/V stalls for takeoff planning charts.

Q. By us, do you mean you or Ms. Brimmeier, were analyzing the data from 132 flights?

A. That fell into my responsibility in that that test was done on the 14th just the day before she left the site to come back and attend to other responsibilities. So while I was onsite I wound up, as I said we had stopped field performance testing they were doing some engine lapse rate testing, and so I had myself and two other performance engineers had an opportunity to reduce most of the CTO data that was collected prior to that point. And that was the information that I presented to Reece on the 27th of March.

Q. Who were the other two engineers that worked with you?
A. Let's see. We had Mike LeMieux, Adam Hart and during that period another Mike LeMieux went back and Jason Merret came out. So there were basically three other performance engineers just two at a time though.
Q. How do you spell Merret?
A. M-e-r-r-e-t.
Q. In looking at those data why do you think Flight Sciences' personnel didn't recognize that Flights 088 and -- let's leave it to 132. Why do you think that you and these other guys didn't recognize that they were stall events?
A. On Flight 132 they simply went back and repeated that test point and came up with another test point at that weight and flap setting condition that met the criteria. And so that was what was used to reduce the data. The other point was not included in our database.
Q. So that one was basically discarded because it was considered a bad run?
A. Yes.
Q. I see. Did you know before the accident that the roll offs that occurred during 088 and 132 occurred at .86 and .87, normalized angle of attack?
A. No, I was not aware until just now exactly what normalized angle of attack that was. But, of course, I don't find that totally surprising. The normalized angle of attack is

relative to the out of ground effect stall angle so the fact that it was occurring at what are considered lower NAOAs, I guess is not all that surprising.

Q. If those events had been analyzed in terms of normalized angle of attack would that have led to some reluctance to, I guess that's rhetorical question, but were you aware that the shaker was increased from .85 to .9 prior to Roswell-2?

A. Yes, I was.

Q. Why did -- I think I have already covered that why 088 and 132 didn't result in a reconvening of the SRB.

Do you know how the G650 flight test schedule and staffing requirements were benchmarked for the flight test?

A. Can you give me a little bit more background on that question?

Q. How did from like first flight to certification when they first made the schedule, how did they decide how long it would take and how many people it would take to sort of run the flight test program?

A. (No response.)

Q. Or is that a better question for somebody else?

A. I'll venture an answer. We had worked up and have to submit to the FAA a flight test plan, which is all of the data points that we plan on collecting. Based upon that assessment we work up a time frame for how long we think it's going to take to cover all of that testing. And then manpower wise we want to have a sufficient crew there onsite to monitor activities, but not necessarily a full complement of people to reduce data and a lot of myriad of other activities that take place frequently after the flight test is concluded.

So I think that's how they went about determining how long it was going to take, looking at the test plan, all the points that had been done and then what would be crew and manning requirements to support that activity based, as much as anything, based upon past manning crew requirements.

Q. Did you feel that the scheduling and staffing committed enough time for data analysis and information sharing in preparation for the next envelope expansion point during field performance testing?

A. Clearly in the case of V_{MU} in hindsight it did not. As I mentioned, however, the key thing you are getting from V_{MU} targets are what are safe attitudes that you can go to that you want to avoid right at liftoff. So we had established those even though the official V_{MU} report had not been done.

Relative to the other testing we hadn't determined that it was critical to reduce data in a timely fashion. We just needed to see where we basically meeting the speed criteria, getting close to the speed criteria to determine whether we had a good point or not that we, and if we didn't, you know, we would go back and repeat the test point.

So we were not for the other testing, the RTO rejected takeoff, continued takeoff. We had not -- did not have a plan in place nor did we on previous programs to reduce data from the prior day's test before we proceeded on.

Q. Do you have a sense of why the end date for the flight testing remained fixed despite repeated delays over the previous 6 months to a year, and the backup of TIAs?

A. Yeah. I was not aware we had a fixed date. I know we were looking to finish up our testing as soon as possible so that we could then move on to TIA testing, but you can't move on to TIA testing until you have collected all your data. So if we did not collect all of our data, company data in a timely fashion then we would have to stay out at Roswell a little bit longer and then probably delay getting the FAA on site. And, in addition the FAA before they come on site they have indicated that they want to review some, if not most of our company test results.

So at the conclusion of company testing then we have to do some serious data reduction to show the FAA generally where we stand to get their assessment whether they are comfortable with what we have done and to come out and do the TIA testing.

Q. So from your perspective you felt that, and if it took longer to get things done it was going to take longer and you weren't necessarily concerned about sort of an, didn't feel like there was an inflexibility that was making things to difficult?

A. No, from my perspective it would get done when it gets done.

Q. Okay. All right.

DR. BRAMBLE: So, we may run a little late for Bob, but I promise you we will get Bob out by the promised time if we start Bob in 15 minutes.

MR. RAMEE: Has anyone poked his head in there? I haven't seen him yet, so I'll step out and tell him when he shows up. Continue.

DR. BRAMBLE: All right. So, I'm finished so I'm going to pass it on to John.

MR. O'CALLAGHAN. I just have a couple follow-ups to what Bill asked; try to get some of the technical details of some of the answers.

BY MR. O'CALLAGHAN:

Q. Regarding the predictive analysis for takeoff performance you mentioned that first principles physics F=ma was used for the acceleration ground rule portion, but that the V/V_{SR} rations were used for the rotation and everything after that. The question then would be would an F=ma analysis for the physics of the rotation part be useful for simulation or something like that, and if you could speak to that general topic?

A. Yeah, no question about it. In hindsight looking at the data if we had a at least full degree of freedom, 3 degree of freedom dynamic program that would have been very useful in gaining further insight into speeds and conditions for the takeoff maneuvers. And from our own internal investigation at review of the incident I think we have decided that that is a very beneficial option that we need to take that we did not.

Q. So historically Brett Leonhardt's group the simulator flight dynamics are still in control folks will not be involved with the sort of analysis you just described, but they will be in the future; is that right?

A. Correct. Yeah, but, you know, the most recent programs really we were dealing with derivatives of existing programs.

The G550 was a derivative of the GV. So there we already had our, there were few, if any, changes between the two airplanes so using the GV CTO data was a very natural thing. The G450 derivative of the GIV using that data was a very natural thing.

As you move off to new aircraft design one of the big lessons learned from this is that you probably want to do a more in-depth 3 degree of freedom analysis to get better insight into all of the critical parameters that are involved in CTO performance. And I think in fairness it takes -- we have been working months to fine tune our ITF analysis to make that match up. And it takes a lot of upfront work to program everything to get that. And so that was because of the effort involved that was not undertaken in the 650 program.

Q. I understand that prior to the development of the new technique, rotation technique in Birmingham the V_2s that were being obtained resulted in large exceedances of the guarantee field length. Can you just quantify large?

A. Yeah, we were seeing the V_2S remember Roswell-1 we were doing a lot of parametric where we exploring different rotation rates, different pitch attitudes and particularly some of the lower pitch attitudes that we were employing during Roswell-1 we were seeing V_2 speeds on the order of 1.2 V stall. So we were adding a good 5 or 10 knots, we are seeing V_2 speeds a good 5 or 10 knots higher than where we expected to be. And as a result our takeoff distances were on the order of 1000 to 2000 feet longer than what our expectation goals were.

That was the impetus behind the January meeting once we saw those results for Roswell-1 we realized that we needed to fine tune the technique to come up with our best technique to reduce distances. So after the January meeting we decided what to do and then we went out to Birmingham and just did flaps 20, CTOEI, one engine inoperative, CTO performance to see how successful we were going to be with that new technique. And basically, that put us at the 1.15 V_{SR} for the V_2 speed and showed that, you know, our guarantee distance was approximately 6000 feet.

Q. Quick question about the Birmingham. It was one engine inoperative. Was it a true one engine inoperative where they pulled the one back to idle or was it symmetric forward thrust?

A. A good point. Actually for Birmingham I think we were pulling two engines symmetrically back to the thrust to weight that you would have with one engine.

Q. Thank you. You talked a little bit about the wind tunnel testing and how the high Reynolds number cryogenic tunnel gave you increased confidence in the stall angle of attack, but, of course, that would be free air only; is that right?

A. Correct. Yes. We had no ground plane, high Reynolds number ground plane data. We had done some low speed San Diego testing and I think there was a ground plane associated with that. But at a low Reynolds number, you get stall at different conditions and that data was somewhat questionable the IGE data that we were getting.

Q. So can they keep clarified from design what the estimate of the reduction and stall angle of attack due to ground effect would be or how hard was that to obtain; if you know the number that it was? I think we have talked about 1.5 degrees but how was that arrived at given the difficulties you described?

A. I think that would be a better question for Bob Mills if I can defer that. I'm not sure exactly how that was worked up and I wasn't directly involved with that.

Q. Thank you. We have talked a lot about Flight 88 and 132 and I think this is covered. But just to underscore or confirm. So the root physical cause of Flight 88 and 132, I mean you mentioned that people saw that while it was an overshoot that the technique wasn't correct but getting at the root physical cause there was no subsequent analysis to determine that or was there?

A. Not that I'm aware of.

Q. You mentioned that one thing that was considered as a solution to the V_2 exceedances was to perhaps do some additional V_{MU} testing at higher pitch angles to see if the speed could be brought down lower. So my question is how high can you go in V_{MU} testing? How do you know when to stop? If you are not geometry limited how would you know a point beyond which you don't want to really try it anymore?

A. Either you make your best assessment of what the in-ground effect stall was going to be. And I think flaps 20 out of ground effect was 14 degrees minus a 1.5 degree would put us at about 12.5 degrees. We were doing V_{MU} testing flaps 20 just the maximum angle 9 to 10 degrees approaching almost 10 degrees. So we had about 2.5 degrees margin relative to what we thought the in-ground effect stall angle was going to be. So based upon that data if people were comfortable in going forward and maybe reducing that to just 1 degree, 1.5 degree we may have had additional margin that we could lower the V_{MU} speeds.

Q. So I think you are telling me that it rests on some confidence and on your estimate of the in-ground effect stall angle?

A. Exactly, yeah.

Q. So regarding that, you mentioned if I understand right, before the testing there was an estimate about 1.5 degrees in that reduction in stall angle of attack due to ground effect and based on Reece's work with the V_{MU} he appeared to have confirmed that because he was come up with about 1.6 degrees. Am I good so far?

A. I think all he was seeing is that it shifted the CL alpha over by about 11.6 degrees. I don't think from his work that there was really any better guidance as to what the true in-ground effect stall angle would be.

Q. So then would Flights 088 and 132 have provided better guidance as to that?

A. If we had known those were stall events at the time. I don't think we had necessarily concluded that that was a stall event. And remember earlier in my discussion today you were asking me about the wing strike, wing roll off V_{MU} event on the GV that was ultimately as far as I know, decided not to have been a stall event. It was an adverse cross wind that was causing that.

So even though we had a wing roll off it was not known at that point to be a stall event.

Q. On the GV there was an analysis undertaken to determine that it was a crosswind effect; is that correct?

A. Correct.

Q. But there's not an analogous say for Flight 88 or 132?

A. No, in the case of the GV we had a wing strike where they had to send out a team of people to investigate the structure. So it became a major incident. And Flight 88 and 132 up and away no serious consequences so a decision was made to continue on with testing that we had just exceeded the limits that they were supposed to target.

Q. Well, if I could pursue that a little bit. The conclusion was that they exceeded the rotation targets. They pitched too high. But how does that translate into physics? Does that lead one down a path towards stall or does it lead one for a slide slip sort of event?

A. With a wing roll off event you can lose effectiveness with your ailerons that may not necessarily be a stall event. At least that's what was concluded on the GV. So I think on 88 and 132 no determination was made that this was clearly a stall event that represented a serious problem.

Q. You mentioned that there may have been some advantage to you analyzing reducing the data from the V_{MU}s and I'm just wondering how specifically would reducing the V_{MU} data or analyzing it have affected the speed schedules.

A. Once I became aware of the flight tested CL alpha data contained in the draft V_{MU} report that Reece had put together and I only became aware of that post-accident or gained access to that report I was able to go in to find out for 9-degree pitch attitude with the flaps 10 the minimum liftoff speed would have been in exceeds of even the V_2 speed that we were providing as a target in that case.

Q. And in regards to the margins the 5 percent and 10 percent margins that are required would an analysis of the V_{MU} data have indicated that there was consistency between meeting all of the FAR requirements in terms of the 5 percent and the 10 percent from the V_{MU} speed and 1.13 v stall?

A. As I mentioned previously with the V_{MU} data had we not had the needed margins then we would have had two opinions. One bump up our normal speeds to meet that or the other option was to go back and test to a higher V_{MU}. It all depended on how our takeoff distances came out whether we could afford to bump up our normal speeds or whether it would be beneficial to go back and perhaps do some additional V_{MU} testing to provide the margin.

On past Gulfstream airplanes V_{MU} has never limited our performance. We are not tail geometry limited. In the past all we did was to check to sufficiently high V_{MU} angles that would provide the necessary margin and we did not take it to the limit or the extreme to know when we truly did get into an in-ground effect stall. We just took it to that level that we could meet our margins. That's all that's required under the FARs and there was no need to test any further.

Q. And my last question is sort of general one. We have been working at this for a few months and then you guys have as well and it's on your mind all the time. Just something general. Is there anything, you can kind of see what we have been asking about, is there anything else you think we should be looking at? We are going to go back and write a report and make recommendations. Is there anything you think we should recommend that might benefit the industry, or public to know about this?

A. Yeah, I think a couple things. One is let's see, a full assessment of in-ground effect stall angles is critical in order to proceed safely with testing. So whatever is necessary CFD, wind tunnel testing to identify that would be very important.

Another item that we have touched on today particularly for new airplane designs having a full 3 degree of freedom dynamic program that can model all of the stability and control derivatives. You have things like pilot control force modeled so that you can make an input to see how the airplane responds at different speeds would be very critical and useful to the analysis to hopefully avoid this in the future.

MR. O'CALLAGHAN. Thank you very much. That's all I have.

MR. GALLO: Can I ask two questions, two fast questions?

DR. BRAMBLE: Okay.

BY MR. GALLO:

Q. Was there any comparative discussions of the GV versus GVI margins related to shaker pusher/limiter in-ground effect AOA stall, and, if so, with who and did those margins take into account the reduction of V_2 in terms of V_2 previously defined as 1.2 V_{SR} now it is 1.13 V_{SR}?

A. The V_2 on the GV was originally 1.2 V_{SM}, actually on the GV we were tail power limited such that we actually did not even meet that criteria. We found that if we attempted to rotate at less than about 1.17 V_SM which was the existing stall certification stall speed criteria in effect on the GV that the airplane was not very responsive. So most of the takeoff performance particularly at the heavy weight on the GV was limited by tail power we would rotate at 1.17 and typically at a heavy gross weight not get to the 35-foot point until about 1.21, 1.22 V_SM. So even with the GV we were paying a slight performance penalty because if we could have rotated aggressively at a lower speed that would have been beneficial.

With the 650, we have a fully trimable horizontal and that provided more than enough tail power to rotate the airplane aggressively at lower speeds. So we were actually from a tail power standpoint able to rotate the airplane in order to achieve a V_2, not -- we did hit 1.13 on a couple of runs but by and large at the guarantee point it was more like about 1.15 V_{SR}.

Relative to, let's see; stall normalized angle of attack for shaker I think for the GV that's historically set at .85. That's where we were initially on the 550 and as we have already discussed I think that was because we did have some nuisance shaker events it as deemed that we would bump that up to .9 for the G650.

Q. What about the margin between IGE AOA stall pre air stall on GV wasn't that 2.5 degrees at that time?

A. I don't at this point recall what the limits were on the GV.

Q. Basically the question was so there wasn't any discussion between those margins and GV contrasting the GVI in the

SRB or anywhere else?

A. Not personally. I don't know if -- and I suspect there's a better than average chance that Reece did look into some of that historical data. He was guided by Ken Obenshain and others in Flight Test. But I can't personally say that that was reviewed.

MR. GALLO: Okay. Thank you. I have no further questions.

MR. RAMEE: Give me 3 minutes or 2 minutes?

MR. BAUER: Could I ask real quickly?

DR. BRAMBLE: Sure.

BY MR. BAUER:

Q. When you talked about being in the TM trailer, did you feel that you would have adequate time between test runs to come up with an accurate assessment of whatever conditions you were looking at?

A. We could look at the data results and it was because of that that Shelly who was the performance representative on Flight 153 was able to assess that we had missed our V_2 target by a fairly significant margin prior to going off to repeat 7A2. So I think we were able to quickly assess some of the key points. We hit the rotation speed? How did our V2 speed look -- that's in the TM trailer environment during the normal conduct. That's about all you can do is take a broad brush approach to see if you are close to your points and, if not, then you want to let the crew know we need to repeat this point because we didn't do something properly for that particular run.

Q. But you would feel like you would have enough time and you could pause the testing for an extra few minutes to relook at the data or review it?

A. If we had a question about whether it was good that would be an option to pause until we were certain that it was good. If not what we could do later in the day or even if we didn't get a chance to look at it until the next day, say, okay, that run was not good because of this and we are going to have to repeat it.

MR. CONNOR: One item I would like to add is that, you know, Shelly Brimmeier and myself were working very effectively and I just wanted to say that I had the utmost confidence in Shelly's ability and I think as you interview her you will hopefully come to the same conclusion. So I felt very comfortable having her onsite as the primary performance individual out there overseeing activity.

So I fully supported her and, in fact, in many respects she understood IADs, the new data reduction methodology a lot better than I did. I just wanted to make that statement on the record that I had full confidence in Shelly's abilities to effectively conduct the performance part of the flight test program at Roswell.

MR. RAMEE: Give us a couple minutes and we will be right back.

DR. BRAMBLE: Yes.

(Whereupon, at 10:29 a.m., the interview was concluded.)

CERTIFICATE

This is to certify that the attached proceeding before the

NATIONAL TRANSPORTATION SAFETY BOARD

IN THE MATTER OF: AIRPLANE ACCIDENT
ROSWELL, NEW MEXICO
N652GD
Interview of Pat Connor

DOCKET NUMBER: DCA11MA076

PLACE: Savannah, Georgia

DATE: October 24, 2011

was held according to the record, and that this is the original, complete, true and accurate transcript which has been compared to the recording accomplished at the hearing.

Letha Wheeler
Official Reporter

UNITED STATES OF AMERICA

NATIONAL TRANSPORTATION SAFETY BOARD

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Investigation of:                  *
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AIRPLANE ACCIDENT                  *
ROSWELL, NEW MEXICO                * Docket No.:  DCA11MA076
N652GD                             *
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Interview of: CURT CROMWELL

Gulfstream Corporation
500 Gulfstream Road
Savannah, Georgia

Wednesday,
October 26, 2011

The above-captioned matter convened, pursuant to notice, at 11:53 a.m.

BEFORE: WILLIAM J. BRAMBLE, JR., Ph.D.
Senior Human Performance Investigator

APPEARANCES:

MITCHELL GALLO
Air Safety Investigator
National Transportation Safety Board
31W775 North Avenue
West Chicago, Illinois 60185

WILLIAM J. BRAMBLE, JR., Ph.D.
Human Performance Investigator
Office of Aviation Safety
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

-

ALAN J. (JEFF) BORTON
Flight Test Pilot
FAA Aviation Safety
Aircraft Certification Service
Wichita Aircraft Certification Office
1801 Airport Road - Room 100

THOMAS M. RAMEE, ESQ.
Deputy General Counsel and Risk Manager
Gulfstream Aerospace Corporation
500 Gulfstream Road, M/S B-06
Savannah, Georgia 31407

TOM HORNE
Experimental Test Pilot
Gulfstream Aerospace Corporation
P.O. Box 2206, M/S A-12

APPEARANCES (Cont.)

JOHN O'CALLAGHAN
Aircraft Performance Group Chairman
Vehicle Performance Division (RE-60)
  Office of Research and Engineering
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

-

MICHAEL BAUER
Aerospace Engineer
Vehicle Recorder Division (RE-40)
  Office of Research and Engineering
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

E. LORENDA WARD
Air Safety Investigator
IIC and U.S. Accredited Representative
Office of Aviation Safety
Major Investigations (AS-10)
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

MARIE MOLER
Mechanical Engineer
Office of Research and Engineering
Vehicle Performance Division
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

I N D E X

I N T E R V I E W

(11:53 a.m.)

DR. BRAMBLE: Let's go on the record.

INTERVIEW OF CURT CROMWELL

BY DR. BRAMBLE:

Q. Curt, thanks for joining us. To get started, can we just get your full name?

A. Yes, Curtis Graham Cromwell.

Q. What's your date of hire with Gulfstream?

A. Let's see, I believe it's March 15th, 2003.

Q. Your current position title?

A. I'm the manager for Flight Test Engineering.

Q. Is that the same position you held at the time of the accident?

A. Yes.

Q. So, you are in the Flight Test Engineering Department?

A. Yes.

Q. What are your roles and responsibilities as the manager of Flight Test Engineering?

A. Let's see, I am responsible for supporting and managing the Flight Test Engineering group. And at the time of the accident, I also had the Flight Test Operations group, which is our aircraft coordinators, and the lead for that group, Phil Burton. And also, the lead for the Data Management group and three resources under him. That's the group that's responsible for processing and supporting all the data collection and analysis activities.

Roles and responsibilities are review and approval for flight test plans and flight test reports, sign off on TSHA's, supporting SRB's, review of flight test reports, the daily summary type reports, and really just help the FTE's get accomplished what they need to accomplish and just be there for support purposes.

Q. How long had you been in that position at the time of the accident?

A. Let's see, I started around the end of August of last year, so about 8 months or so, 7 or 8 months.

Q. And what did you do -- what position did you hold before that?

A. Let's see, part of that I was -- at least 4 years before, I was the Part Development Team Lead for G650 Avionics and Electrical Systems. So, when I started that job, it was the early phases of the requirements development for the G650. So, it was myself and one other person when I got that job and then grew that to a larger team that did all of the requirements and development to design all of the electrical systems and avionic systems and the eventual test of those systems. And for a time period, also I herded all the electrical wiring group to get the initial electrical harnesses design released for the G650's.

Q. Did you ever work on field performance testing as Flight test engineer?

A. No, I did not.
Q. What previous Gulfstream certification programs have you worked on?
A. Let's see, I was on the G550 type cert, G450 type cert, and then on all of the follow-on programs that we did the avionics update programs for those airplanes. So, that was my -- I initially came here as a Dual Systems Engineer. I supported the 550 lab test and certification program and then moved on to flight test where I supported initially flight test for the mini-cert program and then the subsequent Honeywell Plainview certification programs and the 550.
Then as the 450 rolled in, I supported various flight tests for avionics and electrical systems on the G450 and did some follow-on certification programs in the G450 and a lot of trouble shooting for some issues that we had on type cert for the G450 for angle of attack stall bear system. So, I delve a little bit outside of the avionics electrical systems into some aero performance type stuff.
Q. What previous aerospace employers have you worked for?
A. Let's see, a few months out of school I was with Boeing Aerospace based up in Everett, Washington working datalink, VHF sat com, datalink programs, all models except 777. I was there for about 2-1/2 years. Then after that with Honeywell Defense Avionics in Albuquerque, New Mexico, and I was there doing a design requirements development test work for the KC-10 and the C-

5 avionics modernization programs, military upgrade programs.
     Q.   Okay, what did you work on at Boeing again? You said the VHF sat com datalink, for all their aircraft?
     A.   Everything but 777. It was the ACARS LRU, line replaceable unit, and the CMF LRU. That was on everything but the 777. The 777 had a different integrated function. That was a different group handled that.
     Q.   Okay, and what was your understanding of the roles performed by each person working in the TM trailer during the field performance testing for G650?
     A.   Let's see, we've -- I don't have a really good feel on exactly who was in the trailer and who was performing what role for the field performance testing.
     Q.   How about on the airplane?
     A.   On the airplane, Kent and Vivan, left seat/right seat, Reece as the primary test conductor on the airplane, and Dave supported the testing.
     Q.   Which of those people would you expect to be monitoring the flight control system, aside from the pilots?
     A.   If it's not the pilots, it would be I'd expect a combined type activity between Reece and Dave.
     Q.   Where would you expect Reece would be sitting, Mr. Ollenburg would be sitting during the test, which station?
     A.   Without really having the layout in front of me, we've got multiple IADS-type stations in the airplane, so I know Reece

would be in the station that would normally be there for the test conductor, and Dave at another station supporting the IADS monitor.

DR. BRAMBLE: Off the record.

(Off the record.)

(On the record.)

DR. BRAMBLE: Back on the record.

BY DR. BRAMBLE:

Q. What you were just saying about them where they would be located was basically just your supposition based on how things normally work?

A. Yes.

Q. Okay. How was it decided by the company how many data analysts and FTEs would be needed on scene in Roswell for the field performance testing program and how the roles of on-site test conduct and data analysis should be divided among the available personnel?

A. That's going to be a combination of the test readiness reviews that we organize prior to testing and the safety review board to also review that.

Q. And how were the test conduct and data analysis duties divided among the people on scene and on a daily basis during the field performance testing?

A. I can only speculate on that, but that is typically just a decision made by the FTEs that are supporting the testing on site and the Flight Sciences or other groups that are supporting.

Q. Okay, prior to the accident flight, to your knowledge, did anyone suggest that more staff was needed for the field performance testing in Roswell-2?

A. No.

Q. At any point did you request more staffing for that?

A. No.

Q. Did you have any concern prior to the accident that Mr. Ollenburg's duties, cognizant FTE for field performance, on-board test conductor, data analyst, and report writer for all the takeoffs -- for all take-off related testing was too much for one person?

A. The report writing aspects, there was some concern. One of my jobs as a manager is to help move the products as far as the release of flight test reports, flight test plans, things of that nature. So, I knew Reece had some flight test reports that he was working on and had been working on that we were trying to get released to support the TIA. So, just knowing that he's doing testing plus doing reports, that's a challenge for a lot of our FTEs. So, recognizing the fact and that he needed help was definitely there.

Q. You recognized that, you say?

A. Yes.

Q. And so, what did you do to try and facilitate that?

A. Really it was just allowing -- giving Reece the time he needed to complete his tests and to support the reports. You know, the release of the reports wasn't really pacing any upcoming certification testing, so I didn't have that milestone. It was really just commitments that were made by Reece on when something was going to get released and trying to support that date is where we were noticing that someone is not being able to support something. But you're also -- the reason for that is that other testing that's taken priority and maybe going longer than you expect that testing to go.

So, I guess to answer that question, with workload of FTEs on supporting reports there was -- didn't really have another skill set that could have picked that up and done it any faster than Reece could have done it. So, that's something that's going to get released when it's going to get released when we're done testing. So, that's my way of really kind of relieving the pressure. I try not to be a manager that's going to push FTEs to get something released and keep pushing. It's going to get done when it's going to get done.

Q. Was there any concern that maybe some of the data analysis and expansion in comparison to targets, that there was not enough time to get that analysis done and disseminated to the right people before Roswell-2 or did you feel like all the necessary analysis were done before Roswell-2?

A. That was never raised as a concern, so, you know, as far as I could tell, that was never an issue.

Q. So, what you are saying is neither Reece nor any of the other FTEs assigned to the field performance testing said anything like I don't have enough time to get this done, and I should get it done before this or anything like that?

A. Well, as far as those things do come up and we don't go until we're ready, is kind of what I'm saying. Where as far as being able to go do a test, if we're not ready to do the test, we're not going to do it until we are ready to do it. And whether that's doing an analysis or whatever it takes to be ready, you know. We leave it up to our lead engineers and scientists to determine what work is required to get done to support that test.

Q. Okay. Are you familiar with the 1998 Standard Practice Manual that was co-authored by Lee Johnson and somebody else?

A. Yes.

Q. Were you before the accident?

A. Yes.

Q. Would you expect that people working in flight test would be -- on the Field Performance Test Program would be familiar with the contents?

A. Yes.

Q. And Flight Sciences?

A. I can't speak for Flight Sciences, so I would not know that.

Q. Okay. How did Gulfstream's Flight Test organizational structure and policies and procedures conform to the '98 Flight

Test Practice Manual, Standard Practice Manual?

A. For the most part it's pretty close to the general structure. You're referring to like the org chart type structure?

Q. And positions and that sort of thing.

A. Positions, yeah, it's -- I think the main change, I believe, is we've broken out the manager for the maintenance and its rotation into separate roles.

Q. Before the accident or after?

A. That was well before the accident. That was years ago is when that change was made.

Q. Okay, and how about test conduct and analysis?

A. I think it's still consistent.

Q. What was the company policy with respect to required rest time for FTEs on scene during field performance testing?

A. No more than 13 days work straight, and we have our hourly crew date.

Q. Which is 10 hours and?

A. It's 8 hours for high risk and 10 for medium and low.

Q. That's duty time?

A. Yes.

Q. What about the people in the TM?

A. That applies to them as well.

Q. Flight Test personnel in the TM?

A. That would be Flight Test and Flight Sciences.

Q. And it's specified, so I assume that was everyone, right? At the time of the accident what policies and procedures did Gulfstream have in place to manage the safety of the flight test program?

A. The safety review board.

Q. And?

A. And our Standard Practice Manual -- or Flight Ops Manual and the Flight Test Manual.

Q. Standard Practice Manual, Flight Ops Manual, and what was the third one?

A. It would be the Flight Test Standard Practices Manual.

Q. Okay, so SRB, Standard Practice Manual, Flight Ops Manual; is that it?

A. Yes. Yeah, you got the Flight Ops version, the Flight Ops Manual, and then the Flight Test Manual. We called it, Flight Test Standard Practices Manual.

Q. How about FAA Order 4040.26A? It's one of the documents listed in the MOU FAA, along with the Standard Practice Manual and the Flight Ops Manual, as really guiding as a PE and safety documents. Is that factored in somehow?

A. Yes, that's referenced in our Flight Test Manual and supports our determination for risk level and how we conduct flight test programs.

Q. The thing that is a little strange about that particular order is that it seems very specific to the FAA's structure of its organization, and I know it's -- FAA guidance says that manufacturers should use that guidance too, but it seems like it really wouldn't correspond one to one. So, the portions of that order that are sort of considered relevant, I guess, for the manufacturer, is that primarily focused on just like the risk assessment mitigation functions?

A. That is the main part that we pull from that.

Q. Okay. Did the organization follow a safety management system approach to managing safety during flight tests?

A. I don't really have a good understanding of the safety management system. That's not really something that we've gone with here to any degree, but the Safety Review Board is what is our driver for determining and managing the safety aspects of the program.

Q. Okay, so my understanding of the SRB is that the SRB engages in an activity that identifies hazards, assesses risks, and develops mitigation strategies and can be reconvened to investigate accidents. What are the primary mechanisms for feeding safety-related information back into the risk assessment and hazard mitigation strategies during the test program in sort of like an ongoing basis?

A. Well, really I think it's just our collection of are TSHA's, our TSHA database, and we reach out to the NASA hazard database as well to pull history from and hazards and techniques, and that's what feed our TSHA's. But I think it is really just a collection of our TSHA's here. Gulfstream is kind of our database of that type of information.

Q. Does the flight test organization have a written safety policy statement, like sort of describing the organization's approach to managing safety and its priority and its position in the organization's priorities, that sort of thing?

A. Well, I can't really recall exactly where that's documented. I would point to the Flight Test Manual for that.

Q. The time of the accident was there a manager, executive formally accountable or formally responsible for the safety of the flight test program?

A. There was not a position dedicated to that.

Q. What policies and procedures were in place for reporting and investigating perceived hazards for safety-related incidents that occurred during flight testing?

A. That's really rolling back into our SRB process.

Q. So, that was the primary mechanism?

A. Right, and if we have an SRB for a V_{MU} high risk test, and during the conducting of one of those tests, we have something that is unexpected, there's going to be a reconvene of that SRB to review that.

Q. Were you aware that the lead Flight Sciences Engineer was unaware of any formal procedures for notifying management of safety-related incidents during flight testing?

A. I wasn't aware of that.

Q. We noticed that over-rotation was listed as a potential hazard for V_{MU} testing, prime -- to be immune but not for CTO. Do you know why it wasn't listed as a potential hazard for CTO testing?

A. No, no, I do not.

Q. What's your opinion about why the change in the stick shaker setting from .85 to .9 that occurred prior to Roswell-2 did not result in the reconvening of the SRB when it was changed to a less conservative state?

A. I don't have technical knowledge on that change or what drove that, so I'm unable to answer that.

Q. Do you know why flight test results, such as the November V_{MU} testing, were not incorporated into a simulator and/or other predictive model to help refine predictions for Roswell-2 to prepare for further testing?

A. No.

Q. Why was the responsibility for -- are you aware that the responsibility for analyzing the November V_{MU} testing, according to the surviving two Flight Sciences personnel we've spoken with, was considered to be Mr. Ollenburg's responsibility, but that some of the early March continued take-off testing was being analyzed in a preliminary way at least by Mr. Pat Conner? Do you know how that was decided that it be divided up that way?

A. No, I don't have the details on why. Those are things I really leave up to our FTE's, our lead FTE's to work with their counterparts in Flight Sciences to determine what information they need and work out their priorities. If our counterparts aren't getting what they need, they typically will come to me, and I can help our guys with priorities. But in that case, there was no reach out from Flight Sciences on anything that they were not provided.

Q. So, I didn't quite follow that. So, who is supporting who? Is Flight Sciences supporting Flight Test or the other way around with respect to analysis?

A. Well, it depends what the information is, but it really kind of works both ways. If we're looking, for example, for some speed updates based on test results, you know, we will provide data to Flight Sciences. Flight Sciences needs information from us to do their calculations on. So, that's us giving them information. And if we need the results, then we're looking for results from them using our data, so that's kind of a two-way relationship on Flight Sciences and analyzing and supporting us.

Q. Who would you expect would be responsible for analyzing the V_{MU} data?

A. In V_{MU} was a report that Reece was responsible for, so initially, he's going to do some analysis. And then he's got a counterpart in Flight Sciences that also supports that. As far as who that person is in Flight Sciences, I don't know who Flight Sciences had assigned to that.

Q. And you said if there was a need for more support then you'd expect somebody to reach out from Flight Test or Flight

Sciences? Who would you expect?

A. Flight Sciences, typically if the flight test is not providing the proper amount of information to support departments, a formal request will come in to myself or my director. The typical fashion is if, you know, if there's something that's holding someone up from getting a project accomplished or a job accomplished, they're going to come, you know, looking for that person's boss for some help on getting that person to adjust their priorities.

Q. What was your understanding of the cause of the wing drops that occurred during Flights 88 and 132, and how did you come to that understanding?

A. I've only had a very limited amount of information provided. I'm not part of the investigative team. Those were the SOB team.

Q. But prior to the accident, did you know about it?

A. Oh, prior to the accident, I was not aware of the Flight 88 event, and I was aware of the Flight 132 event a few days before the accident run. Reece had shown me the video and asking him why it was -- to a little bit over-rotation, too much pitch, and a little bit too slow. And also, the concern was the yaw damper off, I believe, in those tests as well. So, after that, we didn't do any more of those with the yaw damper off, because the thought was that was impacting the controllability.

Q. What analysis was performed to determine the root cause of the wing drops?

A. On the Flight 88 and 132?

Q. Yeah.

A. You're talking what analysis was performed prior to the accident?

Q. Prior to the accident?

A. I'm not aware of the exact analysis that was performed.

Q. Who would have been responsible for analyzing those events?

A. That would have been -- I would speculate that would have been Reece analyzing data and his counterpart in Flight Sciences.

Q. Do you know who in Flight Sciences?

A. No, I do not.

Q. What kind of analysis would you expect them to have done?

A. Really just monitoring your pitch angle and speeds, monitoring the parameters that you're judging your test success factors on.

Q. What we have gleaned from talking to people is that Flight 88 was described as an over-rotation, and the implication is that it was a stall. And that 132 was assumed to be some sort of lateral control issue related to the inactive yaw damper. Do you know why -- what is your opinion about why no one analyzed where the roll off began or the stall began on Flight 88 and

compared that to predictions about IGE stall angle?
A. I'm really unable to offer any kind of opinion on why.
Q. I'm sorry. I didn't mean to cut you off.
A. No, that's all right. I'm just trying to -- it's easy to think of it in hindsight with what we know now. But at the time, it's up to our engineers to review the data and with engineering and flight up to determine what we're doing is safe. And at the end of the day, that's what we do. The guys are -- not once was safety called into question as far as what we're going to do as being an issue.
Q. In hindsight, I mean, does that strike you as being a problem?
A. Well, yes, at the time. I think we learned a lot about in-ground effect since then. I mean, of course, knowing what we know now, we could have and should have done more. But I think at the time with what we knew and what we had, we were convinced that we had analyzed enough to continue on.
Q. What's your opinion about why 88 and 132 didn't result in a reconvening of the SRB?
A. We made some updates to TSHA's from what we've learned on 88. So, I mean, that's one manner in which we will -- not really reconvening the SRB, but you're making updates to the TSHA's based on what you've learned in previous testing. But I don't have an answer on why an actual SRB was not reconvened.
Q. You think that might have been beneficial? I mean,

without the benefit of hindsight, is there a likelihood that the problems that you know about now with the greater reduction in stall angle might have been detected if there had been a formal SRB process, or do you think that that wouldn't have made a difference?

A. You know, that's so hard to answer. I mean, the more eyes and more time you put on something, that could help.

Q. Did you have discussions with others besides Reece about Flights 88 and 132 before the accident?

A. Well, 88 I didn't have any knowledge of that one; 132 just a brief discussion with my director after I'd seen a video.

Q. What did he have to say about it?

A. Well, at the time he hadn't seen it, so he got with Reece to get the details on it and the understanding and made some phone calls to Flight Ops to understand the event and what the mitigation plans were and what we had learned off of that and how to go forward.

Q. What timeframe was this?

A. That was the -- I believe it was the Tuesday or the Wednesday prior to the accident.

Q. Do you know how high up the organizational hierarchy the incidents were reported?

A. 88 and 132?

Q. Um-hmm.

A. No, I do not. You're talking about reported prior to the accident?

Q. Yeah.

A. Okay, no, I do not.

Q. How was the original G650 flight test schedule and staffing requirement benchmarked, if you know? I mean, I know you came into the process kind of late, but do you know how they set up the original schedule for flight test and how they decide how many people they were going to need for field performance testing on-site, for example?

A. The original 650 schedule head count I do not know. Field performance is really just based on how we've done it before.

Q. Meaning the most recent program such as like 550?

A. Yes.

Q. How is the long-term flight test schedule from revised in the year before the accident? And the portion of the schedule I'm interested in is the one that lays out the flight testing and the estimated TIA completion dates. How was that revised in the year before the accident?

A. Are you just referring to how we determine where we are in the program and when we think testing is going to occur versus when we think the TIA's are going to occur?

Q. Yeah, I guess like what kind of -- did the schedules stay the same, or did it change a lot between like summer of 2010 and the time of the accident? Or were there -- what kinds of

changes may have occurred with the big picture schedule of TIA's?
A. You know, there are schedule changes pretty frequently just based on supplier issues and issues regarding flight tests and issues on supplier tests. So, I mean, the schedule is moving to the right fairly frequently.
Q. You mean the sort of pushing forward deadlines for TIA's?
A. Probably reducing time. We were reducing time between testing and TIA's, and then we were pushing TIA's out further to give us time to give the development company testing done. But we were continuously pushing TIA's and company testing out to deal with issues we're seeing with systems.
Q. Was there kind of a pile up of TIA's in summertime as a result of that, the summer of 2011? I'm talking about scheduled TIA's.
A. Without having that right in front of me, I can't really recall. There's been periods where some TIA's will get lumped up or appear to have a lot in one month. And there were discussions with FAA as far as being able to support that many. And we would go back and look and try to rearrange some things to make it more realistic.
Q. What's the purpose? Why does it matter?
A. Why does?
Q. Of rearranging the TIA's if they get lumped up.
A. Well, when you have multiple TIA's and multiple

airplanes, there's only so much that the FAA could support on a given day. So, if we're showing four TIA's on three different airplanes, then someday we're going to have to rearrange that. I'm not sure what the -- how the organization was at that point of the TIA's, but, you know, we understand there's limitations on how much we can get accomplished on the same day with FAA witnessing. So, we would move things out to support that. Or if it made sense, we would move a TIA from one airplane to another.

Q. Who had the authority to push out the end date for flight tests, sort of like move the final TIA further down the road beyond July or whenever the last one was scheduled?

A. What was the question?

Q. Well, you have got a schedule of all the TIA's that sort of leading up until the final one in July, or I think it was around July of 2011. And then if things were really backing up to the point where you were having 15 or 18 TIA's in a month, who had the authority to say, okay, we're going to move back the final one and not complete the flight testing until 2 weeks later.

A. Okay, we defer to our program management group for that.

Q. Who is that?

A. That's our G650 program manager would be Kurt Erbacher. When we come up to scheduling decisions that we cannot or are outside of our authority to move, we have to get approval to push something out like that, and we do quite frequently.

Q. How understanding is Mr. Erbacher when that happens?

A. I think he's very understanding. One of my jobs is working with engineers to understand how long things are going to take, and we spend a lot of time explaining in detail on what we need to do to get something done when or how long it's going to take to get something done and when it's going to be. So, I mean, we do a pretty thorough job explaining how long things are going to take. So, I think I can schedule changes has been fairly reasonable in that sense.

Q. So you mentioned you guys had some discussions with FAA about moving things around to make the schedule more realistic. Do you remember when that occurred?

A. We honestly do that every Friday with FAA. We have a standing Friday telecon with FAA where we review the schedule and discuss upcoming certification tests.

Q. Were you aware of memos sent March 9 and March 31st from the Atlanta ACO to Mr. Erbacher about -- or to Gulfstream. I know at least the March 31st was sent to Mr. Erbacher about concerns about the schedule and whether the schedule was realistic and should be reorganized to reflect the true status of the program.

A. I've seen one of those memos. I think it may have been the later one that you referred to.

Q. Do you remember when that was received?

A. No, I do not.

Q. Do you know what the response was from the Gulfstream side?

A. I recall us making some schedule up dates. I'm not sure exactly what changes we made, and I don’t recall seeing what our official response was, what our response was back to the FAA.

Q. All right, were you aware of the amount of overtime being worked by Flight Test Program personnel assigned to the Field Performance Test Program during the late 2010, early 2011 timeframe?

A. No.

Q. Who reviewed that information; anybody in management?

A. At that time, I had a group head for all the Flight test engineers that was doing time card approvals. So, that was -- there were -- he was the one that was doing all the time card approvals and was aware of who was working what overtime and helping to manage any kind of crew issues that were coming up to support people getting time off.

Q. Who was that?

A. Paul Donovan.

DR. BRAMBLE: All right. Okay, John, I'm going to pass it on to you.

BY MR. O'CALLAGHAN:

Q. Just a quick follow up clarifying things.

A. Okay.

Q. Going way back to the top in your background, it sounds like a lot of avionics and electronic stuff, but just wondering what your technical background or specialty is?

A. I would say it's avionics, navigation, displays, communication, electrical systems.

Q. So, you're an electrical engineer?

A. Yes, double A engineer, bachelors from the University of Louisville.

Q. Okay, thank you. You did mention that at one point in your career you had worked a little bit with stall warning systems and did some aero on that, so I was wondering if you had a feel for the sort of uncertainty one could attach to an increment installed due to ground effect. We've heard your numbers from 2 degrees, and I think we updated it based on some tests to 1.6 degrees. And I was just wondering if you had a feel for that would be plus or minus how many percent or degrees?

A. You talking in-ground effect?

Q. Yeah, that increment.

A. The in-ground-effect piece is I didn't really have a good feel for that. But the stall work I did on the 450 is there were some issues with some of the data from the TC-450. And we went out and repeated all of the stall speeds and stall characteristics work and to nail down some variances we had in the angle of attack. So, it was mainly all up and away stuff was my experience.

Q. Well, what were the variances you saw there up and away?

A. Let's see, we were adjusting the -- sensor to be its worse case and tolerance. So, I'm trying to recall from memory here on this, but the worse case tolerance and half a degree up and away could impact speeds by 2 or 3 knots.

Q. Okay, thanks. Going back to the staffing we talked about a discussion about this, and I think Phil asked specifically about the staffing for Roswell-2, but I was wondering in general for the Flight Test Program in general, did you ever hear any concerns about staffing or the schedule for the flight test effort from folks below in the organization?

A. Yes, to some degree as far as the right mix of staffing. Really having more people that could support the airplanes from a flying standpoint by themselves, capable of monitoring the systems.

Q. So what specifically was the concern?

A. That ideally we would need more people kind of like Reece and like Dave and like Bill Osborne that have, you know, a pretty vast understanding of the monitoring equipment on the airplane to support flights.

Q. What was the result of those discussions? Did they go up and come down, or what ensued basically?

A. Really just getting more folks trained up front when we get new hires in. We made some additional hires since then, and getting people trained up to support the aircraft more by themselves. But, you know, in addition to that, the aircraft have become more mature as well, so large amounts of monitoring wasn't required as much either.

The report writing is another thing where the help has been asked, and we've been hiring more for that. As far as having resources to conduct tests, we do pretty well at that. It's doing a lot of the flight test reports to support the TIA's and the FAA. That's where we struggle, and so that's one of my jobs is hiring to support that.

Q. So, if I heard you correctly, there was some concerns expressed, and in response, there was some additional training of existing people and some hiring?

A. Yes.

Q. So were the folks who raised these concerns satisfied by that response?

A. Yes.

Q. Thanks. Then also at the beginning, to understand when the work is scoped out, I think this is what Bill was referring to benchmarking, how one decides how many people you need. And I think there was some reference you kind of look at previous programs and compare there. Is that so far so good?

A. Yes, that's a start.

Q. So, how did the staffing, in your opinion, compare to previous programs?

A. I think initially it was not enough, and we've had to increase that considerably since then. And that's where I think we ran into the issue of, you know, if you look at the staffing wise and the folks that were there, those core folks were the ones that could support 650 program from a flying perspective by themselves a lot faster than the additional folks that we hired on. So, we caught up to meet the flying demand, but it took time to do that.

DR. BRAMBLE: And may I just jump in?

BY DR. BRAMBLE:

Q. A key thing to nail down would be when are these changes occurring? Like, for example, the increase in staffing since then, was it before or after the accident, for example?

A. Yeah, and there's been some hiring, I believe, before the accident. I know before the accident to support the FT workload and some after as well. You know, it's really my biggest challenge is, and I've kind of been working through this, is having enough folks to write the reports, the flight test reports to support the analysis side of that and to do things in a timely manner.

BY MR. O'CALLAGHAN:

Q. That initial assessment of scoping out folks and comparing to previous programs, is input solicited from below? Like, for example, folks like Ken Obenshain has been around on many programs and has a lot of experience. Is he brought in to say what are we going to need here?

A. We have schedule reviews each week to go through the outstanding issues and current scheduling. That's where we solicit feedback. That's one of my jobs. I go get feedback from my engineers on what test is upcoming and how much time we need for that test, and that's what falls in to try to create, you know, the most realistic schedule we can for that day until you run into issues.

Q. Do you recall what feedback Ken gave you along those lines?

A. Ken Obenshain?

Q. Yes.

A. No. Ken, since he wasn't really supporting testing directly on the tests, I would normally go to, for example, field performance. I'd get with Paul to understand, you know, are we going to be ready at this time to go, and then how much time do we need to support this. How many days do we need to support that?

Q. In general, what sort of things was Paul saying, Paul Donovan?

A. It would be, well, we cannot go until we get this version of flight control computer upgraded. And once we leave on this date, then we'll need this many days, you know, 20, 24 days to support this. That's what we try to roll into the schedule.

Q. This leads nicely into this next area I'm interested in which is both from here and other folks we've talked to specifically now regarding field performance, it does sound like there's a process or steps and maybe some tent poles along the way, you know, before you can go here, this has to be complete. And I was just wondering if you could outline from your point of view what those tent poles or those steps in the process are for field performance testing and what sort of things need to be complete before you can move on or what can be done concurrently and that sort of thing.

A. Okay, that's really our test readiness review that we did for field performance in laying out, you know, we have a nice breakdown there I remember that Reece put together of all of the testing that we had to do and how long each one of those tests would take in days and also a layout of all the key configuration items we needed and which version of notes we needed to address certain issues, and what version of SCC we needed to address certain issues. So, that was the arena where we would lay out what our key requirements were to go support a test.

Q. So, getting to some detail then, well, specifically V_{MU} comes before one engine CTO continue to take off in the sequence of things?

A. Right.

Q. Is there a reason for that? Why does V_{MU} come first?

A. I couldn't answer that. I defer that to my lead performance guy.

Q. You wouldn't have a feel then whether or not to what level the results from V_{MU} had to be analyzed and adjusted before you could move on then?

A. No, I wouldn't have that answer.

Q. Okay.

A. I would leave that up to our engineers subordinate testing to determine proper sequence and what boxes had to be checked before we moved on.

Q. Right along those lines, did you ever hear or did anybody communicate to you that, hey, you know, we really can't -- we really shouldn't move on until we do a little bit more work in these areas?

A. No, for our test rating reviews, that's not just flight test that's involved. That's pretty much everyone supporting that effort. It's the ground personnel. It's Flight Sciences, engineering, so that was one of the efforts we push for is to get everyone in the room to agree what else do we need to go do before we do this.

Q. Very good. Thanks. To lessons learned, there were some questions asked about that, and I think you mentioned that the TSHA process was sort of the formal mechanism by which lessons learned on previous programs get folded into future programs. Is that correct so far?

A. I guess lessons learned, you know, if it's a lesson learned would be something that we picked up as another hazard that could be there or a technique improvement that's going to roll back into a TSHA. That would be a place where we formally capture that. I'm not aware that we have an official lessons learned database.

Q. So my question there is do you have an example of a TSHA that was changed or updated through this process that you can describe that the TSHA was one thing for one test or program, and then something occurred and said, well, you know what, we'd better update it as a result of that? Is there an example you could give of --

A. I don't really have an example in memory I can pull out.

Q. Okay. Flight 132, I understand that you had actually a discussion with Reece about that flight, and it was a discussion about over-rotation. But then you mentioned because of the yaw damper it might be a lateral directional effect. One of my tasks, I think, as the performance guy on this accident is to provide or understand the technical basis for that argument of why Flight 132 was deemed to be a lateral directional event.

And so, I guess what I'm seeking is what technical arguments or plots were used to explain the physics of that event as a lateral directional in terms of the technical details? I understand the broad scope. The yaw damper was off, and while they were going around the pattern the airplane had some oscillation. But I'm still not clear on during the takeoff rotation wing dip how side slip or rotor or whatever the term was that produced the physics that produced the rolling moment that made the wing dip.

And you mentioned you had this conversation with Reece, so I'm curious about two things. One is if he presented things to you in that little detail that you could share with me, or secondly, if he didn't, who am I to talk to to get an explanation of that level?

A. Okay, the level of detail that I had a discussion with Reece was pretty high level, reviewing the video and the thoughts of that. And then he showed me a couple of plots that were really a time history of where the pitch angle was and angle of attack and the roll and things of that nature. We didn't get into a detailed discussion that I recall of any of the fielding control aspects that you're referring to. As far as who to talk to more, I would refer to Ken Obenshain, who I believe spent a lot more time with Reece on that than I did.

Q. Okay, thank you. So, you mentioned plots of pitch, and how about side slip or rotor?

A. That's a standard thing we put on plots, but I can't recall exactly. I just remember kind of focusing on pitching and rolling when they were in speed.

Q. Okay, thanks. Then you mentioned that regarding Flight 132 you went up to the director of Flight Ops, and I think you thought that he called perhaps somebody over in -- I'm sorry, director of Flight Test and that the record of Flight Test might have called somebody over in Flight Ops to discuss it and file what the mitigation was and so forth. Do you know who the director of Flight Test might have called or communicated with?

A. I know he talked to Jake Howard about that.

Q. Did you hear any feedback from what the results of that discussion were?

A. No.

Q. I think the last question I have is one we've been asking everybody, which is obviously you can see what we're interested in here based on our questions. But if you think there's an area we should be looking into that we haven't raised here, please let us know.

And then, of course, you know the end of our goal and the reason we're here in the end is to hopefully explain what happened and come up with the recommendations for the industry to benefit, to benefit the whole industry and make flight testing better and safer. And since you guys have been in, obviously, the position of thinking long and hard about the accident, maybe you might have some ideas that we could benefit from and the industry could benefit from. So, if there are any of those that you have ready now and would like to share with us, they would be welcome. If not, you can communicate them through Mr. Horne.

A. Okay.

Q. The floor is open if you want to offer anything else.

A. Okay, I really -- I think one of the things we've really dug into recently is all of the in-ground-effect analysis that we've done, and I would expect to see FD would in the future to support that as well. That will be one big thing we've looked more at. And some discussions I've had with some folks as far as larger scale models in a wind tunnel can reveal a little bit more information on an in-ground effect. So, I think the in-ground-effect stall work has been really eye opening that I've seen recently of the accident runs. I mean, it's definitely something to have a much better understanding of prior to field performance.

MR. O'CALLAGHAN: Thank you. That's all I have.

DR. BRAMBLE: All right, Mitch?

BY MR. GALLO:

Q. I'm going to go back to your background a little bit. Just go over what your undergraduate degree was in.

A. It's electrical engineering.

Q. Did you get any graduate degree?

A. No, sir.

Q. Did you attend any courses after your undergraduate degree was received?

A. Only thing I did was I got an MSE, which is a Microsoft System Certified thing that would allow me to be a networking guru. That was when I was thinking about a career change early on, but I stayed away from that.

Q. Have you attended any short courses?

A. No, I have not.

Q. What kind of books do you like to read?

A. A lot of John Grisham, I've read quite a few of those, Clancy.

Q. Now, your current position, is this the position you held when the G650 program was at the time of its inception?

A. The G550?

Q. The G650 program?

A. No, sir. I was on the PDT Lead for the G650. We started in 2005, I believe, 2006 timeframe.

Q. What's the PDT?

A. Product Development Team Lead. We all reported to the Chief Engineer, and we're responsible for leading the -- I was the Avionics Electrical Systems Lead responsible for all the requirement development and certifications.

Q. When did you become the manager of Flight Test Engineering?

A. That was August of last year.

Q. Who held the position before you?

A. Dale Coulter.

Q. Is he still with the organization?

A. Yes.

Q. Can you discuss what happened and what position he's in now?

A. What was that?

Q. What position is he in now?

A. He is now the director for lab tests, instructional tests.

Q. Which person do you talk to with greatest frequency on the status of the program? On the org chart I have Phil Burton, Bill Osborne, and Paul Donovan.

A. I'd say Bill Osborne.
Q. And do you do performance reviews of which employees?
A. I do all the FTE's.
Q. Even those that are listed under Paul Donovan?
A. Yes.
Q. Who would you say is your counterpart within Flight Sciences?
A. The closest would be Tom Lavrisa.
Q. That's the person you talk to with the greatest frequency?
A. Yes. I work with Tom. He was also my counterpart when I was in the engineering group. He was the PDT Lead at that time for Flight Sciences.
Q. In your daily tasks, can you describe what you do day-to-day?
A. A big part of my job is tracking and status, trying to determine where we are in each of the test programs, each of the systems that were going through tests. What testing is remaining, working with the engineers as much as I can face to face to get a feel on what they need to support their testing, how much time they need, where they are in their testing, how they're doing on reports, any kind of help they need on reports, and reviewing what they've produced report-wise and test plan-wise.
Q. Are you reviewing reports that are coming in?
A. Yes.

Q. Reviewing data?

A. I skim over plots as close as I can, yes.

Q. But you are not really doing an in-depth analysis. It's more of a common sense check?

A. That's correct. Yeah, I'm not doing any technical approval. It's more of a managerial review, process oriented review.

Q. Going to the subject of reports, and I believe the reports are written, and it goes through various reviews, and I don't know what those reviews are, but maybe you can discuss that with me. So, when is a report considered complete? If you could step me through that process from its creation to its final approval and who does those?

A. Okay. Well, typically it is the engineer that has performed the test, and if it's not the engineer that performed the test, it's the engineer that's closely associated or considered the call engineer for that system. They will take their test cards and support the aircraft test and get results and then begin the analysis of the data. And typically, we complete the analysis and plotting first to make sure that the tests that we run, you know, after the flight or after the ground test are good results.

And then we'll create the Word document part of that and insert the test results into the Word document and provide our annotations around that, lump in our summary and conclusion recommendations, attach all the plots and then route that out for a review. We'll have an engineer that prepares it, a flight test engineer that prepares that report, his or her report, and then they'll have a person in flight test that checks that for accuracy. That's typically someone that has an understanding of that system. They'll also get out sent out to review to a senior flight test person, and that flight test person is normally a certification representative, either a DER or an AR, you know, highly experienced type person. Also on there it will be reviewed from engineering, so we'll have a counterpart engineering person that's also considered the cognizant engineer or DER for that system. Flight Ops will have a representative on there. Usually, it's a pilot that performed the test, or it's the DER AR for that, and then a manager or myself.

So, that gets sent out for review. We get comments back. We incorporate comments, work face to face to resolve any issues on the report or data, clean it up, send it out for review again. If no comments, then route around for signature, send it over to our data vault here, and it gets logged in. And if it's a company report, it's going to go to FAA for review.

Q. Now, what about reports for each individual flight test, for example, after a V_{MU}.

A. After a flight?

Q. Yes, is that the same process?

A. No, that's what we call really our flight test summaries or our flight test report summary portion. It's the single day what happened on 6001 during Flight 247. That's just going to be that engineer that was the person conducting that flight will document the times, the block of flight times, engine start times, a quick summary of the configuration of the airplane for that flight and what the mission was, some results, a lifting of any engineering issues or maintenance issues and its rotation issues. And that gets sent out to a broad distribution list throughout the company.

Q. Can you name some of the other departments that would receive that that would be on the distribution list?

A. Yeah, that's essentially all departments in the G650 engineering ranks.

Q. Is there a required and an ideal time to get those reports out?

A. Ideally, it is 24 hours after the flight is complete.

Q. Is there a required time?

A. I think the required would be 48 hours, 2 days.

Q. In your opinion what's the best way to share that information? Do you really need to rely on a report to disseminate information that comes in from a flight test, or are there better, more efficient ways for communication of those results?

A. You know, in addition we have debriefs as well, so if people want to hear the debrief, they can dial in. That information is provided out as well. So, that's the quickest way to get some feedback on what happened on a flight. So, we do that in addition to the reports.

Q. Do you think that's better for team formation to work together rather than relying on a report to get out?

A. I think face to face is ideal, but, you know, the key is getting the information out there as required.

MR. GALLO: That's all the questions I have.

DR. BRAMBLE: Okay, we are probably closing in on that half hour point in time.

DR. BRAMBLE: Jeff?

BY MR. BORTON:

Q. Just a question on the FAA involvement. Do you have any idea at this level on what the FAA is delegating in terms of report writing or approval? At least on the 650, are you still -- you're still awaiting a lot of that, I guess?

A. We typically do not ask for delegation. When we're going after doing a certification test, we'll plan on supporting the entire test with the FAA. And as we get into the test, then it's up to the FAA to determine how much they delegate.

MR. BORTON: That's all I have.

DR. BRAMBLE: Tom?

BY MR. HORNE:

Q. Just a follow-up to Mitch's question. From what I've seen from Flights 88 and 132 and the daily report, have you seen any pitches of roll off or wing drop. Do you have any idea why that wouldn't have been entered?

A. No, not at all. I'm trying to recall even seeing a report for Flight 132.

Q. Was there an informal process if something happened during a flight test that would be reported rather than this formal flight test report?

A. No, at that time, no. Since the accident, we've established the incident report. It's in a memo-type form with the requirement to document an incident through the top levels of the chain of command.

MR. HORNE: Okay.

DR. BRAMBLE: All right, back to me.

BY DR. BRAMBLE:

Q. Do you know why Dale Coulter moved to another position?

A. I do not.

Q. Did you have any communication with Mr. Ollenburg in the 72 hours before the accident, 3 days or so?

A. Seventy-two hours, I think --

Q. That would have been like Thursday, Friday, Saturday.

A. Thursday I had my weekly performance report review, and just reviewing the status of open reports. And he had me reset a couple of the V_{MU} and V_{MT} reports he was working on. He had them written and was in the process of kind of getting an internal review on those, but that was the last time I had a formal discussion or a discussion at all.

Q. When was that?

A. That would have been Thursday morning at 9:00.

Q. How long would he have participated in that call?

A. I think the meeting -- it was a face-to-face meeting. It probably went about 30 minutes.

Q. If I recall correctly, I think Reece was off on Thursday. Are you sure? Would it maybe have been Wednesday?

A. It could have been. I'd have to go back and look at my schedule and see. I know --

Q. Okay. It was sometime in that mid to late week?

A. Yeah.

Q. All right, and there was on that Thursday, even though Mr. Ollenburg was off, he had a telecon in the afternoon about something related to the airplane and the testing. Do you know anything about what that was about?

A. Thursday afternoon?

Q. Yes.

A. I don't recall a telecon that I was involved in or that he did.

DR. BRAMBLE: Okay, all right, John and then we'll also hit Marie and Mike and Lorenda.

MR. O'CALLAGHAN: Nothing from me.

DR. BRAMBLE: Okay, Marie?

BY MS. MOLER:

Q. Everyone in Flight Test gets the daily report. Does everyone in Flight Sciences also get the daily report?

A. I do not know.

Q. Okay, it seems like it would have been a really ideal way to kind of just spread that information out to everyone, but if you're saying that it didn't seem like 88 and 132 if it was in there, it wasn't very much of a jarring report. Can you -- do you have any idea of why there would have been a motivation not really to, I mean, maybe downplay the role for them?

A. Honestly, I have no idea. I can't think why that would not have been reported.

MS. MOLER: Thank you.

DR. BRAMBLE: All right, Mike?

BY MR. BAUER:

Q. You made mention of some test readiness reviews. Were there any formal meetings or action lists kept for those meetings, or were the meetings relatively informal?

A. I would say they were formal in the sense that, you know, Reece maintained a listing of the presentations and actions that resulted from that so we can go back and take a look in the files and the PowerPoints where we had I think at least five of them for the test readiness review. I can't recall if we had a spreadsheet tracking actions, but I believe in the last few pages of the PowerPoint we had some of the issues that we were trying to track.

Q. I guess just to be clear, these test readiness reviews are something that are separate from the safety review board?

A. That's correct.

Q. And did it happen either independently from the safety review board before or after?

A. Yes. They're really just our meetings to get together to make sure we're absolutely ready to go and everything is lined up, and we've got the right amount of tires, the right brake configuration, SEC configuration, any outstanding issues, working some of the logistics items.

MR. BAUER: That's really all I have.

DR. BRAMBLE: All right, Mitch?

MR. GALLO: Two questions.

BY MR. GALLO:

Q. During the SRB for the field performance testing, who presented the slides during that meeting?

A. Reece.

Q. Is there anybody else that presented?

A. I don't recall.

Q. How is it decided upon as to the number of test points that were going to be done for the field performance testing?

A. The test plan, we release a test plan that's the same description as I laid out for the test reports. And the test plan has a list of all of the test points.

MR. GALLO: That's all the questions I have.

DR. BRAMBLE: All right, Jeff?

MR. BORTON: Nothing additional.

DR. BRAMBLE: Okay, Lorenda?

BY MS. WARD:

Q. Phil, you may have already asked this. It was one of the questions on the long list, but I didn't hear it exactly. Is that I guess in a previous interview, Ms. Townsend had stated that one engineer was always in the ground for fatigue duty, and we're just trying to get a more definitive definition of what fatigue duty meant.

A. Fatigue duty? One engineer is always on the ground for fatigue duty?

Q. Yes, that was her statement.

A. I don't know. That's not a term that I normally use.

MS. WARD: That's all I had.

DR. BRAMBLE: Tom?

MR. HORNE: Nothing further.

DR. BRAMBLE: All right, we're done. Thanks.

MR. CROMWELL: Thank you.

(Whereupon, at 1:13 p.m., the interview was concluded.)

CERTIFICATE

This is to certify that the attached proceeding before the

NATIONAL TRANSPORTATION SAFETY BOARD

IN THE MATTER OF:	AIRPLANE ACCIDENT ROSWELL, NEW MEXICO N652GD Interview of Curt Cromwell
DOCKET NUMBER:	DCA11MA076
PLACE:	Savannah, Georgia
DATE:	October 26, 2011

was held according to the record, and that this is the original, complete, true and accurate transcript which has been compared to the recording accomplished at the hearing.

Letha Wheeler
Official Reporter

Debbie Mizell
Transcriber

UNITED STATES OF AMERICA

NATIONAL TRANSPORTATION SAFETY BOARD

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Investigation of:                    *
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AIRPLANE ACCIDENT                    *
ROSWELL, NEW MEXICO                  * Docket No.:  DCA11MA076
N652GD                               *
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Interview of: KURT ERBACHER

Gulfstream Corporation
500 Gulfstream Road
Savannah, Georgia

Friday,
October 28, 2011

The above-captioned matter convened, pursuant to notice, at 1:54 p.m.

BEFORE: WILLIAM J. BRAMBLE, JR., Ph.D.
Senior Human Performance Investigator

APPEARANCES:

MITCHELL GALLO
Air Safety Investigator
National Transportation Safety Board
31W775 North Avenue
West Chicago, Illinois 60185

WILLIAM J. BRAMBLE, JR., Ph.D.
Human Performance Investigator
Office of Aviation Safety
National Transportation Safety Board
490 L'Enfant Plaza East, SW

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-
ALAN J. (JEFF) BORTON
Flight Test Pilot
FAA Aviation Safety
Aircraft Certification Service
Wichita Aircraft Certification Office
1801 Airport Road - Room 100

THOMAS M. RAMEE, ESQ.
Deputy General Counsel and Risk Manager
Gulfstream Aerospace Corporation
500 Gulfstream Road, M/S B-06
Savannah, Georgia 31407

TOM HORNE
Experimental Test Pilot
Gulfstream Aerospace Corporation
P.O. Box 2206, M/S A-12
Savannah, GA 31402-2206

APPEARANCES (Cont.)

JOHN O'CALLAGHAN
Aircraft Performance Group Chairman
Vehicle Performance Division (RE-60)
Office of Research and Engineering
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

-

MICHAEL BAUER
Aerospace Engineer
Vehicle Recorder Division (RE-40)
Office of Research and Engineering
National Transportation Safety Board
490 L'Enfant Plaza East, SW

E. LORENDA WARD
Air Safety Investigator
IIC and U.S. Accredited Representative
Office of Aviation Safety
Major Investigations (AS-10)
National Transportation Safety Board
490 L'Enfant Plaza East, SW

MARIE MOLER
Mechanical Engineer
Office of Research and Engineering
Vehicle Performance Division
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

I N D E X

I N T E R V I E W

(1:54 p.m.)

INTERVIEW OF KURT ERBACHER

BY DR. BRAMBLE:

Q. Can you start now with your name?

A. Sure. It's Kurt Herman Erbacher.

Q. Okay. And what's your date of hire at Gulfstream?

A. May 7th, 2001.

Q. And your current position?

A. G650 program manager.

Q. And where do you reside in the organizational hierarchy?

A. I report to Pres Henne.

Q. Okay. And what are your roles and responsibilities in that role, in that position?

A. Oversee the design, development, test and certification of the G650 program.

Q. And do you supervise anyone?

A. Yes.

Q. Who?

A. Quite a few people. We have a direct matrix organization and then an indirect matrix organization. Brian Durrence, the chief engineer, reports to me as do the engineers. In Flight Test we have a matrix organization, the same with Quality, the same with Flight Ops. They're basically dotted line and support the program. The same with Manufacturing.

Q. Okay. And what aerospace employers did you work for prior to Gulfstream?

A. Grumman Aerospace, Piedmont Airlines and Lockheed Martin.

Q. And what prior aircraft certification programs have you worked on?

A. G450. I was the program manager for 450. Also, I was an FAA DER in structures and mechanical systems for 15 years.

Q. And did you work on any other Gulfstream cert programs or in other capacities?

A. Just the 450 and 650. I worked on government programs, but they weren't so much a cert. Just acting in a temporary role for about 6 months between the 450 and the 650.

Q. Okay. And at the time of the accident what policies and procedures did Gulfstream have in place to manage the safety of the flight test program?

A. We have several policies in place. The primary one is that we conduct the SRB obviously, the Safety Review Board, before we do any testing. Obviously, we have our safety of flight policies that we follow.

Q. And how is this changing after the accident, if at all?

A. We now have a chief of safety officer, and we still have our SRB board, and we still follow safety of flight policies.

Q. And who will be in charge of managing the safety function?

A. Just two people who reside on the SRB. It's Tim Farley and Randy Gaston, as head of the SRB, and there's a staff -- I think Brian Durrence -- are all the people that are on it. I am not a voting member on the SRB at all, never have been for the whole program. And then the chief safety officer will be part of the SRB.

Q. Okay. And at the time of the accident what procedures did the company have in place for reporting and investigating perceived hazards or safety related incidents that occur during flight testing?

A. As soon as the policies came up during flight test it was reported back to the SRB.

Q. If incidents came up they were reported back; is that what you meant to say?

A. Yes.

Q. Okay. And has this changed at all since the accident?

A. We haven't had any incidents since the accident, so --

Q. But has the policies or procedures in place for reporting and investigating perceived hazards for safety related incidents changed?

A. No. It hasn't changed. As a matter of fact, I want to make it clear that any perception of any hazard comes up, any individual can write what we call a PR. It gets surfaced. PRs have to be addressed. And if a PR-1 is generated, it stops flight, and any individual in the organization can do that, from quality to engineering to flight ops to anybody. That policy has always been in place in the whole program. We track PRs daily, especially PR-1's.

Q. Okay. And how do you track the PRs on a daily basis?

A. It's done in a system. I think it's on the tool we use it in and there's daily meetings on PRs. They're brought up every week too at executive level in the board room, for all the board room at program review. But in the SRB, no planes allowed to fly with a PR-1.

Q. All right. And prior to the accident what role did you have in managing the safety of the flight test program?

A. Obviously, I support the flight test program. We have people working on the 650 in the flight test program through Barry McCarthy, and I support the SRB in attending some meetings.

Q. And will that be any different going forward?

A. No.

Q. Okay. How do you anticipate that the new safety officer, the new independent safety function, will work going forward once it gets up and running?

A. I don't understand the question.

Q. What role do you think the new flight safety officers will play in the flight test program?

A. Well, obviously, the peer group responsible for overseeing the safety of flight will play a critical role, a focal, another set of eyes.

Q. And so in terms of their day-to-day activities would they formally attend the meetings or do you know -- have in mind yet --

A. I can't speak to really what his formal roles and responsibilities are, what his daily activities would be, even though I speak to him quite often.

Q. This is John Salamankas we're talking about?

A. That's correct.

Q. Okay. And will the two of you be having regular meetings together or --

A. Well, that hasn't been formally communicated at all. I know he is attending the SRBs we're in. I know he does some of the program reviews and some of the technical reviews, but I don't know formally what meetings he will attend. I know he'll be at SRBs for sure.

Q. Okay. Prior to the accident when trying to meet a flight test certification date, how did you try to ensure the company wasn't pushing its people too hard so that safety was not compromised?

A. Safety's paramount. Nothing takes precedence over safety. So we ensure that we have proper parts, proper engineering release, proper pre-testing's done, proper acceptance testing's done, any ground checks. We clear the processes and software through our labs. We go through a whole list of actions to ensure we have proper safety of flight before we fly.

Q. Prior to the accident were you aware of the wing drops that occurred during flights 88 and 132?
A. No. I was not aware.
Q. And did you learn about them after the accident?
A. I learned on Tuesday, right after the accident.
Q. Did you attend a January or February meeting at RDC-1 after Roswell-1 to discuss the difficulties in getting the airplane to meet the takeoff fuel performance guarantees?
A. I don't remember that. In January, you said?
Q. It was a January-February time frame.
MR. HORNE: Can we go off the record, sir, to clarify?
DR. BRAMBLE: Sure.
(Off the record.)
(On the record.)
DR. BRAMBLE: Back on the record.
BY DR. BRAMBLE:
Q. A certification issues meeting, have you --
A. I don't remember. Possibly. I don't know -- what was the certification issue?
Q. Do you routinely attend a meeting called the certification issues meeting?
A. If it's a cert -- there's different types of meetings. If there's a primary cert issue meeting I will be there, yes. But I don't remember that one. I have to go to a certification meeting every week for something. You want to be more specific?

Q. Well, at some point between Roswell-1 and 2 there was a meeting held to discuss difficulties meeting takeoff field performance guarantee from the data coming out of Roswell-1 and there may have been some discussion about strategies for solving that problem.

A. I don't know if you call it the cert meeting. This might be the -- on Mondays and Fridays we go through, during lunch, an engineer's post-op issues and that maybe is what you're referring to. And, yes, I would. If that was it, I was there, yes.

Q. Okay. And so do you remember that particular issue coming up?

A. Um-hum. I remember us talking about field length performance.

Q. Do you know what time frame that was? Was this January, February?

A. I'd be guessing. I've got to look at the schedules. I don't remember to be exact.

Q. But it was sometime between Roswell-1 and 2?

A. Yes, sir. After Roswell-1, definitely. We notified that we had a field length performance. We were looking at it.

Q. Okay. And do you recall what strategies were discussed for resolving the issue?

A. No. I really don't.

Q. Do you recall if rotation technique was discussed?

A. Yes. I remember Dave talked about -- I believe it was Jake talked about rotation technique. Yes.

Q. And was it your understanding that that was going to be the strategy going forward for trying to reduce the field length?

A. From that meeting, if my memory's right, I thought they were going in the lab in the ITF in trying to optimize the technique -- I thought. That's what I remember.

Q. Okay. Do you know who else attended that meeting?

A. There must be 50 people in that room when we do those cert meetings.

Q. Did you attend a meeting that included a discussion of field performance the day before the accident?

A. Yes. Before, yes.

Q. And what was the nature of the discussion that day?

A. We were just talking about they were going back out to execute the field performance test.

Q. Where was that meeting held?

A. It was in RDC-1 in Epsilon Conference Room.

Q. And who else was present at that?

A. It was another 50, 50-some-odd people.

Q. Okay. And who normally issues invitations to those meetings?

A. It's a meeting run by engineering and issued by Brian Durrence.

Q. Do you know what was discussed about takeoff field performance, or do you recall?

A. They were going back out to go see what numbers we could come up with on performance with the techniques, I guess, they used from the ITF.

Q. All right. And did you review the takeoff performance data with any subordinates prior to the accident?

A. No. Only when it was shown up in the room on the charts in the cert meeting that Friday.

Q. And do you remember what the sentiment was among the managers who attended in terms of how the issue was being handled?

A. I think everybody was fully supportive of it. Nobody spoke up and said that they weren't.

Q. Did people seem to feel optimistic that the problem was going to be resolved during the next round of testing?

A. Yeah. I don't know if the word's optimistic, but they just seemed to be more positive.

Q. All right. And who established the takeoff performance guarantees for the G650 and when did that occur and how were they developed?

A. During the development of the airplane as it came out of the plenary design those were the specifications flowing down from, coming out of PD. I'm sure they're market driven conditions for the airplane.

Q. To your knowledge, how was it decided how many engineers would be needed on site in Roswell during the Roswell-2 field

performance testing effort?
A. Barry lays out a person flow, how many support levels he needs.
Q. And did he ever come to you prior to Roswell-2 and say he needed to increase the number of people, number of engineers?
A. No. No. As a matter of fact, even Shelley and Pat Connor came to me prior to it and requested to take out even more engineers and I authorized for it, more for training, but just a large staff of engineers and I authorized it.
Q. Okay. And did Barry pass along any requests from anyone else or mention that anyone else such as Ken Obenshain may have suggested that more engineers were needed?
A. No one's, no, made that -- I've never heard that statement.
Q. Do you know how the roles of the individual engineers that were on site in Roswell were established or is that sort of handled more by others?
A. No. It's handled more directly from the group itself.
Q. All right. How was the original flight test schedule benchmarked?
A. Off of G-V and G550 and G450.
Q. And how was it managed in the year before the accident? What changes were made or adjustments made to the flight test schedule?
A. I don't understand the question.

Q. I guess in terms -- I'm focusing on like TIAs in terms of when you're expected to complete the flight testing and -- I guess I should cut to the chase. The TIAs, sort of our understanding is that they sort of backed up near the end of the flight test program.

A. They do in every program.

Q. Okay.

A. Did on the V. They did on the 450. As you go on, you build and usually at the end is when you have your majority of your TIAs anyway. But, yes, it's been that way in every program I've been on or seen. I think if you pull the Boeing program you'll see the same thing.

Q. And at the time of the accident did the schedule look achievable?

A. Yes. Aggressive, but achievable, as always.

Q. And which people had the authority to revise the TIA dates on the schedule and push them back?

A. We have every Wednesday a flight test review meeting attended by 20, 25 people where we go through the schedules. Any time in that room we -- that's what drives the TIA schedule is what we see and the work flow and where the airplane's at. They get adjusted there.

Q. Okay. And as far as the internal company projected cert date, are you the sort of lowest level person who could approve that?

A. I don't understand.

Q. If you had to adjust back the completion date for the flight testing in such a way that it would affect the final projected TC date, who would have to approve that for that to occur on the schedule?

A. We have a master schedule. We don't make dates up. That's where the airplane flows and where it goes, and when we see the dates move, we announce them and we will tell what they are. We do our best to always hold the dates, but anybody who sees an issue with the dates, or anything we do, we speak up and then we look at the schedule and revise as needed.

Q. Okay. And do you recall having a meeting with the Atlanta ACO manager in March and receiving a March 31st memo that stated that they hoped that their decision to deny the request to split TIA 15 into pieces "would serve as the impetus for other changes to the schedule that are needed to reflect the true status of the program. For sometime now the FAA has expressed our concerns about the overly aggressive schedule and for some time now you've acknowledged unofficially that things are slipping. However, the company TIA schedule continues to reflect a pace that has proven to be unrealistic."

And I guess my question is did you agree with the FAA's assessment and what discussions were held and decisions made in response to the FAA's letter?

A. Yeah, we had a meeting, confirmed meeting, yes. We confirmed that the FAA wrote a letter saying the schedule was aggressive. We thought it was aggressive but still achievable.

Q. And this was before the accident?

A. Yes.

Q. And if you had decided to reorganize the schedule and push it back, push back the projected TC date, could you have made that decision unilaterally?

A. We would have made it as a team. Would have made it as a team.

Q. Who else would be involved in the decision? Who would have to be involved in the decision?

A. Barry, Randy, Brian, Chris.

Q. Okay. And did you feel significant pressure to keep the G650 certification program on schedule and can you describe those pressures?

A. I'm going to say it's pressure. It's bad enough trying to do a job in a time frame or complete a task, but -- me doing my job, just like an engineer doing their job trying to release a drawing or manufacturing guy trying to put the airplane together.

Q. All right. And prior to the accident was G650 flight test program or certification progress tied to your compensation in some way like --

A. There are many things tied to my compensation. Number one on my list is an accident/incident-free flight test program. That carries the same weight or more weight than anything on my executive compensation.

Q. And was that written into your performance standards?

A. Yes. Yes.

Q. Prior to the accident?

A. Oh, yes. It's my 2011 goals.

DR. BRAMBLE: Okay. John?

MR. O'CALLAGHAN: Nothing from me, thanks.

DR. BRAMBLE: Marie?

MS. MOLER: I'm good.

DR. BRAMBLE: Mike?

BY MR. BAUER:

Q. At the beginning you started talking about the problem report process, a problem reporting process. Who could submit a problem report on a level 1?

A. Anybody.

Q. When a level 1 problem report is submitted, is it acted on immediately? So, let's say post-flight.

A. Oh, definitely. The fleet's grounded. When you issue a level 1, we don't fly.

Q. Okay. And that can come from anybody?

A. Anybody.

Q. Is there a separate meeting that occurs later that reassesses the severity level?

A. We look at it, yeah, most definitely. That's a good question. Yes. We take a look at the severity level and a team does that. It's not done by an individual. The PR team gets together and they look and they do an assessment. Actually Flight Ops is involved in it, as is Engineering. So it's not done by any individual; it's done by a team.

Q. So I guess what I'm just kind of getting at is it may be put out as level 1 and then reassessed and brought down to a level 2 or a level 3?

A. Yes, sir. Could be. It depends on -- you look at it. You know, when you first write it, you don't -- necessary that it be more conservative than not. So it's easy to call it a 1 and then downgrade it, than call it a 2 and fly and have an issue. So we tell everybody be conservative when you rate them.

Q. What would be a typical expectation of, let's say of, an engineer, a flight test engineer, a pilot, anybody who writes a PR-1, what would be a typical, I guess -- what would be an expected analysis to be done prior to it being lowered to a level 2? Would it be a hallway meeting? Would it be a prolonged data --

A. Oh, no, it's formal. It's formal. You'll find signed documents. We can track every one and there will be signed documents. It's formal.

Sometimes we go back in the lab to isolate it if it's software. Sometimes the systems safety guys have to go run some numbers and reports. Sometimes you have to go perform some actual tests, structural tests. It just depends what it is, but it is not a hallway conversation by any stretch of imagination.

Q. Was a similar problem reporting system in place for the G450 program?

A. Not quite, no.

Q. This is a new process for the G650?

A. The way we implement a 650 is new, yes.

Q. Just from your experience on the 450 program to the 650 program, did you notice a -- I'm going to say a higher rate of -- I'm going to just say major classification of problem reports versus lower severity?

A. I can't judge it like that. I will just say the 650 is an entirely new airplane; the 450 was a derivative. So the scaling factor of the two airplanes is different, so I -- it would be tough to rate the two, compare which -- but I will say I think we've done a very good job managing PRs in the 650.

Q. I guess the last question is we've had some talk about scheduling and aggressiveness of the schedule, and being a part of previous flight test programs, I can sort of understand that. But have there been any concerns raised either below you or above you about the -- concerns about quality with the aggressiveness of the schedule, quality of the -- would there be any concerns about the quality of the work being performed with the aggressiveness of the schedule?

A. I have never heard that. To me quality and safety is everything. I mean, that's what we sell. So, I had never heard that and if I did, I would address it immediately.

MR. BAUER: I don't have anything else.

DR. BRAMBLE: All right. Mitch?

MR. GALLO: I have no questions. Thank you.

DR. BRAMBLE: Okay. Jeff?

MR. BORTON: No.

DR. BRAMBLE: Lorenda?

MS. WARD: None at all, no.

DR. BRAMBLE: Tom?

MR. HORNE: I'm going to stop it.

DR. BRAMBLE: Okay.

MR. HORNE: I only have one.

DR. BRAMBLE: We do have one final wrap-up question.

UNIDENTIFIED SPEAKER: No, Tom, do you have one?

MR. HORNE: Yeah, I have one.

DR. BRAMBLE: Oh, you do have one? Oh, okay.

BY MR. HORNE:

Q. Kurt, just to expand a little bit, can you explain one method or our method of how we would mitigate a level 1 PR issue through flight restrictions. For example -- maybe one example would be like the yaw damper issue. That was initially a level 1, or PR-1, and then we mitigated it to turn the flight.

A. I guess the team came together. We reviewed the yaw damp issue. We came back and we downgraded it to a level 2, I thought it was. Did some testing on the ground here and over in the hangar, we did some ground testing. And Scott, I believe he found a condition then, if I remember right, found a condition doing some testing that raised it -- I think we moved it back to a level 1, did we not? I'm trying to remember. We made a software change.

Q. Right.

A. We did correct the authority of the yaw damper.

Q. There were a couple of iterations.

A. There were a couple of iterations there, but doing some testing.

Q. When we did mitigate it down to a level 2, how did we -- we did it through restrictions to the flight crew --

A. We did an IFR.

Q. Right.

A. That's the other case too. Good point, Tom. If we do, do some restrictions and change a PR to a different rating, there might be an IFR that follows that?

Q. What's an IFR?

A. In-flight restriction.

Q. And how is that communicated to the crew?

A. All IFRs are briefed before each flight. IFR's are signed by Brian, by Flight Ops, and Barry signs every IFR, and they're aware of it, so -- and there's an IFR book and each pre-sheet of each flight we list all the IFR's and tell you what the restrictions are on each flight.

MR. HORNE: Okay. Thank you.

DR. BRAMBLE: All right. I think we're done. Oh, I'm sorry. I guess I'm in a hurry.

BY MR. O'CALLAGHAN:

Q. Thank you, Mr. Erbacher, for your time this afternoon. The last question is one we've been asking everybody as we anticipate wrapping up our fact gathering phase and prepare to go back and start analyzing and generating a report, which we'll described at the beginning culminates in a finding of probable cause of what happened, but then perhaps even more importantly, recommendations to the industry to hopefully prevent future accidents and improve safety overall. And knowing that everybody here obviously has had this accident on their minds and hearts since it occurred and everybody's thought very deeply about it, we have two questions for everybody. One is if there is anything you can perceive that should be looked at but that we don't seem to be aware of or focused on, as you can perceive through our questions, please bring that to our attention. And, secondly, if there's anything that you think the NTSB should recommend or bring to the industry's attention through our reports and safety recommendations, we'd like to hear that as well. So, if you have anything to offer now, we'd love to hear it. In the future you could pass it on through Tom Horne or -- but with that, the floor's open to whatever you'd like to say.

MR. RAMEE: Off the record, please.

(Off the record.)

(On the record.)

MR. ERBACHER: All right. So in response to Mr. O'Callaghan's question, I would -- or, I think you have a copy. Tom confirmed that -- I haven't seen it, but I've seen a copy -- I'd recommend looking at what we developed from our SRB, in the fact-finding mission. I think there's some really good points in there that would be advantageous to the NTSB. We contributed to those meetings, and I think it speaks for everybody in the company. Everybody who didn't agree with them -- we had a room full of people and then we had individual people too, so I think it speaks pretty well for what happened.

BY MR. O'CALLAGHAN:.

Q. A quick follow-up on that. You reminded me about that. Thank you. There is a bullet on there that I wanted to ask about. One of the bullets, I believe, said that flight 88 and 132 events were not broadly reviewed enough. And I think when we were here in August we had some questions about what broadly reviewed meant, and I think even some of the folks in the room were trying to figure that out as well. So, I was just wondering if in the intervening time if that's been focused a bit and if you could maybe describe what that means.

A. Well, I think having a safety officer now in place, things will be reviewed more at a uniform level, and we'll understand the airplane was talking to us, and I think things will be brought up now and surfaced if any issues do come up in flight test and they can review them as a team.

BY DR. BRAMBLE:

Q. And one last item from me which is that you mentioned that nobody had ever asked you for more FTE resources during the field performance testing. I just wonder during the next SRB to include resuming field performance testing, if one of your senior FTEs made that suggestion, is that something that you would consider?

A. We're providing resources, so we -- if tests are ready and we are adding engineering resources, we're pulling them out of the 650 core to support Roswell testing. You'll see new names out there.

Q. And in terms of numbers, if they wanted to have slightly more numbers than they had before, would that be a possibility?

A. We'll look at everything. Whatever it takes to get the job done properly, we'll make sure we support it.

DR. BRAMBLE: Anybody else? Mike?

BY MR. BAUER:

Q. This is just a general question since you're the program manager for the whole 650 program, are there any procedures or processes in place to allow an individual working on the G650 program a way to bring up a question or concern anonymously to avoid -- let's say if an employee has a concern about reprisal or --

A. That's a great question. A couple of things. Number one, we have a unanimous hotline here in the company so anybody has an issue they can call in and it goes actually to the headquarters building, and everyone gets looked at. So, if you don't want to talk to anybody, you're worried about reprisal or anything, you can call the hotline.

The other thing is we all have open-door policy. Tom will tell you. Call me. Come in my door. Talk to me. We'll keep it confidential. And especially anything related to safety, we're on it. I can't think -- I know it flows down from Pres on down, safety is paramount. And if someone has an issue we listen; I listen. And there is -- if they don't think they're going to listen, there is the hotline they can call.

MS. WARD: Who maintains the hotline?

MR. ERBACHER: Probably Tom can answer that better than I can.

MR. RAMEE: Well, the hotline is a corporate-wide program directed from General Dynamics at Gulfstream. The Gulfstream hotline is run out of our HR function and has its own staff, including a senior manager level person that reports into my boss, the general counsel, my senior vice president of administration.

DR. BRAMBLE: General counsel and vice president of administration?

DR. RAMEE: I think Ira's title is senior vice president administration and general counsel. The executive leadership team.

DR. BRAMBLE: Okay.

BY DR. BRAMBLE:

Q. The nature of the hotline, I think, broad purpose, and can you describe briefly what kinds of purposes it might be used for?

A. It's used for obviously ethics. It's used for if an employee has a concern and he feels like management's not answering it, he calls that line and he can either go and he's guaranteed no reprisal. If he goes in anonymously, he can do that too.

DR. BRAMBLE: Okay. All right. Anything else? Okay. I think we're good. Thanks, Kurt.

MR. ERBACHER: Okay. Thank you.

(Whereupon, at 2:40 p.m., the interview was concluded.)

CERTIFICATE

This is to certify that the attached proceeding before the

NATIONAL TRANSPORTATION SAFETY BOARD

IN THE MATTER OF:	AIRPLANE ACCIDENT ROSWELL, NEW MEXICO N652GD Interview of Kurt Erbacher
DOCKET NUMBER:	DCA11MA076
PLACE:	Savannah, Georgia
DATE:	October 28, 2011

was held according to the record, and that this is the original, complete, true and accurate transcript which has been compared to the recording accomplished at the hearing.

Letha Wheeler
Official Reporter

Aileen Hajmosi
Transcriber

UNITED STATES OF AMERICA

NATIONAL TRANSPORTATION SAFETY BOARD

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Investigation of: *
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AIRPLANE ACCIDENT *
ROSWELL, NEW MEXICO * Docket No.: DCA11MA076
N652GD *
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Interview of: GARY FREEMAN

Gulfstream Corporation
500 Gulfstream Road
Savannah, Georgia

Thursday,
October 27, 2011

The above-captioned matter convened, pursuant to notice, at 10:48 a.m.

BEFORE: WILLIAM J. BRAMBLE, JR., Ph.D.
Senior Human Performance Investigator

APPEARANCES:

MITCHELL GALLO
Air Safety Investigator
National Transportation Safety Board
31W775 North Avenue
--------------------is 60185

WILLIAM J. BRAMBLE, JR., Ph.D.
Senior Human Performance Investigator
Office of Aviation Safety
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

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-

ALAN J. (JEFF) BORTON
Flight Test Pilot
FAA Aviation Safety
Aircraft Certification Service
Wichita Aircraft Certification Office
1801 Airport Road - Room 100

THOMAS M. RAMEE, ESQ.
Deputy General Counsel and Risk Manager
Gulfstream Aerospace Corporation
500 Gulfstream Road, M/S B-06
Savannah, Georgia 31407

TOM HORNE
Experimental Test Pilot
Gulfstream Aerospace Corporation
P.O. Box 2206, M/S A-12
Savannah, GA 31402-2206

APPEARANCES (Cont.)

JOHN O'CALLAGHAN
Aircraft Performance Group Chairman
Vehicle Performance Division (RE-60)
Office of Research and Engineering
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

-

MICHAEL BAUER
Aerospace Engineer
Vehicle Recorder Division (RE-40)
Office of Research and Engineering
National Transportation Safety Board
490 L'Enfant Plaza East, SW

E. LORENDA WARD
Air Safety Investigator
IIC and U.S. Accredited Representative
Office of Aviation Safety
Major Investigations (AS-10)
National Transportation Safety Board
490 L'Enfant Plaza East, SW

MARIE MOLER
Mechanical Engineer
Office of Research and Engineering
Vehicle Performance Division
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

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I N T E R V I E W

(10:48 a.m.)

DR. BRAMBLE: Let's go on the record.

INTERVIEW OF GARY FREEMAN

BY DR. BRAMBLE:

Q. Gary, can you state your full name please?

A. Gary Michael Freeman.

Q. Jumping right into things, what analysis was performed to determine the root cause of the wing drops? What analysis was performed before the accident to determine the root cause of the wing drops that occurred during Flights 88 and 132?

A. I don't know specifically, but Kent Crenshaw did a fairly specific, detailed brief, it looked to me like, I hadn't seen it because I was gone some place, but he did a fairly detailed brief to the pilots and flight test engineering had it as well and they looked at the causes and other than that, I'm not sure exactly what analysis. The next flight, the 132; is that right?

Q. Yes.

A. We talked about it initially. During the brief, during the flight we talked about it but after the flight, Reece and I sat down and talked about it, looked at the data in a cursory manner and I guess the conclusion was that he thought it was a stall but as we looked at the data, he said, look, the stall is at 13 degrees, and these are approximate numbers, and we were at 11½, so it's not a stall. We had over 300 stalls in this airplane, aerodynamic stalls at various altitudes and we've been able to predict it within like a tenth of a degree, very, very close. They say it's going to stall at 14½ or 14 degrees, in that half degree, and that's where that thing would stall based on the data.

So it never occurred to me that the stall angle would be incorrect. And I said to him, I said, look, Reece, we spent hundreds of thousands of dollars to put instrumentation in these airplanes and it says it's going to stall at 13, we're at 11.5. We had the yaw damper off, we pulled the right engine to idle, we have a CL Beta potential on this airplane, the airplane rolled in the direction that it would roll with the yaw on the right, to me. We didn't hit the stall angle of attack. It appears to me that that is a CL Beta due to doing this testing with the yaw damper off. Consequently, we're not going to do any more testing until we get the yaw damper fixed or approval to use the yaw damper. And that's where it stood when I left.

Further evaluation, I guess, was done here. I don't know what it was.

Q. Prior to the accident?

A. Yes. I mean, it was reviewed and looked at by more people and I'm not sure of the extent of that. I've just heard anecdotally people say, yes, we looked at that. Yes, we reviewed it. Yes, we saw it.

Q. So to summarize, just to make sure that I understand correctly what you're saying, you're saying that in all the free air stall testing they've been dead on with their estimates of stall angle and you had over 300 stalls in free air in the airplane prior to the accident and so you had a lot of confidence in the estimate and when you compared the predicted stall angle of 13 to, what was it, the peak AOA or the AOA when the roll started?

A. I can't remember. I don't know.

Q. But you compared 13 to 11.5?

A. We compared 13 to 11.5 and said, look, it doesn't look like a stall. And the number 300, I think it was more than 300. I'm not sure.

Q. But that was prior to the accident?

A. That was months, maybe a year prior to that.

Q. You said we have made this big investment with the instruments in the airplane and I missed some of that, but we're at a high angle of attack and what was the rest of that part?

A. Well, not a high angle of attack, but we pulled the right engine to idle, we were operating without a yaw damper. During several of the flights, there had been comments about the fish tailing, about the sloppy directional control which is to be expected with the yaw damper off but we accepted it because it didn't seem to be a dangerous situation.

So, we were drawn to that conclusion because of the roll in the direction of the dead engine. There should have been a yaw because unless you counteract it perfectly, there should be a yaw in one direction or the other. If you over correct, it could be in one direction. If you under correct, it could be in the other direction. And since we had that engine pulled, we rolled in that direction, there's a higher CL Beta. It seemed normal, natural to assume since we hadn't hit a stall angle of attack that that would be the cause of the roll.

Q. The CL Beta would convert into rolling, is that the idea?

A. CL is rolling moment due to Beta, yes. Rolling moment would be induced by a side slope.

MR. O'CALLAGHAN. Can I jump in?

DR. BRAMBLE: Sure.

MR. O'CALLAGHAN. I'm going to go off the record.

(Off the record.)

(On the record.)

DR. BRAMBLE: Let's go back on the record

BY MR. O'CALLAGHAN:

Q. So, Mr. Freeman, just to follow up on the question about 132, can you describe in your conversations with Mr. Oldenburg after the even? Did you discuss or reach the CL Beta conclusion, specific parameters you may have reviewed, including slide slip or rudder, yaw, those sorts of things?

A. This was a cursory evaluation because we thought this was a stall, so let's look at that. And when we looked at it, I said, look, Reece, and he said, well, it must have been a stall.

I said, I don't think so. If this is the stall angle and this was where we were, how is this a stall? It's much more likely that this was a CL Beta event caused by side slip since we pulled the right engine back and we were having minor yaw excursions without the yaw damper so it's like that's what this was. So you've guys, evaluate it and we're not going to do any more of these.

Q. So were you left with the impression that Mr. Ollenburg was going to evaluate it further and was it evaluated further by others?

A. Yes, I mean, that's why we stopped doing it until it was evaluated or until we could get the yaw damper back on. They are very good at that and either it was said or I assumed that they're going to evaluate it because they do. They look at these things in some detail after the events occur. Some get more attention than others.

Q. Some folks we have talked to this week seem to still think or have the strong impression that even after the accident that 132 was a CL Beta effect. Does that remain your interpretation of it or has it changed since the accident and you've seen the analyses and all these things?

A. I don't think I've even looked at the -- I've seen betas and stuff, if I have, then I don't recall from the 132 event.

However, from what I've seen from before and after, it appears that it could have been a stall. However, if you look at the traces, I wouldn't be surprised if the two are combined because nothing was backing.

Q. If you can recall this in the cockpit, when the event happened, do you remember what your reactions on the controls were like when the event happened.

A. No. I mean, I've seen it. Do I recall specifically what I did? No.

Q. You mean you have seen the traces of what the reactions were?

A. I've seen videos.

Q. How would you describe the inputs that you made?

A. It was just angle of attack.

Q. So that would be considered the stall recovery technique or coincident with it?

A. Well, stall recovery, it's any type of -- not necessarily stall recovery. If you have a roll excursion or any event reducing the angle of attack when you have counter controls and it fits the angle of attack, the controls become more effective. CL Beta is typically reduced. In a lot of my experience, reducing output can restore normal control. It could be stall recovery as well.

MR. O'CALLAGHAN. Thanks. That's all.

BY DR. BRAMBLE:

Q. So what was Mr. Ollenburg's take on it initially as you guys started to talk about it? Did he say, wow, I think we stalled it?

A. I think so. I think we all thought or were making those comments that we think we stalled or it was a stall, I think. That would be one of the conclusions, of course.

Q. How long did it take for him to change his mind about it? Was he attached to that idea or did he dismiss it pretty quickly?

A. I don't know. We had the discussion and I told him that we're not going to do this anymore till we get the yaw damper back. They were going to review the data to determine what went on. That was it. I don't think we talked about it that much more as far as data review.

Q. How long was this conversation, do you think?

A. Not too long, about ten minutes, something like that maybe.

Q. Was he resistant to the idea that it was a CL Beta related event or did Reece readily accept that idea?

A. I seem to recall that he was open to it. I mean, looking at it, I was, look, here's the stall and here's the angle and he was going, well, okay. That's what I recall.

Q. Knowing what you know now, you were saying that it could have been a stall maybe in combination with some slide slip that caused the roll, do you know if aircraft performance -- is it that your understanding of the current interpretation, that 132 was a stall?

A. I think it was a stall. I think if it hadn't stalled, we probably could have controlled it with standard roll control and rudder and that it could have been exacerbated a little bit with CL Beta because I don't know what the side slip was.

Q. Prior to the accident, do you think anybody picked that up or was nobody aware it was a stall until after the accident?

A. I don't know. I don't know where it went from there. I thought it was a CL Beta event and hadn't heard anything different. It would be my guess that they were thinking that as well most likely since I know they didn't lower the target angle of attack to 11.5.

Q. You think it was their thinking that it was a side slip related event because they lowered the angle of attack?

A. No, they didn't lower it. They didn't lower it to 11.5.

Q. Oh, because they did not?

A. Yes. It seems to me, and this is conjecture, that if they said, yes, it stalled at 11.5 degrees, that we would not have tried to exceed 11.5 degrees in the future. So it must have been, I would conclude, that they had determined that it wasn't a stall event. That's my interpretation.

Q. Now, on the morning of the accident, Mr. Ollenburg briefed that they were going to set nine as a pitch target and they were not to exceed 11 because they had been to 12 and it was not a good place to be. So it seemed like he had sort of put in I guess an informal limit of 11 and why do you think he did that?

A. Well, maybe he thought it was a stall. I wasn't aware of that. They were out in Roswell and I was not.

Q. Why do you think it wasn't more widely recognized that it was a stall prior to the accident?

A. I don't know. My guess would be that we thought the angle of attack were correct for the stall and we made the assumption that if the stall angles were correct and there were other factors that could have influenced it and we assumed that those other factors were causal.

Q. To your knowledge, did anybody note the normalized angle of attack that the roll off occurred at in 132 prior to the accident?

A. Did anybody what?

Q. Prior to the accident, did anybody note, bring out or mention, the normalized angle of attack that the roll off occurred at for 132?

A. I don't remember. I would suspect that we talked about. We had shaker and that sort of thing.

Q. Do you remember if the shaker went off?

A. No, I don't.

Q. Do you remember Mr. Ollenburg mentioning anything about they were all occurring below certain -- I'm not very good with that.

Why do you think 132 didn't result in a reconvening of the SRB?

A. I don't know.

Q. Is it that only certain kinds of events trigger that?

A. I don't know why you would reconvene an SRB. After you convene the SRB, I would assume that you could anytime you wanted to but I assume, I guess that they would investigate and determine if that was necessary. If it was evaluated and determined that something was wrong, then I guess they could have reconvened an SRB.

Q. The purpose then would be to determine the mitigation strategies?

A. I don't know. I don't know what an SRB would do other than -- the SRB would only be in response to new findings and new limitations. The actual SRB isn't really going to determine causes. It would be in response to causes and in response to changing parameters unless there was some safety thing that had changed that couldn't be handled without an SRB.

Q. You mentioned that maybe if it was evaluated and determined that something was wrong, it could be reconvened. Who would you expect would evaluate 132 to determine if something was wrong after that initial conversation, which departments and/or people would be involved?

A. Reece and flight test would look at it. Reece Ollenburg and flight test and he would call anybody he felt that he needed. It would be up to him.

Q. Who do you think he might have called if he was to do a more extensive look at it?

A. I guess he would have called aero, called Bob Mills or somebody and talked about it further and maybe he did. I don't know.

Q. I understand there was some difficulty meeting the target V_2 speed at 35 feet during the CTO testing and I'm just wondering in your opinion as to whether or not you felt that prior to the accident you felt that that problem was going to be solvable through technique or whether or not you thought that they should be increasing the V_2 speed?

A. I told them I thought they should be faster.

Q. That the speed should be set higher?

A. Higher.

Q. Who did you say that to?

A. Reece. I've mentioned it several times. He probably got it on audio because I was surprised that the Flaps 10 speeds being slower than the Flaps 20 speeds. The response from Reece was that we're looking at these speeds and that's really all I know about it.

Q. When he said we are looking at these speeds meant that they were reconsidering them or that that was the purpose of being there, testing?

A. I think the purpose was developmental testing.

Q. Did he basically say, no, these are the speeds we have, that's where we're going?

A. No. No, as a matter of fact, I asked him to increase them and he increased them on a couple of events two or three knots.

Q. Did you make that suggestion to anyone else about raising the speeds?

A. I don't know. I mean, no official notification that we need to raise the speeds, no.

Q. Before the accident what was your understanding of the estimated reduction in stall AOA and ground effect compared to free air?

A. None. I didn't consider it at all.

Q. Did you have any knowledge of what the estimated reduction in stall AOA was?

A. No.

Q. Was there any discussion of it during SRB meetings?

A. I don't think so. I don't know that we did a reduction. I don't recall specific discussion of a reduction and stall angle of attack with ground effect. We had a stall angle of attack and that was end of it. How they arrived at it or what specific reductions, I don't recall discussing.

Q. The 13 degree limit, was that an in-ground effect stall? What was that?

A. That was the limit that we were given not to exceed because it's the stall angle of attack that we were given if I remember correctly. If it was 13 degrees, whatever the stall angle was, that was the one that we based V_{SR} and we based -- it's been a long time. The angles that they gave us and the setting that we need for the shaker and all that were based on the angles and those were the angles we used as limit angles, whatever they were. And with these angles it must have been a ground effect because it was below 35 feet and those were the angles that we were using.

Q. So you are saying basically it's your understanding that ground effect had already been factored in to those values you were using?

A. I don't think I talked about ground effect. The only thing that we had was that this is the angle and this is what we're using and I was confident that those were the correct angles and I didn't know about ground effect, gust factors, whatever. These are the angles that we were using that they had computed through fairly extensive data reduction based on stalls that we had done and that's what we were using. I didn't question them.

Q. Before the accident, were you aware of any changes in the predicted stall margins that might have occurred around February as a result of some work maybe done by the aerodynamics group?

A. I don't remember. I don't think so. Reductions in stall margin?

Q. Changes to the predicted stall margins?

A. We'd had all kinds of changes. It would be difficult to recall because we did a lot of up and away testing and a lot of testing with different angles of attack to provide sufficient margin. So I'm not sure exactly what the meaning of your question is but there was all kinds of research or developmental changes to try to get us safely to the best speeds that we could.

Q. I guess specifically we understand that there was a change in stall reference speeds and that may have narrowed the margin between stall reference and aerodynamic stall by-----------------------. Would you care to elaborate on that?

A. I know what you're talking about.

Q. I just wanted to know, before the accident whether or not that kind of information was being communicated to everybody on the team including the pilots?

A. We were involved in it. I was specifically involved in it. I was up flying the up and away flights where we reduced it ------------------------------------- and we were out testing it to see if it was sufficient. Like I said, there was a lot of developmental stuff going on to figure these angles.

Q. How about stick shaker changes, prior to the accident what did you know about changes made to the shaker settings for 6002 during the field performance test program?

A. We were using .85 and .9 and when they were specifically using that, I can't recall, but we had settings of 85 percent and 90 percent of the angle, whatever the angle was determined to be and we talked about it in fair detail numerous times of what angle we were using so that I could understand exactly what the angle was. Not whether the angle was correct, but this is the angle and we're subtracting this much. We're going to shake it this much, percentage of that and that was discussed several times.

Q. Do you recall why the shaker margin was changed from 85 to 90 percent?

A. Probably to, I guess, get closer to the angle and that's the only thing I can think of. Closer to the reference angle I guess because it was difficult to get these angles or get these speeds.

Q. So did inadvertent shaker activations or brief shaker activations, I guess they're all inadvertent in field performance testing, occur when you were flying

A. Yes. Yes, they did I think on two occasions. I recall one specifically. I think another occasion and that's when I was transitioning from the pitch angle to V_2.

Q. How was it decided that it would be safe to bump up the shaker rather than increasing the speeds, the target speeds?

A. We could control the angle of attack fairly accurately once we were intercepting the V_2 speeds. So increasing the angle, you know, even if we exceeded it somewhat we still had margin. So it seemed safe to do that. We had done up and away testing as well where we had gone from .85 to .93 percent so we had experience with this.

Q. So what were those tests called where you were using an .85 to .93?

A. Well, just stall testing. We were determining developing what was necessary for maneuver margin testing to allow us to safely approach limit angles of attack without exceeding them. And depending on the rate that you approach these angles would depend on how close you could get to them. It's standard. We've been doing that in airplanes for lots of years, 20.

Q. So if you were approaching at a high rate, you may have to set it higher so it wouldn't trip earlier or something like that?

A. No, if you're approaching at a higher rate, it trips earlier.

Q. So you might want to set it at .93 instead of .85 so that you could do the maneuver as prescribed in free air?

A. No, the way it works is that you have an angle and if you're approaching at certain rates where you could exceed it inertially or somehow pull through the angle, it would activate earlier to give you warning.

If you're approaching it slowly, you would have less of an opportunity to overshoot.

But that isn't set, that wasn't what we were doing in the ground effect testing. That was the up and away testing that we were doing. I don't think any of that stuff was set.

Q. I was just trying to understand the logic of what it was used for.

A. In all our AOA shakers, I don't know if all of them but the ones in the GIV and the GV and the airplanes we have rate so that if you're pulling rapidly, that there will be stall prevention or stall warning that will activate earlier because there's a high probability that you're going to overshoot.

If you approach it slowly, then you're not really in a dynamic overshoot situation so you can safely approach the reference limits more closely so the angles are higher.

Q. So in which of those conditions would you use the 93 percent threshold?

A. Slow. You would use that if you are very slowly approaching the angle.

Q. The activations of in-ground effects that you experienced is it fair to say that they were nuisance activations because there was considered to be more margin and beyond where the shaker was set?

A. No, I don't think that they're nuisance, I think that they were set at that angle and that's as close as you're going to get to the angle. We're trying to develop a safe procedure.

Q. But I mean when the shaker was increased from 85 percent to 90 percent, it seemed like what we were saying, if we didn't cover this in this interview, but we did at least last time, that the activations that were occurring sometimes maybe drove the bumping up of the shaker limit; is that consistent with your thought?

A. I would suspect. I would guess and I probably would have said, okay, we can do that. I mean, once you get established in the angles where you're gradually trying to move the nose and increase the pitch attitude to intercept the V_2, the angles are fairly precisely controllable. You are not going to result in a large alpha or large pitch change unless it's commanded.

Q. Now, in terms of the decision to change the shaker setting from .85 to .9, why didn't that result in a reconvening of the SRB? Is that not the type of thing that normally would result in a reconvening of the SRB?

A. I don't think so. I don't know. I'm not really involved in the reconvening SRBs or when you do that. If I felt that there was some safety event, I could do that at any time but I don't normally know what an SRB would do other than approve a change which could be, it wouldn't necessarily be -- I don't know why you would reconvene necessarily an SRB unless we thought this is going to be a lot more dangerous.

Q. In retrospect, given what you know now and I'm not sure how much that is, because I don't know the extent that you're involved in --

A. Not very much.

Q. Do you have any sense of the increase in shaker setting playing a roll in the accident or do you have any knowledge of that?

A. No, I don't think so. I mean, I mean the guys were going to an angle of attack that they shouldn't have been going to and they were going there fairly precisely.

Q. Would it surprise you if the shaker hadn't activated prior to the onset of stall?

A. No. If it hadn't activated prior to the onset of stall or towards -- I mean, I can set that shaker to activate at 10 degrees above stall if I want and it will never activate. If you don't set it toward the right angles, it's not going to be of much value.

Q. So is it your understanding that it was set at an incorrect angle?

A. I would guess so. When I was flying the thing, they said it was going to stall at 13. I'm using 13, I'm not sure if it's 13-point or 12-point or something like that. And we were setting that angle minus a value for V_{SR} and factoring in some margins and then using the percentage of that and if the angle is a degree and a half wrong that you're using, and this is the knowledge I have, like I say, I don't have a lot of it, but if you have a degree and a half, let's say into stall and you reference everything at three and a half past stall and you're referencing everything past there, the value is questionable.

So again, if I knew this before or after, it was a long time ago when things occurred to me. It might be a little hazy of when somebody said something to me.

Q. During the testing, what was your understanding of who the primary people were who should be reviewing the results of the test, of each test, in real time or between runs?

A. The TM had the data and Reece and the data and those were the primary people that would look at the data in between runs. That was the only people really.

Q. Would it have been possible for Mr. Ollenburg to monitor the flight control system onboard the airplane and simultaneously look at the data?

A. Would it have been possible? In diminished capacities in both areas, yes.

Q. In the trailer, who do you think or which position was primarily responsible for reviewing the parameters.

A. They had some Performance people and flight test people there in the trailer. That's what they're responsibilities were. I don't know what actual responsibility anybody or anybody had a capability of making a comment or calling something to our attention at any time, anyone does, on the airplane or in the TM.

Q. How about at the end of the day, what was your expectation as to what analysis would be performed by the TM folks and Mr. Ollenburg after flying ceased and prior to the next day's testing?

A. That's up to them. If there was a safety issue, the safety issue should be resolved or we wouldn't press on with it or he wouldn't continue any more of that testing. The data reviewed, what was necessary to review, would mostly be up to them because sometimes they would have to review the data to determine what further testing was required or if anything needed to be repeated, but a lot of it may be just the data that needed to be reviewed in the long term to determine performance characteristics.

So some of it may have been determined to be reviewed prior to further testing, but the majority of it, it wasn't necessary to review it and with the worst outcome being that you either tested too much or had to repeat testing.

Safety issues, such as a roll off, they needed to review that in order to learn what we were doing in testing after that to tell something was wrong.

DR. BRAMBLE: All right. That's it for me.

John?

BY MR. O'CALLAGHAN:

Q. Mr. Freeman, you mentioned that the program used to get V_2 speeds were low and could use increasing and I think you mentioned that you mentioned that to Reece several times. Can you elaborate on why you thought the speeds should be raised?

A. I think I said that incorrectly. What happened was the speeds at the flap-10 settings were less than the speeds at the Flaps 20 settings and those were the speeds I was commenting on. I'd say, look, how come the speeds are less, they should be greater and we talked about that on several occasions. I don't think I had and I'm not sure that we talked about it with the Flaps 20 but I should have said was that the speeds for Flaps 10 were I thought slow and I made that comment several times.

Q. So at a lower flap setting, you'd expect a higher speed and it's the reversal of that that got your attention?

A. Yes.

Q. Did you have any more global concerns about the speeds?

A. I don't think so. I think, no, I don't think I didn't really have any concerns that in general, the speeds were too slow or something.

Q. This may be asking you to speculate too much, but the reversal, the upside down nature of the speeds on Flaps 10 and Flaps 20, do you think that may have had something to do with different pitch targets that were selected for the cards?

A. I think it had to do with, I'm guessing, pure speculation because I'm not sure we've discussed this, acceleration and getting the pitch attitudes set, I don't know, because that could have been for a rotated speed for the V_2 but I don't know. I told him, I told Reece, this doesn't make sense. He said, well, we're in development on these speeds.

Q. The difficulty in achieving V_2, have you seen that on any other programs or planes that you've worked on? Is this particular characteristic something you've seen on other planes, not just Gulfstream's but anything else you've flown?

A. No, I don't think so. It sometimes can be difficult because if you accelerate rapidly, you've got to get the nose to a high position but I think that -- I don't know if it's like this or not.

Q. Was there any discussion within flight ops that maybe there was a something a little off in the fundamental physics of these numbers, that this isn't coming together like airplanes usually do?

A. I don't know if there was, probably not.

MR. O'CALLAGHAN. That's all I have. Thank you.

DR. BRAMBLE: Let's do everybody in a row this time, keep things more efficient.

Marie?

MS. MOLER: No.

DR. BRAMBLE: Mike?

BY MR. BAUER:

Q. Gary, was the telemetry in your belief required for the flight testing for CTOs and V_{MU}? Was TM required?

A. I don't know what TM would really be required for in a lot of these things other than postmortem, you know, other than after the event. It's difficult during a dynamic event for somebody not on the airplane to call an abort or to say something to stop. It's hard to do. We have that for floater events, we have TM for stall events so that they can look at the data real time. An aerodynamic event like a takeoff, by the time a person saw something, made a call, he'd just be kind of interfering with the recovery attempt I think.

Q. But for the actual testing, was it a requirement to have TM available?

A. Yes, it was a requirement I think so.
Q. And if it was requirement, you would expect it to be in the TSHA as a go, no-go item for the test?
A. Well, if it was required, it probably would be in there. It probably should be in there. But if it wasn't in the TSHA, that shouldn't affect whether you went or not if it was required. I mean, I wouldn't say, well, I know it's required but it's not in the TSHA so we're going anyway.
MR. BAUER: That's really all I have.
DR. BRAMBLE: Mitch?
MR. GALLO: Yes.
BY MR. GALLO:
Q. Prior to Flight 132, did you talk to Mr. Jake Howard about the technique that he used on 111?
A. Yes.
Q. Did he describe what he discussed with you as far as the rotation technique he was using?
A. Apply 70 pounds of force, intercept the nine or ten degree, the angle that we were attempting to intercept and then from there, intercept V_2.
Q. Was he describing that technique as a ramp versus a step input?
A. I guess that's an interpretation. It's a step, you pull, you're applying force. That's in keeping with an input that we'd done in GV airplanes, the test criteria.

Q. The stick forces that were being used, those were short term applications of force?

A. Yes.

Q. So therefore it would be certifiable?

A. Right.

Q. What about the associated pitch rates?

A. They were high. It was hard to get them. We were trying to get higher rates, as high a rate as we could. We were trying to maximize the performance of the airplane. We were developing a technique and the system to maximize the performance of the machine.

Q. With those rates, would that be certifiable then, what you were seeing?

A. I don't know if there's any rate limit on the certification.

Q. Prior to 132, I don't know if you have answered this, but what was your understanding regarding the change in the shaker setting from .85 to .90, how that changed the AOA margins?

A. Well, it changed five percent. It changed from 85 percent of the value to 90 percent of the value before the shaker activated.

Q. When did you first learn of that change?

A. I don't remember if we had .85 percent and changed it to .90 or if we started at .90. So much of the testing I have done in the development of this stuff, we used many different margins.

It was not something that would set off huge alarms to me.

Q. Do you recall during the 132 preflight briefing whether Mr. Reece Ollenburg described those changes to the test team?

A. I don't but it was routine for me on a brief because of all the changes and because of the things that Tom and I have been involved in, numerous changes with different margins, different limits, different shaker settings, different adjustments of .34 degrees to have this is the setting, this V_{SR} which is this much less, ------------------------whatever, plus .34 degrees, shaker set at .90 percent of that and we would routinely go over it.

Did I specifically or not, I don't recall. It was routine for me to that so I had an understanding of the angle of attacks that I was dealing with and what my margins were.

Q. Do you sit on the, do you attend the change board meetings or problem report review boards?

A. No.

Q. So how do you learn of changes to the systems, for example, the shaker setting? How do you learn about that?

A. It would be briefed. We would brief any changes to the systems in a preflight brief.

Q. Regarding the change board and problem report review board, who determines who gets invited to those?

A. I don't know.

Q. Do you recall if Mr. Kent Crenshaw or Mr. Vivan Ragusa attended those boards or were on those boards?

A. I doubt they were. I don't know for certain. They have access to the problem reports. They have access to the inflight restriction.

Q. Now, after 132, did you feel that V_2 was impossible to capture and that the speed should be increased?

A. No, I don't think so. I felt it was impossible. It was difficult.

Q. Just to clarify, did you suggest to anybody that V_2 should be increased?

A. No, I don't know if I did. I did talk about the issues with it and the way my method of flying those points.

Q. You mentioned the change in shaker setting to .90 was to help gain additional performance or help capture V_2?

A. I would suspect it was, yes. If you hit shaker, if you pitched up to shaker angle of attack, the maneuver was void. The problem was after the airplane was rapidly rotated to the target angle to the tip of the target pitch attitude, then the next event came to intercepting V_2 and as the airplane was rotated to an increased pitch angle, the G increased obviously and it was close to the limits. So we were at the angle of attack limit. However, to me, it was controllable because you are very slowly increasing the pitch rate and my guess would be that .90 percent was acceptable. We'd been using that in other areas. When we were slowly approaching pitch angles, we were accepting that value.

Q. But that's your suspicion, nobody told you that was the reason that margin was changed, was to capture V_2?

A. I can't recall anybody saying that. I don't have much memory that specific. There was many of them I don't really recall exactly. I don't think I would have been alarmed by a change of 85 to 90 percent.

DR. BRAMBLE: Jeff?

BY MR. BORTON:

Q. The shaker, does it have an Alpha rating put into it on the 650? You mentioned that other Gulfstreams have that.

A. Yes. We have a rate input in some areas. I don't think there's a rate input in this, it was implemented at that time.

Q. I guess the -- go ahead.

A. Let me. The shaker angle of attack limiting has a rate. The shaker I don't think --

Q. I don't know the systems.

A. I'll correct that. The angle of attack has rate limited and the shaker, I don't think it does.

Q. I mean the other Gulfstreams, because I'm just tagging on a comment you made about the other Gulfstreams which I don't know either, I'm just trying to compare. When you have a rate input, does the shaker there have any rate input? Do you recall?

A. Yeah, I'm going to have to review because I know the pusher does. The limit angle of attack is rate limited and I'd have to say, definitively I'd have to say whether the shaker does. But yes, when you have higher rates, entry rates, your pusher occurs at lower angles. Whether it's a shaker or not, it should. I'm guessing, I'd forgotten. I haven't reviewed that recently.

Q. I was just trying to put the framework in for the rotation technique and what was going on in terms of the system supporting you were trying to do in the 650s.

A. Most of the stuff was -- what was implemented and what wasn't, I'd have to review it again. All that was reviewed in the brief and it's on the cards. It's on the front page of the briefing but what was implemented and what was wasn't --

Q. You had a lot of stall experience with the 650. Was the event on 132 as just your seat-of-the-pants feel for it, did it feel like the airplane was stalling to you?

A. It could have. It was a roll. It wasn't -- it's hard to recall.

Q. So the lateral characteristic of rolling off, it couldn't have been a stall as much as anything else?

A. Say again?

Q. I don't want to put words your mouth, but it could have been a stall as much as anything else?

A. Yeah. It could have been loss of lift on the wing for some reason, yes. Well, it was loss of lift or reduction of the lift compared to the other wing obviously.

Q. This might have been brought up before but after Flight 88, I know Kent Crenshaw did a fairly extensive brief to the group of what had happened there. With your experience in 132, even informally, was that broadcast among the pilot group of here's how the airplane will react if you get to this? I mean, I know Reece maybe had that in his mind, but do you know --

A. No, there was not an event. There wasn't something done like it was discussed informally as far as amongst the pilots.

MR. BORTON: Those are all my questions.

DR. BRAMBLE: Lorenda?

MS. WARD: No.

DR. BRAMBLE: Tom?

MR. HORNE: Okay.

BY MR. HORNE:

Q. I'm going to ask the same types of questions but in a slightly different manner. Did you feel you could pull to Alpha V_{SR}, i.e., all the way to 1.0 normalized angle of attack during the capture of V_2 and still have margin to stall?

A. You should have had margin, yes.

Q. Do you think Vivan, Kent and Jake felt similar about that or do you have any specifics?

A. No, I don't but V_{SR}, you should have had margin. If you could go to V_{SR} precisely, he should have had margin. He should not have had an aerodynamic stall at V_{SR}.

Q. Do you think the shaker was set for free air stall or in-ground effect stall?

A. I think the shaker was set where they thought it was appropriate for where we were and that was in-ground effect and I don't think it was discussed. I don't think I talked about it or mentioned it at all.

Q. Now, I'm going to kind of use your experience since you did a lot of stalls. What was your gut feel for what the stall angle of attack would have been at low altitude, say, Flaps 20 which was where 132 happened?

A. Higher.

Q. Higher than 13?

A. Yeah, it would seem to me I guess.

Q. So 13 sounded about right to you?

A. It seemed in the ballpark. It didn't seem like it was something that would be unreasonable.

Q. Then can you talk a little bit about your background, just background test experience?

DR. BRAMBLE: I think we did cover that.

MR. HORNE: Did you cover that?

DR. BRAMBLE: The first interview.

MR. HORNE: I didn't hear anything.

MS. WARD: Not today, he's talking about the past interviews.

DR. BRAMBLE: Did you go the first day or was it somebody else?

MR. RAMEE: Can't we get it on the record?

MR. FREEMAN: Navy fighter pilot. I went through Navy flight training. I flew F4s, F14s, a lot of other airplanes, F18s and a lot of other airplanes in addition to those. I left the Navy and came to Gulfstream and I've flown all the airplanes except the GI. I did the stall testing on the GV and the GVI along with others, of course. I was involved in the stall testing. I've done field performance work in a lot of different airplanes, four or five of them, some aspects of field performance testing, some aspects I haven't done.

BY MR. HORNE:

Q. Have you been exposed to other safety systems other than Gulfstream, other types of safety requirements?

A. Navy, the Navy systems and requirements but that was a long time ago and I really haven't too much been involved in other systems.

Q. So I guess just a general question, how do we compare in the safety process with what you remember about the Navy system?

A. I think we have good systems and good reviews and I think that it's as good or better than the Navy and a lot of it came from a long time ago when the F14 crashed at Grumman and we're a child of Grumman. SRBs and a lot of the safety events came from that. I think it's a good process. Anybody can come to the meetings and discuss. I'm comfortable with our safety and have been comfortable with our safety. There's always room for improvement. There's always room for improvement or change but we're pretty much doing it.

MR. HORNE: That's it for me.

DR. BRAMBLE: I don't have any more. John, do you?

MR. O'CALLAGHAN: Just the final close out question.

DR. BRAMBLE: Why don't you go ahead and do it, you do it better.

BY MR. O'CALLAGHAN:

Q. Mr. Freeman, this is a question we have been asking everybody this week. We're getting near the end of our fact gathering phase of this investigation. We'll go back to Washington and start analyzing. As Bill mentioned at the start of the interview, the whole point of all this is to explain what happened but I think even more importantly is to offer recommendations to the industry to improve things. As you mentioned, there's always room for improvement.

So I have two questions that are wide open for you. One is you can probably tell what we're looking at based on our questions but if you think that there's something we should be looking up that it's not evident that we are looking at, that seems to be escaping us, please point that out to us. That's one.

The second is if there's anything that you after thinking and having this accident on your mind and heart for these months occurs to you that the Safety Board can bring to light to offer to the industry to help improve things, we'd like to hear that as well.

So the door is open to you for anything that you'd like to offer in those areas and if nothing occurs to you at the moment or you want to share something later on, feel free to go through Tom or Lauren to offer it to us in the future, too.

A. Well, we are always looking to improve or make safety systems better. One of the things that I -- to me, the only thing that I could really say is to, what I think, put a little perspective on this incident, this accident. That is that if somebody would read this, read your report or read a report, they might get the impression that this was a moon launch. We've been preparing for this point three years in briefing this and doing all this stuff and getting everything ready and then we went to the moon launch and we launched it and we had a problem.

That's not the case. We make a hundred of these decisions in a week and we have these things going on a continual basis and we as test pilots and flight test engineers make these decisions daily and we try to make the right decisions and we look at the data and we employ the safety processes that we have but this wasn't some event that was contemplated for six months. So it was not just something that was in vacuum. There's a lot of things that we do and go on and there's a lot of decisions that are made. So in that context, it might be a little different than something that was just looked at for years in advance and then it was a singular event.

So that's all I can say that might change the context a little bit. Not to diminish anything but just saying that there's a lot of things that we're doing and a lot of inputs and a lot of factors.

BY MR. BAUER:

Q. Do you believe the pace of the program has anything that affects the safety?

A. Of course, if we want to be safe, we'll put the airplanes in the air. And if we want to be less safe, we'll fly once a year. And if we want to be less safe, we'll fly more than that. We have to make a decision as to what is a balance between risk and what we get. We have to make responsible decisions and all the decisions, every single decision, has to be responsible. It has to be hopefully the right one. But like Homeland Security, you better get it right every single time and I don't know that that's possible. We make thousands of these decisions a year, literally thousands if not more, of these decisions every year at this company. We try to get every single one right, every single one. We try to get it correct and it's not likely that we will.

DR. BRAMBLE: All right. Before you got the follow up question, was there anything else that you had in mind that you want to go over?

MR. FREEMAN: No.

DR. BRAMBLE: With that, I think we're done.

(Whereupon, at 12:00 p.m., the interview was concluded.)

CERTIFICATE

This is to certify that the attached proceeding before the

NATIONAL TRANSPORTATION SAFETY BOARD

IN THE MATTER OF:	AIRPLANE ACCIDENT ROSWELL, NEW MEXICO N652GD Interview of Gary Freeman
DOCKET NUMBER:	DCA11MA076
PLACE:	Savannah, Georgia
DATE:	October 27, 2011

was held according to the record, and that this is the original, complete, true and accurate transcript which has been compared to the recording accomplished at the hearing.

Letha Wheeler
Official Reporter

Lourie J. Brown
Transcriber

UNITED STATES OF AMERICA

NATIONAL TRANSPORTATION SAFETY BOARD

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Investigation of:                  *
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AIRPLANE ACCIDENT                  *
ROSWELL, NEW MEXICO                * Docket No.:  DCA11MA076
N652GD                             *
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Interview of: HAROLD "RANDY" GASTON

Gulfstream Corporation
500 Gulfstream Road
Savannah, Georgia

Friday,
October 28, 2011

The above-captioned matter convened, pursuant to notice, at 3:01 p.m.

BEFORE: WILLIAM J. BRAMBLE, JR., Ph.D.
Senior Human Performance Investigator

APPEARANCES:

MITCHELL GALLO
Air Safety Investigator
National Transportation Safety Board
31W775 North Avenue
---------------------s 60185

WILLIAM J. BRAMBLE, JR., Ph.D.
Senior Human Performance Investigator
Office of Aviation Safety
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

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-

ALAN J. (JEFF) BORTON
Flight Test Pilot
FAA Aviation Safety
Aircraft Certification Service
Wichita Aircraft Certification Office
1801 Airport Road - Room 100

THOMAS M. RAMEE, ESQ.
Deputy General Counsel and Risk Manager
Gulfstream Aerospace Corporation
500 Gulfstream Road, M/S B-06
Savannah, Georgia 31407

TOM HORNE
Experimental Test Pilot
Gulfstream Aerospace Corporation
P.O. Box 2206, M/S A-12
Savannah, GA 31402-2206

APPEARANCES (Cont.)

JOHN O'CALLAGHAN
Aircraft Performance Group Chairman
Vehicle Performance Division (RE-60)
Office of Research and Engineering
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

-

MICHAEL BAUER
Aerospace Engineer
Vehicle Recorder Division (RE-40)
Office of Research and Engineering
National Transportation Safety Board
490 L'Enfant Plaza East, SW

E. LORENDA WARD
Air Safety Investigator
IIC and U.S. Accredited Representative
Office of Aviation Safety
Major Investigations (AS-10)
National Transportation Safety Board
490 L'Enfant Plaza East, SW

MARIE MOLER
Mechanical Engineer
Office of Research and Engineering
Vehicle Performance Division
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

I N D E X

I N T E R V I E W

(3:01 p.m.)

INTERVIEW OF HAROLD "RANDY" GASTON

BY DR. BRAMBLE:

Q. If we could just start by getting your full name?

A. It's Harold Randall Gaston.

Q. What's your date of hire with Gulfstream?

A. It was October 10th, 1994.

Q. What's your current position title?

A. It's vice president for Flight Operations.

Q. What are your roles and responsibilities in that position?

A. Well, the full responsibility for the department, and that's we've got a salesman demonstration side, airborne products support, and then we have the production tests and the experimental. All of those as well as the manning budgeting, the whole planning, those types of things.

Q. Okay, and what previous aerospace employers have you worked for?

A. I worked for the FAA before I came to Gulfstream. I was an aircraft certification ops. I was a test pilot there at the Atlanta ACO for 3 years to the day.

Q. And prior to that?

A. Prior to that, it was with Northrop on the BT test program for 6 months.

Q. And prior to that?
A. Prior to that I was an Air Force test pilot.
Q. For how long?
A. Ten years.
Q. And did you start your aviation career in the Air Force?
A. Yes.
Q. Okay. And what level of pilot certification do you hold?
A. ATP.
Q. How many total flight hours approximately?
A. 8,000.
Q. And type ratings in which airplanes?
A. Let's see, GII through G550 for Gulfstream, and the L382J -- not the J, but the C130 equivalent to it. I was on the J program when I was at the FAA, but I didn't type in it because it was a test program.
Q. Okay.
A. And then before that, the only other civilian was a Cessna Citation.
Q. All right. And prior aircraft certification programs that you've worked on directly?
A. At Gulfstream?
Q. Uh-huh.
A. Well, I was very actively involved in GV test program. And I flew also in the G450, 550 as well. And I've only done

probably about 12 flights, maybe 20 flights in the 650 program.

Q. Did you work on certification while you were at FAA too with the L382J?

A. Yes. I went through the Air Force test pilot school in 1980, and then the first -- I came back to staff for 2 years, and then I went down to B-1 test program and started there as a test pilot. Then I ended up the director of the program.

Q. Okay. What's your understanding of the policies and procedures that Gulfstream had in place to manage the safety of the G650 Flight Test Program at the time of the accident?

A. You want a listing?

Q. Kind of an overview of its major components.

A. Okay. Well, the overall flight test process is pretty much the standard flight test process that I'm used to, all the way from the military up to now. So, we have the test planning, hazards analysis, and along with that the technician planning, test card development. Along with that we have, up to the starting of the test, we have the safety reviews and going over the hazards. And that's pretty much the route I've seen in almost every test program I've ever been in.

Q. Okay. And is that process sort of focused on the SRB as a culmination of that effort?

A. Yes.

Q. Do you serve on the board of the SRB?

A. Yes, I do.

Q. All right, and how have the safety management policies and procedures changed since the accident?

A. Well, the first thing we -- right after the accident, I talked to Barry, and I said the first thing we have to do is look at our practices and procedures and make sure that when we audit those that we don't find -- see if we find something that we actually missed. So, we did a thorough review of all that, and we couldn't find a case where we had gone outside that or we didn't actually follow all of the guidance that we had in place.

UNIDENTIFIED SPEAKER: He asked how the processes have changed since the accident or are changing.

MR. GASTON: Well, a lot of it is detail in terms of the specificity relative to the accident, because we want to go back and obviously look at that. And I'd say in the SRB more to look at test safety monitoring and performance monitoring specifically and what those items would be as far as parameters, both for the crew and as well as in the TM. In the case of Barry, he went back and updated his Flight Test Standard Practices Manual, and it's much more detailed and linked. The same thing for the Flight Ops side.

We before had a tab within the Flight Operations Manual. It was a joint manual between ourselves and both sides of Flight Operations, between the demonstration side -- sales and demonstration and the test side. We took the opportunity now to go ahead and break that out and make two separate manuals. But the intent was this -- probably the hardest thing to do is manage information because there's so much of it. And so, the intent was to try to structure that so that not only would everybody be able to view it, but it would always be fresh and there wouldn't be a case where it would be out of date.

And so, we had already laid the groundwork for a lot of this in terms of looking at how to manage paper and how paper was supposed to work, and we did that in what we call the plain book. And from that, the idea is it's one source for all of the information that a pilot would need relative to the operation of the aircraft, and it actually works across manuals. So, you don't have to be in one and close one and open another, because it's all on your iPad. So, the intent was to do this, to take the FOM, Flight Operations Manual, and say let's look at all of the processes and any of the links or documents and find a home for that within our Flight Operations Manual and go ahead and link to that.

That's only the start of it. The problem is, is that how do you manage a relationship with the other entities and their information, and so we set up a structure for that in the last couple of weeks. And the structure again is, is that -- am I talking too long?

BY DR. BRAMBLE:

Q. No, that's okay. Go ahead. This is important.

A. We have an Enterprise system. That means you can log on and get all sorts of information, okay, and we use our iPad with that. But the problem is, is that it really needs to be federated. That means you've got to divide it up so that people have their own area. And what we did is we're developing -- I'll just say it's an app for that area. So, Flight Operations has its app in that area, but I want to have one for Engineering, and I want to break down Engineering. I want Engineering to have one for the Flight Test, and I want them to have it, for example, Flight Sciences. So, any of the organizations that we interface to, I want to figure out what those lines of communications are and what their documents and processes are.

And then they'll have people that are responsible for their documents and processes and keeping that up, but yet, we will all be able to share and see what the other people's processes and documents are. And that way -- what normally happens is when people come into an organization, what you find is that they get embedded in a process, but they really don't necessarily know their process documents. They really sometimes never even get the big picture because they're embedded in it. So they come to work to do their normal job, and they have their role in that, but sometimes they never have the big picture. But the intent of this is to always let them know what the big picture is. And so, they'll always be able to see what those processes are.

And so, the only way you can do that is that you've got to pull out the information that's all over the place in different drives and different folders that is where -- that's the normal way. But the thing is, is that we wanted to -- I like to manage information. So, the idea is this was the perfect tool to do this. And so, we're finished with the Flight Operations Manual, and we'll have all the links by next week.

And Barry, his Flight Standard Practices Manual is complete. And now what we have to is we have to figure out what the relationship is between the other parts of Engineering. And then we're going to have to roll all of that into our safety management system and Q-Pulse.

UNIDENTIFIED SPEAKER: Speak to the Aviation Safety Office.

MR. GASTON: Okay, the Aviation Safety Office was created as an outcome of a recommendation from an independent safety review team that came in. And so, the question what was the structure that one would look like. And the recommendation was it had high visibility within the company. And so, what we did is -- not what we did, but Larry Flynn, president of the company, did is he interviewed people. And in this case, John Salamankas became the aviation safety officer. I think he has about 35 years of experience with Gulfstream, so he pretty much knows everybody and all of the processes within Gulfstream. So, he's probably the most perfect candidate I think for it. And then at the same time, we had safety representatives from each of the different areas. So, example, you have a safety representative from Flight Test Engineering, Flight Test Operations, and then you would also have one from Engineering, and they all report to the aviation safety officer. And the intent of that is to provide people whose sole purpose is to monitor safety. I say their sole purpose, but the major part of their activity is to look at that.

The good thing though is, I think, was that they are also embedded within the organizations. A lot of times when you create safety organizations, the people that are responsible for safety live down in another building or someplace else, so they really never have their ear to the ground. I think the best way to do it is in John Salamankas's case is he's still the same office he always had within Flight Operations. And everybody has a lot of respect for John, and John will be able to listen to things, go to places, and people won't look at him as being out of the norm that he's there. And his direct line goes to the president of the company. And so, they communicate, and if there's any issues that, for example, Larry Flynn has a question on, he goes directly to John Salamankas. If John Salamankas knows something is out of order and he thinks that the president of the company should know, then he informs him of that.

And the same thing for the people in the different organizations. They communicate the issues that they think are problematic, and they can go to John, and John in turn can go to the president if he thinks that that's necessary.

BY DR. BRAMBLE:

Q. Thanks. That's a very thorough overview, and it looks like a pretty big change.

A. That's also on the iPad.

Q. Say again.

A. That's all on the iPad as well, all the reporting.

Q. All right. At the time of the accident what procedures did the company have in place for reporting and investigating perceived hazards or safety-related incidents that occurred during flight testing?

A. Well, problem reports, okay, that was I guess I'd probably say the most institutionalized method of identifying instances or problems with the aircraft.

Q. We have heard that there are also some safety reporting programs that had begun in the Flight Ops area prior to the accidents. Do I have that correct?

MR. HORNE: Can we go off the record?

(Off the record.)

(On the record.)

BY DR. BRAMBLE:

Q. Can you describe how the safety management system processes have been instituted and expanded in the company in recent years?

A. The first SMS was within Flight Operations, and it was 5 years --

MR. HORNE: Okay, if you're talking back 5 years ago, then you might be right.

MR. GASTON: I am right. I know I am. It's 5 years ago. And it originated within the demo side of the house. And the reason why is that you're looking for some Good Housekeeping stamp of approval for your department. And that existed at the time. There was an outside entity where you could go to and say we'd like to get a certification for safety, and that we're a good, safe department.

And so, they went to IS-BAO, IDAC, and got our International Standard for Business Aircraft Operations certification. From the initial review to the actual achievement of the certification, it took one year, and that's about normal. It takes about at least one year to get all of your stuff together, because it includes both the maintenance side of the house as well as the operations side. And I think we've been through three audits since that, and we've done very well on all of those.

It did not exist though for the test side. We had asked if there was a case for being able to do it on the test side, but the people that did that said, well, we don't have a safety management system specifically for that. The key to the safety management system is that you've got data monitoring. So, in this case, the data monitoring is aircraft parameters. So, you're looking at is the aircraft being operated outside of its normal envelope based on certain parameter limits. And that information is captured by in this case it's Austin Digital. And they give -- our reports are aggregated with all the other Gulfstream operators that are in that, and then we get those reports. And then we can see specifically how we do. Okay, but we can see how we're rated relative to the fleet. So, that was our first effort to that.

The key to it, though, is that you've got data, and the other thing is that you've got safety reports. You've got ground safety reports and airborne safety reports. And so, you build a culture of people noting, and those things are sent in. They're reviewed, and they're resolved. But there's an anonymity to that also that people that put that information in, only the safety officer would know that. It's not that the manager would necessarily have that. So, they handle at that level to obviously keep people from having open discussion about issues that they see and that -- I won't say non-attribution, but the idea is that they would feel free to speak.

BY DR. BRAMBLE:

Q. So, how do you do that with experimental lines?

A. It would be no different. If you --

Q. Tell them what you're planning on doing.

A. Okay, actually, it would be for Flight Ops, it was on the test side. It was never an issue though that if the pilot was having issue that they felt that they couldn't raise it, even though we didn't have a reporting system. I never knew of anybody that didn't feel free to come talk to me if there was an issue, and then we'd work towards finding a resolution to that.

But the process that we have now is actually better than what we had previously, because now you have the capability. You still have the SRG SRs, the reports that you can do, but you also have a safety structure that is outside the normal chain of command, so to speak, and it can go right to the president of the company. And so what that really does is it changes -- it really does change the behavior of a lot of things when you do that because everybody that sees that that structure is there knows that. It forces a certain behavior, in essence, is what it does, by virtue that that exists.

Q. Prior to the accident, you had this safety reporting system and data monitoring on the production and demo side?

A. The demo side, not the production. Production is the same.

Q. Just the demo side?

A. Just the demonstration side. Everyone, product, support and sales and demonstration side. It's about 35 pilots in our group.

Q. The ground and air safety reports, those were phased in when? What year?

A. Five years ago.

Q. Okay. Were those utilized by the pilots on the experimental side?

A. No.

Q. No, okay. In your mind, would that reporting system transfer easily over to the experimental side for the pilots, or would it require some modification?

A. No, I think it translates over relatively easy, absolutely. The thing that's going to be interesting to manage is going to be the -- we have problem reports, okay, which in essence can act as a safety reporting system. But the thing now is that you have to be able to figure out is it a safety report, or is there a problem on board. So, that's the one thing that we're going to have to figure out how to manage.

Q. Maybe both. And so, is that already in place that it has been moved over, or is that in process?

A. It's in process. We have the Flight Test Operations, Flight Operations has finished their -- we've done all of our documentation. We're set up for safety management system at this time. Barry McCarthy's group is in the process of finishing theirs now. And then engineering is in the process of doing their SMS as well. And what we're looking toward is how we have an integrated SMS amongst us. Otherwise, we're siloed.

Q. So, a Safety Management System approach is going to be used in developing the sub-programs for engineering and Flight Test as well?

A. Correct. Actually, the whole company will have it. All the areas of the company will be covered in an SMS.

Q. Had there been a plan to migrate that over to Flight

Test and Flight Sciences prior to the accident, or is this sort of a new initiative?

A. Well, the company had that intention, I think, because it was working towards that end. But we didn't know that. Actually prior to the accident, we didn't know that the company had already been working on a safety management system.

Q. You mean the company as a whole?

A. The company as a whole, right. They had already in some areas already implemented that.

Q. In which areas?

A. On the maintenance side.

Q. In terms of guidance for setting up the SMS components for the Flight Test side, is there available guidance on that, or will you guys be sort of pioneering this?

A. There's plenty of guidance.

Q. What guidance will be drawn upon primarily?

A. Well, the FAA has their own package, okay, and it's a phased package. Okay, so, we're doing Phase 1. I think there's three phases.

Q. Is that the FAA advisory circular on the SMS?

A. Um-hum.

Q. So, that was based on the FAA's advisory circular for SMS?

A. Right.

Q. You say you are working with the ACO on that implementation?

A. Right.

Q. Is John Salamankas leading that effort, and have you been involved as well?

A. John Salamankas has been the most involved, and that is the first thing understanding what that meant, okay, in terms of the SMS and how we were going to integrate ourselves. So, he had, right after the accident, said we're going to have to look towards seeing if there's an SMS system available. And so, I knew the FAA had the elements of it. And then so I asked John if he would set about studying that, so he spent a lot of time going over that and just figuring out how we were going to implement that. So, he worked on writing our individual SMS manual for Flight Operations.

Q. Is he experiencing -- how is that working out in terms of working with the other sub-areas, Flight Testing, Flight Engineering? Is he --

A. He's actually helping them with theirs.

Q. Is he finding it fairly easy to explain the purpose and components and what kind of objectives it would have?

A. Yes. Actually, in essence, when you look at the document and the elements of it, because it's either Flight Test or Engineering, you can take that document and pretty much tailor it to yourself based on the information that we have. You can get a readily idea of it and say, okay, I know I don't do that, but I do this. And so, you can come up with your own document relatively quickly. But you still have the indoctrination, the course, and all that other stuff that goes with it to understand what it means.

Q. And the document that they would be referring to as a model from Flight Ops is titled what?

A. I think it just says Flight -- I don't have a copy or the title of it, but I think it's Flight Operations safety management system.

Q. Great. All right, prior to the accident -- I think you already answered this, but you played a hand in developing the safety program in the Flight Ops side before the accident started, is that correct, based on the IS-BAO guidance and that sort of thing?

A. Yes.

Q. Turning to the SRB, do you serve on the SRB?

A. Yes, I do.

Q. Are you a voting member?

A. I'm co-chair.

Q. And do you vote?

A. Oh, yes, I vote.

Q. Do you know whether the lead Aerodynamicist for the G650 program was present during the field performance SRB?

A. I can't remember. I'd have to look at the -- he probably was, no doubt. Let's see, I don't see his name there. I don't see his name.

Q. Would it concern you if he was not -- well, does that suggest to you that he was there or that he might have been there?
A. No, I think he was cited. It would have been captured, because this goes around the room. It looks like it says 27 people on the list.
Q. Okay, so, is it fair to say he probably was not there?
A. It looks like he was not there.
Q. Would it have been of concern to you that he was not present, or would you have viewed that as something that was necessary?
A. No, I actually would not have.
Q. Okay. Can you explain why?
A. Well, you've got a lot of other people here that are competent. I think on this whole list to pretty much address all the stuff that we were looking at on the SRB.
Q. Speak up too, please.
A. Okay.
Q. Okay, prior to the accident, when the company was trying to meet a flight test certification date for a new airplane, how did you try to ensure that the company wasn't pushing your people so hard that safety was being compromised?
A. I look at the schedule all the time. And I manage it basically to make sure I have enough people to meet with the schedule, what I think it's going to be.
Q. Which schedule is that?

A. The schedule that's on the board every day in Flight Ops.

Q. That's the schedule of pilots assigned to flights rather than the certification flight test schedule?

A. Right, but early on we started to make sure we're hiring up and have enough people, enough test pilots to make sure we can man the airplanes and meet the schedule.

Q. How do you -- does your flight due to time policy play a role in that too?

A. Uh-huh.

Q. Who monitors the compliance with that?

A. Well, that usually goes into -- and, obviously, individual pilots can monitor that. I don't specifically monitor the hours that they've done. It's in the guidance in our office manual.

Q. Is that something that you would envision the new Safety Officer in Flight Ops to track or not so much?

A. He could, but I think most of the pilots when they look at the schedule, they can -- anytime there's guidance in the document, and there's authorization to ask for deviation from that, I would get a call. So, if anybody is looking for a deviation relative to some limit, then I get the call on that. But the Flight Test side of it is the hours were, I think, generous enough in terms of what a Flight Test day was. I think most all of them would fall within those parameters.

Q. How about on the demo side? Does anybody track that?

A. Yes, they do. On the demo side, the dispatch does monitor that, and so do the crews.

Q. Prior to the accident, were you aware of the wing drop incidents that occurred during Flights 88 and 132?

A. On 88.

Q. How did you find out about it?

A. Kent told me. Kent Crenshaw told me.

Q. When did he tell you?

A. Oh, it was sometime after it happened, and he said he wanted to do a presentation on it. And I said, well, what had happened, and he told me the specifics of it and said it was an over-rotation. And he just wanted to make sure he captured the event and made sure everybody else knew about it, and so he put together a PowerPoint presentation on it.

Q. Okay, and what were the lessons learned from that event?

A. I think the primary lesson learned was, one, to make sure an individual entering into doing testing has experiences to build up. That was probably the biggest take away from that. I think he was surprised at the rotation rate that it was able to generate. It kind of caught him unawares.

Q. As an experienced pilot and test pilot yourself, is there a rotation rate range that you feel comfortable with and above which you might be a little concerned that it would be difficult to maintain the adequate precision?

A. I recognize it when I see it. You know, 6 to 8 degrees per second would probably be a good upper limit. Somewhere like 8 degrees per second. Nominal is probably 5 degrees per second.

Q. Prior to the accident, your understanding of the cause of the wing drop during Flight 88, you mentioned an over-rotation. Could you describe in more detail what you might have known about what led to the over-rotation? And I guess you already described its high rotation rate and would have participated in the build up. But from an aerodynamics standpoint, what was your understanding about how the over-rotation translated into the wing drop?

A. Well, what I knew is from what Kent told me. He said it overshot to like 14 degrees, I think he said at the time. So, high rotation rate, and the wing rolled off. And I asked him, I said, what was the resolution, and said, well, it had been discussed within flight tests, and they were happy with understanding it. And then for him, it was to go ahead and put together the PowerPoint. I actually didn't see the PowerPoint that he gave, because I was not there at the time. But after the fact, I did go through his whole PowerPoint.

Q. After the accident, or you mean after the presentation but before the accident?

A. After the presentation, right.

Q. I see. What is your understanding now about the root cause of the wing drops in those two flights?

A. Well, in this case they had a stall, both 88 and 132.
Q. I understand from what you are saying that Kent said that Flight Ops had looked at it and was satisfied with the resolution, but --
A. I didn't say Flight Ops. It was with the Flight Test and the engineering.
Q. Okay. And did he provide any details about the analysis that was performed to determine the cause?
A. No.
Q. Since the accident, what's your understanding of how those events were analyzed?
A. Well, from the presentations I've gone through, and the events were analyzed within the Flight Test Engineering group within Flight Test.
Q. At a meeting that we attended where some conclusions were presented about the accident, there was a statement on one of the slides that the events were not -- was it broadly?
A. Broadly disseminated.
Q. Broadly disseminated?
A. Broadly reviewed.
Q. Could you go into more detail about what that meant?
A. Well, I think I've said this. Taken outside of the Flight Test Engineering part of the community and more dissemination within engineering and specifically within Flight Sciences.

Q. Who should have been responsible for taking a closer look at the data from those incidents in your opinion? And what kinds of analysis should have been performed? Should the primary responsibility have been with Flight Test or Flight Sciences?

A. I would say it would have been a collaborative effort. But Flight Sciences I think would have taken the data, and they would have compared it against what they had already filed with the stall and angle of attack or what their in ground effect stall estimates were and be able to find out that they were actually an error. So, it would be Flight -- I guess, Mills would be one, and then -- you know, primarily Mills, Bob Mills.

Q. In your opinion, should those incidents have resulted in a reconvening of the SRB or some other type of response?

A. I'd have to say yes.

Q. And the response would have been reconvene the SRB or something else?

A. Well, I guess I'd say if the analysis had been done, and you knew that there was a variance, then you need to go ahead and convene the SRB. That means it wasn't expected that they'd exceed the AFE predicted angle of attack as opposed to it was less than predicted.

Q. Okay.

A. But you can still say reconvene the SRB for procedures.

Q. So, the investigating side of that if, you know, you had an incident like that would take place more in Flight Test and

Flight Engineering, and then the SRB would more to review the findings and determine or approve any changes?
A. Or go forward.
Q. Okay. And with the new system, what role would the sort of safety ASO focals, safety officer focals in the different groups play in that process if you had a similar event say?
A. I think it's just a heightened awareness primarily, looking at the data anytime you see any unexpected or unanticipated activity, especially a roll off.
Q. Would they participate in the analysis of the event, or only the SRB, or --
A. The safety side of it?
Q. Yes, safety officer?
A. They would be there. They would be involved.
Q. And the analysis side?
A. They'd be listening -- I would put it that way -- because in the end, they're going to have to report on it.
Q. All right. Did you attend a January/February meeting at the RDC-1 after Roswell-1 to discuss the airplane not being able to meet takeoff field performance guarantees?
A. No.
Q. Did you attend a meeting about field performance held the day before the accident?
A. No.
Q. Did you review the airplane's tested versus guaranteed

takeoff performance field length with anyone prior to the accident?

A. No.

Q. Before the accident, what was your understanding of the reduction in stall AOA in ground effect compared to free air, and how did you come to that understanding?

A. Well, actually, I was actually more of an acceptance of what the numbers represented. That was, I think, a 1.6 degree reduction relative to the free air.

Q. Were you aware of that reduction prior to the accident or only after reviewing?

A. More after, I have to say that in terms of the number.

Q. Do you recall if there was a discussion of that during the SRB meeting for field performance?

A. I don't recall.

Q. Did you expect that that effect would be further refined as part of or during the field performance effort?

A. I'm not sure I understand the question.

Q. The decrement and stall angle between free air and ground effect that was briefed at the SRB meeting, could you expect that that value would be changing at all?

A. No.

Q. What was your knowledge coming out of the field performance SRB about what the shaker settings would be on 6002 and how the shaker would be used as a warning for the crew?

A. It was going to be .85.
Q. .85 on the last outset?
A. Right.
Q. Prior to the accident, what did you know about any changes made to the shaker settings for that aircraft subsequent to the SRB?
A. I didn't know about the change. That would be a reason to reconvene the SRB.
Q. If you had known prior to the accident, do you think you would have recommended that?
A. Yes.
Q. Why?
A. Well, because when you go to the SRB, you're looking at what the safety parameters of the configuration is, and then you really want to be sure in that case what the maneuver margins are going to be. So, when you're at that point, at point knots, I'm used to a .85. So, if you're under .9, and so it's .9 over what? And so, for me, I just want to make sure that there was an absolute number and not just a reference relatively normalized. I like to know the actual number in terms of how much angle of attack is reserved.
Q. What is your understanding prior to the accident of whether the TM was required to be present during high risk testing, high risk flight testing?
A. My assumption is that the TM would be present.

UNIDENTIFIED SPEAKER: When he asks required, he means that the testing cannot go on without it.

MR. GASTON: Oh, no, no.

UNIDENTIFIED SPEAKER: So, why don't you answer the question completely and use the definition in the answer?

MR. GASTON: Okay. It would not be limiting in the fact that a TM was not available, and my assumption is that he knows how to do the testing.

BY DR. BRAMBLE:

Q. So, if it was not available, you could proceed?

A. Yes.

Q. How is it decided how many engineers were needed on site in Roswell during the field performance test effort?

A. The nominal for testing was for two pilots and one FTE for the test flights. That's historically been the case for field performance. But in the instant case, there was four for flight control system monitoring parameters, and that's why we had one additional person on board. That's my understanding.

Q. You have been involved in the review of the incidents or the accident in some depth?

A. Yes.

Q. What's your conclusion about who was monitoring the flight control system and who was the test conductor aboard the aircraft between the two FTEs, Mr. Ollenburg and Mr. McCollum?

A. Reece Ollenburg.

Q. Was doing which duty?

A. His responsibility, I think, was he was looking at performance monitoring.

Q. The aircraft performance parameters during the maneuvers?

A. Yes.

Q. Okay. So, Mr. McCollum would have been doing the SES monitoring?

A. Right. Correct.

Q. Has anybody ever suggested that those roles might have been reversed during the accident flight?

A. Not that I know of. Nobody said that to me. This is my own assumption.

Q. What pressures were you under, if any, to keep the G650 certification program on schedule?

A. Nothing unusual in the sense of any other test program I've ever been in. You always have schedule pressures. But if comparatively speaking on the 650 back to the GV is that the flight schedule on the GV was more aggressive than the 650.

Q. How long did it end up taking until you got that full certification?

A. It was 18 months, almost 2 years. I think it was, yeah, about 2 years.

Q. How long was the G650 expected to take at the time of the accident?

A. I don't have the specific time.
Q. Okay.
A. Coming up on 2 years on the first flight right now.
Q. Prior to the accident, was the G650 Flight Test Program or certification progress tied to your compensation in some way?
A. No. Well, if it was, nobody said. Just a second, please. Schedules are schedules, but the reality is is that you look to maintain on the part of the pilots that their objective is to execute it safely. You can plan for ambitious schedules, but the reality is is that between weather and airplanes and other factors, it has its own pace regardless of what you intended to relative to the calendar side. I don't put a lot of energy or emotion into scheduling. We work hard to make it happen, but we do it in the constrains of we're going to do it safely.
Q. One last issue I wanted to ask you about is we understand that Mr. Crenshaw may have had some sort of unusual issue involving his sense of smell, may have reported losing his sense of smell?
A. Yeah.
Q. Do you know anything about that or when that might have occurred?
A. Yes, it was in March, I believe.
Q. Of 2011?
A. Yes, and he was 650, flying a 650 down. Was it a 6003? Yeah, I flew the same airplane. I flew the airplane, and I had, I

think, 8 sorties one day. And it was a case where I just had an excruciating headaches. And in the case of Kent Crenshaw -- I just thought it was, you know, up and down pressurizations, sinuses or something was the cause of the headache. And Kent though, he said -- I don't know if he could smell a fume in the airplane or something, but the end result was he said he didn't have a good sense of smell. He had lost his sense of smell. Not for everything but for some things, he just couldn't smell.

And he came into the office and told me about it, and he said he'd like to go ahead and get himself checked for that. And I said, "Kent, whatever you need to do, go get yourself checked to your satisfaction." So, he had engaged the doctor, I think, up in Philadelphia and went and had himself checked. I said, "Well, don't worry about it. Just come back and tell us what the expense is, and make sure you're satisfied that you don't have an issue." And I told him that smell saturation, things like that which are nerve related usually take some months to resolve themselves, just like any nerve activity does. They're very slow to respond to correction. And I said probably within 3 or 4 months, you won't notice it.

Q. The doctor said that in 3 or 4 months, it'd probably go away?

A. No, that's me. That was my prognosis, only from having nerve damaging and how long it takes to heal.

Q. So, the company paid for his evaluation in Philadelphia?

A. I guess that's a fact, because, you know, I told Kent to go up there and we would take care of it.
Q. Do you know who he saw?
A. I do not.
Q. Did you ever see any records back from the doctor?
A. No, I did not.
Q. What did he tell you was the resolution?
A. I didn't -- if he did tell me, I don't remember. He seemed just happy with the fact he was going to be able to get somebody to give him, I think, an examination on it. I think the doctor told him the same thing what I told him, and that it would probably resolve itself over a short period of time.
MR. RAMEE: Tell why do you think that?
MR. GASTON: Why do I think that? Well --
MR. RAMEE: Did Kent tell you?
MR. GASTON: Did Kent -- yeah, well, when he came --
MR. RAMEE: No, put it on the record. Tell why you think the doctor told him the same thing.
MR. GASTON: Well, Kent came back and he didn't have a lot of energy. If he had a lot of energy on it, he would have continued to pursue it. That would be his nature, and he didn't. So, somebody else could probably corroborate that, but that's my assessment of Kent at that point.
BY DR. BRAMBLE:
Q. So, Kent didn't continue to assess it because he had

plenty of energy? Is that what you said?

A. No, no, he didn't continue -- if Kent had more concerns about it, he would have continued, and he would have let me know. He'd say, look, I'm not satisfied. But at that point, I knew he came back, because he had visited with me. And if it hadn't been to his satisfaction, he would have told me. We've known each other for 31 years.

MR. O'CALLAGHAN: Off the record.

(Off the record at 4:01 p.m.)

(On the record.)

BY DR. BRAMBLE:

Q. So, you said you had known Kent for 35 years.

A. Thirty-one.

Q. Oh, 31, okay. I'm getting less reliable here as the day wears on. How did you first get to know him?

A. I met Kent at the L.A. Airport back in 1980. We had both been selected for the Air Force Test Pilot School, and he was in uniform, and it was on a Sunday. And I don't know anybody that travels in uniform on a Sunday, but Kent was in uniform. And so, his nametag was there, Crenshaw, and test pilot class was a small list, so I knew the list and I recognized his name. And I was just in civilian clothes, and I went up and I said "I bet you're going to Edwards to get your flight eval." And he looked at me like how do you know, you know. So, that was the beginning of our friendship.

UNIDENTIFIED SPEAKER: If you want to get out of here, the answer to that question would have been in flight test pilot school.

MR. GASTON: Pardon? Okay, okay, it would have been a short answer.

UNIDENTIFIED SPEAKER: With the non-relevant stuff, it would be better.

MR. GASTON: Strike all that. That's why I can tell you if he had a problem, he would have let me know.

BY DR. BRAMBLE:

Q. What was your assessment of his -- did you fly frequently with him in recent years?

A. Yeah, we flew together. We fly in Gulfstreams.

Q. And what was your assessment of his skill as a pilot?

A. He's a very good test pilot, very good pilot. He was very meticulous.

Q. Okay. Did Kent mention -- did Mr. Crenshaw mention any other health-related concerns before the accident?

A. No. He was in good physical shape, pretty much jogged every night. We live in the same neighborhood. We'd pretty much run into each other. He went one direction, and I went the other direction, so we'd usually cross.

DR. BRAMBLE: Okay, John?

MR. O'CALLAGHAN: Thank you.

BY MR. O'CALLAGHAN:

Q. Thank you, Mr. Gaston, for your time this afternoon. So, a few follow-ups. Do you guys need a break or keep going?

I got a little bit up to V_2 overshoots on the G650. I presume you're aware of the difficulties that the team was having in that area?

A. (Nonverbal response.)

Q. Something I am asking all the pilots is whether that difficulty is something they have seen on other programs in their career, be it civil, military, or any other -- not only in Gulfstream's, but in any other airplane they've flown or tested, whether that particular difficulty in achieving V_2 speeds is something that they've seen before on other airplanes, or it's sort of new or unique to the 650 in your experience?

A. Well, I think it was a combination of two things. One was the pitch rate in the short period, the excitation. I can't speak for other people, but myself, yeah, I have flown other airplanes that on rotation you get to a pitch bobble. So, if that's what you're asking --

Q. I guess I'm asking more about consistently overshooting V_2.

A. Oh, I'm sorry, during the flight test, developmental flight test?

Q. Yeah, during the flight test, sure.

A. My experience is not there.

Q. So, the follow-up to that is again, you know, with hindsight it's maybe a bit unfair to ask, but if it is sort of a unique problem that hasn't been seen on other airplanes, and other pilots they've given the same answer, I'm just wondering if it would lead one to question whether the basic numbers that were being provided were sound.

A. That's what you would suppose. I mean, if you're trying very hard to do something, to achieve the test objective, at some point you have to ask am I trying too hard to make something that doesn't want to happen. In the case of the 7A1, the maneuver there, when I reviewed that initial test point after the accident, one of the things they did after the takeoff -- I mean, the pilot himself might not note the -- he's not going to note it at liftoff, necessarily, but he'll note that he overshot the speed. But I believe Kent did.

So, they went up and tried to stabilize on the point in free air and find out what pitch attitude they'd get with the same power setting as they did on the ground and see what pitch attitude that would be, and I think it turned out to be about 14 or 15 degrees. But it was some acceleration. When I saw that, to me, that would have indicated the point was not possible, because you'd have to achieve that pitch attitude on the ground, which is too high of a pitch attitude to capture V_2. So, that told me that the point was not doable.

Q. Okay, thank you. You have already answered the question about the bullet and the SRB conclusions about one of the lessons was the analysis for a review of the incidents of Flights 88 and 132 wasn't broadly reviewed. I'm just curious whether the information management systems through the iPads that you described at the beginning, do you foresee that would be a mechanism through which a broader review would occur, or how the information availability at the fingertips would alter that?

A. To me, that's more structural organization for communication. That's what that is. That to me is the root cause there.

Q. A little bit on the safety reporting system, I think it is, and I listened with interest to your description of how it works on the demo side, and I think I heard that there were parallels to be had in the testing side. But I think I also heard that sort of the key or the foundation of the system on the demo side is this data monitoring. And when you exceed tolerances or something, or see if something goes outside some defined envelope, it probably sets off flags, and then you can monitor. Well, I was thinking how that might work in flight testing when kind of the definition is to find out where the envelope is or go beyond it. And you have a whole crew of people monitoring it at the time, so just a comment to that.

A. Well, on the test side, you are always monitoring those parameters. But, obviously, the thing is is that what limits are you putting on those as far as exceedances? So, in this case, how much are you going to allow yourself to exceed roll or pitch before you go back and look and see what are the procedures you're using that would have to be modified.

Q. I want to ask some more questions about Flight 88, and I'm going to take a little bit of a different tactic this time than I have in the past with some other folks. And I think what I'll do is outline a series of thoughts or logic path and then a conclusion. And I'd like you to listen to that and criticize it and listen for if my logic is unsound or founded on false premises or unfair or relies too much on hindsight, or in other ways is faulty. And just give me an honest assessment and criticism of this thought process.

So, we look at Flight 88, and everybody acknowledges that the root cause was an over-rotation. In my mind, the context of that, the implication is that the angle of attack got too high. It was flow separation and a loss of lift on one wing more than the other, which caused a rolling moment, and that's the fundamental physics behind the roll-off. At the same time, this event, which I'll describe as a stall, occurred without the activation of the stall warning. So, putting those two together, it would be reasonable to conclude that the stall warning settings were not set properly, and that that might be an opportunity to discover that the in ground effect stall angle was not where folks had estimated it to be. And then that would -- and so basically, the conclusion then was that Flight 88 was sort of, unfortunately, a missed opportunity to discover that stall in ground effect was lower than what was expected. So, that's the sequence of thoughts. And am I going wrong anywhere in that?

A. I'm 100 percent with you.

Q. Thanks.

UNIDENTIFIED SPEAKER: Can we go off the record for a second, please?

(Off the record at 4:12 p.m.)

(On the record.)

BY MR. O'CALLAGHAN:.

Q. Again, thank you for your answer regarding Flight 88. As follow-up, and I know that you weren't familiar with Flight 132 before the accident, but in hindsight now, was that another missed opportunity?

A. Yes, both of them were missed opportunities that -- we like the airplanes talking to us.

Q. Meaning that the stall in ground effect was lower than --

A. Yes, absolutely.

Q. Thank you. On that subject about the reduction in stall angle of attack due to ground effect, I know the traditional number that had been used on past programs based on experience is about 2 degrees. Do you have a feel for what the uncertainty value on that -- so, it's 2 degrees plus or minus X percent?

A. I didn't know that. I really didn't. I didn't know the uncertainty level. I mean, I know what the number is now, but I didn't know at the time.

MR. O'CALLAGHAN: Okay. Thanks. That's all I have.

DR. BRAMBLE: Okay, Marie?

MS. MOLER: I'm good. Thank you.

DR. BRAMBLE: Mike?

MR. BAUER: I'm good.

DR. BRAMBLE: Mitch?

BY MR. GALLO:

Q. I have a question that scopes what a test pilot -- how a test pilot is differentiated from an operational pilot. An operational pilot could fly the G650, but what are your expectations in the functions of the test pilot as opposed to just the operational pilot? What would you expect from a test pilot?

A. That's kind of a broad question. But, well, the first thing is, first and foremost, is the discipline, and they have the experience in flight testing because we're not in the business of training people to become test pilots. And so, it's that, and it's the safety experience process experience. Those are the things I look for. I have pilots that are better pilots in terms of just actual perform a maneuvers than some of the test pilots, I'm sure, because that's a different skill. But the total package is the skill set to be able to perform in maneuvers but yet has the education that goes with it.

Q. Okay, and as far as the education, you are relying on their understanding of theory of the test program?

A. Yes, I am.
Q. To what level? Are they actually expecting to actually do the formula calculations prior to the test and what level of theory are they using?
A. Not so much they're going to do the calculations, although a good number of them probably can do that. The point though is that they know that the theory is there. That's one thing, and the experience that they bring to the table from other programs.
Q. And as a test pilot, are you relying on the engineers that have developed the tests in providing you the correct information?
A. You're relying on them if they've provided you with the information, but I still think you have to question the data. And in the course of doing the testing, you should be looking at it the whole time to make sure that it passes a common sense test.
Q. During, for example, field performance testing, there's a test team, and that test team is comprised of maybe somebody from Flight Sciences. Would it be a concern to you that the personnel from Flight Sciences didn't understand the correlation between the change from .85 to .90 normalized AOA, that that change is actually a 33-percent reduction in AOA?
A. Yeah, I thought they should understand that. I guess that would be my expectation, yes.
Q. Would that be a concern to you as a test team?

A. I think the first responsibility of that is to the FTE side and the test pilots themselves.

Q. Have you done field performance testing before?

A. I did all the field performance testing for the GV.

Q. What is your personal comfort level as far as the margin between where a shaker would be set at and in ground effect AOA? What margin would you be comfortable with doing those tests?

A. In terms of alpha angle of attack?

Q. Correct.

A. I'd have to say a minimum of 1 degree, but I'd like to have more, maybe 1-1/2 to 2 degrees.

Q. Now, would that be different if you had a stick pusher or AOA limiter active versus a test that didn't have either one of those? Would your personal margin then change?

A. Like I said earlier in the testimony, I like to know the number, because I'm looking at the number and that's what I'm concentrating on visually. The problem is, is that the shaker is -- I won't say it's an artifact, but I'm reacting to that, whereas, I can close loop on an angle of attack. Or in the case if you've got the PLI, the pitch limit indicator, you could close on that just like you do a specific angle of attack, but I'd still be wary of what the actual angle of attack is.

Q. Did Jake Howard or Gary Freeman discuss with you during field performance testing that they thought the V_2 speeds were unattainable or they should be increased?

A. No. There may have been a conversation, but the problem is at this point, so much has transpired, I can't tell if it's pre or post. Gary said the numbers, and that was the flaps, 10 flaps, 20 speeds for rotation; it didn't make sense to him because the speeds were lower for flaps 10 versus flaps 20, and he said he questioned that, which is, guess what -- I mean, that's what you expect the test pilots to do is meet their common sense model.

Q. Do you attend the Friday certification issues meetings?

A. Pardon?

Q. Do you attend the certification issues meetings that are held on Fridays?

A. Not always, no.

Q. If you don't attend, does somebody else from Flight Operations attend?

A. It would probably be Jake Howard. He's usually the project pilot.

Q. Did any of the other pilots that were flying during the field course development, did they attend in addition to Jake?

A. I couldn't tell you. I mean, usually the pilots that are actively involved in the testing, they would have attended. That would be my estimate.

Q. Did you attend the certification issues meeting the day before Flight 153?

A. I did not.

Q. Have there been past occurrences during developmental testing in which flights have been stopped and programs stopped because predictions were so different from what was realized in testing?

A. I cannot specifically recall it that way, the way you're saying it. But did we stop flights because we're not prepared to proceed? Yes.

Q. Aside from not being prepared to proceed, but the predictions were different from what you found out during flight testing?

A. Not in my experience.

Q. What are the flight test techniques that determine stall angle of attack in ground effect?

A. There is none that I know, flight test technique to do that personally.

Q. Do you attend the change boards or the PR review boards for the PR reviews?

A. No.

Q. Who from Flight Operations attends that?

A. Mostly Jake Howard.

Q. Even during field performance development?

A. I couldn't honestly answer that.

Q. Do you know if any of the other pilots attend those review boards?

A. I don't know. I couldn't tell you specifically.

Q. Who assigns the pilot or pilots to attend the change or

order PR reviews? How is that determined?
A. I don't know. I assume it would be Jake.
Q. But do you know who would -- I mean, how is it decided upon who attends from Flight Operations?
A. Well --
Q. Does Jake Howard decide that?
A. I guess I'd have to say yes.
Q. But you are not certain?
A. No, I'm not certain.
Q. In reference to this next question, it could be from 650 going all the way to current or previous programs, have experimental test pilots ever written reports following flight tests?
A. Yes.
Q. The day-to-day flight testing?
A. They usually make their day-to-day -- they make their day-to-day -- following the test, they'll do their own report.
Q. That was being done before the accident?
A. I'd see Kent's reports.
Q. Do you know if Mr. Howard and Mr. Freeman also created reports after each individual test?
A. Some do; some don't.
MR. GALLO: That's all the questions I have.
DR. BRAMBLE: All right, Jeff?
BY MR. BORTON:

Q. We talked a little bit about rotation techniques during discussion. Can you go over -- maybe the best way to ask the question is did you ever discuss that for the 650 in terms of what they were working on for field performance or takeoff rotation techniques in terms of the type of inputs and rates of the inputs to try and make the numbers?
A. No, no, actually it was only after that I looked at the rates, and I thought they were too high.
Q. You had mentioned that earlier, so I just wanted to know if there was any discussion. And then just an educational question on my part, do you all, as far as the engineering pilots, do they cross-pollinate or go over and fly production or maybe even some delivery flights as a way to broaden what they do?
A. They do. That's the expectation is that they have the operational experience with the airplane.
MR. BORTON: That's all my questions.
DR. BRAMBLE: Lorenda?
BY MS. WARD:
Q. I just have one. Do you happen to know who set up the SRB so the director of Flight Test and VP of Flight Operations co-chaired it?
A. Set it up that way?
Q. Yes.
A. That's -- I can put it this way. It's always been that way as far as I know.

Q. So, when you came here in the '90s, it was set up that way?

A. I guess I have to say yes. It's just one of those things that was in the process all the way through at the beginning of the 650 program. Obviously, back in other programs, I was at the SRBs also, so --

MS. WARD: That's all I had. Thank you.

DR. BRAMBLE: Tom?

MR. HORNE: Just one quick question.

Did you get any reports from Kent, e-mails or reports on any of the flights on field performance testing?

MR. GASTON: Not that I recall.

MR. HORNE: Okay. That was it.

BY DR. BRAMBLE:

Q. Just one follow-up. To your knowledge, was Kent taking any over-the-counter medication in the 72 hours preceding the accident?

A. Only what I've seen or heard, and I guess it was some antihistamine.

Q. Did he tell you about that?

A. No.

Q. How did you find out about it?

A. I can't remember. I just heard it, but I didn't know if it was factual or not.

Q. Did you know about it before the accident?

A. No, I think it was part of the autopsy. I think that's where it came from.

DR. BRAMBLE: Okay, is everybody else okay, or --

MS. WARD: John's follow-up question?

DR. BRAMBLE: Oh, yes. John, your closer.

BY MR. O'CALLAGHAN:.

Q. The closing question we've been giving everybody is an open question to tap your knowledge and wisdom, especially since the accident since we know it's been on everybody's hearts and minds involved and thinking about it very hard. We're at the end of our fact-gathering stage here, and we'll be going back and doing analysis and preparing a report. The purpose, as Bill has mentioned, is to find out what happened, what we call probable cause, but then perhaps even more importantly, offer recommendations to the industry to hopefully prevent future events like this and improve things across the board.

So, the question is two-fold. One, if there is something you think the NTSB should be looking at that it's not apparent that we're looking at based on our questions or what you've heard about the investigation through Tom or others, please point that out to us where we should go looking or researching some more. And secondly, if there's anything that you think the NTSB can bring to light through its report or its recommendations that would benefit the industry, we'd be happy to hear that as well. So, with that, the floor is open to anything you'd like to provide.

A. For the first question, in any accident you really are looking at all of the elements and ask yourself, well, what do you think would allow it to happen? And so, I've thought about that a lot, because you get lots of information. But then after a while, you start distilling it, and you start thinking about what the pilots were doing and how they were thinking.

And the first thing that I put on my list when I made my list was there was a paradigm shift which we did not appreciate as a company, and that is, our aircraft was not tail-powered limited or geometry limited as we had in the past. In the case, we were essentially tail-power limited as to what rotation rate we could generate and also the fact that by the time you rotated and got to the pitch attitude, you also had liftoff. And so, this transitional going through the in ground effect, essentially went through it relatively quickly, and in addition to the fact that you had usable angle of attack on the aircraft that you really couldn't take advantage of. So, in ground effect was never a high priority in the GV program especially.

So, to me that set the stage. And the reason it set the stage is because it allowed Kent to rotate. Okay, and when he went down the runway, he saw V_2 coming and he captured V_2. And what allowed him to capture the V_2 was that the test card had no mention of the fact that you needed to first hold the pitch attitude and then hold that until liftoff.

Now, the CTOs on step 6 or step 7 describe it as, you know, rotate your pitch attitude, and then as you see the V_2, you capture V_2. So, that's what Kent did. But on the abuse of CTOs, there was a statement there that said specifically that you will wait until you note the fact that you're airborne. So, that was an internal problem. And I think that really emanates from the history of our experience. So, that to me allowed the events to happen.

And the other major factor was the fact that everybody was performance monitoring but not safety monitoring. And so, in the case of Kent trying to do the maneuver, he had performed 80 CTOs or participated in 80 CTOs up to that point. The only person that had more than Kent was Jake Howard, who had 88 total maneuvers. Vivan had 50, and Gary Freeman had 20, I believe. All right. So they had plenty of experience. So, based on the fact that it wasn't, to me, a question of performance because you could see he had actually nailed the pitch attitude within exactly 9 degrees, but he proceeded to rotate. And the one thing he did not want to do was to exceed 11 degrees, but in my mind, he never realized he was still on the ground, and so he just over-rotated on the ground and got roll-off.

And the reason -- I looked -- I thought the longest time as to why the pilot would not see a roll. It really bothered me, because pilots normally try to control, test pilots especially, roll to within a degree. And so, his attention had to be focused elsewhere, and that's the same for Vivan. And so, when I looked at -- I questioned people and asked what his habits were, and I was absolutely convinced that the only way he could get the performance he wanted to get was he was in the HUD looking at the pitch limit indicator, and as a result did not see roll because he was concentrating too much on looking at from pitch to airspeed, pitch to airspeed, and so he didn't see a roll. And I'm convinced that Vivan was looking at the weight on wheels to see if he was airborne to get the gear up, and as a result, he did not see roll until after probably 5 degrees. And I think that's where he -- since I was at the NTSB for the initial CDR --

DR. BRAMBLE: Can we go off the record for a second?

(Off the record.)

(On the record.)

DR. BRAMBLE: Let's go back on the record.

MR. GASTON: The point was that Vivan didn't -- he called it too late. It was after the point where they'd lost lateral control. Because when I looked at all the data, my guesstimation was they lost lateral control at 5 degrees, and that was early on. And at the roll rates and looking at the inputs that the pilot put in, and then even when he did put in full, it didn't change the rate. He was still at 10 degrees per second from just my looking at the data. And at that point he was going to have the wing strike.

So, the procedure that was there was essentially to do a go around. I think at that point it probably wouldn't have made any difference, even if he had decreased pitch attitude, because the wing was stalled. So, my thinking was the only way he could have probably avoided the end result was he had to abort. But the whole paradigm is, is at that point, even though they was runway available, there was not a discussion that talked about the concept of refusal speed. That means you still had runway left; you do have the option to go ahead and abort. And so, he elected to do the go around instead with power, adding power. And the problem there is the spool-up time on the engines and the fact that the right wing was stalled and on the ground. So, I guess that's probably all I have to say.

BY MR. O'CALLAGHAN:

Q. In terms of any recommendations for the industry?

A. Well, the thing is relative to the industry is that afterwards, I did an information search. I looked at every combination on Google of the degradation of angle of attach, in ground effect, every kind of combination of words to see what hits I would get, and there really wasn't very many leads at all. And I went to the -- at least I couldn't find them. Maybe you gentlemen are more successful. But the other one was I went to the Flight Test Safety Committee website and looked at all the information they had. So, what I find is that there is bits and pieces of information, but there is really not an overall comprehensive site or point that people would go to at different, let's say, phases of the flight and look at information. It's not complete. So, what I would say is that what I hope Gulfstream does out of this effort is take what we know and populate that website with information that other people can take advantage of.

MR. O'CALLAGHAN: Okay, thank you very much.

DR. BRAMBLE: Mitch, you have a follow up?

BY MR. GALLO:

Q. I have one question. You were based at Edwards. Why not perform the V_{MU} testing on the G650 -- been there?

A. You could do it there. I mean, we've looked at Edwards before. It's much easier to do the testing at -- in terms of just the administrative aspects of it, at Roswell because there's so little traffic is one piece of it. At Edwards, you're going to have to integrate yourself within the flight test community there. So, it's not as easy, although you've got the advantage of the lake bed, but you're still going to do the V_{MU}'s -- the lake bed is off the end of the runway. You're going to do the V_{MU}'s on the runway. And I did look afterwards, because we had --

Q. The V_{MU}'s or the CTOs?

A. It doesn't matter. Anytime you're going to lose lateral control or the possibility of that, the idea is that if you did it on a lake bed, it doesn't matter where you go, right? But you wouldn't do them on a lake bed. I don't think historically it's done there anyways. I've never seen it done on a lake bed. It's just the lake bed is an option after takeoff if you need to go ahead and land. But the problem is -- I did Google Earth and looked at all the obstructions that are around the runway at Edwards on the runway too, and there's just lots of concrete everywhere. So, Edwards is actually a worse location in my mind, in the absence of airplanes being parked along the side of the runways; that's the case at Roswell.

MR. GALLO: Thank you.

DR. BRAMBLE: Anybody else? Okay, I think we're done.

MR. GASTON: Okay.

DR. BRAMBLE: Thanks, Randy.

(Whereupon, at 4:51 p.m., the interview was concluded.)

CERTIFICATE

This is to certify that the attached proceeding before the

NATIONAL TRANSPORTATION SAFETY BOARD

IN THE MATTER OF: AIRPLANE ACCIDENT
ROSWELL, NEW MEXICO
N652GD
Interview of Randy Gaston

DOCKET NUMBER: DCA11MA076

PLACE: Savannah, Georgia

DATE: October 28, 2011

was held according to the record, and that this is the original, complete, true and accurate transcript which has been compared to the recording accomplished at the hearing.

Letha Wheeler
Official Reporter

Debbie Mizell
Transcriber

UNITED STATES OF AMERICA

NATIONAL TRANSPORTATION SAFETY BOARD

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Investigation of:	
AIRPLANE ACCIDENT ROSWELL, NEW MEXICO N652GD	Docket No.: DCA11MA076

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Interview of: PETER HENDY

Gulfstream Corporation
500 Gulfstream Road
Savannah, Georgia

Tuesday,
October 25, 2011

The above-captioned matter convened, pursuant to notice, at 8:09 a.m.

BEFORE: WILLIAM J. BRAMBLE, JR., Ph.D.
Senior Human Performance Investigator

APPEARANCES:

MITCHELL GALLO
Air Safety Investigator
National Transportation Safety Board
31W775 North Avenue
West Chicago, Illinois 60185

WILLIAM J. BRAMBLE, JR., Ph.D.
Senior Human Performance Investigator
Office of Aviation Safety
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

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ALAN J. (JEFF) BORTON
Flight Test Pilot
FAA Aviation Safety
Aircraft Certification Service
Wichita Aircraft Certification Office
1801 Airport Road - Room 100

THOMAS M. RAMEE, ESQ.
Deputy General Counsel and Risk Manager
Gulfstream Aerospace Corporation
500 Gulfstream Road, M/S B-06

TOM HORNE
Experimental Test Pilot
Gulfstream Aerospace Corporation
P.O. Box 2206, M/S A-12
Savannah, GA 31402-2206

APPEARANCES (Cont.)

JOHN O'CALLAGHAN
Aircraft Performance Group Chairman
Vehicle Performance Division (RE-60)
Office of Research and Engineering
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

-

MICHAEL BAUER
Aerospace Engineer
Vehicle Recorder Division (RE-40)
Office of Research and Engineering
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

E. LORENDA WARD
Air Safety Investigator
IIC and U.S. Accredited Representative
Office of Aviation Safety
Major Investigations (AS-10)
National Transportation Safety Board
490 L'Enfant Plaza East, SW

MARIE MOLER
Mechanical Engineer
Office of Research and Engineering
Vehicle Performance Division
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

I N D E X

I N T E R V I E W

(8:09 a.m.)

INTERVIEW OF PETER HENDY

BY DR. BRAMBLE:

Q. Can you please state your full name?

A. Peter Hendy.

Q. H-e-n-d-y?

A. Yeah.

Q. Date of hire with Gulfstream?

A. Month and day I can't remember, 1999, August of '99.

Q. What's your current position?

A. Flight test engineer.

Q. Your department?

A. Flight test engineering, which is Department 343.

Q. What are your roles and responsibilities?

A. I was the lead flight test engineer for 6002 and I'm not know the lead flight test engineer for 6005 and I have area responsibilities, generally systems and power plant related.

Q. How was your role different from Mr. Reece Ollenberg's role on the 6002?

A. Essentially the functions of the lead flight test engineer that I had while the airplane was in Savannah divulged to Reece when the airplane was in Roswell.

Q. Who were your previous employers in the aerospace industry?

A. Prior to Gulfstream, I worked as a contractor for a DER consulting company in Phoenix. It was just a group of independent DERs and that was from '95 to '99.

Q. Any particular manufacturers?

A. There wasn't any particular manufacturer affiliation. It was an independent group of engineering support type people.

Q. And at Gulfstream, what previous certification programs have you worked?

A. Prior to the 650, the 550, the 450 and then prior to that, I was involved in a lot of STC supplemental type certificate work in the service center side of the organization. So a lot of STC work on GIIs, GIIIs and GIVs, in-service airplanes.

Q. Have you been involved in any field performance testing directly yourself?

A. Directly, no.

Q. What was your understanding on the day of the accident of who was in charge to the trailer, the telemetry trailer?

A. Well, I wasn't there so I don't know specifically on the day of the accident who was doing what specifically.

Q. In general, do you know which sort of position of the several folks or several positions in the trailer regardless of which specific person was in them was supposed to be in charge of the trailer?

A. I really don't. I don't. A lot of the work that I do with respect to the systems and power plant typically doesn't involve the use of telemetry, by the nature of testing, thus I don't really have a real feel for the telemetry trailer and its use in terms of who is doing what and where.

Q. In your role as the lead flight test engineer for 6002, were you aware of the speed schedules used for field performance testing?

A. Again, my area of specialty is really not what I call classic aircraft performance testing. My expertise lies within the systems and the power plant universe. So with respect to the performance takeoff schedules, I wasn't deeply involved in many aspects of those.

Q. I imagine the answer is going to be the same for this but how about for the stall protection, shaker settings?

A. Again, I was generally aware of them just by normal communications of what they were normally set to for non-performance flying.

Q. Did you hear anything about inadvertent stick shaker activations that were occurring during the test flights?

A. I don't recall any specific discussion other than the 132 event and the Flight 88 event. I was aware of those in general terms.

Q. Were you aware of the decision to increase the shaker activation threshold?

A. No.

Q. Do you know who in Savannah was responsible for making changes to the software in the flight control system? How that actually occurred?

A. In terms of?

Q. If there was an update to the software system, who actually made the change to the flight control computer?

A. I mean in terms of the loading of new software on the flight control computer, there's a whole process by which that occurs, but it's generally carried out by engineering in association with maintenance. There's a maintenance component to it and then an engineering verification portion as well.

Q. Did you do any work with that?

A. Never have, I mean, other than occasionally being on the airplane while they were doing it. I was never actually directly participating in changing the software on the airplane.

Q. Did you participate in meetings amongst group heads or managers to discuss how the flight test data from Roswell was comparing to performance targets?

A. I don't recall any specific meetings, no.

Q. What was your awareness of the cause of the incidents that occurred on Flights 88 and 132?

A. I think I was only peripherally involved in the discussions so that the conclusions that were drawn after those investigations were over I wasn't directly or participate a great deal in those activities.

Q. Before the accident, did you have any impression of what the cause was?

A. Honestly, no.

Q. Do you have any idea why they didn't result in the convening of a Safety Review Board?

A. No, I don't have any idea why that wasn't one of the things they did.

DR. BRAMBLE: All right. That's it for me.

John?

MR. O'CALLAGHAN: Just a couple follow ups.

BY MR. O'CALLAGHAN:

Q. Regarding the area of flight controls, perhaps the answer is buried here but where are the requested changes to flight control gains or logic or say the stall shaker settings, where are those born and at what point in the process do you become aware of them for implementation on the airplane?

A. I guess they can be born in several places but they come from the flight sciences and flight control group. They come from analysis of the data for performance and they can come from analysis of the data from within flight test and then get promulgated back that way.

Q. Then they enter your universe when you get a request from one of those departments or how does that work?

A. Again, since I don't really spend a lot of my time doing field performance testing, changes like that typically don't or have not historically entered my universe at all.

Q. Do you have flight control gains or anything like that or are you talking about the stick shaker setting?
A. Well, in general when we're doing the testing which I'm most familiar with which I tend to get tasked, I don't typically do anything with the airplane other than what its current defaults happen to be. So historically, I haven't had much opportunity to do too much of that.
Q. And this may be outside your sphere as well but from your current position or past positions, do you have a feel for the uncertainty that's in stall angles is and the allowance made for that and when the program with shakers -- specifically, I'll get to what I'm driving at is there was an estimate for the reduction and stall angle of attack due to ground effect and that's coming out one side and then on the other side you have coming up thresholds for where the stick shaker will activate. I'm just trying to get a feel for what are reasonable numbers for the uncertainty in the knowledge of stall angles of attack and reductions due to ground effect and those sorts of things.
A. Yeah, again, you're out in a place that's outside my typical area of expertise and to elaborate a little bit, generally, when I was flying on the airplane, we were backed off considerably from any -- we didn't need to be close to any stall AOA for any of the testing I was typically conducting. Thus, we would always just default to the conservative, first flight type settings for all those variables. So there was always an inherent

margin in the settings that we had when I was most often on the airplane.

Q. And, again, the tests you were involved with, you mentioned power plant and systems?

A. Right.

Q. Can you give just a few examples of those sorts of things?

A. Well, for example, during engine air start testing with an engine shutdown inflight to confirm it relights, there's no need to be particularly close to a stall speed. So if everything is way out to the right on the envelope from there generally.

And system testing, the other work that I do with the cabin pressurization system or the air conditioning system, you know, the air conditioning system know or care how fast or slow the airplane is going. So you are flying around in the middle of the envelope all day long.

Q. Something just general about the folks you work with, how many private pilots are there in the flight test department, or people involved with the 6002s?

A. How many private pilots are there? I don't really know. But in terms of flight test engineering, I know there's a couple I think.

Q. The people involved, let's say, with the 6002 airplane.

A. Nobody springs to mind. I don't believe there were any.

Q. The last question I have is one we have been asking everybody as we're nearing the end of our fact gathering phase here, probably by the end of this week, we'll be going back to Washington and start looking at all the things we've gathered and analyzing and at the end of our process is recommendations to hopefully improve the industry and make things safer.

So we're just tapping everybody's brain here who has obviously thought about the accident for many months and just ask if there is anything you think we should be looking at that we haven't maybe mentioned through our questions or anything in general that you think we should be offering to the industry through the course of this investigation? We'd be happy to hear it.

A. Nothing immediately springs to mind but if I think of something I will let you know.

MR. RAMEE: You haven't mentioned much in your questions to this guy.

MR. O'CALLAGHAN: True.

MS. WARD: Can I just interject here generally about the mission stuff.

BY MS. WARD:

Q. Can you just explain whether a lead flight test engineer means and is?

A. So for each airplane there's a lead flight test engineer and there's typically sort of a backup or second flight test engineer who is in the case of 6002 was Reece. We have responsibilities for whatever testing is our area of expertise, which as I mentioned in my case is power plant and systems and air conditioning and things like this. So we have a responsibility for those tests regardless of which airplane they occur on.

We also have a responsibility to sort of babysit the airplane specifically and do the planning with respect to, you know, harmonizing all of the requirements, all the testing requirements, that are on the airplane, making sure that we can do as much testing as we can concurrently. Essentially, looking at all the things, all the taskings the airplane has, picking and choosing the testing that occurs and when it occurs and making sure that it's configured appropriately to do those tests. So it's like I said a coordination job if you'd like.

Q. I'm glad you used that word coordination because one of the things that we're kind of curious about is the communication that goes amongst the three groups. So you as a lead, if you're back here in Savannah and you have a team that's out in Roswell, how do you communicate back and forth to the team?

A. In the case of the testing that was being conducted in Roswell, while it was in Roswell, I wasn't directly engaged on a day-to-day basis with the airplane because as I said earlier, the responsibility of the sort of coordination piece of what was going to happen to the airplane tomorrow, how it needed to ballast, how much fuel it needed, were there any other test points that could be conducted in conjunction with the testing that was the primary mission, those responsibilities sort of divulged to Reece when he was out there doing that.

So to answer the question of my involvement with the airplane while it was in Roswell, it wasn't. I was not involved in its care and feeding on a daily basis while it was there.

Q. But you are considered the lead though, right? And then Reece kind of defaults to it because he is the secondary?

A. And because the testing in question was Reece's area of expertise and not mine. It makes much more sense to essentially have two people to switch off.

So while the airplane is off doing performance related testing, Reece had the responsibilities of the lead FTE and while it was back in Savannah doing the other things it was tasked to do, the responsibility came back to me.

Q. Now, did you and Reece have calls setup at a particular time of the day, because it was out there for two weeks, at some point during that two weeks, did he give you any feedback of how the test is progressing?

A. The communication path doesn't really come through me when you're talking about results of testing, the field performance testing. It didn't necessarily come back through me and the results and the day-to-day behavior the airplane, we have a morning call that happens at 7:30 every morning, broadly speaking. The mission for the day was discussed at those meetings and that happens every morning at 7:30, Savannah time.

But then other sort of day-to-day operational things with respect to the airplane that was just entirely self-contained within Roswell.

Q. I guess I'm not getting --

A. Reece needed a ballast change or Reece needed a fuel load change, I mean, all those things were just carried out entirely autonomously within Roswell. He didn't need to involve me.

Q. Let's say in past, we'll just throw out this past Roswell event. Let's say when he was out there and at any point in time has he ever called you or asked for advice or if you had any questions or something like they weren't hitting a target, did you speak to you, I don't know if he thought of you as more senior or not, did he look to you to that role did he work autonomously?

A. No, I think if it was a question about something the airplane was doing, there was something systematically, the airplane was, you know, this message was being posted or the engine was doing something strange or there was a maintenance message they couldn't rid of, something nuts and bolts like that, then there would have been a conversation but if it was not hitting a seed target, you know, I'm not the right person to ask.

Q. But you are systems, right?

A. Yeah.

Q. Is the stall protection system considered a system?

A. In the context of what we're talking about, the system is not one with which I am very familiar.

DR. BRAMBLE: Let's go off the record.

(Off the record.)

(On the record.)

DR. BRAMBLE: Let's go back on the record.

MR. HORNE: If Reece had a problem with test execution of the field performance test, who do you think he would have consulted in flight test engineering?

MR. HENDY: I think the first stop would have been Paul Donavan.

BY MS. WARD:

Q. And also going back to the communication side, as far as flight test engineering and within performance, how does each of the different, I'm going to use the word stove pipe because that's how I'm envisioning things now, how does the cross-pollination go to the three different entities?

A. Three different?

Q. There's flight test, flight ops and then you have performance.

DR. BRAMBLE: There's more than that but the ones we've been concerned about are aero performance and flight sciences and flight test engineering and flight ops.

MR. HENDY: Right. I'm sorry. I missed the question now. I apologize.

BY MS. WARD:

Q. How do the three different groups, how do the disseminate information? Are there scheduled calls, like is it a weekly call or daily call, so that this group knows what this group is doing so that everybody is on the same page?

A. In Roswell, everybody, all those three entities were all represented, right? So those three groups of people were all in the same room together every day.

Q. Where does a call back to Savannah happen or are they working by themselves for the two weeks that they're out there?

A. Well, as I mentioned, the flight test, what is the airplane going to do today and maybe what is maybe the airplane going to do tomorrow, that occurred daily, as a daily morning call that just speaks to in very general terms what the airplane's mission is today, what are we doing today, takeoffs, landings, whatever it is. And if we know that far ahead what we're going to do tomorrow, then we talk about that too.

In terms of the discussion back and forth between the community at Roswell and the community at Savannah, when I was out there doing systems related testing, power plant related testing, if there was an issue, you know, an unexpected result, then we may call whoever we felt was appropriate to help us figure out the answer, otherwise, it wasn't a sort of every day at four o'clock you do the call and talk about what happened today. But if there was a test result that didn't make since or what happened, we couldn't figure it out, then you would obviously call the relevant folk within whichever relevant community it was, be in Gulfstream Engineering or my universe is Gulfstream engineering and then there would be the vendor engineer, Rolls Royce for example or something like that.

MS. WARD: Okay.

DR. BRAMBLE: Mitch?

BY MR. GALLO:

Q. Are there other FTEs assigned, for example, in aero dynamics or a lead aero dynamics FTE, is there such a title, or avionics?

A. The organization is broken down that way so essentially there's power plant and systems, there's avionics and there's aircraft performance.

Q. So is there, I guess, correct me if I'm wrong when I'm using the titles, but is there a lead or head aerodynamics FTE?

A. Not specifically in aerodynamics, aircraft performance is what I would call it. That's how I would characterize it. That's the three breakdowns we have in the organization.

Q. Who would that be then?

A. Paul Donavan.

Q. What about for avionics?

A. That position is open at the moment. It's unfilled.

Q. How about data systems and analysis support?

A. Are you talking about the person, who it is?

Q. Yeah, the lead, the FTE for that.

A. Larry Vincent has control of all the data in the data storage and integrity.

Q. Going by your title, how do you handle all changes coming in, get your systems right? How do you handle all the system changes coming in and how do you get that disseminated to, for example, maintenance and other groups?

A. Well, if it's upgrades and so on, is that what you're talking about?

Q. Right.

A. Well, the decision to upgrade the airplane depends somewhat on the system in question but there's various different gates depending on the system. For example, the engine control software, which is critical software, there's a whole process that Rolls Royce goes through to issue a flight release of the software. It goes through the ITFs here in Savannah and gets confirmed to be okay there and once that happens, then it goes on an engine.

Q. Does it come to you then? How do you fit in that chain?

A. In terms of once we get notification that it's been through all the relevant gates to be cleared, the gates are different for each system depending on its criticality, then it becomes available, if you will. Once it's given, you know, flightworthy status by an engineering and/or the vendor, then it becomes a logistics question of, you know, which airplane needs it first, which airplane is going to do the testing that this software requires and then it's matter then of coordinating that with the maintenance and coordination entities.

Q. So then is that your role then and you coordinate with maintenance?

A. In terms of if you -- directly, probably not. There's an aircraft coordinator position as well who has responsibility for actually generating the paperwork that puts the piece of software or the LRU physically onto the airplane. That's a somewhat joint responsibility, figuring out when it makes the most sense. Do you need this now or can you wait until a more convenient time?

Q. Do you have meetings with the other FTEs, for example, Larry Vincent and avionics and Paul Donovan to discuss the status of the airplane, what changes are being made?

A. There's a weekly departmental meeting that occurs that's what's going on this week and then there's also a weekly schedule look ahead sort of meeting with management that speaks to what's going on the next three days, what's going on in the next week, what's going on in the next month and obviously, that day, for all the airplanes.

Q. You report directly to Paul Donovan?

A. No, I report to Kurt Cromwell.

Q. Again, I'm going by your title again as lead on 6002. Did you handle test requests that were coming in?

A. Yeah.

Q. Did you get any from flight sciences regarding the field performance testing?
A. No. Again, that would tend to become a function of the subject of the request as opposed to the specific airplane it was requested on.
MR. GALLO: That's all the questions I have.
DR. BRAMBLE: Jeff?
BY MR. BORTON:
Q. Just sort of a follow on to the lead up to -- in the original scheme for development certification 6002, obviously had some performance test related for it?
A. Right.
Q. What was its other major functions?
A. So other than the performance it did, the power plant development that I talked about and certification, equipment, cooling and ventilation. That's another big piece of the exercise.
Q. So areas that you obviously were dealing with as a specialist but there were areas that you weren't as well?
A. Yeah, the bias, if you look entirely at how much time I was spending doing each thing, the reason I ended up being the lead FTE was because, you know, 70-odd percent of its taskings were relating to stuff that I do and the other 30 percent was things that I'm not too familiar with.
Q. Then a process when it gets time for certification and

let's say you're putting a performance test plan together, a field performance test plan for certification, that again, the shepherding of that whole test plan all the way through Gulfstream processing through the FAA and all that would be done by another entity?

A. Yeah, in that case, in this specific example, that was Reece's entire or that was entirely within Reece and Paul's universe and I had little or no involvement. I don't believe I had any involvement with the creation or approval of that test plan at all other than peripherally to make sure that whatever specific instrumentation that Reece needed to execute that plan was provisioned for on the airplane. In other words, if he needed a specific piece of instrumentation that would other have not been on there had the airplane just been through systems work, then I had a responsibility to soundly check what he asked for and what was on the airplane and make sure it was all there. And if there was a discipline act, to set the ball rolling on getting whatever it was installed.

Q. When you are doing developmental tests with Gulfstream, is there a company conformity process that happens to make sure you have at least some idea of what you're doing in terms of software loads?

A. There's a software control mechanism that's actually controlled by a software control drawing. It's not really a drawing, it’s a giant word document that lists -- engineering generates one for the program that lists all the permissible versions of all the software that's on the airplane.

Q. As lead FTE then you would be aware of the general configuration of the airplane for running tests?

A. Oh, absolutely.

Q. Would it be, I guess I'm just getting a feel for your responsibilities. Let's say it's a performance test, so there's certain software loads you're dealing with.

A. Right.

Q. Let's say the flight control system and stall margins. The level of detail you need for that level of conformity would be the duty of maybe someone like Reece as opposed to yourself?

A. Well, it would be -- Reece would have levied the requirements saying, you know, we have to have this functionality in the software, whatever it is. And then we know we need thus and such a software level in order to go conduct this testing because it's a prerequisite. So obviously if the airplane doesn't have the proper prerequisite software on it, then we need to go figure out, okay, is it because we just haven't had time to put it on their yet or is it that it's not available yet. And if the answer is it just needs to be installed before we go do the tests, then that was kind of joint thing that, hey, we need to update the airplane to make sure it has software whatever.

Q. You are involved in that but you may not necessarily be the person that starts the ball rolling?

A. Maybe, maybe not. And if someone were to ask me, well, what's specifically in this software that Reece needs in order to go do the test, again, the answer would have to go back to the person conducting the test, who was more aware of what the specific details and content of that software load was.

Q. Just a final question. I think this is my last one. Could you explain the difference between an aircraft coordinator and a lead FTE? Is a coordinator in flight test?

A. They are part of the flight test organization. They have responsibility for -- they are the primary interface between flight test engineering and the maintenance organization within flight test. So they have physical -- there's a primary coordinator for every airplane just as their lead FTE for every airplane. So they are responsibility is the discussion of what's going on tomorrow with the airplane, it needs to have this, it needs to be ballasted to this, it needs this much fuel, it needs to be ready by this time and you need to make sure that software XYZ is loaded on the airplane before we go. So those instructions would come from the lead FTE to the coordinator who would then go generate the various work requests and work instructions and other things to make sure the airplane was flight ready for the mission the next day. It's a very symbiotic relationship.

Q. Sure. I guess in general the idea of a lead FTE is a follow through from previous Gulfstream work. In other words, is that the way the company is usually done mostly in programs and --

A. Yeah, certainly in the 550 and the 450, the two big programs that I've been involved in and we did it that way on both of those. The same thing with the coordinator. The coordinator position as been around certainly since the GIV which is the mid '80s.

MR. BORTON: Those are my questions.

BY MR. HORNE:

Q. Just wanted to tag on to that a little bit more. When you worked with aircraft coordinators to come up with the configuration of the airplane, could you explain a little bit about how you get that configuration and where you document how you explain it to the crews?

A. The configuration specifically with respect to the --

Q. Let's say in your area, the roll software is changing.

A. Right.

Q. And so new software comes to you and it needs to get loaded onto the airplane. Can you just describe how that would go from you to the coordinator to the work order back into the configuration so that you brief the pilots?

A. So, the new software is available, we get the clearance through the ITF and the software control drawing gets updated which essentially gives us permission to put it on the airplane, you know, when we see fit. So we cut a work instruction. The coordinator cuts a work instruction, in this case telling the engine manufacturers to install new software on the engine. That then drives a return to service instruction that's a set of specific maintenance actions that have to occur to return to service with the software in the airplane to return to service and then once that's accomplished and it's good, then Quality will release the airplane for a flight.

And then essentially a summary of the changes that are introduced by the software are typically then attached to the flight cards for the next mission so that you can talk to the crew about the changes that have happened since the last flight. This is the new software load and here is what it does and these things are allegedly supposed to be fixed.

So if we see something, we need to write it up or this is a known issue, so if you see this, we'll know that we don't have to go any further and that sort of thing. Is that where you're going?

Q. Yeah, and the configuration sheet on top.

A. On the front page, I'm sure you've seen it, the configuration sheet, the front page of the flight card deck shows the salient facts about the airplane's configuration, stuff that is important for the crew to know as far as what software is on what box so the big ones are always covered. The FCC's, the primary avionic software, the engines and whatever else is germane to that particular airplane's configuration for that day.

Q. Who are the required participants in a flight briefing that would make sure that what's briefed is correct?

A. The coordinator is typically required, obviously the FTE, the crew. If there's a need to have engineering specifically by name present, then typically make sure they are on the phone or there. If it's a change that's something more involved, then it can be easily briefed by the FTE.

Q. Kind of switching gears a little bit on you. Did you know there was a restriction on the YAW damper being off for some of the Roswell-2 testing?

A. Yeah, I think I was aware of that, yes.

Q. How would you find out about that and how is that documented?

A. I mean I think the discussions of the YAW damper were, because I was there two weeks before the testing, and I know we had talked about it when I was out there.

Q. But if a restriction like that comes out where you can't use the YAW damper for takeoff and landing, how is that documented?

A. They would give us an IFR or there would have been a note on the cover page I would have thought.

Q. I assume you go to the 7:30 meetings quite often?

A. Yeah, most days.

Q. Did Roswell participants call in?

A. Generally, somebody did. I'm struggling to remember who specifically would. There was usually somebody on the phone.

Q. For most meetings?

A. I would say so.

DR. BRAMBLE: Go ahead and ask him.

MR. HORNE: Did the 7:30 call cover all the airplanes in the test fleet?

MR. HENDY: Yeah, it would cover all that were not in long term maintenance. Typically, those aren't discussed but any flying airplane would have been discussed at the 7:30 call. But there's not a 7:30 call routinely on Saturdays, Monday through Friday.

BY DR. BRAMBLE:

Q. You said the 7:30 call covered all airplanes in the fleet or airplanes that are back in Savannah?

A. Generally, the ones that are flying over the next couple of days would be discussed in the 7:30 call. We have a couple of airplanes, for example, that are in long term maintenance and those are typically not discussed because their status isn't changing. They're just still in maintenance.

Q. Who typically participated in the calls?

A. Generally, the coordinators for all the airplanes, the FTEs as a group back in Savannah, all the FTEs typically, and then Ryan McCarthy typically participates most mornings and then the rest of the management chain of command. So that's flight test engineering, flight test instrumentation management, flight test maintenance management and then flight test management, the director of flight testing, typically.

MR. RAMEE: Peter, when you said Ryan McCarthy did you mean Barry?

MR. HENDY: Barry. So there's at least one representative of each of the groups within the flight test organization at that meeting and then engineering is typically present on the phone as well.

BY DR. BRAMBLE:

Q. Are you familiar with the flight test standard practice manual?

A. Yes.

Q. Were you before the accident?

A. Yes

Q. How do you use that?

A. On a daily basis, not very often. As you are aware, it hasn't changed very much lately. It's content has not. But I periodically look at it but I wouldn't say more than -- on an as needed basis to answer the question.

Q. How closely do the roles and responsibilities as described in the document parallel with actions in actuality?

A. I would suspect they've evolved since that document was last updated to some extent.

MS. WARD: How so?

MR. HENDY: How have they evolved?

MS. WARD: Uh-huh.

MR. HENDY: You know, honestly, I would have to go look at the document again and compare it. I haven't looked at it recently.

DR. BRAMBLE: John?

BY MR. O'CALLAGHAN:

Q. Just a little bit of follow-up on the various roles of the FTEs assigned to air plans. From the conversation I gather that they're sort of functional folks like yourself especially in the power plants and systems and Paul Donovan I understand is performance. And then I heard that basically they'll assign somebody to an airplane based on that airplane's primary mission for testing.

A. Yes.

Q. Was 6001 used primarily for performance and stalls and that kind of stuff?

A. Right.

Q. Who was the lead FTE for that one?

A. Bill Osborne.

Q. Is Paul Donovan ever assigned as an FTE as lead to an airplane?

A. No, he wasn't.

Q. I guess we'd have to look at an org chart. Can you just describe the relationship between Bill Osborne and Paul and yourself and Reece in terms of hierarchy?

A. There's two pieces to this. There's the lead FTE responsibility, which is essentially a coordination responsibility and then there's the functional sort of, I'm struggling for a term, perhaps test owner is one way to put it, where the lead FTE is in some cases the same as the test owner. The owner, or the person whose responsibility is to gather the data, analyze the data, write the report and in some cases that's two different people depending on the test in question.

So the lead FTE is the lead FTE and then there's, you know, we're going to go test something and the expert on that is Paul Donovan. So Paul Donovan has, you know, custody of the airplane, if you will, for the conduct of those tests. Reece has custody of the airplane for the conduct of his tests.

Well, that's it. There's a lead FTE position that may or may not be the same as the person responsible for conducting the test on that particular day.

Is that helpful?

MR. O'CALLAGHAN: Yes, it is. Thank you.

DR. BRAMBLE: Mike, do you got anything?

BY DR. BAUER:

Q. A couple. You talked about these IFRs.

A. Right.

Q. How many IFRs would there, let's say, have been in place in 6002 at the time or in general?

A. Something like 40 I would have to guess. That's the total. A number of that magnitude I would say.

Q. The flight test cards usually don't have space for all

40 of them to be listed. Is that a document that's carried with the flight test engineer that's flying the airplane?

A. Generally, there's a summary sheet of just the title of each of the IFRs and any germane language from the IFRs and that was typically attached to the flight test cards.

Q. But all of them would be available to the crew?

A. Yeah, the summary sheets were written in such a way that the important, germane pieces of information related to the IFR are captured in a summary form. The physical, signed PDFs of the all the IFRs are available electronically.

Q. You mentioned that you weren't necessarily involved in telemetry work in the TM trailer. Have you been involved in the past with the TM trailer at all for other testing?

A. On one or two occasions I think I've been in there for monitoring purposes.

Q. What do you consider the role of the flight test engineer in the TM trailer?

A. I think it depends entirely on the mission at hand. I mean, my experience has been purely as a monitor for systems of which I'm familiar and while you're off going to do another test.

Q. I guess maybe an example for your experience. If you had some power plants and you're using the TM trailer, would you be the lead of the TM trailer as the flight test engineer in the TM room or the TM trailer? I'm trying to I guess get at the role of a flight test engineer who is usually in the telemetry trailer, are they considered the lead of that trailer for all, let's say, any discussions that need to take place or communications with the aircraft?

A. Yeah, I have more experience actually in the TM facility here than I do in the trailer. I would expect that the trailer would be just a small version of the TM room that's in Savannah in terms of the roles and responsibility.

So, one person could be declared the person responsible for communication with the airplane so you don't end up with lots of different conversations trying to be relayed to the airplane at once.

Q. Would that person normally be a flight test engineer or a disciplined engineer?

A. I think more often than not, certainly in Savannah, it's been a flight test engineer.

Q. I guess one final one. Does Gulfstream have an executive or anybody that you consider formally accountable for safety of the flight test program?

A. I think we're all accountable to some degree or other. I don't know if there's a specific name or a position I could come up with.

MR. BAUER: That's all I have.

DR. BRAMBLE: Marie, I skipped over you. Do you have anything you want to ask?

MS. MOLER: No, thank you.

DR. BRAMBLE: Mitch?

MR. GALLO: I have no questions.

DR. BRAMBLE: All right.

MR. HORNE: Did you have any safety concerns of any kind about Roswell?

MR. HENDY: No, not specific concerns.

DR. BRAMBLE: Let's go off the record

(Off the record.)

(On the record.)

DR. BRAMBLE: Let's go back on the record.

Peter, do you have something additional you would like to add?

MR. HENDY: If the question is related to who specifically by name I would go to in the event if I had a safety concern, I think I would go to probably two people. I would go to the G-test pilot and I would go to the director of flight test. So that's Barry McCarthy and John O'Meara. Now you've got me thinking. And obviously there would also be discussions on a working level and I think that if anybody had a safety concern, I would expect to have discussions with people, peer level conversations prior to going to management for an example.

MS. WARD: I think the question that Mike Bauer was trying to ask is, is there anyone within the agency, within Gulfstream, that has an independent role that would function as safety?

MR. HENDY: At the time of the accident, there was not.

MS. WARD: Thank you.

DR. BRAMBLE: Let's go off the record.

(Off the record.)

(On the record.)

DR. BRAMBLE: Let's go back on the record.

I have some that has to do with workload.

DR. BRAMBLE: Do you feel that your workload was appropriate for the responsibilities that you had?

MR. HENDY: It wasn't a normal workload. It was a high workload but it was appropriate.

DR. BRAMBLE: Lorenda, do you have any follow ups?

MS. WARD: No.

DR. BRAMBLE:. Mitch?

MR. GALLO: Yeah.

BY MR. GALLO:

Q. Why do you say it was not normal but rather high? What are you basing that on?

A. Well, normal is 40 hours a week. I think the flight test program is routinely more than that.

Q. I was wondering if you were considering that based on feeling tired every day or was it based on hourly?

A. It's based on how many hours of work one does in a week.

BY MR. O'CALLAGHAN:

Q. How many hours a week were you working?

A. It's a very variable question.
Q. On average over the last year or so?
A. Average 60 probably.
Q. How many days a week?
A. Again it varies but five or six.
Q. Do you find that typical across manufacturers like this program or is it unique?
A. I've only worked for Gulfstream in flight test programs so I can't really comment but I would expect it's similar.
DR. BRAMBLE: That's it. Thanks.
(Whereupon, at 9:09 a.m., the interview was concluded.)

CERTIFICATE

This is to certify that the attached proceeding before the

NATIONAL TRANSPORTATION SAFETY BOARD

IN THE MATTER OF:	AIRPLANE ACCIDENT ROSWELL, NEW MEXICO N652GD Interview of Peter Hendy
DOCKET NUMBER:	DCA11MA076
PLACE:	Savannah, Georgia
DATE:	October 25, 2011

was held according to the record, and that this is the original, complete, true and accurate transcript which has been compared to the recording accomplished at the hearing.

Letha Wheeler
Official Reporter

Lourie J. Brown
Transcriber

UNITED STATES OF AMERICA

NATIONAL TRANSPORTATION SAFETY BOARD

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Investigation of:                  *
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AIRPLANE ACCIDENT                  *
ROSWELL, NEW MEXICO                * Docket No.:  DCA11MA076
N652GD                             *
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Interview of: PRESTON HENNE

Gulfstream Corporation
500 Gulfstream Road
Savannah, Georgia

Friday,
October 28, 2011

The above-captioned matter convened, pursuant to notice, at 4:59 p.m.

BEFORE: WILLIAM J. BRAMBLE, JR., Ph.D.
Senior Human Performance Investigator

APPEARANCES:

MITCHELL GALLO
Air Safety Investigator
National Transportation Safety Board
31W775 North Avenue
West Chicago, Illinois 60185

WILLIAM J. BRAMBLE, JR., Ph.D.
Senior Human Performance Investigator
Office of Aviation Safety
National Transportation Safety Board
490 L'Enfant Plaza East, SW

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ALAN J. (JEFF) BORTON
Flight Test Pilot
FAA Aviation Safety
Aircraft Certification Service
Wichita Aircraft Certification Office
1801 Airport Road - Room 100

THOMAS M. RAMEE, ESQ.
Deputy General Counsel and Risk Manager
Gulfstream Aerospace Corporation
500 Gulfstream Road, M/S B-06
Savannah, Georgia 31407

TOM HORNE
Experimental Test Pilot
Gulfstream Aerospace Corporation
P.O. Box 2206, M/S A-12
Savannah, GA 31402-2206

APPEARANCES (Cont.)

JOHN O'CALLAGHAN
Aircraft Performance Group Chairman
Vehicle Performance Division (RE-60)
Office of Research and Engineering
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

-

MICHAEL BAUER
Aerospace Engineer
Vehicle Recorder Division (RE-40)
Office of Research and Engineering
National Transportation Safety Board
490 L'Enfant Plaza East, SW

E. LORENDA WARD
Air Safety Investigator
IIC and U.S. Accredited Representative
Office of Aviation Safety
Major Investigations (AS-10)
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

MARIE MOLER
Mechanical Engineer
Office of Research and Engineering
Vehicle Performance Division
National Transportation Safety Board
490 L'Enfant Plaza East, SW

I N D E X

I N T E R V I E W

(4:59 p.m.)

INTERVIEW OF PRESTON HENNE

BY DR. BRAMBLE:

Q. If you could just start by giving your full name.

A. Preston Henne, H E N N E.

Q. Okay. And what's your date of hire at Gulfstream?

A. Date of hire at Gulfstream, September '94.

Q. And your current position?

A. Senior vice president, Programs, Engineering and Tests.

Q. Okay. And your roles and responsibilities in that position, can you briefly describe them?

A. Well, in this position, I have Flight Ops that reports to me. I have Engineering that reports to me. I have the program office, which is all the significant program managers that report to me. I have the ODA for the FAA that reports to me, and I have CPLM, which is Corporate Product Lifecycle Management. That's the organization that maintains the new design venue for CATIA and so forth that reports to me. And so it's to manage all of those functions.

But focus is primarily one of, obviously from the title, engineering and tests, a lot of activity on the front end with development programs, but we also do the sustaining engineering as well. So we keep track of things that occur in service and make sure that if there's something that occurs in service, we take action on that and make sure that there's a response, a corrective action identified, implemented and so forth. So it's everything from technology development on the front end to the technical side of the in-service fleet.

Q. And your previous aerospace employers?

A. Twenty-five years at McDonnell Douglas. That's it. There's only one other stop.

Q. And what positions did you hold there?

A. Well, everything from aerodynamics engineer up to program manager. I was vice president and general manager of the MD-90 Program at McDonnell Douglas before I came to Gulfstream. I worked on C17, done some of their new development programs. MD-90 was the last one of those. I was chief design engineer on the MD-80. I was chief design engineer on what would have been an unducted fan program, the UHB program. And, finally, the program manager on the MD-90.

Q. And your prior cert programs worked on at Gulfstream?

A. Well, I started here with the G-V. We did the 550. We did the 450, the 150, now 650 and 280.

Q. And were you here in your current position the whole time?

A. More or less. I came here as head of Program Management and basically the big activity at the time was the development certification of G-V, and so I've been involved in that kind of a position since then.

Q. Okay. And to your understanding, what policies and procedures did Gulfstream have in place to manage the safety of a flight test program before the accident?

A. Well, all of the flight ops, manual procedures, the flight test procedures. There were a set of procedures both in the Flight Ops Organization, which reports to me, and the Flight Test Organization. Now, since we had the accident, everybody's gone back and looked, and there were clearly some outdated or old procedures and information in there, which we have since been bringing forward to update and include in a SMS format, but those two areas both had documentation in place and procedures in place.

Of course, in the flight test program, the items like TSHAs are used to evaluate a particular test and whether or not it's hazardous, how hazardous it is, and what the procedure should be relative to that test. So I think from an industry standard standpoint, I think we pretty much were following the norm from an industry standard standpoint. Some of them were probably -- some of the procedures and manuals may have needed some updating.

Now, that's really from a test standpoint. From an in-service product standpoint, there's another set of functions and guidance that goes on there. We have every morning, for example, a safety review team that meets and reviews everything that's occurred in the last day in the fleet. And so, if there's an item that's regarded as a safety item that shows up there, that gets everybody's attention. I get all of the abnormal service reports, the ASRs, that come out of the fleet and we take a look at those. So for the in-service fleet, there is another whole system that we keep track of daily. I don't know if that was what you were looking for in there or not.

Q. Yeah, that's helpful. And in terms of the changes since the accident to the approach to managing safety and the test program, I wonder if you could describe that a little bit?

A. Well, one of the things that we did was we implemented a more formal notification system to make sure that a broader audience, if we have an event, gets notified and our response involves a broader dissemination of the information. That was something that we set up pretty quickly. One of the things that we have done is we've taken -- for all of the high risk flying that we have yet to do, we've identified the most senior engineering people and said you're now going to be involved in that with the flight test engineering guys. And so, we created some stronger pairings involved between Flight Test and the design organization to make sure that the most senior talent is involved with the high risk tests that remain.

We've gone to strict adherence to crew duty day. So no break in the rules on the crew duty for both the flight test guys and the flight ops guys. We're hiring more flight test engineers. We've introduced additional aircraft and crew safety equipment on board. I'm sure this has been brought up before, but things like the fire suppression system that we're putting in the airplane that will be doing our field performance is something that has been added, different flight suit materials that's got a higher fire protection capability. So there's been a number of things like that that have come out of the initiatives.

I don't know how much you've gotten into everything that we've done relative to Flight Ops and Flight Test procedures and documentation update, but we did have an internal -- an independent safety review team of external folks that came in to audit both Flight Ops and Flight Test. And so we're responding to their report on us. We did three internal audits of the Flight Sciences Organization. We did a low speed aero audit. We did aircraft performance audit. We did the -- one other one, low speed aero, the performance. I've forgotten the third one.

UNIDENTIFIED SPEAKER: Simulation.

MR. HENNE: Simulation. That's what it is. Thank you. How could I forget that one? And there are some recommendations that are being put in place for all three of those. And so we have actually a safety action plan underway. And all of those things: the independent review team, our internal audits, the Flight Ops activity and the Flight Test activity all have contributed elements to that action plan.

We have as part of the simulation -- the internal review, one of the things that has come out of that is an initiative to actually see if we can do a much better job at the non-linear flight simulation where you really are going to the edge of the envelope and can you develop better simulation capability to, from an engineering design standpoint, do a better job at appreciating it and, from a design and operation standpoint, know what we're getting into better than just a more linear kind of simulation that is the standard. So there's some simulation work going on there as well that's coming out of that.

BY DR. BRAMBLE:

Q. And in terms of the independent review, did you guys turn to a resource that other Flight Test programs could utilize or take advantage of or is it more of a custom --

A. It was custom. Actually, when we decided to do that, I exercised some of my old contacts. We got some contacts from senior pilots at Douglas and Boeing, senior pilots at NASA and some references from the FAA, and some flight test engineering type folks also. I called them up, and I basically spoke to them myself and asked them if they would participate in the independent review and got a group of those individuals and then we handed it off to our outside counsel to arrange and do the interviews. And he got a team out of that and that's basically who the representatives were.

Q. Okay. And on the crew duty for the flight test team, how is that going to be tracked going forward?

A. How is that going to be tracked? I think in Flight Ops and Flight Test they basically are keeping track of the schedules to a finer extent, and if they get to a point where, you know, they're about to bust the duty cycle, whether it's a medium risk or high risk test, they basically knock it off. And people have started talking about that, and that's what they do. So, you know, people are basically saying I'm coming up to an hour and so you got to plan the rest of the time doing that. So --

Q. So before it was a little bit less rigid?

A. Yes.

Q. And will the duty and flight duty time limits be applied to all the people on site for testing or just some people?

A. It's for test engineers and the cockpit crew.

Q. And people in the trailer as well?

A. Well, I'm not sure how you'd judge time for the people in the trailer. I'm not sure about that.

Q. Okay. And the duty times will be tracked more carefully on the flight test side, too, not just the demo side and --

A. Oh, yeah. I thought that's what you were talking about. That's --

Q. Just clarifying.

A. Yes.

Q. Okay. And at the time of the accident, what procedures did the company have in place for reporting and investigating perceived hazards or safety related incidents that occurred during flight testing and what role did the SRB play in that process?

A. Well, I was going to say, the procedure was SRB. I think anybody can still bring an item up for safety review, and we have both Engineering SRB and a Flight Test SRB. The Flight Test SRB reviews the test programs and procedures and so forth, but in reality, anybody that had a safety concern, can bring it up. And if there's a member of the SRB that says, hey, we need to take a look at this, then there is a meeting called. So the inputs can come from a lot of different directions. The engineering SRB, for example, will respond to the morning safety review team's results. If there really is a safety item that comes out of that, it'll be brought up to the chairman of the SRB.

Q. Would an SRB meet to investigate an incident or more after the incident had been investigated to approve the --

A. No, to investigate.

Q. And is that the way that you understood it to operate prior to the accident?

A. Yeah.

Q. Okay. And has the role of the SRB changed at all since the accident?

A. I think probably the role of the Flight Test SRB has expanded. I think the depth that the Flight Test SRB is going into now is probably greater than it was before. I'm not sure I'd say the Engineering SRB has expanded a great deal in terms of the responsibilities.

Q. Okay. And we understand that there are some new positions created for safety officers in the company.

A. Yes.

Q. And I wonder if you could describe how you see them fitting into the revised safety management processes?

A. The safety office is one of the recommendations that came from the independent review team, and it was set up first of all to report to the president. So it doesn't report to me. The office reports directly to the president. There is a safety officer position, and he has three people that reports directly to him, and what we identified was we need a focal for Flight Ops, and that's Bud Ball (ph.). We need a focal for Flight Test, which is Chris Licavolle (ph.), and we need a focal for Engineering because those are the big three areas involved in the flight test safety area, and that was Tom Rothermal (ph.) for Engineering.

So those basically are ex my organization. They're ex everybody else's organization, and their charge is to take a look at, at this point, what's going on in any kind of flight test aspect, what's going on in any kind of flight safety issue. It may not be flight test. It may be demonstration. It may be some other aspect of it, but related to flight, related to aviation basically, and make sure that the aspects of safety are at the highest standard. So an audit, an overview, a monitor kind of capability.

Q. And what's your sense about why that company didn't already have this type of program in place? Is this sort of new for flight test in general throughout the industry or --

A. Well, I would say at one point right after Randy Gaston was head of Flight Ops, was made head of Flight Ops, we had a safety officer. Ted Mindenhall (ph.) was made a safety officer reporting to the then-president, and I'm not sure it was ever very effective. I think it was maybe a job at that point that languished and eventually went away. I'm going to guess it was having trouble finding things to do, and so we didn't have any accidents or big events like this one, and so I think somebody at some point made a decision that it wasn't worth filling the position.

Q. And do you recall during what years that the safety position was filled previously?

A. I don't. I would be guessing, but it would be -- I'd be guessing. Maybe late nineties.

Q. Can you speculate -- I shouldn't say can you speculate. Was part of the reason that the safety officer was looking for things to do because maybe there weren't adequate industry guidelines available at the time?

A. That would be speculating. I don't know. I don't know.

Q. Okay. Did you attend the field performance SRB?

A. Yes. Well, a field performance by -- field performance, you mean the Flight 153?

Q. No, the pre-accident --

A. No, I didn't. No.

Q. All right. Before the accident when trying to meet a flight test certification date, how did you keep a handle on whether the company was pushing its people or wasn't pushing its people so hard that safety might be compromised?

A. Say that again.

Q. Prior to the accident when trying to meet a flight test certification date, how did you try to ensure that the company wasn't pushing its people so hard that safety might be compromised?

A. Well, I mean, we have weekly meetings in the program area, and one of the, one of the parts of that meeting is a summary of flight test activity, and normally you'll talk about schedule. You'll talk about what's being done relative to planning for this test, planning for that test, and there was always a discussion whether or not somebody could make that schedule or not. I'm not sure we've ever had a flight test program that held schedule. So quite often the tests move because people aren't ready or it wasn't ready to do it in a safe fashion. So the test program schedule is quite dynamic for that. From my standpoint, I relied on the process that flight ops has in place and flight test has in place to go through all of the safety reviews and make sure things are done safely, and we regularly slid tests based upon them not being ready to do and not having enough people to cover everything. So it was not a forced schedule in reality. I mean you have to be safe in an airplane company. That comes first. So --

Q. All right. Prior to the accident, were you aware of the wing drops that occurred during Flights 88 and 132?

A. No. I wish I was.

Q. And what do you think your reaction would have been if you had been informed?

A. If I had been informed that there was a safety event like that, I would have sure asked a lot of questions.

Q. And is there any particular action or range of actions that you would have expected as a result of that?

A. Well, it depends upon what the answers were. I mean if you have a safety, a clear safety event, you've got to go through and identify why. I mean are you operating the airplane correctly? What were the factors involved in the operation of the airplane? So it's -- it would be a review board kind of activity to ask all the questions.

Q. All right. Do you recall whether you attended a January/February meeting at the RDC1 after Roswell-1 to discuss the airplane not being able to meet takeoff field performance guarantees?

A. I can remember a meeting. I'm not sure when it was that we talked about the results of Roswell-1 and the speeds being high and field lengths being long.

Q. Do you remember where it was and who attended?

A. I don't. It had to be out in RDC. That's where all that activity is.

Q. And do you recall what solutions were discussed for bringing the performance down to the desired field length?

A. I have to think it was, it was Jake refining his procedure or something to that effect, and I don't remember if that was -- because they went from Roswell-1 to the other field.

UNIDENTIFIED SPEAKER: Birmingham.

THE WITNESS: Pardon.

UNIDENTIFIED SPEAKER: Birmingham.

THE WITNESS: Birmingham, you're right. Birmingham, and I think Birmingham was to refine his procedure. I really don't remember if that meeting was before or after Birmingham. I don't know.

BY DR. BRAMBLE:

Q. And at that time, did Mr. Howard seem optimistic that they would be able to achieve a desired field length with a refined technique?

A. I have -- I'm not sure about achieving. I think he thought he could do better.

Q. And did you attend a review about field performance held the day before the accident?

A. No, I didn't know there was a meeting.

Q. Okay. Do you know how many -- how it was decided how many engineers would be needed on site in Roswell during the field performance testing?

A. Don't know.

Q. And who would have been making those decisions?

A. That would have been a combination of Barry McCarthy and the performance guys, the flight science performance guys.

Q. And do you know how the engineers, the various engineers' roles would have been established for the field performance?

A. No.

Q. Okay. Are you aware of anyone requesting more staffing in this area?

A. Before or now?

Q. Before the accident?

A. No.

Q. And since the accident?

MR. RAMEE: Other than conversations you may have had with counsel.

BY DR. BRAMBLE:

Q. Other than conversations you may have had with counsel after the accident?

UNIDENTIFIED SPEAKER: I guess not.

MR. RAMEE: No, you might have. You might have. If you have information from other than me, you're welcome to disclose it.

THE WITNESS: Well, I'm not sure what's covered by counsel or not here. I mean since then, we basically have said we need more flight test engineers, and so that's the reason for some open racks right now for flight test engineers. On the performance side, frankly we're probably reorganizing our aircraft performance group, and there's probably going to be some other individuals assigned to the test program at Roswell when we go back there. So there is going to be some shuffling around of some assignments and some I'll say reorganization or reassignment activity. The flight test engineering organization is an interesting one because their workload is extremely cyclical. When you're in a program like this, the load is very high, and then when you're between development programs, the load's very low, and so there's a natural tendency on the part of the flight test engineering guys to not want to peak up very high because it means they're going to have to layoff or reassign or find homes for people on the downside. So there's a dampening effect on the population that you can run into.

BY DR. BRAMBLE:

Q. And in terms of that reluctance, would that be like at the flight test director level or --

A. (Nods affirmatively.)

UNIDENTIFIED SPEAKER: You have to say yes, Pres.

THE WITNESS: Yes. Sorry. She can't get motion on that machine.

BY DR. BRAMBLE:

Q. Pres, this is --

A. Yep, TIA schedule.

Q. -- the TIA schedule from the WebEx on Friday, April 1st of --

A. Okay.

Q. -- this year.

A. Yep.

Q. And one of the things that has come up in the course of our investigation is the letter that was sent to Anthony Beck, I think and Kurt Erbacher about the schedule from FAA and the NACO --

A. Yeah.

Q. -- on March 31st, and this peaked some interest for us. This schedule seems to show a pretty big pile up of TIAs near the end of the flight test program --

A. Uh-huh.

Q. -- and I wonder what the status was with respect to sort of the end game on this schedule at the time of April 1st? Was there, was there any consideration of extending that out further or what was your expectation about what was going to occur with that?

A. Well, there's, there's a couple of things that come into play there. Number one, if you go back and you look at the G5 version of this, for example, there is a tendency for the TIAs to pile up and actually execute them that way. Now when this evolved like this, it was clear the end date was going to slide. I mean the pile up was significant, and when a TIA -- you can see what happened up here. If you got a December 1st version of this, the pile up would have ended around March, okay. And as we progressed, the number accomplished each month is not the same as the number planned in the succeeding months. And so very typically these things stretch out, and we would have expected in this case some of these to spill as well, and we're still in that mode frankly. I mean we were down for two months, and now we've got one less airplane. So it's equally a challenge. What you'll find with at least a program is it's easy in the test world to slip because you have 30 percent unforeseen events that show up, and so it's going to happen, but if you don't plan for a tighter schedule, it'll slip even more. And so the way schedules end up looking, they always look like you can't do them, just so that we pay attention to the schedule and do them as effectively as we can. A lot of thought goes into these TIAs that are the test points that are in the future, and that's why it's so dynamic because something unforeseen happens on a particular TIA, and so you've got to pull something forward or move something around to a different airplane to put in its place, and so the scheduling of this is for the duration of the test program, extremely dynamic. I haven't known one to not be that way.

Q. And to reiterate what I think I heard, the December schedule showed the TIAs piling up and ending around March.

A. I think you would find that. I'm not sure if it was December. Maybe it was November, but you can find earlier versions of that that show a similar concentration.

Q. And that's December 2010 or November, or somewhere in 2010 --

A. Yeah.

Q. -- is what we're talking about?

A. Yes.

Q. All right. And at what point, you know, how much closer would you get to that end of that before you think it would have stretched out more after April 1st?

A. It was probably due to stretch out again. I can't say when it would be but it's literally an ongoing process. You know, we've been working now, once we started flying again, and we accepted the fact that we weren't going to make the end of the year with a TC, we converted to a provisional TC program, and that automatically flipped the target for TC to be done flying end of February and TC at the end of March. Well, right now the schedule shows us flying into March, and so there's real risk that the TC literally as we speak moving into an April or May timeframe right now, just based upon what can be safely scheduled for the airplanes.

Q. Okay. And in terms of the pressures to keep the program on schedule, can you describe sort of what your constraints are and --

A. At this point, we are over budget. We're late.

Q. But prior, prior to the accident I guess.

A. Prior to the accident, well, we were -- even at that point, we were still over budget and sliding. I mean my job is to give the customer what he wants, when he wants it and at the price he agreed to, and so far I'm not making two of those three. So the pressure is on, but safety is a given. So the accident was extremely painful.

Q. All right. And the last one and we've been over this with some other people, but in terms of compensation, the flight test program schedule, was completing it by a certain date tied to your compensation in some way and was safety plugged in in some way?

A. Well, I mean safety is our first objective on people's objectives, is to improve upon safety, and so that's the first thing that we report on. And I think program performance is number three I think. I forget. The -- and clearly in my case and people that report to me or in my organization, finishing the type certification of the 650 is one of those items identified, finishing type certification of the 280 is one of those thing identified. Some other program milestones are part of that and so finishing the program certification is part of my objectives. Now I can't tell you what that means in terms of compensation. It's in my list, and I get graded on that list of performance as a whole. So, you know, I get a grade for everything on there.

Q. Okay. But there wasn't like if you, you have to finish it by September 28th or you don't get a large bonus or something like that.

A. No.

Q. Okay. All right. And the specs, the performance specs, that's just part of your standard list for your performance review or --

A. The performance specs for me?

Q. Uh-huh.

A. Well, yeah.

Q. Or the list that you're talking about, what do you call that?

A. Objectives, the general dynamics executive compensation objectives.

Q. Okay.

A. GDEC objectives.

Q. Okay. Okay. Thanks.

DR. BRAMBLE: John.

BY MR. O'CALLAGHAN:

Q. Thank you, Mr. Henne, for your time this afternoon, getting into evening. I'd like to start with Flights 88 and 132. At the time before the accident, would you have been -- would you expect -- would you have expected to have been informed about those events and do you have any ideas why you were not informed?

A. No. I mean would I have been expected? Yes, but in hindsight, it would appear as though the conclusion was that it was not a serious safety problem with the airplane it sounded like from the, from the work that was done at that point in time.

Q. Uh-huh. And --

A. So I suspect it never, it never really rose to me in that process.

Q. Okay. And without the benefit of hindsight, that even at the times those events occurred, do you think that there were missed opportunities to identify that the aircraft's performance and ground effect was not what was predicted?

A. Yeah, it was already -- my view of that is the airplane was talking to us, and we had two data points that said the performance is here, not there. I mean that's what I think was going on.

Q. Okay. Thank you. In the SRB conclusions or safety findings, there's a bullet that says -- that kind of parallels with what you were saying, that the Flight 88 and 132 events were not broadly reviewed, and I was just wondering if you can describe what you think broadly reviewed means and what didn't happen back then that should have happened and what would happen today with --

A. What I would hope happen today is that the flight ops community, the flight test community and the design engineering community would sit down and look at the event and understand what happened prior to proceeding, and I'm not sure that was done in sufficient depth.

Q. Okay. Were you familiar with the difficulties with V_2 that the program was encountering in terms of consistently overshooting the V_2 targets?

A. I guess I'd say that we had a hint of that in the meeting that you brought up on speeds, but it wasn't until I said, you know, all of the post-accident SRBs. Where I got concerned about it, it was clear particularly when you looked at the flaps 10 data which was the accident situation, that his speeds, he wasn't getting the speeds right, and we sat in that, in the SRB going through and going through and going through, looking at the accident traces for several weeks to the point where you memorized where the bumps and lumps were in all the traces, and frankly one weekend, I took the traces from that home and just sat and looked at it, and I got so tired of looking at the accident trace, I looked at the one before it, and he -- the one before it, the run before, he was clearly demonstrating a V_{MU} point, not an engine out at V_2 point. I mean he was lumbering along on the ground for about 6 seconds, at his target attitude, and so I started looking, digging more into the data and I came to the conclusion that when they dropped their target pitch attitude, they had an inconsistent set of speeds for that, for that series of points. They had an inconsistent test point. It was not executable. And so that's when it -- and that was like, I think that was probably a month after the accident when I talked to our flight sciences guys and said you have a problem here because these speeds don't work, and that's when it was brought into the SRB.

Q. Okay. Maybe this question is superfluous given the very comprehensive answer you just gave, but have you seen similar difficulties in any other program that you worked on in terms of --

A. No, not really.

Q. And so the question I have asked several folks, and I'll ask you as well, the uniqueness of the problem, would that suggest that there's just something fundamental on how the numbers are coming together, or numbers are provided that makes it unsound?

A. No. I think, and I'll give you my opinion on that. My opinion was that the flight test guys and the flight sciences guys were not coordinated in setting up the speeds and looking at the speeds when they changed what they were doing in the test. When they went from 10 degrees to 9 degrees, suddenly they had a point they couldn't execute and, of course, then for the flight crew that was trying, that becomes a point of frustration. So I think that the coordination there was what fell short.

Q. So if I hear you correctly, in your opinion, the more fundamental problem if you will --

A. I don't think it's an industry -- I don't think that's an industry or test, global test process thing. I think that's coordination within us.

Q. I understand that and what I guess I'm interested in is -- well, let me back up to the previous question. I guess what I was thinking there is that the problem with V_2 was sort of consistent over what was seen in Roswell-1 and there was the effort in Birmingham to try to come up with a different technique to resolve it, but essentially the problem was that crews were finding difficulty in not getting too fast at 35 feet, right, and I've asked others and I think they echoed your same response when they told us that they really hadn't seen that sort of a problem on any other programs that they had worked within Gulfstream or civil or military type airplanes.

A. Yeah.

Q. And so that prompted me to wonder given that the problem seemed to be unique on this airplane that looks a lot like other airplanes, whether that would have been a hint that, well, maybe there's something fundamental in the way the numbers have been generated that's inconsistent with the basic physics of the problem, and so I guess let me reask the question now that you know where I'm coming from. Did the persistent problems with the V_2 indicate there was some fundamental issue with how the speed schedules were generated to begin with?

A. Yeah.

Q. Okay. You mentioned very many significant things that have changed since the accident that improved the safety systems and programs, you know, the presence of senior people at the site and reviews among folks and the work that Bret Leonhardt is doing with the simulation and all this.

A. Uh-huh.

Q. Are the things that you mentioned, are they all the result of the independent review board?

A. No.

Q. Are there some things that Gulfstream came up in the -- or are there other things that the safety board came up with that you haven't mentioned or --

A. Well, there's a whole slew of items from the safety review board. Some of them I've mentioned, but there is a whole action plan that was developed from that plus our internal reviews, plus our process and documentation reviews. So the independent safety review board recommendations are a subset of the entire action plan. So I mean there are many, many action items in that plan.

Q. Okay.

MR. RAMEE: We can provide you a copy of those action plans.

DR. BRAMBLE: Okay. That would be great.

MR. RAMEE: It will eventually be part of our submission. So we might as well -- if it's going to be part of your factual report, we can go ahead and provide it early.

DR. BRAMBLE: Thank you. That would be very helpful.

BY MR. O'CALLAGHAN:

Q. Regarding the new safety officers --

A. Uh-huh.

Q. -- I understand that a lot of what they do is kind of on a regular basis perform audits.

A. Uh-huh.

Q. I was wondering how would individual events be brought to their attention?

A. Well, frankly they're now on distribution for just about everything. So they are being communicated with now as part of the team basically. John Salamankas, the safety officer, was -- he was in a meeting I was in earlier today on in ground effects, and so he's basically part of the team. Tom Rothermal is now -- I mean all four of them are being invited to appropriate sessions and they're on distribution for notes and minutes and so forth. So it's been woven into the organization.

Q. It sounds like they won't lack for things to do.

A. No.

Q. You mentioned a reorganization of flight sciences.

A. Yes.

Q. I was curious. Is that just a musical chairs of different people getting different roles or is it a structural reorganization of disciplines?

A. It's both actually. We're taking a look at what falls under the flight science umbrella which includes acoustics on one end which includes power plant, aero stuff, flight sciences stuff. On the other, it has the classic loads. It has aerodynamics. It has -- control. It has aircraft performance, and we're probably going to shrink down the size of the umbrella and take some of the organizations like the power plant performance and put it in power plant. We may take the loads and put it into structures. That's where it is in a lot of other companies. And the three primary ones, the aerodynamics, the S&C and aircraft performance, when we did the internal audits, it was very clear that aircraft performance from a talent standpoint was pretty weak. So we've actually -- we actually saw that coming, and there is a pipeline of experienced people being brought in, some from outside, to build up the ranks of people. Some of the people involved in the 650 activity, setting speeds for example are going to be reassigned to a core organization. So there's some reassignments going on as part of that process as well. So it is a restructure and there is an attempt to build up the talent capability in some of the weaker areas.

Q. Okay. Thank you. I just have one question about schedule. I understand very well I guess, that industrywide, you know, flight testing is kind of its own beast when you talk about intensity and working hard and, you know, the pace of things.

A. Uh-huh.

Q. And that one has to look at it through that lens and really can't compare flight testing to say normal 8:00 to 5:00 jobs, but even given that, you know, within -- just taking the flight testing across the industry, you know, there's got to be a bell distribution or some sort of probabilistic distribution of intensity there as well. And so I've been trying to get a sense of how intense this program was in this other world, you know, that's already intense to begin with, and I was trying to think, well, what are measures of that and, you know, I was thinking of the overtime that people work or the overtime rates and the duration over calendar months of those rates might be some sort of measure. So I guess my question would be, with that background and that context, in your experience, where does this program fall on the bell curve of intensity for flight test programs in general? Is it on the left, right there in the middle or is it out there in six sigma to the right or where is it?

A.   No, to me I'll say it's typical. I would put it in the middle of the bell. One of the metrics that I have always looked at in a major program flight test activity is your average flight hours per airplane a month, and it always seems to average, you know, 35 to 40 and that's about where we are. My perception is that if you looked at this point in time during the G5, it was the same level of effort and push in flight test.

Q.   So it's the same number of say flight hours per airplane per month. How about people per airplane?

A.   Overtime rates or people loading.

Q.   Yeah.

A.   I'd have to go look at the data. I'm not sure I've compared that versus the previous program but, you know, we pay attention to overtime and if somebody's getting up into the 50 percent, we start asking why, you know, does he need help, and we've seen that before where, you know, people start getting up into heavy, ongoing overtime, and you sort of say, don't we need more of them?

Q. Fair enough. Ongoing, would that be two, three months or a year, six months?

A. No, no, not a year.

Q. What would ongoing mean?

A. Ongoing would be if they're doing that for a couple of months or something long.

Q. Okay.

A. It needs to come down from that.

Q. Thank you very much.

MR. O'CALLAGHAN: That's all I have.

DR. BRAMBLE: Marie.

MS. MOLER: I'm good, thank you.

DR. BRAMBLE: Mike.

BY MR. BAUER:

Q. You made mention in there early on talking about the G5 TIA schedule kind of saying it was, and go ahead and correct me if I'm wrong, that it looked similar to the G6 TIA schedule, if you were to compare the two programs.

A. Uh-huh.

Q. We've heard some earlier testimony that during the G5 program, that the FAA noticed some, I'm going to use the term quality escapes with reports that were presented to the FAA. Given the G650 program and the pace of the program, and there's been talk of aggressiveness of schedule, at your level, has there been a concern raised or thought about versus the quality of the work compared to the schedule aggressiveness, I mean basing it with the G5?

A. Well, it's funny you bring that up because today we had one. We've submitted 67 or 68 company reports to the FAA over the last probably couple of months, and we had one, I'll say last week, maybe it was earlier this week, where FAA called up and said, hey, your report shows noncompliance, not compliant. What's going on? So it's funny you bring that up because we had an example of that. Now if it's 1 in the 68 reports, and it sounds like it was miswritten as opposed to a real problem, but we'll sort our way through that. I don't know if that's good or bad but 1 in 68 is probably better than we did on the G5. So I really don't know how to judge that.

MR. BAUER: I don't think I have anything else.

DR. BRAMBLE: Mitch.

MR. GALLO: I have approximately three questions or just three questions.

UNIDENTIFIED SPEAKER: With subparts?

MR. GALLO: Maybe.

BY MR. GALLO:

Q. Let me just ask my question and I'll get to the rationale behind them but following Roswell-1, you had a meeting to discuss the airplane not being able to meet its performance guarantees, and in that meeting, Jake Howard was present, and he indicated to you that he may have a way of being able to achieve V_2 speed to some effect. I don't know what the exact words were that you used.

A. You would have thought I would have remembered that, huh?

Q. But did he ever indicate to you that or suggest that the V speed should increased?

A. No, I don't remember that.

Q. Okay. And then following Birmingham, was there another meeting that may have been held with you to discuss Birmingham's results?

A. Well, I'm not sure because I'm not sure if the meeting that you were talking about was after or before Birmingham.

Q. Okay.

A. I don't remember two actually.

Q. This just adds background to the subsequent questions --

A. Okay.

Q. -- but during the field performance phase testing for G650, did you ever meet with the other pilots that were involved I doing the field performance?

A. No.

Q. So it was primarily Jake Howard.

A. Yeah, yeah.

Q. So that kind of leads to my end question is that you had group heads present either during the certification issues meetings or other meetings to discuss performance of the aircraft. But you have pilots who are flying high risk flights such as Mr. Kent Crenshaw or Mr. -- Augustov (ph.) or Mr. Gary Freeman, wouldn't you want them to be also present because you have group heads of different departments but by the nature of what they're doing and the risk level of the mission, they're essentially the group head of what the airplane is doing. So wouldn't you want them to be present in these higher level meetings so you could solicit their input?

A. Well, in hindsight, that's probably, that's probably not a bad idea. Now frankly, I rely on Randy and the flight test SRB, if there's a safety issue, to address that. By the time it gets to me, I mean it may be they're saying, hey, the field length's going to be long or, you know, our speeds are high, just as a matter of information coming to me. Here's the bad news, guys. So in terms of determination of something to be changed, I sort of -- I have to expect the people below me to be addressing that. You know, having four in a room is probably better than one. That frankly means you'll get five opinions but -- so I have to trust the organization below me at some point to get a good consensus.

MR. GALLO: Okay. That's all I have. Thank you.

DR. BRAMBLE: Jeff.

MR. BORTON: I'm good.

DR. BRAMBLE: Lorenda.

BY MS. WARD:

Q. I just have one. I was just curious, the independent safety review --

A. Uh-huh.

Q. -- conducted, if they happened to recommend that you have an independent flight test SRB instead of having the Vice President of Flight Operations and the Director of Flight Test co-chair it?

A. Independent flight test SRB, I'd have to go back and look at their book, look at the recommendations. It doesn't -- that doesn't ring a bell.

Q. Okay.

MS. WARD: That's all I have.

DR. BRAMBLE: Tom.

MR. HORNE: I have a clarification question.

BY MR. HORNE:

Q. When we were talking about duty limitations strictly for the field performance testing, and I think there was a question along the lines of would the engineers be expected to adhere to duty time limitations. I wanted to expand on that just a little bit --

A. Okay.

Q. -- to make sure we get the right record. If an engineer in the TM room for example is required to monitor a safety in flight test item, would you expect him to --

A. Yes. Yeah.

Q. -- of a crew duty --

A. Yeah.

Q. Okay.

MR. HORNE: That's it.

DR. BRAMBLE: Anyone else?

John, you want to wrap up?

MR. O'CALLAGHAN: Sure.

BY MR. O'CALLAGHAN:

Q. Mr. Henne, our closing question is one that we've been giving to everybody. It's basically to solicit your input to our investigation in an open way, whatever you can think of. Basically we're concluding our fact gathering phase, and we'll be starting the analysis phase and as Bill probably mentioned, that culminates in our report, the finding of probable cause, what happened and perhaps more importantly safety recommendations to the industry to hopefully prevent future events and improve safety across the board. So with that in mind, we've been asking all the folks who were closest to the accident, who have been weighing it in their minds and hearts for these months and to have obviously given it a lot of thought, two things we've been asking them. One is if there's something that we should be looking at, that it's not evident that we're looking at, on the basis of our questions or the feedback you're getting from Tom and Rick, please point that out to us.

A. Uh-huh.

Q. And secondly, if there's any safety recommendations to the industry or other things that you think the NTSB should highlight to the industry, through our report or recommendations, we'd like to know that as well. So with that, the floor is open to whatever you'd like to tell us.

A. Well, I think, from everything that we've gone through, I think when we went through the review of the simulation guys and the low speed aero guys, and frankly, it's those two organizations that have shed a lot of light now on at least our understanding of what happened. Going forward, we're going to make significant investments in the simulation area, at the edges of the envelope, if you will, and in CFD. Now we didn't talk about CFD, but it's been a key for us to understand what wasn't estimated correctly, and so what I've told my boss is, we're going to make some major investments in improving our CFD capability for the edges of the envelope and for our simulation capability at the edges of the envelope. In fact, we've already had our first meeting with flight safety to challenge them to work with us on improving flight simulation capability in the non-near range so we really can identify here's what the airplane's going to act like. How do we design that out or how do we design, how do we train for it, et cetera? So I think in terms of simulation and in terms of aerodynamic characteristic determination, via CFD, there's a lot that can be done that we just haven't done. So I mean those are two areas that looking forward we're going to change the way we technically do our airplanes.

Q. Okay. Thank you very much.

DR. BRAMBLE: Thanks for your time.

THE WITNESS: Okay.

(Whereupon, at 6:06 p.m., the interview was concluded.)

CERTIFICATE

This is to certify that the attached proceeding before the

NATIONAL TRANSPORTATION SAFETY BOARD

IN THE MATTER OF:	AIRPLANE ACCIDENT ROSWELL, NEW MEXICO N652GD Interview of Preston Henne
DOCKET NUMBER:	DCA11MA076
PLACE:	Savannah, Georgia
DATE:	October 28, 2011

was held according to the record, and that this is the original, complete, true and accurate transcript which has been compared to the recording accomplished at the hearing.

Letha Wheeler
Official Reporter

Kathryn A. Mirfin
Transcriber

UNITED STATES OF AMERICA

NATIONAL TRANSPORTATION SAFETY BOARD

Investigation of:	
AIRPLANE ACCIDENT ROSWELL, NEW MEXICO N652GD	Docket No.: DCA11MA076

Interview of: JAKE HOWARD

Gulfstream Corporation
500 Gulfstream Road
Savannah, Georgia

Thursday,
October 27, 2011

The above-captioned matter convened, pursuant to notice, at 8:13 a.m.

BEFORE: WILLIAM J. BRAMBLE, JR., Ph.D.
Senior Human Performance Investigator

APPEARANCES:

MITCHELL GALLO
Air Safety Investigator
National Transportation Safety Board
31W775 North Avenue
---------------------s 60185

WILLIAM J. BRAMBLE, JR., Ph.D.
Senior Human Performance Investigator
Office of Aviation Safety
National Transportation Safety Board
490 L'Enfant Plaza East, SW

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-

ALAN J. (JEFF) BORTON
Flight Test Pilot
FAA Aviation Safety
Aircraft Certification Service
Wichita Aircraft Certification Office
1801 Airport Road - Room 100

THOMAS M. RAMEE, ESQ.
Deputy General Counsel and Risk Manager
Gulfstream Aerospace Corporation
500 Gulfstream Road, M/S B-06
Savannah, Georgia 31407

TOM HORNE
Experimental Test Pilot
Gulfstream Aerospace Corporation
P.O. Box 2206, M/S A-12

APPEARANCES (Cont.)

JOHN O'CALLAGHAN
Aircraft Performance Group Chairman
Vehicle Performance Division (RE-60)
Office of Research and Engineering
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

-

MICHAEL BAUER
Aerospace Engineer
Vehicle Recorder Division (RE-40)
Office of Research and Engineering
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

E. LORENDA WARD
Air Safety Investigator
IIC and U.S. Accredited Representative
Office of Aviation Safety
Major Investigations (AS-10)
National Transportation Safety Board
490 L'Enfant Plaza East, SW

MARIE MOLER
Mechanical Engineer
Office of Research and Engineering
Vehicle Performance Division
National Transportation Safety Board
490 L'Enfant Plaza East, SW

I N D E X

I N T E R V I E W

(8:13 a.m.)

DR. BRAMBLE: Let's go on the record.

INTERVIEW OF JAKE HOWARD

BY DR. BRAMBLE:

Q. So, Jake, could you state your full name?

A. My name is Jacob Merritt Howard.

Q. Let's just jump into it here what was your understanding of the cause of 88 and 132 and how did you come to that understanding?

MR. RAMEE: Before or after the accident?

BY DR. BRAMBLE:

Q. Before the accident.

A. Those flight numbers it sounds like the ones they were using for our field performance testing.

Q. But in terms of the wing drops that occurred during 88 and 132, what was your understanding of the cause of the wing drops and how did you come to that understanding?

A. Specifically for 88?

Q. Uh-huh.

A. 88 was from an over rotation and the conduct of a V_{MU} and I was on board for that one and just during the recovery. And then 132 was, at the time was considered from the YAW damper being inoperative and lateral directional event.

DR. BRAMBLE: Off the record.

(Off the record at 8:10 a.m.)

(On the record.)

DR. BRAMBLE: Let's go back on the record.

BY DR. BRAMBLE:

Q. Since the accident what's your understanding of the cause of those events?

A. With the investigation for 88 it's still the same. It was an over rotation. There could have been some pre-stall that was there. And on 132 was essentially the same, excessive pitch that could have led to some pre-stall event for the roll off.

Q. I'm not sure if we asked this last time, but why do you think -- Well, to your knowledge, did anybody analyze where the stall began on 88 or 132 relative to what the predicted stall, IGE stall angle was?

MR. RAMEE: Before the accident?

BY DR. BRAMBLE:

Q. Before the accident.

A. Oh, there was extensive analysis done through wind tunnel and through the engineers to determine what the in-ground effect on the angle of attack was. So on both of those we probably from 88 even at the time thought we were close. But on 132 we hadn't encroached upon the stall angle of attack with the knowledge that we had.

Q. I'm sorry. On 088 you said that it did approach the --

A. We don't know. I mean with the numbers that we had there is a possibility, but once again off the ground because of the change in critical angle with altitude there are some affects there so --

Q. So you think there was some comparison before the accident but it was complicated because of the change in altitude and the changing predicted stall angle?

A. The dynamics of the maneuver.

Q. Who was responsible for analyzing aircraft performance on those flights before the accident?

A. The FTEs normally are the initial, the front line, they will evaluate that information but then it will go into the engineering department if there are any other analyses of the maneuvers.

Q. And in this case did it got into the Engineering Department for 88 or 132 before the accident?

A. I don't know.

Q. Did you play a role in analyzing the data from flights 88 or 132?

A. 88 I was there, so, yeah, we went through that, On 88 --

Q. Before the accident?

A. Before the accident, yes. It was an admitted over rotation. So it was, the corrective action was not to over rotate on any subsequent maneuvers.

Q. In terms of the analysis did it consist of reviewing like time histories for certain parameters from the incident

flight?
A. Yes. On 088.
Q. On 088?
A. Yes.
Q. And 132 you didn't, you weren't involved in that?
A. I was back in Savannah. So I was not involved in that.
Q. Any additional analysis that you were involved in besides looking at the time histories?
A. For that flight or?
Q. For 88.
A. No, Kent and I spoke a little bit about the presentation that he put together.
Q. Before the accident did anybody tell you at what normalized angle of attack the roll off began?
A. At normalized angle of attack?
Q. Uh-huh.
A. There were angles of attack with having a normalized presented on the display but a normalized angle of attack, no.
Q. Do you mean in the cockpit?
A. Uh-huh. Now, let me make sure that we are both talking the same definition for normalized angle of attack. You are talking about the normalized display that's a percentage of the available angle of attack displayed to the pilots?
Q. I think it represents the same term that we have discussed with the engineers, which is basically the ratio of the,

there's a ratio related, there's a point related to stall at the top and then at the bottom there is a 0 lift angle of attack and it's a ratio of where you are between those two points. It's like the shaker setting is expressed in --

A. In normalized, yes.

Q. -- 25.9?

A. But when you mention on a roll off for a normalized angle of attack what would be above 1.0 display because that's just the alpha star reference value.

Q. I guess what I'm wondering is did anybody ever tell you before the accident and after 88, okay, here the roll off started at a normalized angle of attack of .86?

A. No.

MR. RAMEE: I'm not sure what question he answered, Bill.

BY DR. BRAMBLE:

Q. Did anyone before the and after Flight 88 ever brief him that the roll off occurred at .86 normalized angle of attack was the question.

A. I don't recall being told that number.

Q. In your opinion, why didn't the roll offs that occurred I Flights 88 or 132 result in a reconvening of the SRB?

A. For 88 we knew what caused the anomaly and as I mentioned earlier it was from an admitted over rotation so a technique that was corrected and then part of that is even within the TSHA that this is, there is kind of a probability that that may occur.

For the 132 the investigation that ensued after that one decided that it was without having the YAW damper active. And so then we terminated testing with YAW damper inoperative for doing those maneuvers. And because at the time it wasn't considered a stall event then that resolved the issue.

Q. With whom did you have in-depth discussions about those roll off incidents, Flights 88, and 132 before the accident?

A. 88 was internal out at Roswell. And then Kent also discussed I guess back here with Randy well after the event I believe. And 132, I was back in Savannah so I wasn't as involved in that discussion.

Q. Randy is Randy Gaston?

A. Uh-huh.

Q. Who is the director of flight ops?

A. He's vice president of flight ops.

Q. Was the takeoff technique of the 65 pound pull that was developed by the time of the accident was that continued, was that expected to be acceptable to the FAA during certification?

A. During the development it was within the guidelines of the advisory circular. Yes.

Q. So was there an expectation that that had to be back, sort of made more, less abrupt or less strong for cert testing or is that sort of typically the kind of pull forces you would see for cert testing?

A. We were still in the development but you are allowed up to 75 pounds and that's what we had used on previous programs, was a 75 pound pull.

Q. As far as the pitch rates that were generated during these takeoffs were they, did they seem higher or lower than in other aircraft during certification testing to you, the rotation, pitch rate for the continued takeoff tests or?

A. That's what we were developing the different pull forces also for and so that sometimes depends on speeds, CGs and flap settings. And so the 65 pounds, 65/70 pounds was a start point. So depending upon the conditions the rates were higher at some conditions.

Q. We talked a lot last time about V_2 and how it was difficult to reach V_2 and so the technique was being refined to try an avoid exceedances. And so there are different ways to approach that problem. I guess one is to try and change the rotation technique another is to increase the V_2 speed. And I just wonder if you could give us your opinion about why the V_2 speed wasn't adjusted up at some point prior to the accident?

A. I don't know.

Q. The last time you were in Roswell in early March doing takeoff testing how optimistic were you that you were going to be able to solve the problem by modifying the rotation technique?

A. Well, the last time I was at Roswell, which was the first rotation we really didn't do too many of the CTOs so we didn't investigate that portion as much. I concentrated on those when we went to the Birmingham flight.

Q. So after Birmingham did you feel like it was an achievable goal with the current aircraft design and configuration, a modified rotation technique that you could meet the criteria of V_2 plus or minus 2 knots?

A. I don't know. It was such a small subset that we did it in Birmingham. It was pretty much one condition attempting to do that. So that's what the development program was for.

Q. Did you, Gary, or Kent suggest to Flight Test or Flight Sciences before the accident that they needed to raise V_2 or were you guys sort of focused on seeing if you could make it work with the technique first?

A. We were using the numbers we were given to see if we crime scene make the numbers.

Q. During pre-flight briefings for field performance takeoffs how did you discuss AOA margins? Did you talk about it in terms of degrees or normalized angle of attack?

A. Most of it was within normalized because that's what is displayed for us and it's the stick shaker with a PLI that we relied upon. But then, again, it depends on the maneuver.

Q. Before the accident what understanding did you have about the margin between stick shaker and aerodynamic stall either in or out of ground effect?

A. Well, the penalty for in-ground effect stall was 2 degrees of margin. And then the margin between the stall to the alpha SR at the time I don't recall whether they were using -- And then about, it was around-- So we had discussed the values especially during the V_{MU} since the pitch attitude is approximately angle of attack. But that .85 we had adequate margin from stall even in ground effect.

Q. Were you aware prior to the accident that the shaker setting was increased to .9?

A. Yes.

Q. Did you ever fly it with the setting at .9?

A. I did not do a CTO with it set at .9, no.

Q. Would you have been comfortable using it at that setting prior to the accident -- Actually let me back up. I apologize. I reviewed this last night but it just occurred to me that you mentioned that you talked to, you actually called Reece about this and shortly before the accident when they decided to bump it up. Was that March 24th?

A. I don't know.

Q. Was it like approximately a week-and-a-half before Reece went to Roswell?

A. It was during the discussions with Flight Sciences when the decision, back and forth between Reece and Flight Sciences was to make it to .9 to bump it up slightly.

Q. During a meeting?

A. The meeting that they decided that and then Reece and I spoke afterwards about the encroaching upon the margin that was there and he went through all the numbers and said, no, they is still margin available, with the information we had at the time.

Q. What prompted your calling him about it? I mean were you just seeking further explanation or were you a little concerned about it or?

A. Both. Just making sure that all the analysis had been done, that reducing that value was okay.

Q. What information did he show you or discuss to sort of back up his assertion that it would be safe to do that?

A. Well, they had done all the analysis. They had presented tables of decrements from all the different items and then still showing what a margin we would have available to the in-ground effect stall.

Q. So to your understanding in-ground effect there would still be at least 2 degrees of margin between the shaker setting and the, you said either V_{SR} or aerodynamic stall?

A. No, I didn't say that. I said we knew that the in-ground effect had a decrement of 2 degrees from the critical angle of attack. And then with the other items that we would still have a margin. I don't remember what the margin was.

Q. Beyond the 2 degree?

A. Beyond the .90 normalized AOA to stall.

Q. So from .9 to 1.0 you are saying 1.0 is the aerodynamic stall.
A. No.
Q. Is it V_{SR}?
A. It is. It would be a normalized alpha SR but, yes, V_{SR} equating to that.
Q. I'm just trying to distinguish because V_{SR} has a margin error of stall?
A. From VS, correct.
Q. So 1.0 is V_{SR} and .9 is where the stick shaker is?
A. Yes.
Q. So then between .9 where the stick shaker is set and where the aerodynamic stall occurs the V_S what was your understanding of how many degrees of margin there was in AOA between those?
A. I don't recall,---------------------- I'm sorry from free air stall. So in-ground effect would have had a decrement of ---------------
Q. You mean a margin?
A. A margin, yes.
Q. So is that what Reece explained?
A. In his analysis and his tables, yes.
Q. So is it your understanding that Reece knew that the margin was pretty thin between where the shaker was going to be set and where the aerodynamic stall could be set? Like that it

was only, that he understood it was only -------------- between shaker setting and aerodynamic stall?

A. Whatever the value was, he created the tables and knew the numbers we discussed about, yes.

Q. Did he seem concerned about how tight it was?

A. He didn't express that to me, no.

Q. Was this margin of --------------- was it tighter than margins you had seen on past programs, certification programs like did you do field performance testing on GV?

A. Not on the GV. I did 550 and 450.

Q. Did you have a sense that there was going to be sort of less or more margin from stall with the shaker for this airplane?

A. I didn't know what the values were on the previous program so they didn't give me that much detail.

Q. I guess what I'm wondering and one of the ideas that we have kicked around a little bit is the idea that on this airplane there may have been some effort to sort of shrink the margin because you are going to have the alpha protection with the fiber wire system. But then during flight test because you don't have the alpha protection enabled you have got shaker but you might have a smaller margin than you would have on other airplanes a smaller margin, you know, for error between shaker and the stall angle so it might be a trickier task from a piloting standpoint. Is there any merit to thinking about it in those terms or are we off base?

A. I don't know. We try to take advantage of the equipment as much as we can, of course, to maximize performance. But I don't know that anyone has expressed it quite like that.

Q. Before the accident what was your understanding of the reduction in stall AOA and ground effect compared to free air and -- we just talked about that. Sorry. One second.

Was there a discussion of stall, in-ground effect stall margins during the SRB prior to Roswell-2?

A. Yes.

Q. When was this SRB, was there one held between Roswell 1 and 2 or just before Roswell-1?

A. We held one before Roswell-1 and I don't know if we held another one before Roswell-2. I don't recall.

Q. So at the time of the SRB the shaker was going to be set at .85 and the IGE stall decrement was estimated to be about 2.0 degrees?

A. Yes.

Q. And then subsequent to the SRB the shaker setting was increased to .9?

A. Yes. But not in a vacuum, of course, everyone knew that we were changing those values.

Q. Why do you think that a formalized SRB wasn't called when Flight Test decided to bump up the shaker setting?

A. I don't know.

Q. Did you have a sense that sort of the right people were involved anyway through informally or?

A. And that was it and then, yeah, the information had been disseminated.

Q. Who provided the information to Flight Test about the in-ground effect stall angle decrement?

A. I don't know.

Q. Before the accident were you made aware of any changes to the predicted stall margins that occurred during the field performance test program as a result of the shift from the K1, as a result of a stall speed update that occurred around February?

A. Ask that again?

Q. Before the accident did anyone tell you that there had been a stall speed update around February that resulted in some slight revisions to the stall speeds?

A. They could have. I don't recall.

Q. I think we discussed last time that the shaker setting was bumped up because of what was perceived to be nuisance activations.

A. Yes.

Q. Did you experience some of these nuisance activations?

A. Yes.

Q. I think we have a feel for this, but someone is likely to ask us this in the future well, you know, why was the activation of a shaker considered to be a nuisance activation? So if you can just kind of briefly explain that that would be --?

A. Sure. On climb out you attempt to optimize the climb rate and so we used just under the shaker, which is identified by the pitch limit indicator. So if there's any slight little bit of turbulence of variations then you may accidently trip that shaker indication. All the nuisances that I had had were on climb out.

Q. A meeting that you discussed that Reece had with Flight Sciences about changing the shaker settings, did you attend that or did he, did somebody just brief you on it?

A. Well, there were multiple meetings when this was all decided. The one that I had gone to it was all explained in full was held over at the RDC and I know that Reece and the engineers had been discussing that many times without me involved.

Q. Was that over at RDC 1?

A. The meeting that I attended was in RDC 1, yes.

Q. Was the nature of the discussion, hey, we've got these nuisance activations during climb and we have got some margin so we could move it up a little bit to give ourselves some more room, is that the idea?

A. The meeting I'm reference all that analysis had been complete and this was the decision to go ahead and make it .9.

Q. Did that basically reflect the rationale; we've got these nuisance activations during climb and that would invalidate the test and so we have some more margin so we are going to increase it just to give ourselves a little bit more room?

A. That was the gist of the basis.

Q. Was the video from Flight 132 shown during the meeting?
A. No.
Q. Do you know what -- from a physics standpoint do you know who looked at sort of what the aerodynamics were that underlay the 132 roll off?
A. No.
Q. What was the aircraft performance group's role on site in Roswell during the field performance testing?
A. I don't know all of their duties and responsibilities a lot of it was the data analysis.
Q. Did they do data analysis after you guys finished testing for the day?
A. After we acquired data then, yeah, then they would start crunching it.
Q. I mean after you -- like in between runs or also after you guys quit flying?
A. Well, they would look at the data stream. They were in the trailer. I don't know exactly what they did, the performance engineers in the trailer and the flight test engineers in the TM trailer did. So I don't know how much of an analysis they did while we were flying.
Q. Did you get the sense that Mr. Ollenburg when he would go back to his room after you guys were done flying, or when you guys would go back to the hotel would spend hours, you know, going over the day's test results or was it more like the people in the

trailer were going to sort of just package it up and then they would look at it when they got home or how did that work?

A. Well, after we were flying we would still stay in the office for quite some time doing analysis and looking at that and then showing up in the morning. I don't know how much time he dedicated in his hotel room. I know the performance group would also stay. There was usually three or four of them that were there crunching data all day long.

Q. So after you guys would quit flying around like mid to late morning and then go to the office and then would everybody who was on the airplane and the people in the trailer get together and review data, or how did that work?

A. Well, we'd debrief and then everyone does their own role and responsibility afterwards to continue depending upon what we acquired some of the data was necessary for continued testing and other of it was, you know, set aside so that they could do the analysis back here for AFM performance creation.

Q. So -- and then the pilots would they typically -- how many hours did you typically stick around in the office after -- like a typical day with V_{MU} or takeoff testing what time would you guys quit flying and then what time would you then leave the office and be done for the day as pilots?

A. Depends on weather and the test cards. We would show up usually a little bit before sunrise, get the briefing out of the way and then go out and do testing until the winds, as long as the winds held anyway and then we would knock it off usually, I don't remember when we were there the couple of times. But get in around 6:00 or so and then leave around 4:00 or 4:30.

Q. The office?

A. Yes. That's the best of my recollection. I don't know. I would have to look.

Q. Then did the performance people also pack it up about that time or did they typically stay into the night running data analysis?

A. Usually they were there later. I don't know how late. A lot of times we would try to get together for supper a few times and, you know, 6:00, 7:00, somebody just be coming from the alpha center, but you would have to ask them.

Q. What was your understanding of the roles performed by each person working in the TM trailer during the field performance testing, what was each -- how did each person function during, and in between test runs?

A. I don't know.

Q. Do you know who was sort of the person in charge in the TM trailer, in charge of the engineering part of things?

A. It depends on who was out there. Usually it was whichever FTE, a lot of times that would be assigned out there. The times I was out there it was Cynthia. Between her and then Shelly from the performance group a lot of times would be out there and they would normally be the ones on the radio talking.

But it just depends on the assignments.

Q. Who seemed to be sort of more involved in making the decisions about whether the runs were okay and communicating that to the pilots? How did that work?

A. Usually you would know on the airplane whether it was a good run or not.

Q. Because the FTE in the back would tell you or you guys would know in the front?

A. You know. It may come back and they say, well, your numbers were off a little bit so we will repeat that one. But it was coordinated between the FTE onboard and then the one in the trailer. And the performance engineer that was in there that would speak up.

Q. For the engineers in the back of the air plane were their roles strictly segregated? Like, one person would only be monitoring the flight controls continuously and then the other person would look at the test data or did they kind of mix it up like could each person sort of do both at the same time?

A. I don't know.

Q. Was there anyone in the TM trailer responsible for monitoring the maximum pitch attained during runs or maximum AOA attained during rotations to make sure that the airplane wasn't exceeding desired limits?

A. They were monitoring parameters. I don't know what all parameters they were looking at.

Q. As lead project pilot you worked pretty closely with Reece Ollenburg. So I assume you are pretty familiar with his duties that he was the cognizant FTE for field performance and onboard test conductor for the takeoffs and that he was doing data analysis and he was going to be writing the report. How did you feel about his workload? Did it seem like he had a reasonable workload or did you have any concerns about him having too much on his plate?

A. No, it was about normal, what we normally have done because it wasn't just him, of course, because he did rotations out also. He was the primary for field performance. But then we had other FTEs that would come out and assist in the duties.

Q. The others you are talking about for field performance would Paul Donovan?

A. Paul Donovan, I think Chris Booth went out. Nathaniel Rutland went out. And then they would also have the flight analyst type FTEs like Cynthia went out.

Q. Are you familiar with the 1998 flight test standard practice manual? I think we did talk about this last time. You said you thought this was pretty available to all the pilots in the flight ops?

A. It's not restricted from anyone.

Q. But you didn't know for sure whether they had, everybody had a copy but that they could easily get one if they wanted one.

A. Yes.

Q. Are you fairly familiar with the contents of the manual?
A. That's a subjective term, but, yes.
Q. I guess really the question is how closely did the Flight Test organization structure and policies and procedures conform to the manual?
A. I think pretty well within their organization.
Q. In a March 9 letter to the manager of the Atlanta ACO, or from the manager of the Atlanta ACO to Anthony Beck concern was expressed about an incident involving the YAW damper and nose wheel steering system and the event that occurred with the sort of veer off to the side.
A. Yeah.
Q. And the FAA asked Gulfstream to perform an internal review or the Company's change approval process and ensure that all concerned parties would be informed of changes to the flight control system and other systems that direct pilot interface. To your knowledge, was this review performed and what lessons were learned or changes implemented as a result?
A. Each time one of the new software loads come out then the Flight Sciences guys will provide a briefing of that and then invites Flight Ops and Flight Test to attend. And then those that were not there they will either do a makeup or then they can have access to the presentation.
Q. Who did the briefing again, flight control?
A. Flight Sciences group.

Q. So the pilots were usually present for that?
A. As many as could attend when the software load changes, yes.
Q. So was this a change, did you feel like the information about changes was distributed sort of more effectively after that incident than the review.
A. Well, we had done that to an extent beforehand also. We tried to open it up though and invite more people as opposed to -- I'd say the dissemination became better.
Q. Did you feel as a pilot and as a chief project pilot that people were keeping you adequately informed about changes to the system? Did you feel like they were pretty open for communication?
A. Yes.
Q. Early in the takeoff testing there was a lot of discussion among the team about AOA degree limits on the flight test video, and then later the team seemed to switch to talking about target pitch and normalized AOA and AOA with degree limits weren't discussed much anymore. What was the reason for that? Was that just because basically you are looking at the normalized, you have a normalized AOA display to monitor or -- do you have any?
A. Well, it depends on the testing that you are performing also. For example, like in VMU we have to be extremely cognizant of angle of attack only because you are on the ground you have to

take that in-ground effect decrement and you disengage shaker indications even. So the concentration is on angle at that time. Whereas, for example, performing the CTOs the normalized is used as a reference because that's where the pitch limit indicator is presented and so that and the -- pretty much the do not exceed line, so then it can be a discussion of the normalized. So it depends on the test that you are performing.

Q. So during the VMU the shaker is active or not active?

A. Usually it is inactivated.

Q. During the continued takeoff testing, when you are using the normalized angle of attack, do you think the fact that the AOA is expressed in normalized units made it a little less obvious how close you might be in terms of degrees to where the aerodynamic stall occur or was that pretty transparent to you because you kind of understood how they correlated?

A. The normalized angle of attack is presented in small digital readout. That's normally not even referenced during the dynamics of that maneuver. You won't even see it. And that's why you utilize other cues like the PLI.

Q. Like the PLI. And the PLI was essentially a dynamic representation of that which gave you a feel of how close you were and how quickly you were approaching the normalized limit?

A. Exactly.

Q. Did you participate in meetings amongst group heads or managers between Roswell-1 and 2 to discuss how the flight test

data from Roswell was comparing to performance targets?
A. Probably.
Q. How often were such meetings held?
A. I don't know. All of that, do you remember back in that all that data is very preliminary that we were getting at the time. It wasn't very complete. So there really wasn't a very good picture of it.
Q. How about during Roswell-2?
A. I don't recall.
Q. How was the flight test schedule managed and revised in the year before the accident? What was the process for sort of reviewing it and making changes as needed as the program progressed through the field performance testing?
A. You mean for each of the airplanes, that whole flight test schedule?
Q. Yeah. I guess I should not bound it to field performance testing because really it's sort of like the whole program and all the TIAs like, how often did you guys meet to review that and how were decisions made about whether to bump back the date and that sort of thing?
A. That's handled by flight test. I don't get involved in that.
Q. Did you feel that staffing on site in Roswell permitted enough time and resources for data analysis?
A. Once again it depends on the test that's being conducted

at the time and the objective of what analysis is for the short term.

Q. How about, well for V_{MU} and continued takeoff did you feel like the analysis, there were enough staff resources to analyze the data as the testing progressed on site?

A. I think so.

Q. How about between major field performance efforts, like Roswell-1 and 2, did you feel like the engineers had enough time to process the data, you know, after Roswell-1 before starting the next big round?

A. I don't know. You would have to ask them.

Q. There is a March 31st letter that was sent from the Atlanta ACO to Anthony Beck and Curt Erbacher stating that the FAA was not going to allow the splitting of TIA 7 into pieces and that they hoped that their decision would serve as an impetus to change the schedule somewhat to reflect the true status because they thought that the schedule was unrealistic and didn't reflect where the Company was in the program.

Were you aware of the letter, did you hear any discussions before the accident about that?

A. Not before the accident, no.

Q. We noticed on the TSHAs that over rotation was listed as a potential hazard for V_{MU} but not, it wasn't listed on the CTO card and I wonder why, we were wondering why it wasn't on the CTO TSHA, related TSHA?

A. Yeah, we had discussed this before also. A CTO is a relatively normal -- I say relatively normal event that the standard line pilot be expected to execute. There are abuse takeoffs that we do discuss that, the over rotation portions of, but a CTO would be a single engine failure on takeoff and the pilot continues. So that wasn't expected to be a hazard.

Q. But it is considered a high risk test, right?

A. Yes. Part of that is also defined by FAA order 4040.26(a), that specifies it.

Q. I assume after the accident that an over rotation is considered a significant risk for CTO testing too?

A. No.

Q. No. Okay.

A. Not for CTO. For abused, yes. It will be placed on TSHAs though to let you know.

DR. BRAMBLE: Off the record.

(Off the record at 9:04 a.m.)

(On the record.)

DR. BRAMBLE: Let's go back on the record.

BY DR. BRAMBLE:

Q. I'm actually getting pretty close to the end here. So we may get out of here at a reasonable time depending on how much everybody else has.

A. Don't tease me.

Q. Are you familiar with the GIV and GV wing drop or are you familiar with wing drop incidents that occurred during the GIV and GV field performance testing programs?

A. Yes.

Q. Are you aware of analyses that were performed as a result of those incidents?

A. I have looked at some of the documentation from that, yes. In fact, one is a prerequisite for review before we go out and do some testing.

MR. GALLO: Was that familiarity with GIV wing drop was that before the accident or after the accident?

MR. HOWARD: Before.

BY DR. BRAMBLE:

Q. The document that you said was a prerequisite to review before you go out and do field performance that was a prerequisite before the accident?

A. Yes.

Q. Which document is that?

A. It's an internal memorandum discussing the accident, or the incident.

Q. Is that for the GIV or GV?

A. The GIV predominately.

Q. Our impression is that the effort to sort of investigate and analyze those incidents, the GIV and GV incidents was more extensive than the efforts to investigate the wing drops during Flights 88 and 132. The only, the main thing that stands out is that, you know, in those incidents you had a wing tip strike on the GIV and a hard landing on the GV that required inspections. And whereas the 88 and 132 events didn't involve any ground contact or potential damage.

Is that why there wasn't any -- well, do you feel that there as less analysis done for 88 and 132 and is it primarily because there was ground contact?

A. I don't know. I wasn't here when the other events happened.

Q. But for the G650 based on the documentation that you read about GIV for example, does it seem like they did a more extensive investigation of that than Flight 88, for example?

A. No, I don't -- I wouldn't -- I don't know what they did to be able to provide that memorandum. I know that their incident was, I won't say similar, but it was somewhat. The FAA was onboard an over rotation on a V_{MU} and that their winds were in excess and so then it had the roll off with an over rotation. And they did have a wing tip strike.

Q. Maybe I'm belaboring the question, but would you expect that would draw more scrutiny and more attention than if you have got a wing tip strike?

A. It would be my guess that, yes, it would.

Q. What kind of tools did the Company use to try and carry aerodynamic performance and safety lessons across from major cert program to major cert program, like GIV to GV to G650?

A. I don't know.
Q. Was it primarily sort of just transmitted from one experienced person to the next through overlap or was there any kind of, were there like databases?
A. That's part of it. There are memorandums that were there. We have, of course, all the files for previous reports that I know that the flight test engineers will look at to see the results from previous programs.
Q. So in looking back over everything related to the accident it seems like there were really at least three things that could have been warning signs that if properly interpreted might have alerted people to the fact that the IGE stall angle was greater than it was thought to be at the time. Two were the incidents 88 and 132. And then a third that wasn't really directly related to stall angle, I guess, but really was more something that sort of drove the higher and higher pitch angles during the rotation was the V speeds being off for the target pitch angle. So it seems like these are three sort of links in the chain that might have helped to prevent this. Now, obviously, we have the benefit of hindsight. So we know the significance of these things.
But if somebody had analyzed where the stall occurred on 88 and if they had thought 132 was a stall and they analyzed where the stall occurred relative the predicted stall, we think, you know, maybe someone might have noticed that it was lower than .9

normalized angle of attack and we also think that if somebody had been looking at the data coming out of the earlier runs on the day of the accident they might have noticed that liftoff wasn't occurring until right around the predicted V_2 speed, or the target V_2 speed and that the airplane was actually pitching to the target pitch and then even rotating a little further before 35 feet.

So these are, we are going to have to try and answer the question, you know, how are these signs missed and it is always easy in hindsight to say, well, you know, these are, this is just hindsight bias, you know, but the challenge going forward is to try and help people figure out how not to miss these kinds of signals and as the lead project pilot, somebody who is familiar with this and I'm sure has wrestled it a lot, you know, why do you think those signals were missed and is there anything that could have been -- what would you recommend that programs do to try and avoid this kind, you know, missing signals like that when their predictions are not accurate and they don't, maybe there are some signs that the airplane is trying to tell them something about it?

A. Well, a couple. One is for the Flight 88 incident the airplane wasn't instrumented to determine what the stall happened and it was a very dynamic rapid maneuver. So there are a lot of conditions that, and maybe they should analyze it, but not knowing the wings weren't tufted or anything else to know that it did stall. So it would be hard to determine that when it is compared with some of the other data that they have analyzed through wind tunnel testing and cryogenic tunnel testing.

The 132, once again with the data that we had had and without having the YAW damper considering that it may have been a YAW damper effect and then getting some CO beta that caused the wing drop had also from the time that airplane, once again wasn't instrumented to determine if that was a stall event or not an as they did the analysis with the information they had said, okay, well, it wasn't -- There was something lateral directional occurred.

Throughout the maneuver, you know, between runs unless we do like one run a day and then assess it, it would be difficult the try to come up with something to analyze it at the time for an event, for example, on the 88 that was an admitted over rotation and say, well, we just won't do that again for that VMU maneuver.

So I agree that there has to be a balance of analysis and then continued testing. And we have put into place since then any kind of an abnormal event that occurs then it is reported up and then gets the proper attention.

Q. So how would a similar event be handled under the new process?

A. Well, for example, on I guess we can use 88 since I was one on board. We had stopped at that time and do an analysis to see and it's one of those where on that on that was a pilot admitted, oh, I did too much. If I had kept it within the constraints and the test is doable because we continued and all the rest of the maneuvers that day were fine.

Q. Anything else?

A. No.

DR. BRAMBLE: John.

MR. O'CALLAGHAN: Thank you. Just a couple clarifications.

BY MR. O'CALLAGHAN:

Q. A lot of this we talked about when we had our conversation in June I think it was or July. So I will try to be brief.

Talk about the V_2 capture and the difficulties there. I'm trying to get a feel -- last time we talked about I think the GV and G550 and that the procedure on that airplane I think as you described it was you basically rotate to a target pitch, maintain that to 35 feet and what you have at 35 feet was your V_2 essentially and that on this program it's a little different in that you probably have to maybe adjust pitch to maintain V_2.

So perhaps the GV or the G550 isn't the best comparison airplane, but I was wondering are there other airplanes in your experience that you have flown that you have tested where you have experienced a similar difficulty in achieving V_2? You know, like is the difficulty that were experienced in this program paralleled with any other aircraft that you have flown in your experience?

A. No. Through a test program that I have been on, no. But they weren't quite the same in engine response or anything else like this airplane.

Q. So for an airplane where maybe, again, I want to kind of put aside airplanes where you just hold a pitch until 35 feet and accept it or maybe include those, but what normally, in your experience for most airplanes what is it normally like to do this exercise and capture V_2?

A. Actually it is similar to what we do because even in those where you would hold an attitude you may have to make some small corrections if you have an accel depending upon your speed. So to keep whatever the published V_2 is that may be necessary. And then there's a difference between the single engine and two engine maneuvering when you are doing an all engine out or an all engine operating case. So this really isn't too much different that you rotate and then capture a V_2 speed.

Q. I'm trying to make this comparison between the GVI and other air planes. This difficulty in getting too fast or overshooting the target or not being able to pitch high enough, soon enough to avoid that, in your experience that has not only been paralleled in other, after -- you usually have no problem settling into that, finding the pitch and settling into the speed; is that a fair characterization?

A. Well, there's a difference in the flight test maneuver and normal piloting maneuvers. So if you weren't doing a flight test there has been evaluations even if you go to flight safety usually people aren't as aggressive and so they are always exceeding V_2 speed and always have to slow down. So it's rare that they catch a V_2 at 35 feet like we do in flight test just because usually when people have an engine failure they are much more gingerly handling the airplane.

Q. But just talking about flight testing. In doing this particular exercise to build an AFM?

A. In my experiences it has not been as challenging.

Q. So following that a little bit, did you have any discussions or was there any suspicion that perhaps there was something not adding up in the basic physics that was going on in terms of the speeds that were provided?

A. Yeah. We had talked about maybe have to increase the V_2 speeds because of not being able to get to the values.

Q. How did that resolve itself with those discussions, how far did those discussions go and how were they resolved?

A. Mine was early on in the testing of Roswell-2 and so then I had to continue get developed with techniques and as we continue to evolve throughout the program then they may had been adjusted. We were still attempting to try to target those speeds within the operation confines of the airplane. So keep it within the limits of the PLI and --

MR. HORNE: I think you may have said something a little wrong. You said early on in the testing?

DR. BRAMBLE: Off the record.

(Off the record at 9:26 a.m.)

(On the record.)

DR. BRAMBLE: Let's go back on the record.

BY MR. O'CALLAGHAN:

Q. This what you just described led to the Birmingham tests. I have a couple questions about those. I understand that they were continuous takeoff with the thrust for a single engine simulated by just pulling both engines back symmetrically.

A. Uh-huh.

Q. I think I know the answer but can you describe why it was done that way?

A. It reduces risk.

Q. Do you have a feel for what the thrust to weight ratios that were tested in Birmingham and how those compared to the thrust to weight ratio that was in place for the accident flight?

A. No. I do not.

Q. Moving on to Flight 088 we have talked about this a lot and Bill asked this question about all the discussions that were taking place and you mentioned there was a lot of discussion on scene with the team there. So I presume that included Mr. Ollenburg, Ms. Brimmeier and the others there, of course. Do you recall any details of the conversations say with Reece and Shelly about the event and what he talked about?

A. No.

Q. Now, I understand, I think it's pretty clear that we've acknowledged that it was an over rotation and that implies some flow separation, beginnings of a stall and that was what produced the roll event. What I am struggling to understand a little bit, maybe you can help fill in my understanding is that I understand the stick shaker was active for V_{MU} testing. Mr. Horne just showed me notes from a V_{MU} test where it actually went off. So I think that shows it was active at least for some V_{MU}s. Let me just ask; do you think it was active for 88?

A. No, I don't. I know that's an allowable technique and we had done it in earlier programs and I did not recall.

Q. But let's go with the presumption that it was active then if -- so what I'm wrestling with is if we had the beginnings of a stall event that produced a roll and commanded a roll but there was no stick shaker prior to that if that entered into the conversation those two facts were kind of discussed in the same context, that we had a stall event but no stick shaker. And, again, with the hindsight bias that Bill mentioned, that might have been an entry into looking at where stall was actually occurring compared to stick shaker settings. So the question, to get to the point is, did the activation of stick shaker or absence of stick shaker with Flight 88 enter into the discussions of that event?

A. I don't recall.

Q. You don't recall, okay. And how about when the conversation you had with Mr. Ollenburg about the adjustment of the stick shaker setting from .85 to .90 where you had concerns and then he presented the data that suggested there was still margin, the Flight 88 event was that mentioned or considered in that conversation?

A. We didn't revisit 088.

Q. In a previous conversation during the week we had with somebody the rotation technique prior to the Birmingham exercise and Roswell-2 I guess -- the rotation technique that was used in Roswell-1 was described as benign and that that might have been part of the difficulty in overshooting V_2. Do you recall that description of the technique as benign at any point?

A. Actually we used two different ones because Kent and I were out there at Roswell-1 and I used the technique that we had used previously with a rapid pull and then adjust to a pitch attitude and it was, Kent was using a little more gradient. So we were actually investigating at the time the technique to utilize. But then we weren't concentrating as much on the speeds when we were doing Roswell-1. It was mostly on the rotation technique and then to it to an attitude. So we weren't concentrating, in my recollection, on trying to hit a V_2 speed or a V_2 plus 10, V_{35} speed.

Q. So this characterization of you guys are rotating to benignly or something like that was never brought to your attention or discussed with you, to your knowledge?

A. No. We were up there, in fact, CTOs weren't even part of what we were doing the first trip out at Roswell except for trying to get initial investigation on techniques and what we are going to do. So that was what we had done on Roswell-1.

MR. O'CALLAGHAN. Okay. Thanks. Can we go off the record for a little bit?

DR. BRAMBLE: Uh-huh.

(Off the record at 9:33 a.m.)

(On the record.)

MR. O'CALLAGHAN. Let's go back on the record.

BY MR. O'CALLAGHAN:

Q. Mr. Howard, talking about Flight 132 I'm curious about the physical arguments or rationale by which a stall event on that flight was excluded and the conclusion that it was a lateral directional event was arrived at, the arguments by which that was deduced, if you will. Can you shed any light on that for me, please?

A. Sure. From what was relayed to me was that they looked at the data the angles that they got to, the information that they had on what the stall angle of attack would be and since they had not even gotten close to that there was still margin there and they excluded that from being a contributor to the roll off.

Q. And the conclusion that it was lateral directional?

A. Yes, from YAW damper -- from previous anomalous behavior with the YAW damper off.

Q. Thank you. So my last question is the one we have been asking everybody. This is the end of our fact gathering stage here most of it here on scene at Savannah probably. We have been talking to a lot of people this week and we really appreciate their help and their input.

MR. RAMEE: John, can I recommend that we defer that question until we go around the room because I want to step outside with the witness and come back and answer that question.

DR. BRAMBLE: It's fine with me.

MR. RAMEE: You will get a better answer I think.

MR. O'CALLAGHAN. That's fine.

DR. BRAMBLE: Mitch.

MR. RAMEE: Then you can go around the room 10 more times if you want based on his answer.

MR. GALLO: Unless you want to take a break now and continue.

DR. BRAMBLE: We might as well just end with it.

MR. GALLO: I might have some additional questions after you come back.

BY MR. GALLO:

Q. In reference to Flight 081, that was VMU heavy flight you have flown.

A. Uh-huh.

Q. Was there a knock it off AOA for that flight?

A. We were using pitch angles; I think we did come up with a knock it off pitch angle that would equate to an AOA because on those maneuvers you go to a pitch angle and then just hold that throughout the maneuver.

Q. Did you have a knock it off with 10.5 degrees AOA though, if you recall?

A. I don't know. We did both 20 and 10 flaps I believe on that one.

Q. I think the heart of the question is, to define a limit is the term knock it off typically used --

A. Yes.

Q. -- in the organization here?

A. Yes.

Q. Was it used in the subsequent flights like for 132 or -- I'm sorry, the ones that you have flown?

A. Yes. And knock it off, abort.

Q. So subsequent to 081 what was the knock it off limit was it AOA or was it pitch target that was briefed?

A. I don't recall.

Q. In the technique that you used for your takeoff technique, can you describe why you would not tough the control yolk but rather have your hands hovering above control yolk?

A. Me?

Q. Yes.

A. Just so it doesn't pollute any control forces as you are going down the runway because normally that's where they determine where the pilot input is for rotation is movement of the column. So then I would --

Q. Were you involved in the development of techniques using a step versus ramp input?
A. That was one that was discussed when we had Roswell-1. Kent and I kind played with them a little bit, the different techniques.
Q. Who originated that technique of step and ramp inputs?
A. We have been doing steps for, at least here from my understanding for a long time.
Q. So it wasn't something that was unique to this program?
A. No.
Q. Can you describe what the benefits of using a step versus a ramp in terms of capturing V_2 would be?
A. From a column input?
Q. Yes.
A. It's to, one is for repeatability of data. Another one is to get the input to the elevator and let it go on the actuator limits.
Q. Did you find one to be better suited than the other one?
A. We didn't go too much further down the ramp, only because of the repeatability process of that because if you do a ramp then it depends on if you do it by time and then you have variability of time input. Like you said, over a second that may vary from pilot to pilot. Whereas a step input is relatively consistent so that you could get consistent data.
Q. Do you think that's a technique that Ms. Shelly

Brimmeier knew about before field performance testing or did she learn of that through working with flight operations?

A. I don't know.

Q. During Flight 088 at the time of the wing drop or immediately after wing drop was there a lot of cockpit discussion with Mr. Ken Crenshaw about what occurred?

A. A lots is a subjective term. We discussed what happened and that's where it was an admitted over rotation and to have corrective technique for the subsequent maneuvers.

Q. Now, you attended the SRB for field performance testing on October 7. How were you invited to that meeting? What's the process. Do you just show up?

A. No, there's usually an e-mail invitation.

Q. Who sends that invitation out?

A. I don't know who sent that one out. Many times it's Barry McCarthy who's --

Q. And during the SRB can you describe what you remember of Reece Ollenburg's presentation during the SRB? What we have been told he created the slides to present. Do you remember what the topics of discussion were?

A. Well, it goes to what our objective was to go out there. It was a professional, thorough briefing SRB. As we went through that we went over the location that we were doing it, what we were going to do out there and then also then cover the TSHAs that we were going to comply with.

Q. During his presentation did anybody present that there was an in-ground effect stall during the GIV program, during the SRB?

A. I don't recall.

MR. GALLO: Why don't we could go off the record for a second because it might be easier?

(Off the record at 9:47 a.m.)

MR. GALLO: Let's go back on the record.

BY MR. GALLO:

Q. Referencing the slide from the October 7th SRB meeting GVI field performance - V_{MU} build up, the slide title is GVI Ground Effect, SDWT Data F20. Did Mr. Ollenburg describe how he got these values?

A. I don't recall.

Q. Did he describe how he discerned the free air and in-ground effect C_L versus AOA?

A. I don't recall if he mentioned that or not.

Q. Now, the other slide that I want to reference is under SRB Action Review, that one slide I have a question it says, FCC load 4. -- can you just read it?

A. The second bullet that's at the far left indentation?

Q. Right.

A. FCC 4.22 software on 6002.

Q. Correct.

A. Yes, what do you want?

Q. Under that bullet FCC 4.22 SW on 6002, under that it says stick shaker protect held feedback for the AOA limit to the aircrew. Do you recall that the stick shaker was going to be the defining AOA limit during that presentation?

A. Well, it is when we are doing maneuvers for the CTOs, we use stick shaker which is the PLI.

Q. It gets into another area, during the meeting you had regarding the change of the stick shaker from 0.85 normalized at .90, you mentioned there were two meetings. There was first a meeting and then you followed up in talking to Reece during a second meeting possibly.

A. I'm sure there were many more meetings than that, but we did reference the one at the RDC where the decision was made to go ahead and do that. And then mine were telephone conversations and with Reece talking about it. It wasn't a meeting necessarily.

Q. Did you have any discussions in a group or a meeting with Mr. Nathaniel Rutland regarding that change?

A. Even the meeting at RDC I had mentioned that, you know, changing that value encroached upon margin. So I don't know if Nathaniel was there or not and I don't remember if I specifically spoke with Nathaniel or not.

Q. But Mr. Reece Ollenburg was at that meeting; is that correct?

A. At the RDC?

Q. (Non-verbal response.)

A. I don't recall.
Q. We were told that Mr. Nathaniel Rutland said that he received a PR from Mr. Reece Ollenburg for the change from .85 normalized AOA .90 and he had a discussion and I'm wondering if during that discussion with Mr. Reece Ollenburg if you attended that also?
A. I don't recall attending that.
Q. When you discussed the change .85 normalized AOA to .90 normalized AOA did you understand the correlation and angle of attack degrees?
A. Did I understand the correlation --
Q. Yeah.
A. Yes.
Q. You did?
A. Yes. I don't remember exactly what that quantified value is, but yeah, I understand that there is a change in angle of attack.
Q. Did you realize it was approximately 33 percent change in angle of attack; if you go from .85 to .90 the correlated change in AOA is about a 33 percent change?
A. 33 percent change of what?
DR. BRAMBLE: Could we just go off the record?
(Off the record at 9:55 a.m.)
(On the record.)
DR. BRAMBLE: Let's go back on the record.

BY MR. GALLO:
Q. So the question is at that time, at that meeting that you had to discuss the change of .85 to .90 normalized AOA that translated into a 33 percent in the AOA margin from shaker to --
DR. BRAMBLE: 33 percent reduction.
BY MR. GALLO:
Q. -- 33 percent reduction of margin?
A. I didn't recall the quantified value at the time.
Q. Do you remember who the other participants were during this meeting?
A. The room was pretty full. I don't know all the participants that were there. Most of the flight control, flight sciences folks were in the room.
Q. Were you aware that Mr. Reece Ollenburg refined his in-ground effect stall AOA margin from 2 degrees to 1.6 degrees?
A. I don't recall that I know that.
Q. Can you describe what flight test techniques there are to determine the stall angle of attack on an airplane in-ground effect or ones that you have --?
A. You mean flight test techniques?
Q. Correct.
A. None that I know of. Usually you try not to define that value close to the ground.
Q. I believe you mentioned that the free air margin from stick shaker to stall was 2 degrees?

A. No, I didn't say that.

Q. What was that typical margin if you are in free air from stall to shaker?

A. It depends on where the shaker value is set because there is free air stall and then there is a margin between that and the alpha SR and they have gone back and forth and I don't know what it would -- depends on flap configuration also, which is a degree or maybe, I think at one time he went to a degree and a half or a half a degree. Then that sets normalized at 1.0. And then from that then you would have a shaker value at a certain other normalized and then that delta would give you the margin.

Q. So minimally it would be a degree in free air?

A. Oh, minimally it would be more than that, much more than that.

Q. So comparing that to the in-ground effect stall margin why would you go to a lesser value, if I follow the logic correctly of a 1 degree margin for shifting the shaker from .85 to .9?

A. Because you had more margin than that to the shaker. The 1 degree was only to 1.0 normalized. And then shaker was set at .85. So that gave additional angle of attack margin to stall and then subtract the decrement from the in-ground effect so that there was still margin available and then through their analysis said, okay, well, we can still reduce that by .05 and still have margin to stall.

Q. Do you think the use of normalized angle of attack is a unit that is easy to work with amongst the test team because in talking to Ms. Shelly Brimmeier and Mr. Pat Connor they did not know of the correlation of the change from .85 to .90 in terms of the reduction in AOA of approximately 33 percent?

A. You are going to have to ask the engineers on that one.

Q. Do you recall attending a meeting in RDC-1 after Roswell-1 or Mr. Obenshain was present, Mr. Henne was present, to discuss whether the airplane could capture its performance success criteria, the contractual ones such as V_2?

A. I could have been. I tend to go to quite a few meetings.

Q. In meetings you attend are there also test readiness meetings?

A. Test readiness meetings?

Q. Yeah, I think we were told that there were test readiness meetings and there was also change meetings, configuration change meetings possibly?

A. Yes.

Q. What's discussed in each of those meetings?

A. Well, test readiness meetings a lot of times it depends on, one is the airplane status the ones going out to Roswell, which was I believe the one today is logistically, how we are going to get everything coordinated. So it's a logistical status not only of the equipment, but also of where we are within the test planning process, instrumentation. That's a test readiness meeting.

Change board, if that's what you are bringing up, is a different meeting to determine whether or not some software/hardware component of the airplane should be changed or not.

Q. With the change in the shaker setting would that be presented in a change board?

A. It depends on where they are going. That one I think was just in a preliminary view readiness board, PRB, problem report review board. And so then it goes through that process and is investigated. I don't remember if it went to the change board or not.

Q. But do you remember this being presented to the problem report board then?

A. Uh-huh. That was the meeting I was referencing to that we went to and we decided, okay, yes, we will make the change.

Q. Do you remember who all attended that?

A. That's the one I said I don't remember everyone, but the room was full. Most of it Flight Sciences, flight control folks.

Q. Do you recall attending a meeting at RDC-1 the day before Flight 153 where Mr. Tom Lavrisa was present and maybe some other people?

A. I don't know.

MR. GALLO: I think that's all the questions I have.

DR. BRAMBLE: All right, Jeff.

BY MR. BORTON:

Q. Just a couple. Just trying to get an understanding for maybe Kent Crenshaw's experience with stalls in the 650, maybe what development flights he had done on that?

A. I don't know what Kent did on any of the aerodynamic stall maneuvers with this, but he had done some of the setting slide slips. He was with Scott Bussey when they had a, they were doing setting slide slip and had an event that was investigated but he was fully in one of the primary test pilots for the program.

Q. Obviously he had the roll off event in 88 with you.

A. Yes.

Q. I guess I am just wondering about the pass down maybe of the information from development work and stall characteristics, what this airplane was like to maybe the group in general, but also to Kent and his understanding of how the airplane stalled and best ways to recover, et cetera.

A. I don't know. There were the discussions on it. There wasn't anything formal that I know of, but we talked about the characteristics, which are relatively similar to previous Gulfstreams at low altitude on, in fact a little less violent, a little more benign on the roll off characteristics at lower altitude.

Q. So he was reasonably well versed in all that?

A. I think so.

Q. On the technique for what you -- and I realize this has development work that you are doing so you are kind of seeing where the boundaries are, seeing what works and then what you have to do to get it certified. It seems like, maybe you can correct me on it, but you are kind of using the PLI like a flight director in that you knew that's where your limit was and if you stayed below that in terms of shaker you would be okay. But were you, and I'm showing my ignorance of the cockpit and all that. But were you using either the heads down or heads up and the PLI, is that sort of function, you know, that's my cue for pitch or was there something else that was going on there?

A. I use heads down to third screen just because of scaling and everything else. And then use that for initial pitch target. And then the PLI doesn't come into effect until after you hit that and then you are approaching V_2 and then as you attempt to capture V_2 then you know that the PLI is your limit.

Q. The PLI is not up there all the time it only comes up if you get in a certain proximity --

A. Yeah, if your normalized AOA is above .7.

Q. Where I'm leading to is again into the takeoff techniques and what you are developing. I guess without, you know, without a flight director bars up there, obviously you just had your pitch, and you knew where you want to put it. The fact that, you know, there's known reduction in margins and maybe the use of -- and help me out -- what sort of build up or build down you used in, you know, getting close to where you thought the limits would be, making sure you didn't stall the airplane as best you could in terms of maybe rotation speeds, rotation speed increments, you know, variations in rates, you know. It seems like you were exploring all that. Was that -- I guess there's my real question. Was it somewhat left up to the individual pilot to work that out or was it worked out in a plan because I'm a little fuzzy on that?

A. Well, where we are getting the CTO or the entire plan is a buildup. You do the maneuvers appropriately to find out the numbers for the field performance like the CTOs. Then that's why we had done VMCG work already. We have done the VMU work. Those all look good. So then you continue through that and then you take the values from the wind tunnel and then they created the performance numbers that should work.

Q. I'm sorry to interrupt you. I just want to target on the rotation technique in terms of the variations you had.

A. Okay. So the rotation technique is bounded pretty much by the advisory circular that says, 75 pound pull is the max I can utilize. And so that is the limit. So then as you work into that then you start checking the speeds. But the speeds that were there that were given were to be the appropriate for that weight and CG through the analysis. So, you know, we work with the most conservative, with a high trust and the flap settings and then we go from there. So, yeah, there is a buildup or builddown technique, whichever way you want to specify it.

Q. Do you think, I was under the impression Kent was using more of a ramp input for what he was trying to do, but you think it was more of a step in terms of what the agreed-to technique that you were after?

A. That's somewhat subjective too. Whether it was a, you know, if it's within a half second is that still considered a step input or is that a half second ramp? Now, what we were doing is continue looking at pull forces and seeing is, you know, a 60, 65 too much. So there was maybe some adjustment there to see the impact and the effect. So, yeah, it was still in development.

Q. At the end of the day, you know, you have to get certified so the variations that you might see out in the field in terms of how people do it, the variation rates and all that. How were you expecting to work all that out in terms of, you know, you -- it seemed like you had a pretty set force input and you were targeting at the high end of the rotation rates in terms of what's normally done for rotation. Were you expecting that to find that sweet spot and then work that out?

A. That's the objective to find that and then you publish that information on how the information is developed within the flight manual. You know, use this technique to get the values that are there. And then, of course, when we go to certification the FAA pilot will fly them and then he will make also his comments on whether or not it', you know, requiring exceptional pilot technique or skill.

MR. BORTON: All right. That's all the questions I have.

DR. BRAMBLE: Tom?

BY MR. HORNE:

Q. Were you aware prior to the accident of the difference between the V_2/V_{SR} speed schedule that evolved from the GIV/GV time frame to the GVI time frame.

A. Pat Connor had showed some of the plots on that.

Q. Before the accident?

A. Yes.

Q. So were you aware that it had moved down to FAA minimum of 1.13, V_2/V_{SR}?

A. I don't recall the value.

Q. Going back to the meeting where the .9 was decided I understand that was in the PRB?

A. To the best of my recollection it was.

Q. So I kind of know who the individuals are who were there, but my question specifically was did Kent know that it had been changed to .9?

A. I know there was a discussion. I couldn't say specifically when but --

Q. Kent wasn't in the meeting?

A. He was not in the meeting that I can recall.

Q. But you think there was a subsequent discussion with Kent that it had been moved, are you sure or you are unsure?

A. I don't know.

Q. What about were Randy and Barry McCarthy briefed on the change?

A. I don't recall.

Q. That's Randy Gaston and Barry, co-chairs of the SRB.

Probably ought to give you this plot, which is a plot provided by Nathaniel Rutland that's labeled Flaps 10 alpha schedule Roswell-2. This was developed after the accident and it's an attempt to explain where the shaker settings were the .9, .85, and also the 1.6 degree in-ground effect decrement. So mainly my question is going to focus on the line that shows the alpha CL max, the stall alpha, free air and then the decrement that was applied to that for in-ground effect and then line is the .9 shaker line and that's the .85 shaker line. And this is the mock number for the accident run 7A2.

So my question is I think earlier you said that you were not aware that Reece did his own calculation of what the decrement and in-ground effect stall angle was based on the VMU testing.

A. I didn't recall that he had moved to 1.6, that I know of. And I could have, he could have shared that with me.

Q. So taking the predicted stall angle at 14.6 if I remember right at those conditions.

A. Okay.

Q. And subtracting the 1.6, you get about 13 degree stall in-ground effect. And then the shaker was set to go off, it looks like at about .6 degree margin?

A. Yeah, 12.4, 12.3.

Q. Were you aware that moving the stick shaker from .85 to .9 reduced your stall margin in-ground effect down to a value of .6 degree?

A. Like I said, I didn't remember the quantity. That's why I made the -- I did have the concerns and Reece went through the numbers and said, it's good. So I did express concern about changing it.

Q. Of course, if you use the original estimate of 2 degrees you would be down to about a .2 degree margin?

A. Yeah.

Q. Having known that -- if you had known that -- I guess this is a subjective question too, but your opinion now if you had known how close those were --

MR. O'CALLAGHAN. Are you talking about the .6 or .2?

MR. HORNE: Either one.

BY MR. HORNE:

Q. Would you have still used the PLI as the limit during rotation pace?

A. The PLI wasn't used during the rotation. It was mostly used during the climb out phase. The rotation phase was just to set angle until you started to capture the V_2 and then you would use the PLI. But still it's close margin and this is still on the ground, you know, taking in-ground effect as opposed to no gamma supposedly. It was briefed. There was no gamma to it and you are right on the ground as opposed to any climb outs. So getting away from the ground, of course, that increases the margin.

Q. Okay. So the PLI wasn't really a limit during the initial rotation?

A. No, but --

Q. You had to be airborne before you could use the PLI?

A. Right. Because you would go to the angle and then start to use the PLI as you continued to rotate to capture V_2 and then climb out at V_2.

MR. HORNE: Okay. Thanks. That was it.

MR. RAMEE: I was going to go chat with him and then answer the big question too.

DR. BRAMBLE: Off the record.

(Off the record at 10:15 a.m.)

DR. BRAMBLE: Back on the record.

BY DR. BRAMBLE:

Q. One of the things we are asking everybody is given that you have had time to think about the accident and it has been on your mind a lot and you have intimate knowledge of the program and to a certain extent -- did you work on the post-accident SRB?

A. I was involved in, yes.

Q. We would be very interested to know if you have any suggestions for things that we should look at that we aren't already looking at or if there are any things that you think it would be good for us to use our podium for to broadcast to the industry, recommendations or improvements in the way that manufacturers could conduct programs to improve safety.

This is basically your chance to just pass on any suggestions that you may have.

A. In my involvement with you all's investigation seems like you all have been very thorough and touching all of the points. Of course, in retrospect it is the data, you know, as engineers there is never enough data and if we had had more of the data, more of the analysis for the in-ground effects would have been very beneficial because then we could have revised a lot of the things using that information to develop different techniques, procedures or performance values.

Q. Anything else?

A. Not that I can think of.

Q. Is the Company doing that now going forward?

A. Yes. As I mentioned we have put into place some, we broadcast more any abnormal flight events, even to the point where we also share it with Atlanta ACO and come to a resolution. And then reinforce the importance of data.

DR. BRAMBLE: Thanks very much.

(Whereupon, at 10:33 a.m., the interview was concluded.)

CERTIFICATE

This is to certify that the attached proceeding before the

NATIONAL TRANSPORTATION SAFETY BOARD

IN THE MATTER OF:	AIRPLANE ACCIDENT ROSWELL, NEW MEXICO N652GD Interview of Jake Howard
DOCKET NUMBER:	DCA11MA076
PLACE:	Savannah, Georgia
DATE:	October 27, 2011

was held according to the record, and that this is the original, complete, true and accurate transcript which has been compared to the recording accomplished at the hearing.

Letha Wheeler
Official Reporter/Transcriber

UNITED STATES OF AMERICA

NATIONAL TRANSPORTATION SAFETY BOARD

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Investigation of: *
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AIRPLANE ACCIDENT *
ROSWELL, NEW MEXICO * Docket No.: DCA11MA076
N652GD *
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Interview of: HAROLD "CHIP" KING

Gulfstream Corporation
500 Gulfstream Road
Savannah, Georgia

Thursday,
October 27, 2011

The above-captioned matter convened, pursuant to notice, at 1:56 p.m.

BEFORE: WILLIAM J. BRAMBLE, JR., Ph.D.
Senior Human Performance Investigator

APPEARANCES:

MITCHELL GALLO
Air Safety Investigator
National Transportation Safety Board
31W775 North Avenue
West Chicago, Illinois 60185

WILLIAM J. BRAMBLE, JR., Ph.D.
Human Performance Investigator
Office of Aviation Safety
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

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ALAN J. (JEFF) BORTON
Flight Test Pilot
FAA Aviation Safety
Aircraft Certification Service
Wichita Aircraft Certification Office
1801 Airport Road - Room 100

THOMAS M. RAMEE, ESQ.
Deputy General Counsel and Risk Manager
Gulfstream Aerospace Corporation
500 Gulfstream Road, M/S B-06
Savannah, Georgia 31407

TOM HORNE
Experimental Test Pilot
Gulfstream Aerospace Corporation
P.O. Box 2206, M/S A-12

APPEARANCES (Cont.):

JOHN O'CALLAGHAN
Aircraft Performance Group Chairman
Vehicle Performance Division (RE-60)
Office of Research and Engineering
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

-

MICHAEL BAUER
Aerospace Engineer
Vehicle Recorder Division (RE-40)
Office of Research and Engineering
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

E. LORENDA WARD
Air Safety Investigator
IIC and U.S. Accredited Representative
Office of Aviation Safety
Major Investigations (AS-10)
National Transportation Safety Board
490 L'Enfant Plaza East, SW

MARIE MOLER
Mechanical Engineer
Office of Research and Engineering
Vehicle Performance Division
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

I N D E X

I N T E R V I E W

(3:27 p.m.)

INTERVIEW OF HAROLD "CHIP" KING

BY DR. BRAMBLE:

Q. Chip, if we could start by getting your full name, or at least your first, middle initial and last.

A. Okay. Harold is my first name; S is the middle initial and King is the last name. I go by Chip and known as Chip at Gulfstream.

Q. Okay. And what was your date of hire at Gulfstream, or at least month and year, if you can remember?

A. July of 2002. Maybe August, first of August 2002.

Q. And your current position?

A. Senior production test pilot.

Q. And the office and department that you're in is?

A. 926. I work for John O'Meara and John Salamankas.

Q. Do you still work for John after his change to the new role, John Salamankas?

A. John Salamankas? Well, I don't -- maybe not. Actually, we all do, right? He's the head safety guy now. I think he's still in the office. I'm not sure what his status is right now.

Q. Okay. And, so, we understand that you did some experimental test flying in the G650 program the week before the accident. Had you worked on other previous flight test programs, developmental flight test programs?

A. At Gulfstream? Well, the 450. I was involved in the 450 performance stuff also out at Roswell. And then I'm a retired military aviator and I've done some operational test stuff at VX9.

Q. What's VX9?

A. It's a fixed-wing fighter test squadron out on the West Coast at Point Mugu, mostly weapons and operational test weapon systems.

Q. Okay. And your primary duties and responsibilities here at Gulfstream are what?

A. Primary is production test flying. I'm also the formation lead guy responsible, or manage that program. I do experimental tests as well, company developmental-type stuff. Did some stuff involved with the G150 steep approach and EVS company testing. And then, what I did with the 450 on the performance with Jake.

Q. Was it field performance?

A. Field performance, yes.

Q. Okay. And did you do any field performance flying in the G650 program prior to that week before the accident?

A. I think Jake and I went out for a 3- or 4-day period and I don't remember the specifics of it -- out to Roswell prior to going out to Roswell-2.

Q. Okay. All right. During your pre-flight briefings for the field performance flights, how were AOA margins discussed? Was it in AOA degrees or normalized angle of attack for -- I guess

I should specify -- for takeoff-related testing?
A. Well, I don't remember specifically. Both terms were discussed.
Q. And did you do takeoff-related testing?
A. Did not do -- I did primarily the landing performance stuff. We did some engine margin, lapse rate stuff where we actually practiced or we, you know, looked at the techniques which on the engine lapse rate required pulling an engine back to maintain a comfortable attitude while measuring the other engine at MCT thrust.
Q. Okay. And the week before the accident when you were flying aircraft 6002, what understanding did you have of the margin between stick shaker and aerodynamic stall in or out of ground effect?
A. It wasn't discussed about the ground effect. Did not talk about ground effect. But it really didn't affect the things that we were doing as far as the performance landings.
Q. And how about the free air margin between shaker and stall and aerodynamic stall, did you have a feel for that?
A. No.
Q. Did you know anything prior to the accident about changes in predicted stall margins that might have occurred in the 2 or 3 months prior to the accident?
A. No.
Q. And how about changes made to shaker settings for

aircraft 6002 during the field performance test program during that period?

A. Roswell-2?

Q. No, between Roswell-1 and Roswell-2?

A. No. I know there were some adjustments to speeds and the varying flap settings, which obviously is going to affect your stall margin, but I wasn't involved in any of those. So I don't think it's -- I was aware, but again I wasn't involved in it.

Q. All right. Were you aware of the wing drop events that had occurred on flights 88 and 132?

A. Yes.

Q. Prior to the accident?

A. Yes.

Q. And what was your understanding of the cause prior to the accident?

A. I don't know about 88. I think there was some attributed to the fact that they didn't have the yaw damper, and they just knocked off that type of testing after that until they got the yaw damper back. So I'm not sure of the exact cause, was not aware of the cause.

Q. Okay. And 132?

A. I'm sorry. 132 is, I think -- isn't that 132 the one where the yaw damper --

Q. Yeah.

A. Yeah. So that is the one that I was talking about.

Don't know why on 88, and just know that they didn't continue any testing after that, and I'm not sure if it was attributed to the yaw damper, or whatever. I guess they weren't comfortable with not having the yaw damper after that event.

Q. All right. Did you participate in any meetings where either of those events was briefed?

A. No.

Q. Okay. Did you ever see the external video for Flight 132?

A. No.

Q. Did you hear anything prior to the accident about nuisance stick shaker activations during field performance testing?

A. No.

Q. Did you hear anything about stick shaker activations occurring during performance takeoffs at all?

A. Yes.

DR. BRAMBLE: Off the record, please.

(Off the record.)

(On the record.)

BY DR. BRAMBLE:

Q. Okay. Can you describe the context of those events, what you had heard?

A. Nothing specifically. It probably was the result of 132, Flight 132. But again, it wasn't tied to any one specific event. We had some events on the performance landings where the -- we had some airspeed excursions of like 3 to 5 knots. As the thermals built it got a little bumpier, but nothing specifically.

Q. So you had some events where the stick shaker activated on landing when it was bumpy?

A. Not on landing, but in the approach.

Q. Okay.

A. Maybe changing configurations.

Q. Was there any discussion about whether or not the shaker setting should be changed?

A. Not that I'm aware of.

Q. Okay. Do you recall any difficulties the week before the accident achieving the target touchdown speeds during the performance landing?

A. The target touchdown speeds?

Q. Um-hum.

A. As I mentioned earlier, yes. We had a couple of 3- to 5-knot excursions, but it seemed to be just prior to knocking off testing later in the day.

Q. Oh, the excursions were for the touchdown speed? I missed that.

A. We're targeting a touchdown speed and on the approach, normally crossing the threshold, you know, as we got over the runway area where the heating built up, the airspeed was plus or minus 3 knots occasionally.

Q. Okay. And do you recall having to repeat tests because of that?

A. Yes.

Q. How many times?

A. I don't recall. You know, maybe twice. Certainly no more than -- I don't remember doing it any more than three times. I think if we had to do it more than twice, we were done for the day.

Q. Okay. Do you remember anyone saying, you know, what; we're going to stop here because even if we haven't achieved the landing criteria exactly, we're not going to do any more of those?

A. We stopped because the environment wasn't conducive to continue testing, not because we were -- just because the environment wasn't conducive to testing.

Q. Okay. Do you remember who made that decision?

A. I think it was a collaborative decision, discussion, amongst the crew and confirmed with the FTEs.

Q. Do you recall whether Paul Donovan played a role in that decision?

A. No, he didn't.

Q. And were there any objections from personnel in the trailer?

A. No, none.

MR. BAUER: Bill, can we maybe just clarify something?

BY MR. BAUER:

Q. Was telemetry involved in any of the testing hat you did that week?

A. Yes. They were in the trailer monitoring, yeah.

Q. So TM was involved?

A. Yes.

Q. Okay.

A. Valerie and Cindy, I believe, were in the trailer.

BY DR. BRAMBLE:

Q. Okay. All right. One of the things that we were hoping you might be able to help us with is to provide any information that you might have about Mr. Crenshaw's activities in the 3 days or so prior to the accident. Because he wasn't home, we don't have your normal sources of information from spouse or that sort of thing to sort of try to document sleep and off-duty activity. Can you recall -- I guess we could start with the day of the accident. Do you recall when you first saw him?

A. I was relieved on Friday by Vivan, so I left Friday to go home on the 200.

Q. Oh, right, right.

A. So I was not there Friday night.

Q. Okay.

A. I was there for the week. I think he arrived on Monday, if I'm not mistaken. He flew into Albuquerque commercially and then drove down, and I think it was Monday. I'm not 100 percent sure of the day.

Q. Okay.

A. I had been there for a week previous to his arrival flying with Gary. And for some reason, I remember Kent showing up Monday afternoon around 1:00, after lunch, and I think he may have even flown that afternoon, but I'm not 100 percent sure. Again, I'd have to go back and look.

Q. So that was several days before the accident?

A. No, he didn't fly. I think we briefed the next morning's card, but I'm not 100 percent sure. That's how I think I remember it.

Q. Okay. So the accident occurred on Saturday?

A. At 9-something.

Q. And you left on Friday?

A. Yes.

Q. And so I guess you're saying he arrived the previous Monday and then --

A. So we had Monday night, Tuesday, Wednesday, Thursday together. And we went out to eat -- you know, we drove to and from every day. We went out to eat on at least three of the four nights. I think there was one night that we didn't go out to eat together.

Q. Which night was that?

A. I'm not 100 percent sure. Yeah, I think it might have been Wednesday or Tuesday, but again I'm not 100 percent sure.

Q. Okay.
A. We were pretty much -- we knew we had early mornings, so we -- personally, I tried to stay on East Coast time because it made it easier to get up early in the morning. So we were, no kidding, done with dinner no later than, I want to say 8:00. And usually, we'd go straight from dinner back to the hotel and go our separate ways. So after, I would say, 9:00, I have no idea what his sleep pattern or anything like that was like. Every morning he appeared very well rested so I'm assuming he got a good night's sleep. We'd meet downstairs and grab whatever the hotel had there for breakfast and coffee, then drive in together.
Q. Okay. And so, what time were -- did Kent say anything about what time he was waking up in the morning?
A. No. No.
(Asides.)
BY DR. BRAMBLE:
Q. All right. And did he mention what time he was going to sleep at nights?
A. No. No, he didn't.
Q. And how about alcohol, did he --
A. None.
Q. All week?
A. As far as I know. Not in front of me.
Q. And did he mention whether he was taking any medications?

A. No.
Q. And did he mention how he was sleeping?
A. No.
Q. Did he exhibit any symptoms of health-related problems?
A. No, not at all.
Q. Did he mention whether he had any problems with allergies?
A. No.
Q. Okay.
A. We talked about -- he had had a period of time where he felt like he had lost some of his sense to smell and we talked about that. But, I don't know, that might have precluded the allergy thing. So, I don't know.
Q. Okay. And did he mention any undue stress in his home life?
A. No. He was very -- seemed very happy, very content. He had a plan. On Thursday -- I can tell you one specific that I can remember very well. He was paying his mortgage and he was talking about how he had -- you know, they had a period of time that they were going to have it paid off and he was very content and very comfortable with it.
Q. And what's your sense of the safety culture at Gulfstream compared to past places you've worked?
A. My only experience prior to this was military. I thought we had a similar safety culture. We're all predominately

made up of military aviators. I thought it was good and I still think it's very good.

Q. And prior to the accident, what managers or executives at Gulfstream played a significant role in managing safety?

A. John O'Meara, all of our leadership at Gulfstream. I know Randy Gaston was -- the ultimate irony is we had just had a safety standdown, I think, the week or so prior. Or we had had a discussion about it maybe a week or so prior. Some of it was related to something that occurred in Appleton, but I think even before that accident there was a period where we had an all pilots meeting and it was predominately -- I can remember Randy briefing a mishap from the Air Force. I think it was the B1 test program of a specific accident. We basically dissect the anatomy of an accident and how the events can build. So I think it was good. Randy Gaston, John O'Meara, John Salamankas, all of our leadership. And that's on the flight ops side.

Q. And how about on the flight test side?

A. Again, flight ops, flight test. The FTE side, I'm not familiar with. So when I say flight ops, I'm speaking of flight test and flight --

Q. Um-hum. Okay.

DR. BRAMBLE: All right. You got anything Marie?

MS. MOLER: I do.

BY MS. MOLER:

Q. When you were working on the 450 program and doing

performance work, did you do takeoff work then?
A. Yes. On the company developmental, yes.
Q. Right. And when you were doing that takeoff work, did you ever find difficulty meeting the V_2 and V_r speeds that were set?
A. No.
Q. Okay. So during this program did any of the other pilots who would do takeoff work, did they ever express to you that they were having difficulties meeting the V_2 speeds?
A. No.
Q. Okay. If they had brought that up to you, theoretical, would that have struck you as being somewhat unique?
A. No, because it was a completely new designed aircraft. No, I don't think it would have.
Q. Okay. I know that you had stated earlier that you didn't have a lot of experience with the shaker, but -- again this is another theoretical question. I'm just kind of trying to get a pilot's perspective on this. If you were doing takeoff testings, especially if you used your higher risk takeoff testing, would you expect the shaker to be on and, therefore, as kind of a limit?
A. Would I expect the shaker to be on? I'm not sure I understand what you're saying.
Q. During our discussions you said that sometimes the shaker isn't necessarily activated for some of the V_{mu} testing, or people are unsure whether or not it is.

A. I'm not --

MR. HORNE: Can you clarify?

DR. BRAMBLE: Let's clarify, yeah.

MR. HORNE: Okay. I think the question you're trying to ask is would the shaker have been enabled?

BY MS. MOLER:

Q. Well, that's one question, but I'm just -- my thing was would you be expecting the shaker? Would you have in your mind that the shaker would be --

A. For this type of testing?

Q. Um-hum.

A. Yes, it would have been.

MR. HORNE: I still don't know if you asked the right question.

MS. MOLER: Okay.

MR. HORNE: Are you asking him would you expect the shaker to come on during the maneuver?

MS. MOLER: Yes.

MR. KING: Oh, no.

MS. WARD: If it failed?

MS. MOLER: Well, no, that actually isn't quite the question I was asking.

BY MS. MOLER:

Q. I was just asking if there was an expectation that you could use -- that the shaker was a tool that you had, to know --

A. That would be functioning?
Q. Yeah.
UNIDENTIFIED SPEAKER: That it would be operational.
DR. BRAMBLE: Yes, operational.
MR. KING: That would be yes.
MS. MOLER: All right.
DR. BRAMBLE: Anything else?
MS. MOLER: No. Thank you.
DR. BRAMBLE: Mike?
BY MR. BAUER:
Q. For the testing that you participated in the week prior, what was -- do you happen to remember the risk level assigned to those tests?
A. I did usable fuel testing, which I think was a medium risk. We did performance landing; I think was medium risk because of single hydraulics. Engine lapse rate. I believe that was medium risk as well because we did some of that at Telluride at a high altitude. I think it's all medium risk.
Q. Okay. For that testing, was it your belief if telemetry was required or not required, the use of telemetry?
A. Telemetry was not required, I don't think, for the engine lapse rate. It was not required for usable fuel, but it was for the performance landings, I believe. That's my understanding.
Q. Okay.

A. Or my belief.

MR. BAUER: That's all I have.

DR. BRAMBLE: Mitch?

BY MR. GALLO:

Q. You mentioned that Mr. Kent Crenshaw indicated to you that he had a loss to the sense of smell. Did he describe what that was attributed to?

A. We had one of the aircraft, test aircraft, was emanating an odor and people were complaining of it and Kent had attributed it to that.

Q. And did he ever describe which aircraft and the circumstances, if you know?

A. No. He never described that to me. I mean, I know because I was involved in the testing and I know which airplane it was.

Q. So which airplane was it?

A. 6003.

Q. And what period of time did that occur?

A. I don't remember. It was during the early stages of some of the anti-ice stuff they were doing.

Q. When you're doing landing tests, you indicated a plus or minus 3-knot excursion approaching the runway surface?

A. Right.

Q. Can you tell me what that was attributed to?

A. Air quality. The limit for the test is plus or minus 2

knots and it's 3 to 6 foot per second rate of ascent.
Q. Did anybody indicate that may have been attributed to probe error or display error?
A. No.
Q. And during that testing how many times would you repeat a card? How many runs per card, if you can remember?
A. Like I said, it was probably maybe twice and if it got to that point where we're having to look at it more than that we -- you know, the air quality was deemed undesirable and we would knock off testing.
Q. You said that the decision to discontinue testing was a collaborative decision, but who initiated the suggestion to stop testing?
A. I don't know if it would be an initiation of let's stop testing or if it was, god, you know that was a difficult point, you know, plus or minus. You know, I'm just doing everything I can do back and forth, back and forth. And then it was like whoever was in the left seat, probably -- it was probably Kent or myself said, you know, it's probably time to knock it off.
Q. Who initiated the discussion to knock off testing?
A. It was collaborative. I don't know any other way to discuss it. As a crew, we're talking about how difficult it is to maintain the target and --
Q. You mentioned you had done some takeoff performance testing?

A. Yes.

Q. What is your comfort factor in terms of margin between in ground effect stall AOA and shaker without a pusher limiter active? In terms of degrees.

A. I don't know if I've ever given that any consideration, to tell you the truth, with consideration to ground effect. The performance stuff that I've done in takeoff was on the 450, which was not a new type design as far as wing goes. So there was a certain amount of comfort level with that to begin with because of the increased engine thrust.

MR. GALLO: That's all the questions I have. Thank you.

DR. BRAMBLE: Jeff?

BY MR. BORTON:

Q. Just back to your landing performance. Just to make sure I have the description right. You were hearing intermittent shakers, then you were trying to do the flare, reducing air quality?

A. No, no, no, not in the flare. Usually it was during a transition, you know, making a configuration change, either bringing the engine back, configurations maybe using the speed breaks and nibbling at shaker occasionally. But the airspeed changes were usually crossing the threshold or in the overrun where the thermal or the heating would affect the air quality.

Q. Did you all squawk that as a -- you know, the intermittent shakers, how would you treat that? As a squawk?

A. No. We didn't squawk it. I think the discussion was that it was a air quality issue. Because we'd go out there first thing in the morning and it would be dead-on, plus or minus a knot. It was a noticeable difference as it got later in the day.

Q. Back to kind of a culture question. It seemed like you all as pilots would have semi-regular means to talk about different safety topics, et cetera. We're familiar with Kent Crenshaw's presentation about Flight 88 and what happened there. Was there any kind of discussion about the 132 events in terms of just maybe pilot meetings or anything like that?

A. No. Because I think that happened fairly close to the accident.

Q. There really wasn't the time to --

A. And the only people involved were the people that were going in and out of Roswell, so no.

Q. And then I forget your answer. There was a pass-down in terms of your knowledge, though, about what happened on 132 since you were involved a little bit on that?

A. Yes. Only because my -- you know, the way it was set up, for continuity purposes, you didn't ever swap both people out at the same time. So there was always a continuity of one guy who's "been there, done that" kind of thing. So Gary was the guy that I was flying with a week preceding my time with Kent. And there was some discussion with Gary and I that we talked about it, because some of the things that we were doing on the engine lapse rates when we were pulling the engines back, we were very conscious of the angle of attack and airspeed at that time.

Q. Are you referring to you and Gary talking about 88 or 132?

A. 132.

Q. Because 132 happens with Gary and Vivan after you've left. No, I guess it's before you left.

A. No, it was before. No, I relieved Vivan.

Q. Okay.

A. And then it happened --

Q. He came back and relieved you again?

A. Right.

MR. BORTON: Those are all my questions.

BY MS. WARD:

Q. Did you say that you had flew with Mr. Crenshaw on both Thursday and Friday?

A. No. Yes, actually we did. We flew Friday morning.

Q. At any of those recent flights did he express any concern about the field performance testing?

A. No. Not to me.

Q. Okay. When you were flying with Gary the week before, did he mention to you any of his concerns about any of the speeds?

A. About the speeds? No, Gary did not.

Q. No? That's all I have.

DR. BRAMBLE: Tom?

BY MR. HORNE:

Q. If I heard right you said, when you were doing lapse rate testing you and -- or Kent, I guess, was practicing takeoff technique?

A. It was Gary and I doing the lapse rate.

Q. Did you and Kent during that week practice the takeoff?

A. Any takeoff? No, we did not.

Q. So you didn't practice it?

A. No.

Q. Okay. Do you happen to know what the shaker normalized angle of attack setting was the week you were there? When they would come in, in normalized angle of attack?

A. I think it was 15 or 13. I don't remember exactly.

Q. You know, AOA, right, no point -- whatever.

A. Oh. I don't remember exactly. No.

Q. Okay.

MR. HORNE: That's all I have.

DR. BRAMBLE: All right. Marie, anything else?

MS. MOLER: I'm good.

DR. BRAMBLE: Mitch? Mike, do you have anything else?

I guess you weren't here to hear what was preceded, so I let Jeff -- Lorenda? Okay. I think we're done.

MS. MOLER: No. Closeout.

DR. BRAMBLE: Wrap up the questions. All right. That's usually John's job. John's gone.

BY DR. BRAMBLE:

Q. Okay. What we've been asking everybody, given your closeness to the process and your expertise with the program is, whether you might have any suggestions for things that we might look at that we might not already be looking at, or any recommendations for improvement for how these programs are conducted that we might make to the industry-at-large?

MR. RAMEE: Let's step outside for a minute. I am going to brief you on this one.

MR. KING: Yeah.

(Off the record.)

(On the record.)

MR. KING: The answer to the first part of that question would be, I don't think there is anything. I think some of the things that we've implemented since the accident, as far as the safety program, the initiatives that -- or going back and reviewing the performance data with the performance team, the fire suppression that we're putting on 6 hours in one before going out and conducting the remainder of the performance testing. I just think that the whole culture at Gulfstream has been made aware and the overarching -- the voice that John Salamankas will have in his position, straight to the leadership now, will be beneficial for the future of the safety of the flight test program.

DR. BRAMBLE: Anything else?

MR. KING: No.

DR. BRAMBLE: Okay. Thank you, then. Thank you, Chip.

MR. KING: Thank you.

(Whereupon, at 4:24 p.m., the interview was concluded.)

CERTIFICATE

This is to certify that the attached proceeding before the

NATIONAL TRANSPORTATION SAFETY BOARD

IN THE MATTER OF:	AIRPLANE ACCIDENT ROSWELL, NEW MEXICO N652GD Interview of Harold "Chip" King
DOCKET NUMBER:	DCA11MA076
PLACE:	Savannah, Georgia
DATE:	October 27, 2011

was held according to the record, and that this is the original, complete, true and accurate transcript which has been compared to the recording accomplished at the hearing.

Letha Wheeler
Official Reporter

Vanita Tildon
Transcriber

UNITED STATES OF AMERICA

NATIONAL TRANSPORTATION SAFETY BOARD

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Investigation of:                  *
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AIRPLANE ACCIDENT                  *
ROSWELL, NEW MEXICO                * Docket No.:  DCA11MA076
N652GD                             *
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Interview of: THOMAS LAVRISA

Gulfstream Corporation
500 Gulfstream Road
Savannah, Georgia

Wednesday,
October 26, 2011

The above-captioned matter convened, pursuant to notice, at 1:55 p.m.

BEFORE: WILLIAM J. BRAMBLE, JR., Ph.D.
Senior Human Performance Investigator

APPEARANCES:

MITCHELL GALLO
Air Safety Investigator
National Transportation Safety Board
31W775 North Avenue
West Chicago, Illinois 60185

WILLIAM J. BRAMBLE, JR., Ph.D.
Senior Human Performance Investigator
Office of Aviation Safety
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

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ALAN J. (JEFF) BORTON
Flight Test Pilot
FAA Aviation Safety
Aircraft Certification Service
Wichita Aircraft Certification Office
1801 Airport Road - Room 100

THOMAS M. RAMEE, ESQ.
Deputy General Counsel and Risk Manager
Gulfstream Aerospace Corporation
500 Gulfstream Road, M/S B-06
Savannah, Georgia 31407

TOM HORNE
Experimental Test Pilot
Gulfstream Aerospace Corporation
P.O. Box 2206, M/S A-12
Savannah, GA 31402-2206

APPEARANCES (Cont.)

JOHN O'CALLAGHAN
Aircraft Performance Group Chairman
Vehicle Performance Division (RE-60)
  Office of Research and Engineering
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

-

MICHAEL BAUER
Aerospace Engineer
Vehicle Recorder Division (RE-40)
  Office of Research and Engineering
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

E. LORENDA WARD
Air Safety Investigator
IIC and U.S. Accredited Representative
Office of Aviation Safety
Major Investigations (AS-10)
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

MARIE MOLER
Mechanical Engineer
Office of Research and Engineering
Vehicle Performance Division
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

I N D E X

I N T E R V I E W

(1:55 p.m.)

DR. BRAMBLE: Can we get your full name, please?

MR. LAVRISA: Thomas Peter Lavrisa.

INTERVIEW OF THOMAS LAVRISA

BY DR. BRAMBLE:

Q. And what's your date of hire with Gulfstream, or month and year, or even just year if it's --

A. Well, I started here in 1984, in March of 1984. At the time I worked for Grumman Aerospace, and I was loaned out to Gulfstream to support the GIV program. I was here for about a year-and-a-half, and then in -- let me see. In '86 I got offered a full-time job here at Gulfstream. That's really my -- my start date was 1986. I worked here from '86 to 1991 on the GIV program, and then I left for 5 years. I worked at Saab Aircraft, Saab Aerospace out in Sweden for 2 years on the Saab 2000 program in their flight test program. That was from '91 to '93, and then in '93 I left Saab and worked at Lockheed in Marietta, Georgia on the C130J. And then in 1996 I came back here to Gulfstream to work on the GV in the propulsion engineering department. My official start date, when you add it all up, is 1989.

Q. And so you mentioned that you worked on the GIV program, and what other Gulfstream certification programs have you worked on?

A. On the GIV I worked in the -- started off in the propulsion engineering department. I was loaned out to flight test, and I worked in propulsion engineering on the GIV flight test program. After that, I left. The other certification programs I worked on was the GV when I came back, the G450, the G550, and the G650.

Q. And any of those programs -- on any of those programs were you intimately involved with the field performance testing prior to G650?

A. No, I wasn't. I was at Roswell several times during the field performance tests, but my role was doing propulsion system analysis, working -- making sure there was no issues with the engines, doing thrust labs, and engine margins assessment.

Q. All right. What are the aero and performance groups' responsibilities during a field performance flight test program? The aero performance -- Shelly Brimmeier and Connor's --

A. Aircraft performance group. Okay. Their responsibilities, at least up to date on the G650 program, has been to participate in the test as DERs. They agree to the test plan and approve all the test points. They observe the test, they witness the tests, and they confirm that the test points were flown correctly. From that they will -- it's a shared responsibility that some of the flight test data gets analyzed, gets passed back to the performance group, and then from that analysis of data, they'll create the flight manuals.

Q. All right. And so who is the head of the -- Were Shelly

Brimmeier and Pat Connor like joint heads, group heads of the airplane performance group?

A. No. I guess maybe I need to backtrack a little bit. I came onto the program. I was in propulsion engineering. They asked me to be the PDT lead, product development team lead for the 650 program. At that point we had a core group, and then we would farm out people to the work program, so I -- from there I created a team, and from that team Shelly Brimmeier was chosen to be the head of performance for the 650. She was fairly new to the company. Probably been here about 5 years or so. Pat Connor was the -- was kind of the lead performance engineer in that group. He was the DER. Shelly at that point was not a DER when she got assigned to this program. I worked with her for -- since 2005, and she's been underneath me since then. She got a DER ticket about 3 or -- probably about 3 years ago, and she was promoted to group head of performance in -- about a year-and-a-half ago.

Q. Okay. And what factors -- what fact or what aspects factored into the decision to promote her to group head?

A. A position was open. There was a REC open for that particular position. There was maybe two -- two or three others that had applied, but they really didn't qualify for that position. Shelly probably had the most experience out of that group in terms of performance experience and leadership experience in terms of heading up the team. So she was the one that was ultimately chosen. In that role she was responsible for not only core performance, the core functional group, but also for 650 performance and also for AAP performance, even though her duties kind of forced her to be more focused on the 650 than any of the other programs.

Q. What's AAP performance?

A. Advanced aircraft performance. It's a new program at Gulfstream.

Q. All right. So, what is your opinion of her experience and technical competence as a group head?

A. No. She knows all aspects of aircraft performance engineering from -- In the beginning we were focused on mission performance, making sure we meet our mission guarantees for range. She would -- she knew how to do all the analysis, knew how to use -- knows how to use all the tools, and also was -- she was also responsible for field performance and meeting balanced field length guarantees. She would break down each of the performance aspects into various components. She was tracking whether or not we were meeting our breaking coefficients, whether we were meeting our thrust requirements, what our rotation speeds needed to be to meet our performance guarantees. So she was responsible and she would track that. She tracked that from the beginning of the program to determine our progress and whether or not we were meeting our guarantees, primarily on balanced field length and mission performance.

Q. How was the balanced field length performance target established?

A. It was actually done before I was on the program. It was developed in PD or preliminary design, product development. I'm not sure how the number actually came about, but the -- it was a balanced field length of 6,000 feet at sea level standard day at max takeoff gross weight, which was 99,600 pounds. I can speculate, but it was due to -- to remain competitive in the industry and also -- that was very similar to what our numbers were for the G550.

Q. What was the altitude again?

A. Sea level --

Q. Oh, okay.

A. -- standard day.

Q. Are you familiar with -- oh, of course you were, because it's under you, too. Compare Bob Mills' and Shelly Brimmeier's day-to-day involvement in -- during flight testing in their respective areas in terms of their approach to supporting the testing.

A. Well, I mean obviously --

Q. Were there any differences in their styles or --

A. No. I mean Bob Mills is kind of in a class of his own. He's our staff scientist. Bob can work from anyone, to the technician all the way up to the senior VPs and can speak anybody's language equally well. Bob works well with everybody. He knows how to get along with everybody, how to make everybody work together. He takes ownership of his tasks, which is anything aerodynamics related. He takes pride in what he does and he takes ownership of all those tasks. He owns essentially the outside of the airplane, so he's very sensitive when people try to mess with the outside airplane.

Shelly is also -- she had a good working relationship with everybody in the flight tests. She knew Reece and Valerie and all -- Paul and all the flight test engineers. She would -- she didn't have any issues. As far as I can tell, she was able to coordinate with them. Had a good working relationship between Shelly and the flight test engineers. She was also -- she also had a lot of ownership. She was -- in terms of the field performance, and she was highly involved with Reece in the planning of the field performance testing and supporting all the testing throughout the test program. Her responsibility was also mission performance. She supported all the -- anytime we would go up and fly a particular mission where we tried to do some long-range flights, she was up front and she had all estimates in place in terms of what the expectations were, and her and her team did all the post-test analysis of all the missions. So she was very well versed in how flight test works and also how their data systems work and be able to pull data off the IADS system and manipulate it and use it and reduce it.

Q. For takeoff performance testing versus free air stall testing, did they have a different approach in terms of predicting performance and then rolling test results back into predictive modeling?

A. They would run takeoff performance, but they didn't have a full dynamic performance simulation program. They would break it down into pieces: the acceleration phase, the rotation phase, the climb out phase. And they would have different programs that would address -- it would be one program, but it would be broken down in pieces, is what -- it wasn't a -- like an FSIM or a dynamic simulation program.

UNIDENTIFIED SPEAKER: -- performance group?

MR. LAVRISA: Yeah. The aircraft performance group did not have a dynamic tool that would be able to specifically predict performance.

BY DR. BRAMBLE:

Q. Whereas the aerodynamic -- applied aerodynamics group did? Bob's group?

A. No. No, applied aerodynamics did not, either. That resided in the flight dynamics group. They had a program called FSIM, flight simulation. It is a desktop tool and it was also the same tool that was being used in the -- in their case lab, their engineering labs, and also in the Gray test facility.

MR. RAMEE: Go off the record.

(Off the record.)

(On the record.)

DR. BRAMBLE: So let's go back on and say --

BY DR. BRAMBLE:

Q. Well, let me clarify. What I was asking about was, I guess, did Bob Mills and Shelly Brimmeier have a different approach to the predictive modeling aspect of flight testing for free-air stall testing versus takeoff performance testing?

MR. RAMEE: And in that question you're assuming that they both had an approach prior to the development. So, you know, one may have been charged with it and the other wasn't, so -- Tom can take care of that. I think he can. Can you answer his question?

DR. BRAMBLE: All right.

MR. LAVRISA: Yeah. I think --

DR. BRAMBLE: Let's go off the record for just one second.

(Off the record.)

(On the record.)

DR. BRAMBLE: Let's go back on the record.

BY MR. O'CALLAGHAN:

Q. Okay. So, I think the question we are looking at is the value and necessity, perhaps, of predictive -- predicting the answer to a flight test prior to conducting the test --

A. Um-hum.

Q. -- based on first principles of physics the way Bob Mills expressed it, by means of, you know, solving differential equations, and I think -- throughout the maneuver that you're looking. And then using the test results, be it in either stall testing or in takeoff performance testing, to confirm the validity of your predictive analysis and then correcting the model. So, I think one way you expressed to me privately, and then I think also in the interview, was that one wouldn't really use testing to gather data from which to build a model at the outset, but rather one would use the flight testing to confirm or check the model.

A. Okay.

Q. And I think, if I can -- I think I characterized his opinion fairly when I say that on the stall testing, that sort of thing was in place, but perhaps not so much in the field performance testing, and one example of that would be sort of what you've outlined is at the V-1 program. It would do F=ma for the ground acceleration part, but the rotation and climb-out would be based on empirical -- or ratios that were kind of chosen beforehand.

A. Yes.

Q. So there seems to be a difference there, and I guess the question would be, one, did you agree with Bob's assessment or do you recognize this difference that he seems to mention, and would you comment on whether you agree with his assessment of the benefits of one versus the other?

A. Sure. I guess maybe just to back track a little bit, when we did all the stalls performance testing, we had cryogenic wind tunnel data, and Bob knew ahead of time what the stall speed for that particular altitude and particular weight of the airplane would be and what the angle of attack should be, and he had some very quality wind tunnel data, so he was able to predict it within a knot or two. So his methods were good on this program, so he was just confirming his numbers. With regards to field performance, we did not, I don't -- we did not have a good tool to perform a dynamic takeoff simulation and to evaluate margin to stall and knowing what the angle of attack is during the entire maneuver. That was not available prior to the field performance testing.

Q. Um-hum.

A. Those tools were available, but they weren't residing within the aircraft performance group.

Q. Which tools were those? You mentioned FSIM and --

A. FSIM, yeah.

Q. Okay.

A. We could have -- we use ITF quite extensively prior to the testing to develop some techniques prior to field performance testing, but I don't think that we looked a lot at a lot of the details in terms of what the actual angle of attack is during those maneuvers and how close we were to stall. It was more of a technique development using speeds that were generated by the performance group.

Q. And I think I understand. I agree that in the absence of data with which to construct a model for the stall angle attack and ground effect, the use of FSIM or other simulator tool may not get you any more information about that. But I think sort of the focus of our discussion with Bob about the use of a F=ma type approach is that M.I. had illuminated the difficulty in achieving B2. Just, you know, the physics of rotating at a certain speed, pitching up, and then hitting 35 feet at the target, --

A. Right.

Q. -- that the difficulties that were being experienced might have been illuminated ahead of time by the use of a dynamic tool such as FSIM and perhaps save some time or effort in trying to solve that problem through rotation technique.

A. Yes.

Q. Does that sound right or --

A. Yeah. I agree if we had a tool, we might have identified the problem sooner. You know, we can -- with a dynamic tool we could have determined that, yeah, you're rotating and you're not lifting off and you're holding the pitch attitude on the ground and accelerating that attitude before it lifted off, where we didn't discover that until we flew the airplane itself. So there would have been some benefit to have some type of dynamic tool and do quite a few trade studies on speeds and pitch targets before we flew the airplane.

Q. I'm going to guess the answer is because it was never needed before. Why not have an FSIM as part of the process at the time to do the sort of things you described?

A. Yeah, I agree. It would have been a good idea.
MR. RAMEE: Do you know why we didn't, is the question.
MR. LAVRISA: No, I don't.
BY DR. BRAMBLE:
Q. All right. Did you feel that the team in the TM trailer on the day of the accident was sufficiently experienced to provide full support to the on-board tester during high-risk field performance testing, such as the testing conducted during Flight 153?
A. I would say no.
Q. And on what do you base that assessment?
A. I wasn't aware of, the day of the accident, who was in the TM trailer. I knew that Shelly was out there. I didn't recall that, who her supporting members were. You know, the other two engineers, Eric Upton had not -- he'd done some field performance testing. He wasn't highly experienced. And B.J., the other engineer in the TM room at the time, this was his first day doing field performance testing.
Q. And what was your understanding of the roles performed by each person working in the TM trailer during the field performance testing on the day of the accident?
A. Well, this is after the fact, but the test coordinator, which was Cynthia, was to, for each flight condition, determine what the correct speeds are to be used for the flight, confirm with the FTE on board, with Reece, and also confirm with Shelly

the correct speeds and targets that they were planning for that particular test, and then post-test analyze and determine whether or not those targets were met.

Q. Who was doing that?

A. My understanding, it was Shelly that was doing a lot of the post-test analysis.

Q. Okay. And then which of the FTEs aboard the airplane, to your knowledge, was reviewing test results and which one was monitoring flight control systems?

A. From what I've been told, Reece was monitoring the flight control systems, and Dave was monitoring the test.

Q. From what you've been told post-accident?

A. Yes.

Q. All right. And how were people working in the TM trailer trained for their roles?

A. I can't speak for flight tests, but the performance engineers, obviously Shelly was primarily the lead person. She had been on field performance tests before on the G450 and had participated in those particular tests, and so she was the lead flight sciences performance engineer for that particular test. And the other two were -- B.J. and Eric were there to assist with anything that she might need to be done at the time, and also to gather experience.

Q. How was it decided how many data analysts -- and maybe you don't describe them that way, so I should say how was it decided how many engineers would be needed on scene for -- or on site for the field performance testing program on the day of the accident, and how were the roles of the on-site test conductors and data analysts supposed to be divided among available personnel?

A. Like I said, I can't speak for the FTEs, but for the aircraft performance engineers, Shelly had come up with a schedule ahead of time where there would always be three aircraft performance engineers on site at all time, and it was always -- she always ensured that either her or Pat Connor would be on site at all times, and they would have an overlap between them so they could transfer information before they moved on and continued testing. It was typically in 2- or 3-week shifts, is what they were targeting. In 3-week shifts with maybe a week overlap. And we were trying to get as many performance engineers as we could out there to -- for training. Some of those were also supported by the other program, AAP. They were willing to -- in the core group, they were willing to fund the travel and the expenses for other performance engineers to go out there to witness the testing also for training.

Q. That was the capacity B.J. was there in?

A. Yes.

Q. And how about Eric?

A. Eric was part of the core group and he was supporting the test, so he had a little bit more experience in field performance, so -- and him and Shelly. Shelly was the primary on the test, and Eric was secondary on the test, with B.J. in training.

Q. All right. Did you feel before the accident that the level of analysis support on site and Roswell data analysis support was adequate?

A. I think maybe the level of support was there. The major issues which Shelly conveyed to me for both Roswell and Roswell-2 was being able to get data off the aircraft in a timely fashion and analyze it. I don't think the infrastructure was there to be able to get that data to them quickly and for them to be able to analyze it quickly. It was difficult for me to tell exactly what the status was on the airplane and were we close or far away from meeting our targets. It would take some time after the particular tests and usually after they returned before we actually got a good understanding of where we were.

Q. An did that give you any concerns in either efficiency or safety concerns that you didn't usually have a good feel for where you were relative to the targets test and then after you came -- after they returned?

A. It wasn't -- I never had a safety concern. I always had an efficiency concern: Are we getting the right amount of data? Are we getting the answers? Are we getting the performance figures that we were targeting? How close were we? Trying to determine if there's anything else that we need to do. We're always trying to stay one step ahead of the problem, if possible, and try to mitigate it, find out if there's any risks with meeting some of our performance goals. So it was challenging at some times because we didn't know where we stood with regard to our performance goals. But I never felt any safety concerns.

Q. And so, just to be clear, it wasn't the expectation that where the aircraft performance was falling relative to the performance targets would be established for all the day's tests prior to the next day?

A. Could you repeat that again?

Q. Well, I'll repeat it in a more open way, I guess, which is, did you expect that each day's tests would be analyzed and compared to performance targets thoroughly prior to the next -- the resumption of testing the next morning?

A. No, I didn't expect that. I didn't think that was a reasonable expectation that everything would be matched up day for day. It was more -- I felt it was more of a we're going to go out to do these tests and collect the data, and then afterwards we would do an analysis to see how we meet -- how we are relative to our performance targets.

Q. Did you ever --

A. I never felt like it was that easy for them to turn things around that quickly in one day with -- in a short period of time they'd be able to analyze the data and say, "All right. Our bounce field-length target was 6,000 feet. We're at 6,300." I didn't think that was reasonable to be able to turn that around in one day.

Q. And would it have been reasonable if there had been more experienced analysts on site?

A. I don't think so. There's a lot of runs that are performed, qualities assessed. We create scatter charts to determine where you are on a specific trend. I don't think you can focus on one or two or a handful of points to determine if you meet your performance guarantees. I always felt it was probably at least a week's worth of analysis or 2 weeks' worth of analysis to determine exactly where you end up.

Q. Did anyone ever suggest to you that more staffing was needed on site to help with analysis?

A. No.

Q. And did you ever request more?

A. No, I did not. If Shelly had any concerns with the level of staffing, she would have told me, but she never said that to me. She came up with a plan three engineers at a time with a full span of testing, and she was comfortable with that and I was comfortable with that.

Q. And was she comfortable with the pace of testing?

A. Yes. The only thing she was uncomfortable with was the rate that the data was getting back to her and the mostly computer infrastructure issues that they were having, internet access, access to data.

Q. This is on scene in Roswell?

A. Yes.

Q. Are you aware that there was a test requirements document generated in addition to the test plan for some aspects of flight testing, but for field performance testing there was just the flight test plan and no test requirements document submitted to flight test?

A. Yes.

Q. What was the reason for that, for field performance testing? Why was it just the one and not both?

A. In some instances -- well, it depends on the engineer, the cognizant engineer. Some would issue the test requirements document. Some would just work directly with the flight test engineer to coordinate it all into one test plan instead of having to create a test requirements document that gets looked at and folded directly into a test plan. The two, flight test engineering and flight sciences engineering, would just work together and create the test plan and eliminate a step in the process.

Q. Is there anything that would be in a test requirements document that was not included in the test plan?

A. Early on in the program, flight test proposed that test requirements documents be written in support of all the flight test plans, and when they laid out the format of the test requirements document, it looked like a flight test plan almost exactly. So I raised my hand and said, "Why don't we just get the guide engineers together with the flight test engineers and just write the flight test plan, and eliminate a step in the process?" In some instances -- in most instances that's what happened, is we just took the cogs -- cog engineers, flight test engineers, and did that and just wrote the test plan. In some instances there were some TRDs that were written. I know Bob Mills had written quite a few on stall speeds and there were some other tests that he had written a specific test requirements document. Cruise drag, flow visualization. The majority of the other test plans in the various other disciplines were just coordinated into the final flight test plan instead of a TRD.

Q. So is any -- getting back to my original question, do you think any information would be lost or is it there? Was there any disadvantage to combining into a document for field performance testing? I'm not -- I don't have an answer in mind. I don't have an opinion. I'm just wondering what you think, because I don't know. We haven't seen a requirements document yet.

A. I'd say a requirements document would be completely from a cog engineer's standpoint. He can put everything out on the table and then flight test can work from there. But when you're combining it and -- I don't know. Maybe. Maybe there's something that might be lost in the translation. Yeah, I guess it's a -- I agree, there could be something lost if a TRD was not written.

MR. RAMEE: Just a second. Let's go off the record.

MR. LAVRISA: Sure.

DR. BRAMBLE: Off the record.

(Off the record.)

(On the record.)

BY DR. BRAMBLE:

Q. All right. So, Mr. Lavrisa, we were talking about whether or not there are any advantages to issuing a separate TRD before a flight test plan and whether or not there is anything unique in a TRD that's lost if you just developed a flight test plan, and I guess that's the question. I mean -- and another part to that would be, well, Mr. Mills -- Dr. Mills decided that he would stick to the requirements plan first and a test plan separate. So I don't know whether he had a reason for that or he was just adhering to this protocol. What's your opinion about the utility of the TRDs?

A. I could give you one example of Bob's TRD where it was at -- you know, was necessary. The plan was to do a test where you spray fluid on the outside of the airplane and you can determine flow visualization and look at separation, and he wanted things done specifically a certain way and he was the mastermind behind developing the system and how he wanted it to look and how it needed to be visualized. So he put in specific details in his TRD that said, "This is exactly how I want this test run." But the there's other instances where we did not write TRDs, such as

-- I know there's a lot of propulsion tests that we do that are very similar day in and day out; engine re-starts or engine handling. And we just took past test plans, revised them, had agreement between the cog engineer and the flight test engineer that, yes, this is the right procedure to follow, this is the right tests to perform, and it was just done simply as a flight test plan without a TRD. And I believe field performance kind of fell into that realm. Field performance is very similar from one aircraft to the next, so it was just a collaboration between the cog engineers and the flight test engineers in terms of developing the flight test plan for field performance.

Q. Okay.

A. Initially the certification plan was written by Pat Connor in flight sciences, and then from that is where the flight test plan was derived.

Q. By? Who wrote the flight test plan for field performance? By Reece and -- or by Mr. Ollenburg and --

A. I'd have to find a document to find out who --

Q. Okay.

A. -- wrote it and signed it. But I don't know off the top of my head.

Q. All right.

A. My assumption is it was probably Reece that wrote it, but I'd have to dig up the flight test document to see that for sure.

Q. All right. And --

MS. WARD: For this one?

MR. LAVRISA: For field performance?

MS. WARD: For this field --

DR. BRAMBLE: Yeah. That's what we're talking about.

MS. WARD: It is, it's Reece.

MR. LAVRISA: Okay.

DR. BRAMBLE: And the others.

UNIDENTIFIED SPEAKER: Here. We have it just so we get the record straight.

MR. LAVRISA: Okay. Just want to say it right. So it was written by Reece, checked by Paul Donovan and also approved by Pat Connor, who is our lead DR for performance.

BY DR. BRAMBLE:

Q. Okay. And so, getting back to the original question, you had said something could be lost if a TRD was not written. Is that sort of -- is that your feeling about the TRDs and the test plans? Or do you really -- do you feel like it's not always necessary to write a TRD?

A. I don't think it's always necessary to write a TRD. I think in this instance, seeing who signed it, obviously Reece wrote it and it was reviewed by Pat, who's very thorough in his reviews, and reviewed by Jake, who's very thorough in his reviews, and everybody else that's on there, I don't see any reason why a TRD would help in this instance.

Q. All right. And would you expect that Ms. Brimmeier and the other flight sciences people who were on scene in Roswell supporting the flight test would be familiar with the 1998 flight testing or practice manual?

A. I don't know if they would be or not.

Q. And how about on the flight test side?

A. I can't say.

Q. All right. How is corporate technical knowledge retained across development programs in flight sciences area and made available for use?

A. All the memos are kept in a certain location, secured within flight sciences. The knowledge is typically transferred, because the -- we have pretty high retention rate in engineering, and most of the engineers that worked on the GV are also working on the -- the lead engineers are working on the 650. So that's how. I would say the basic knowledge is transferred by commonality of engineers from one program to the next. For example, I worked on the GIV, GV, G450, G550, G650. The same with people like Bob Mills, Pat Connor. They've been with the programs from the beginning, and that also flows across to flight test. Ken Obenshain, for example, has been here for a long time. Also goes across to flight ops. And that's fairly common through most of the engineering. Also, there's been quite a few people that have been around and have twenty, thirty years' experience within Gulfstream that have moved from one program to the next.

Q. Okay. How were the GIV and GV wing drop incidents reported and analyzed, and what lessons were learned from those events?

A. The GIV wing drop, I was actually there and witnessed it when it happened. I was standing on the side of the runway.

Q. The first one or second one?

A. The GIV, the first one that scraped the wing tip.

Q. Okay.

A. I didn't know there was a second one. I was in propulsion engineering at the time. I was not involved in field performance, so, you know, I stood back while the performance engineers and aero engineers assessed the situation. And I'm not sure what the final outcome of that was. I believe it was a change to stick push or schedules. GV, the roll-off events I had heard about, but I was not involved in that at the time. I was working in propulsion engineering on the GV at the time. I had heard that it happened at Roswell, but I didn't see any -- what the resolution was behind it.

Q. Okay. Why wasn't a similar level of analysis done for the wing drops that occurred during Flights 88 and 132 on the G650.1?

A. I don't know. I was not aware of those events until after the accident.

Q. At the time of the accident, what policies and procedures did Gulfstream have in place to manage the safety to flight test program?

A. I know there's a safety procedure document that's created by flight test and flight operations, but I don't know any more further than that. Well, I mean I can -- we do have safety review boards well prior to first flight and prior to any high-risk testing, addressing safety concerns prior to these tests.

Q. What's the safety procedure document? Is it titled "Safety Procedures" or --

A. I don't know. I've seen a copy of it, but I can't specify the title.

Q. Did the company have a written safety policy statement regarding -- related to flight testing?

MR. RAMEE: You mean beyond the two that he just mentioned?

DR. BRAMBLE: Yeah. I don't know whether it includes his policy statement or not about the priority of safety related to other organizational priorities.

MR. RAMEE: His --

MR. LAVRISA: I'm sorry?

MR. RAMEE: The vision statements were the only thing that --

MR. LAVRISA: Right. The safety vision statement --

BY DR. BRAMBLE:

Q. Well --

A. Are you talking about a specific --

Q. -- in the international Civil Aviation Organization guidance, they provide guidance for safety management system programs, and one of the things that's recommended and has been adopted throughout the industry on the operational side is that there be certain essential components to a safety management system, and that would include things like a written safety policy that sets forth the organization's priorities with respect to safety and other goals, and that there would also be an executive accountable for managing safety and responsible for safety performance. So I guess what I'm trying to find out is, to your knowledge, was that kind of structure, policy and accountability set up here or not?

MR. RAMEE: Can we go off the record?

DR. BRAMBLE: Sure.

(Off the record.)

(On the record.)

BY DR. BRAMBLE:

Q. So, returning to the original question which is, at the time of the accident what policies and procedures did Gulfstream have in place to manage the safety of its flight test program? I'd be interested to hear your thoughts.

A. At the time of the accident, I'd say well prior to the accident, we have safety review boards which went into details and about each of the specific tests that we were performing, from continued takeoffs to rejected takeoffs to V_{MU}'s, and during each of those we went through each of those specific tests, we talked about the procedures for each of those specific tests, and we also went through the TSHAs for each of those tests with a fairly sizeable group of members of flight test, flight ops engineering to review all those and agree on those prior to the test. Actions were taken, action -- any action from any person in that group was considered and they were addressed prior to the actual test itself. You know, our company's number one priority is always safety. We take that in consideration when we do our designs, making sure there's adequate margins in our designs. We also obviously follow all the fire requirements, make sure that we meet those requirements. We have additional company requirements above and beyond that to ensure that our design is safe.

Q. And so in terms of documentation guiding this, the primary reference material would be what? Or the significant reference material. It doesn't have to be a single primary reference.

A. Probably the single document that initiates it is our configuration document: What's our aircraft? What's our configuration? What's our goals? And what are the requirements that we need to meet? And from there, those requirements get passed down to our suppliers and get passed down to engineering and also we write certification plans, show how we meet the fire requirements. In some instances there will be requirements that get levied from the program that are stricter than the fire requirements.

Q. All right. And at the time of the accident, was there a particular manager or executive or more than one who was considered responsible for managing the safety of the flight test program?

A. That would be Barry McCarthy, director of flight test engineering. Director of flight test.

Q. And what policies and procedures did the company have in place for reporting and investigating perceived hazards or safety-related incidents that occurred during flight testing?

A. I don't know what those -- I know there's procedures that are in place, but I don't know what the name of that particular document is

Q. Why did the lead flight sciences engineer say there were no formal procedures for notifying management of safety-related incidents during flight testing?

MR. RAMEE: Do you know who that title belongs to, Tom?

MR. LAVRISA: No, I don't.

DR. BRAMBLE: That would be Shelly Brimmeier according to our understanding.

BY DR. BRAMBLE:

Q. Well, why did Shelly Brimmeier indicate that to us? Or do you have an opinion as to why she had that understanding?

A. I don't know. Maybe she just didn't know that there was a policy in place to do that.

Q. Before the accident, what was your understanding of the reduction in stall AOA and ground effect compared to free air, and how did you come to that understanding?

A. I was not involved in that, and I didn't come to an understanding about that until after the accident.

Q. Was there a discussion of this difference during the SRB, the reduction in the IGE stall angle? SRB for field performance testing.

A. I can't recall if there was or not.

Q. And -- I'm sorry.

A. No. I said I can't recall that.

Q. Okay.

A. I'd have to go back and look at the presentations and the notes.

Q. Did you expect that that effect would be further refined as part of the field performance testing effort for during that period?

A. I don't recall if that was discussed during the SRB.

Q. And what information about IGE stall was provided to flight testing, when, and by whom in terms of -- how did they get an estimate in terms of -- that they might use to determine how to fly the test?

A. I don't know if that was passed along to them, but I can speculate, not that that's worthwhile doing.

MR. LAVRISA: Tom?

MR. RAMEE: I'm sorry.

MR. LAVRISA: They asked how did flight test get information about the shift and in ground effect stall angle and when was that passed along to them. I said I don't know if it was, but I could speculate how it was.

MR. RAMEE: You can speculate if you want.

MR. LAVRISA: We did wind tunnel testing, low-speed wind tunnel, in and out of ground, in fact, with a ground plane board, and that data was collected and it would have shown shift in the -- not necessarily the in ground effect stall angle, but the shift in the CL versus alpha curves for out-of-ground effect versus in ground effect. Anything else at that point, if it was provided, it would have just been estimated.

BY DR. BRAMBLE:

Q. Okay. And prior to the accident, what did you know about changes made to the shaker settings for Aircraft 6002 during the field performance test program?

A. I wasn't aware of any changes that were made.

Q. When did you first hear about stick shaker nibbles, if you did at all, that were occurring during the field performance test program? It was described by the test pilots as nibbles. It was basically brief activations during maneuvering flight that were undesirable -- considered undesirable.

A. It was probably -- it was after the accident, like 3 or 4 weeks after the fact.

Q. And -- asked that. How was the decision made to increase the stick shaker activation threshold prior to Roswell-2?
A. Well, I think there was the fact that they were getting these nibbles, and they felt that it was -- there was -- the right words. I know they were getting these nibbles and they felt that the shaker was too close to a flyable condition, so they moved the stick shaker a little bit further out of the way so it wouldn't interfere with the testing.
Q. Do you know who made the decision?
A. No, I don't.
Q. And what is your opinion about why the change in the shaker settings didn't result in the reconvening of an SRB when it was changed to a less conservative state?
A. I don't know. I don't know why an SRB was not reconvened.
Q. Do you have an opinion about why the Fortran program that was being used by the airplane performance group was provided unachievable V_2 speeds for Flight 153? Well, I should qualify that. How is it that the flight crew -- the flight test team on the day of the accident ended up with V_2 speed targets that were not achievable.
A. I think the prediction for the V_2 speeds and the VR speeds was too low based on our analysis of the accident. Just required too high of an angle of attack to achieve.
Q. And do you know why that was the case? Do you know it

came to be that the V_2 speeds were not achievable or that they were provided with incorrect speeds?

A. I think there was a lot of information that was taken from the GV and carried over to the G650 in terms of speed ratios, and that may incorrectly have been done.

Q. What methods for predicting the takeoff performance for the G650 were used in addition to the Legacy Fortran program, if any?

A. I believe it was just the Legacy Fortran program.

Q. And what analysis -- were there any analysis methods used to confirm the speed schedules produced by the Fortran program? And if none, then would it have been appropriate to start at a higher V_2 speed and build down to the 1.13 V stall, V_{SR}, V_2?

A. I don't believe there's any other programs that were used to confirm that speed schedule, and, yes, it would have been appropriate to start at higher speeds and build down.

Q. Did you review the airplane's tested versus guaranteed takeoff performance with top managers and subordinates during the test program prior to the accident, and how often and in what settings?

A. It was usually about once a quarter that we'd review performance with management. It was typically Shelly, myself, Pat Connor, Bob Mills, and then we would typically have Kurt Erbacher, Pres Henne involved, and the chief engineer, whoever it would be at the time, most recently Brian Durrence. We would have a regular review on field performance status, and it would typically be after we would have a change to one of the major inputs, whether after we finished it, and wind tunnel test and collected some more data after we did some braking tests or dynamometer tests where we were going to change the braking coefficient, whether we had an update in an engine deck, and then we would go back and reassess performance.

Q. And when was the most recent of these meetings prior to the accident?

A. We had one the day before the accident.

Q. And what was discussed with respect to takeoff performance, if anything?

A. The discussion was of where we were relative to our guarantees based on the latest Roswell testing. The assessment is that we were very near, very close to our targets.

Q. And was that based on testing at the -- that was the Flaps 20 testing?

A. Yes.

Q. And at a 9-degree rotation target pitch?

A. I can't recall what the target was for those particular field lengths.

Q. Okay. And, all right. Let's walk through how several aspects of data reduction analysis were supposed to be divided up among the flight sciences and flight test personnel who were involved with field performance testing. The way it was described by someone else was that it might consist of the following four steps: data review, data reduction, data analysis, and then expansion. And that would be, I guess, in comparison to the targets. How were these areas supposed to be divided up between the flight sciences and the flight test personnel during the field performance testing?

A. During the field performance tests, the flight test engineers were conducting the tests and making sure that we were meeting our speed targets, and that was a combined effort between flight test engineers on board the airplane and the flight sciences engineers in the TM room. Post-test, then they would -- flight sciences engineers, along with the flight test engineers, would analyze the data to determine what the rotation speeds were, what the liftoff speeds were, what the speeds at 35 feet were, and they would get an agreement between the two groups as to what the actual values were. Flight test response was -- flight test had responsibilities to determine braking coefficients and do some of the other analysis, and eventually that would be agreed between flight test and flight sciences; "Yes, we agree with your data reduction." And then from there would get passed on to flight sciences, and flight sciences would be the only ones that would do the AFM expansion.

DR. BRAMBLE: John, do you want to elaborate a little bit on this? Do you have any additional questions about how these things were divided up in the four areas? Or is that sufficient for you?

MR. O'CALLAGHAN: Do you want our conversation on the record?

DR. BRAMBLE: Let's go off the record.

(Off the record.)

(On the record.)

DR. BRAMBLE: All right. We're back on the record.

BY DR. BRAMBLE:

Q. I'm going to just summarize what I think you just said, and then you let me know whether I've got it right. So, during field performance testing, you've got flight test engineers conducting the tests --

A. Um-hum.

Q. -- and seeing if they're meeting the speed targets, and then -- but that's a combined effort with -- between the flight test engineers and the flight sciences engineers who are in the trailer. And then post-test, right after the test, I guess, but before the next test, flight test and flight sciences engineers would analyze rotation speeds, liftoff speed, 35-foot speed, get an agreement between the groups, and then flight test had the responsibility to determine braking coefficients and some other analyses, and then it would be -- these things would be agreed on and passed on to flight sciences, and flight sciences would do the only -- would do the AFM expansion. And I think -- I don't remember if you mentioned it, but there might be -- would there be an intervening report? There was a flight test report prior to the AFM expansion; right?

A. Sometimes they're worked in parallel.

Q. And what about my overall summary? Did I have that right?

A. Well, after the conduct of each test there'd be an analysis to determine what the speeds were, and from -- it would be a comparison. For example, on the day of the accident, Shelly would say, "All right. Here's the targets." They'd agree on the targets and then they'd determine the speeds from the IADS data, and then at that point it was decided whether or not they met their targets or not and whether they needed to change anything, and that -- from my understanding, that seemed to be between Shelly and the FTEs on board the airplane, just to get a final agreement that, yes, this is where our speeds are, this is what our -- this is where our targets were and these are where our speeds are and this is how we matched up. So that would be a quick snapshot review of the data between runs, but there was no detailed, extensive analysis of the data from one run to the next. It was just a cursory check of some of the basic parameters to see if they fell within the test requirements.

Q. Okay. And then how about the other steps we were talking about? Would that be the third data review, this portion?

A. Data review.

Q. And then how about reduction and analysis?

A. The intention from the beginning was that flight test would do the majority of the data analysis. It would get passed on to flight sciences for AFM expansion. But it ended up being a collaborative review and analysis of the data to make sure that both flight sciences and flight test agreed on the data reduction and agreed on the final numbers were correct. Once they agreed upon that, then they would get passed on to flight sciences for AFM expansion. And this could occur not days or weeks. It could be, you know, a little bit longer after the event that we've done some of the data analysis.

Q. After the test? Could be done --

A. Right.

Q. -- a little bit longer after the test?

A. Yeah. Like most recently we were developing a provisional type certificate, a flight manual using some of the Roswell data in terms of braking coefficients. So, even though we'd flown a lot of the tests in March, we analyzed the results over the past few months so that we can roll it into a flight manual, and that was all collaborative effort between flight sciences and flight test, and a lot of it was manpower availability. If we didn't have enough flight test engineers to support the analysis, we would step in. Flight sciences would step in and help out at that point in time. But there was always agreement when the final data got released that flight sciences and flight test were in agreement that that data was correct.

Q. Okay. Did Ms. Brimmeier ever mention to you difficulties analyzing the data between each day's testing or being able to keep up with, I guess, doing the data review between each day's testing?

A. Difficulty not with respect to the work load, but I think difficulty with regard to being able to access the data in a timely fashion, specifically with Roswell-1 where they -- The first time they went out to Roswell and did some testing, they had a very difficult time being able to get to the actual data. Roswell-2 significantly improved relative to Roswell-1.

Q. Okay. What were your expectations as to what analysis of safety critical parameters would be performed at the end of each day's skill performance testing prior to resumption of testing the next day with respect to takeoff specifically?

A. My assumptions were that the safety aspects of it would be handled by the test pilots, the flight test engineers, and the flight sciences engineers on site.

Q. Was there anything specific like parameters that you thought they should be monitoring for continued takeoff testing?

A. Not at the time. I left it in the hands of those organizations.

Q. In your opinion, is it necessary to complete the analysis of V_{MU} test data before continuing on to the next major phase of field performance testing, and particularly the tests that were being performed in Roswell-2?

A. Yes.

Q. And to your understanding, was that analysis completed prior to Roswell-2?

A. I did not see the report until after the accident. May was when I first saw it, and it was a draft version of the report.

Q. We understand that Reece had completed that in mid-March, and so that was a draft report, but did you feel like the -- do you feel like the data had been adequately analyzed prior, even though the report was still in draft form? Or do you think there should have been more analysis or communication of that data prior to the start of the Roswell-2 testing?

A. If it was communicated, it wasn't communicated up through myself or Bob Mills or in aero performance, but I believe it was communicated between Reece and the performance engineers. They were aware of that data and that it existed, and they reviewed that data.

Q. And was it your understanding that Ms. Brimmeier would have participated in the analysis of the V_{MU} data, or Mr. Connor?

A. No. I don't think they participated in the review and analysis of that data. That was all done by flight test.

Q. And prior to the accident, was it your expectation that they would have -- that they had participated in that and you only learned that after the accident, or at the time did you know that that was something they weren't doing; they weren't doing an in-depth analysis of V_{MU}?

A. I wasn't aware that they were doing an in-depth analysis of the V_{MU}.

Q. So as they progressed from V_{MU} testing to other portions of the field performance flight test program, were the flight science aircraft performance leads supposed to be analyzing the data in parallel with flight test engineering, or only doing the immediate review on scene the day of the test?

A. Flight sciences engineers were doing just the immediate review, but they were not doing the whole V_{MU} analysis. They were relying on flight test engineers to perform that analysis.

Q. And how about for other portions of the field performance testing like continued takeoff?

A. The CTOs were a little bit different because we were doing -- taking a larger portion of that analysis in terms of determining the actual speeds flown, his speed ratios, VR and VS, the V_2 speed ratios. Those were all analyzed primarily by flight sciences, by Pat Connor.

Q. And then after the tests, were Mr. Connor and Ms. Brimmeier analyzing the results of those tests sort of week by week as they went along, or was that also expected that flight test would do that and they would only do the, you know, immediate review, cursory review?

A. No. Flight sciences did that analysis, and they kept up with it. As they added more test points, they updated their charts. They compared the initial Roswell-1 tests, the additional tests where they went off to Birmingham to improve on their takeoff technique, and also the Roswell-2 testing. I know they had charts that compared all three of those particular series of flight tests to determine speed ratios and what the improvements were or the differences were.

Q. And do you know why the difference for the V_{MU} testing, why it was expected that flight test would do the in-depth analysis there, but flight sciences was more involved with MU takeoff analysis?

A. No, I don't. I suspect it just might be historical and that's how it was done in the past.

Q. All right. So the aircraft performance group did perform analysis of the Birmingham test flights as well, you said?

A. Yes.

Q. What was your understanding of the causes of 88 and 132 again? How did you come to that understanding?

A. I didn't learn about 88 and 132 until after the accident, and it came out as part of the 6002 safety review, accident review.

Q. You didn't learn about either of those incidents prior to the accident?

A. No, I did not.

Q. And does that surprise you that no one would have communicated that to you?

A. Yes.

Q. Why do you think that no one ever told you about it?

A. I don't know. I mean it was known by quite a few people within flight test and flight sciences, but it was -- at the time of the events on 88 and 132, it was -- based on what I've been told from Shelly, it didn't appear to be a big deal. Didn't appear to be a significant event. It was a roll-off that was corrected by pilots and they continued on, and it was not considered a significant event.

MR. O'CALLAGHAN: This is what Shelly told you after the accident?

MR. LAVRISA: Yes, that's what she told me after. I didn't know anything about 88 or 132 before the accident.

BY DR. BRAMBLE:

Q. Okay. Do you know what kind of analysis was performed to determine the root cause of the wing drops during the 88 and 132?

A. No, I don't.

Q. Who would you expect would be responsible for analyzing the performance of the aircraft during those flights?

A. It would have primarily fallen under Bob Mills and aerodynamics.

Q. That's who you think should have analyzed it?

A. That's who should have analyzed it.

Q. And do you know who did?

A. For 88 or 132?
Q. Uh-huh.
A. My understanding is 88 was done by flight test, and 132 had a combined effort between flight test and flight sciences. The flight dynamics control log group had a part in that one.
MR. HORNE: Can I clarify?
MR. HORNE: Was that post-accident or pre-accident?
MR. LAVRISA: Pre-accident.
BY DR. BRAMBLE:
Q. Okay. In retrospect after the accident, what is your understanding of the cause of those events?
A. Based on analysis done by Brett Leonhardt, the cause of 88 and 132 was tip stall.
MR. O'CALLAGHAN: To be absolutely clear, both of them?
MR. LAVRISA: Yes.
MR. O'CALLAGHAN: Both events were?
MR. LAVRISA: Yeah. Based on his residual analysis, which I believe we've shown you, he showed there was a divergence that occurred on 88 and 132, similar to what happened on Flight 153, and there was a right-hand dip stall.
BY DR. BRAMBLE:
Q. Why do you think flight sciences personnel didn't recognize that they were stall events?
A. I'm not sure if they were involved in the Flight 88's. And 132, it was passed off to control logs, because there were

some concerns that it might have been something to do with a yaw damper issue that might have caused the event, and it was more of an investigation of the control logs and did the surfaces move properly, and the assessment was that they did.

Q. In looking back-- and I may have already asked you this. I apologize if I did, but what's your opinion about why those two events didn't result in a reconvening of the SRB?

A. My opinion is that they were not considered to be a significant event to require a reconvene of the SRB. And also, the cause of those roll-offs were a little different. One was a V_{MU} with an over-rotation, and the other one was a rotation too early. It was attributed to that rather than if you had flown it properly, it wouldn't have the problem. Seems like it was known that something was done incorrectly on those particular flights, that if done correctly wouldn't have caused a roll-off.

Q. So what processes were in place prior to the accident to encourage sharing of information about performance issues or unexpected events like the wing drops on 88 and 132 across relevant sub-disciplines in flight sciences, like Bob Mills' group and Shelly Brimmeier's group? Like were there sort of regular information sharing opportunities between the sub groups that were working on the G650 within flight sciences, or like what opportunities were there where, you know, Bob Mills, for example, might have learned about and gotten involved in the analysis of those events?

A. I'd say after every flight there's a post-flight debrief. Could have been obtained in that fashion. Usually if there's a problem in flight test that requires somebody from any of our disciplines to look at a problem, there'd be either a problem report issued or the FTE will directly contact the cog engineer and ask for assistance; do you have a methods-are-at-issue problem reports or flight test reports that would identify the issue.

Q. Flight test reports, and what was the other type of report?

A. Problem reports.

Q. Problem report. Okay. And are you aware that there was some initial estimate of IGE stall that may have come from aerodynamics and that Mr. Ollenburg may have refined it a little bit further, using wind tunnel data and/or flight test data? Are you aware that that happened or --

A. Not until after the accident was I aware of that. There were some estimates from wind tunnel data or previous aircraft programs that he refined based on his V_{MU} data that he had collected.

Q. And why do you think he didn't collaborate with Bob Mills' group in developing the refined estimate?

A. I don't know.

Q. All right. Do you know how the original G650 field performance flight test schedule and associated staffing requirements was benchmarked for, like, the Roswell-1 and II testing?

A. Well, the overall GVI flight test schedule was based primarily on how we did the GV. That's how it's initially benchmarked.

Q. And how about for the number of flight sciences and flight test engineers who would be on site?

A. Flight test engineers I can't speak for. Flight sciences engineers was in agreement that Shelly -- between Shelly and I, after she put together a plan, her and Pat Connor put together a plan and showed it and put it out in front of me and said, "Does this work for you?" And I said, "Yeah, if that's what you guys agree upon, I'm okay with that." And again, it was the overlapping of Shelly and Pat as DERs to be there for the full time during the testing, and then having two additional engineers to support them at all times so there would always be three flight sciences engineers at the field performance testing at all times.

Q. And in looking at the April 1st weekly web "X" which showed the schedule going ahead with the TIAs and in talking to people about the history of the flight test program, it seems like there was sort of a pile-up of TIAs in the summertime of 2011 at that time, and what I -- I guess we're interested to know how the schedule got revised to that point and whether or not the personnel working on the flight -- the field performance flight test program would have felt pressured or constrained by the compressed time frame near the end of the flight test program, and whether or not you felt that it was generally understood there was some flexibility if things didn't work out; that that could get extended. I realize that's a compound question, but -- so, I guess first we could start with, you know, how did it get to that point where all the TIAs got piled up? And then, secondly, do you feel like that created any kind of undue pressure on the people working on site or people actually participating in the testing?

A. Well, the way the TIAs got piled up is we had an end date as to when we were trying to get the airplane certified by, so as we move along in the program, the end date stayed still, but testing wasn't necessarily being completed on time, so all the TIAs got squashed closer together at the end on multiple airplanes. We had multiple TIAs on multiple airplanes all at the same time.

UNIDENTIFIED SPEAKER: And now the second part of the question.

MR. LAVRISA: And now the second part to that. In terms of undue pressure, I think everybody felt the pressure of the program and trying to complete on time. Whether or not that influenced any decisions at Roswell at the time, I don't know. We -- well, if I can backtrack, when we realized from Roswell-1 that we had issues with meeting our field performance and that looked like we were nowhere near our targets, there was a review of the data and determined that the technique wasn't -- was very benign.

Our takeoff technique was very benign and we needed to modify it. So that's when the decision was made to go to Birmingham. So whenever there was -- even though we always had schedule pressures, if there was a problem that needed to be resolved, we always made room to address that particular problem before moving on. We injected the extra testing at Birmingham to do more technique development before going back to Roswell.

BY DR. BRAMBLE:

Q. And do you feel like the constrained or the tight schedule affected data analysis as the program progressed?

A. No, I don't think so, because there'd be various disciplines working on that airplane at specific times. So performance would be on the airplane, and then they would get off the airplane and somebody else would get on there, and then in the interim they would have time to review their data before continuing on to the next series of tests. It was crunch time, and it's been like that for a long time for everybody to get their work done, but there was still occasional breaks where you can take a look at the data and have a reasonable amount of time to do an accurate assessment.

Q. Okay. And did you feel the scheduling by March was any tighter than it was on the prior programs, like GV or GIV?

A. I was in a different role on the GV and G450 programs. My focus was on propulsion engineering and I didn't see everything else that was going around compared to my focus on my particular job. But now that I'm -- as the director of flight sciences with seven different departments and everybody's got a piece of the airplane, I can see the schedule pressure is pretty high. But can I compare it to the previous program? I would have to say no. To me it seems like the pressure is significantly higher in this program, but mainly because I have a lot more responsibility rather than just propulsion.

Q. Okay. And one of the things that we heard from at least one other senior person who's been around on previous programs was that it seemed like there were fewer folks to do the analysis on site than there had been in previous programs. Is that consistent with your perception based on your past experience?

A. Just kind of in the GIV days and -- it seemed like we had about the same level of people on site as they had at Roswell, based on GIV days from the late '80s.

Q. So the size of the team sent to Roswell for the G650 field performance testing was similar to the size of the team of engineers sent out -- specifically the engineers I'm interested in -- sent out for the GV field performance testing? Oh, wait. You were talking the GIV.

A. For the GIV.

Q. I'm sorry.

A. I was not there for the GV.

Q. Okay.

A. I can't comment on that.

Q. Let's constrain that to GIV. So what you are saying is that the engineering team sent to -- that participated directly in the field performance testing was similar for G650 as it was for GIV? That's your recollection?

A. Yes, that's correct. On GIV we did not have a TM trailer, though.

Q. Did you have a TM room?

A. There was a TM room, but it was a portable antenna and there was not a trailer with IADS screens like we have now. They did have a trailer that would collect the data and send it to us in a separate building.

Q. Okay. And did you feel like the scheduling and staffing permitted enough time during the G650 field performance test program for data analysis and information sharing in preparation for the next envelope expansion point on site?

A. I would say yes.

Q. How about at the end of the day and before the next day's tests?

A. I don't know. I wasn't out there.

Q. All right. Are you aware of the schedule -- the memo -- a March 31st memo that the FAA sent to Gulfstream about the -- urging that the flight test schedule be revised to reflect the true status of the program, and saying that the current schedule appeared to be unrealistic?

A. Yes.

Q. Was there any response or discussion or decision-making that occurred prior to the accident after the memo was received?

A. (No response.)

Q. I mean I know it came in on the 31st of March, which is Thursday, and then the accident occurred 2 days later. But were there any -- did you participate in any meetings discussing that?

A. There's not any specific meetings. I believe it was talked about at our April 1st meeting, which was on a Friday. We have a weekly certification issues meeting. Been held every Friday since the beginning of this year.

Q. Was it raised at the meeting?

A. It was raised, but it wasn't discussed in detail.

Q. And was there any talk about what the response was going to be or what was going to be done?

A. No, not that I recall.

DR. BRAMBLE: All right, John.

MR. RAMEE: Let's take a break.

DR. BRAMBLE: Um-hum.

MR. RAMEE: I think it's been going on an hour and 45 minutes.

DR. BRAMBLE: Yeah.

MR. RAMEE: Time to --

DR. BRAMBLE: Yeah. That's okay.

MR. RAMEE: Time to rest.

(Off the record.)

(On the record.)

DR. BRAMBLE: John, you had some additional follow-ups you'd like to ask.

MR. O'CALLAGHAN: Yeah.

BY MR. O'CALLAGHAN:

Q. Thank you, Mr. Lavrisa, for your time. I do have some clarifications and follow-ups, and I apologize for the bouncing around nature of this, but hopefully it will still be clear.

First thing, I was wondering if you could just describe for us, is for field performance testing basically the steps involved, and I imagine this would parallel what's in the test plan. But if you could sort of maybe describe the reasons why things are done in a certain order and what results are necessary for moving on, if that's the reason the order is set up the way it is, and sort of the tent poles or critical milestones along the way for the field performance testing.

A. Okay. I want to qualify I'm not a field performance expert. Probably the majority of what I've learned has been after the accident and not leading up to it. Do you still want me to elaborate based on what I know now versus what I knew at the accident?

Q. Sure.

A. So my understanding is that we do the V_{MU} tests first, determine the CL versus alpha and ground effect curves first, and then determine from there what the appropriate liftoff speeds would be, and then from there you would develop the speeds and confirm that your speeds are appropriate based on the V_{MU} testing. So that would be the order of testing. You would start off with V_{MU} testing, and then you would start off with CTO testing, and then work your way down from CTOs, all engines operating, to one engine inoperative.

Q. Okay.

A. One engine inoperative being throttle back to idle first and then finally at the end you would do one engine inoperative with full throttle chops -- or full fuel cuts, and then eventually you'd have to work your way down to the abuse cases on top of that.

Q. Okay. So then, thank you. That helps. So specifically regarding the construction of the lift curve based on the V_{MU} testing, does that sort of need to be in hand before you move along to the subsequent tests that you've mentioned?

A. I would say yes. You need to understand the V_{MU} curve in ground effect and lift curve in ground effect before you continue on with the -- to CTO field testing.

Q. Okay. And we know that Mr. Ollenburg was constructing one of those. I guess that would be the subject of his V_{MU} report, his drafting a V_{MU} report.

A. Yes.

Q. But in your estimation, at the time of the accident was the knowledge or was the curve constructed and validated and distributed, or this handshake between flight sciences and flight test that occurs regarding, say, that particular analysis, was that mature enough to the point for going on to the CTO testing, the way you understand it and as you've just described it?

A. I was told that Reece had developed a curve and then he had shown it to Bob Mills briefly. It was not a -- I don't recall if it was a hand sketch or an Excel plot, but he did have a curve that showed the shift in ground effect versus free air for the CL alpha curves. So it was shown to Bob Mills before the accident and it showed the shift of 1.6 degrees on the CL alpha curve.

Q. Okay. And to be clear, that 1.6 degrees is a shift in CL -- or the shift in alpha at some particular CL, but not necessarily a shift in stall? Or did it --

A. No.

Q. -- did it include both?

A. It did not include any shift in stall.

Q. Or was that a particular lift coefficient, that shift in the --

A. Yes, and it seemed to be up at the high end of the CL curve, and he basically had parallel lines between the two CL alpha curves at the high end.

Q. And so in your estimation, Dr. Mills gave his blessing to V --

A. I don't know if he gave his blessing. He just said that he had seen it, but I don't believe -- I don't know if he gave it his blessing.

Q. Okay. And the reason I ask is because when you were describing sort of the cooperation between flight sciences and flight test, that there would be a meeting of the minds at some point on an agreement that, yes, the data has been analyzed and reduced correctly, and so I'm interested if the treatment of the V_{MU} data had reached -- if that process or that occurrence applied to the V_{MU} analysis and whether Reece's talking to Bob constituted that or not, in your opinion.

A. In my opinion, it was just mentioned in passing. It wasn't a detailed data review of the V_{MU} data.

Q. So it wouldn't really rise to the level of the sort of --

A. No.

Q. -- thing you were describing?

A. No.

Q. Okay. Thanks. Regarding Flight 132, we have had some very interesting conversations about that this week, because at the beginning of the week my understanding was much what you described; that today everybody understands that that event, along with the accident and Flight 88, were stall events. But there's still, I think, folks that we talk to who are still of the opinion that appeared to be prevalent at the time or shortly after the event on 132 that it was a CL data or some sort of LAU (ph.) directional event associated with the unavailability of the yaw damper, and I think that sort of conclusion even appears in some high level PowerPoints about post-flight activities on 132.

And what I've been trying to chase down, because it will be my job to explain it, is what was the technical rationale or the physical explanations that were brought to bear and the data that was looked at and associated physics that were brought to bear to conclude or assert that Flight 132 -- the roll-off on Flight 132 was LAU directional and not a stall, if you're aware? And you mentioned somebody within flight sciences looked at it from the auditor ??point of view.

So, if you know the answer to the physics of that or you know somebody I could talk to, to find the answer, I'd be interested in either.

MR. RAMEE: Can we go off the record for a second?

MR. O'CALLAGHAN. Sure.

(Off the record.)

(On the record.)

BY MR. O'CALLAGHAN:

Q. On March 24, 2011, there was a meeting to discuss the movement of the stick shaker threshold from 25 normalized angle of attack to 0.9. In addition in that meeting, video from Flight 132 was shown. The presentation that those people put together, summarizing some of the events from that meeting and specifically post-event actions following Flight 132, noted that the take-away from that flight was that the roll-off was caused by a lateral directional disturbance CL data, roll view to sideslip, aggravated by the unavailability of the yaw damper. And so my question is, do you know of any rigorous physical analysis that supports that take-away conclusion, or can you point me to somebody who might be able to provide that?

A. I don't know of anybody that did a rigorous analysis of that particular maneuver to prove that it was CL data that caused the roll-off, prior to the accident. After the accident, Brett Leonhardt did his analysis, the residual analysis that showed that, yes, there was a large disturbance and there was an increase in the yawing moment and increase in the rolling moment, which is indicative of a wing tip stall. He did that same analysis on Flight 88 and came up with the same results, and the same analysis on Flight 153 and came up with the same result. It was a tip stall that caused the roll-off in all three flights.

Q. Thank you.

A. Um-hum.

Q. Okay. An easy one now. Going back to your background, first of all, your technical background, discipline, or specialty from what you've described, I imagine it's aero propulsion? Do you have a particular specialty or discipline you focus on?

A. When I started off with Grumman, I was doing wind tunnel work on the A6, and EA6B was my first job. Then I came down to Gulfstream and they needed assistance in the propulsion engineering department, so I worked in propulsion engineering on the Tay engine. And then after a while they needed support in the flight test program, so they asked me to work propulsion flight tests, so I handled all the engine starting, engine handling, thrust laps rates, engine margins, anything -- anything associated with engines was my specialty. Specialty in flight test. I did the same on the Saab 2000 program, and then I also did very similar work on the C130J and also did some systems integration on the C130J.

Came down here to Gulfstream in '96 and worked on the GIV. Again went into propulsion engineering and worked closely with flight test on any propulsion-related issues, and worked on that for the 450, the 550 -- well, first the GV, G450, G550, and then I started doing that on the G650 at the time, and then they asked me to become the PDT lead for flight sciences and take over all the flight sciences for this program. So that was in late 2005, and in March 2010 is when I became director of flight sciences for this program.

Q. Thanks. So a very strong aeronautical engineering --

A. It was mostly propulsion engineering, propulsion flight test throughout my first 15 years, and then really the last 5 years was where it's been multi-discipline across all disciplines in flight sciences for more -- moreover as a technical and managerial lead.

Q. Okay. Thank you.

A. I'd be handling technical issues, but also HR issues and performance reviews and things of that nature. So it was a little -- and budgets and everything else.

Q. Okay.

A. It was a little bit of everything. But I have one lead for each department, so I'll allow them to pretty much handle their technical disciplines as necessary.

Q. Thank you. Did Pat Connor apply for the aero group head position?

A. I don't know.

Q. No?

A. I don't think that he did.

Q. Okay.

A. He was the acting group head for a long time. I don't think he liked that --

Q. Yeah.

A. -- leadership/managerial role where he had to do performance reviews and things.

Q. I understand and sympathize. Regarding reduction in stall angle of attack due to ground effect, do you have a feel for what a reasonable uncertainty number, a round estimate that's provided based on low miles an hour wind tunnel testing or "S" programs might be? We know the estimate was 2 degrees and you would say -- I'm just asking you, you would say 2 degrees plus or minus percent?

A. I wouldn't know.

Q. Okay.

A. I really didn't get a full appreciation for this until after the accident.

Q. Sure. A little bit about the difficulties in getting data. I understand that it was more of a problem in Roswell-1, and things really improved in Roswell-2. Was it your impression that Shelly and her group were idle on the ground in Roswell-1 or II, waiting for data and really couldn't proceed until they got it?

A. I didn't get the impression that they were idle. I think there were -- there's always work to be done, but I got the impression they were maybe frustrated because of the fact they couldn't get their data quick enough.

Q. Okay. I listened with interest to the discussion about safety programs and policies and procedures, and it just made me think to ask if there is merit in making responses or processes for reporting of incidents or unusual results in testing part of the TSHAs, or would that dilute the purpose of the THSA? Just if you have an opinion on that.

A. No. I think a TSHA is just a safety process, but I think the reporting of events should fall in some other document, some other area rather than a TSHA.

Q. Okay.

A. I think that should be independent of TSHAs.

Q. All right.

A. If you get an event on a flight that's a low-risk flight and something happens, it should be reported.

Q. In your opinion, did the wing drops that occurred on GIV, GV, and GVI qualify as loss-of-control events?

A. I can't say for sure on the IV and the V, but I'd say the VI is definitely loss of control.

Q. Okay. That's been answered. Now, I understand that you didn't hear about Flights 88 and 132 and the wing drops on those flights until after the accident. But when you did learn of them, do you recall if a stall warning was received on those flights or was triggered?

A. I don't recall.

Q. I think where I'm going with that is -- never mind.

Now, you described the rotation technique prior to the trip to Birmingham, and that was used in Roswell-1 as benign. Can you quantify that a little bit? What do you mean by benign?

A. I think lower pitch rates and not as aggressive in terms of meeting your V_2 speeds. So as a result, the field lengths were significantly higher --

Q. Um-hum.

A. -- and guarantees to the tune of, like, 7,000 plus feet.

Q. And can you quantify, say, the pull forces and the pitch rates that were attained there versus what would be more reasonable or permissible?

A. I don't recall what they were for Roswell-1.

Q. A question regarding schedule. You mentioned how sort of the end point was fixed, but things that had to be done by the end point were sliding, so as a result there was a lot of compression in the end there. So my question is, at what point does one cry uncle and ask for relief, and was that done and what was the response?

A. I think at some point it comes to pass you realize you're not going to make the schedule and it's just going to be what it's going to be. You do the best that you can on your particular task and the schedule falls where the schedule falls. We don't -- I mean we drive as we can to it, but at some point it will stretch out. We have weekly meetings to discuss flight test schedules and we shuffle things around as best they can to fit so that you can get the right tests on the right airplane. We allow the proper amount of time for each test. We allow the proper amount of time to instrument the airplane or upgrade the airplane, and it's all discussed on a weekly basis. So the schedule is a -- it was fairly fluid and it still is, and we're constantly working it to optimize the schedule and make it as best as possible.

Q. I have a follow-up to that and I don't mean to be facetious, but I mean obviously, say, if the end point on paper was tomorrow and you're not done, then usually by that point or certainly for points in the past one would say, "Well, we have to slide it." At what point does -- you know, is it with one week out? Two weeks out? Three weeks out? I mean you said at some point we'll say things have to slide, but when does that occur so that the folks who think that management still expects them to get things done by a certain date has relented and now it's -- they have more time to do it?

A. I would say it's probably 3 or 4 months out.

Q. Three or 4 months?

A. Yeah. When the reality hits that you're not going to make that particular date and there's just too much testing to be done in that time and it's not going to work.

Q. And my closing question is the one we're giving to everybody.

DR. BRAMBLE: Hang on, John.

MR. O'CALLAGHAN. Oh, sorry.

DR. BRAMBLE: Would it be beneficial at all to look at the schedule from April 1st for the TIAs, I think, or --

MR. O'CALLAGHAN: I'm not familiar with this at all. Maybe if you want to go through it, I guess.

DR. BRAMBLE: There we go. All right. So, John, you can take a look at first and then we'll hand it over to them and see whether or not you think that would be the appropriate point or not. This is from April 1st and these are the TIAs that were scheduled in April and May and June, and then July was the last month of the flight test program. So things had slid, and a number of these were supposed to be spread back here a few months, according to my understanding, and they kind of piled up here, but

I don't -- you can verify that, but if you wanted to have a concrete reference point, you could show him that and say, well, is March the point at which -- because that's 1, 2, 3 -- 3 to four months from the end of the flight test program and the point at which he would want to slide it or not.

MR. RAMEE: Yeah. Sounds like you have the question well composed in your head, and can you ask --

DR. BRAMBLE: Okay. Let's go on -- well, why don't you guys take a look first and --

MR. LAVRISA: Sure. I've seen these before.

DR. BRAMBLE: This is the front half if you guys need it, but it's -- that page is the only one --

UNIDENTIFIED SPEAKER: Is this a meeting you go to?

MR. LAVRISA: Yes. I go to this meeting weekly.

UNIDENTIFIED SPEAKER: Okay.

MR. RAMEE: Let me go off the record and out the room, and we'll be back and we'll answer the question.

DR. BRAMBLE: Okay.

(Off the record.)

(On the record.)

BY DR. BRAMBLE:

Q. So, Tom, can you identify the document that we're looking at?

A. Yes. This is a G650 flight test program. It's a weekly WebEx that was between the FAA and Gulfstream. They have these on a weekly basis every Friday. It's a discussion on upcoming tests and what the current schedule is.

Q. Okay. And there's a page in there that shows the TIA schedule and it shows quite a number of TIAs in April, May, June and some in July, and I just wonder if the number of TIAs scheduled per month there had given you any concern during the meeting, and maybe you wonder if maybe the end date should be pushed back.

A. I wasn't there for this particular meeting, but I would get a copy of these schedules usually on a -- every time it was updated, I would get a new schedule that would include these, and we would always see these TIAs shifting to the right. And I don't know if you noticed on the bottom, but it showed the actual TIAs accomplished and starting at one, two -- the most we ever did was three a month, and then in April we had nine, May there was eleven, June there was nine, and then July there was four. So we always looked at the schedule and we realized that they were not realistic.

Q. And so what did you anticipate going forward was going to happen with that schedule?

A. I anticipated that we weren't going to meet the schedule and it was going to slip to the right, further to the right.

Q. You mean the last TIA would slip further beyond July?

A. No. We would think that the ones in April would probably shift, and these would be spread out probably over a few more months.

Q. So the TIAs would extend into like August, September?

A. Yes.

Q. Okay. And at what point do you think that decision would be made? I mean at that time when the -- you know, you might have seen these schedules in March or late March or around the time of the weekly WebEx. You know, what point might you have anticipated that the schedule would be pushed beyond July?

A. I would think at some time in April that decision would be made, and we -- these schedules would be reviewed on a weekly basis all the way to the -- all the PDT leads, all the directors, program manager, up to the senior VP of engineering programs.

Q. And why do you think it hadn't already been extended, given that you'd only been able to accomplish like three per month and you had 9 to 11 in mid-summer per month scheduled?

A. It was said early on that we would finish all our testing by July, so, you know, trying to keep that goal. We always find out if we give our suppliers a little bit of leeway, they'll take all of it and then go above and beyond that. So we want to keep the pressure on the suppliers to provide their parts, finish their qualifications tests, and do all of their things on time, so we did not like to let our suppliers know that we were slipping, because they would take advantage of that.

Also, I think it was trying to keep -- if we spread this out over a longer period of time, I believe that people would take it a little bit easier and it would slow down a little bit, and we like to keep a sense of urgency at Gulfstream to keep things moving.

Q. Anything else that's there, or is that it?

A. Like I said, at the -- I know we presented these on a weekly basis, but down in the ranks it was pretty well understood that this was not a realistic schedule and that we weren't going to make it. You know, to do each one of these TIAs, you have to finish the company test and issue a company report, and then the FAA has to approve that report or approve the TIA, and then you have to do the conforming and then inspect the airplane and get it ready for the testing. So, all the test plans and test reports have to be completed and approved and ready to test, and there's just -- we knew there was just no way that we'd be able to do twenty TIAs in 2 months. We didn't have the resources to do that, and the FAA didn't have the resources to support it, either.

DR. BRAMBLE: Okay. Thanks.

BY MR. O'CALLAGHAN:

Q. My last question is the one we have been asking everybody, which is just this, that we're nearing the end of our fact gathering. This is probably our last week of big interviews before we start our analysis process, and of course the end, as Bill mentioned at the beginning of the interview, the objective for the investigation, one of them anyway, is to come up with recommendations to the industry or to hopefully improve things.

So, two questions for you in this area.

One is if there's something we, the NTSB, should be looking at or considering that it's not apparent that we are looking at or considering based on our questions, please let us know or suggest some additional avenues we could pursue.

Secondly, if there's anything you think the NTSB should recommend to benefit the industry at large and improve flight testing safety, we'd be interested in hearing that as well.

So, with that it's wide open for anything you'd like to suggest now, or if something occurs to you later, you know, please offer it through Tom Horne.

A. Okay.

Q. We'd love to hear it.

A. Sure. I'd like to make a few comments if I can. I mean in the beginning right after the day of -- day after the accident, I was assigned to the heading of loss-of-control team, and I did that to the point that we generated the presentation. But then immediately after that point it was like, all right, what do we need to do to return to field performance safely?

So we started the team up about 3 months ago, a very similar team. We still have Bob Mills there. We've got Brett Leonhardt there. We've included flight test engineers, Paul Donovan. We've got a project engineer that's been assigned to it, Jacob Norton, which you've worked with also.

So we've now for the past 3 months been working on how do we get back to field performance safely, taking the findings that we've had and how we did it in the past and how we plan on doing it in the future. So what we've focused on is we're going to have a consistent crew. We know who's going to be the pilot and co-pilot at all times. We'll have one FTE that will be on board the airplane only. We'll have dedicated crew in the TM trailer that will be there for the entire duration of the test, and everybody will observe the crew duty days. Everybody will have an assigned seat in there. Everybody will have an assigned task. We'll have Brett Leonhardt doing his in ground effect analysis. We'll have other aero engineers in the TM trailer. Bob Milles will be there. So there'll be a lot more oversight on the safety aspects of the particular test.

In addition, we'll have a team in Savannah that will be on the daily briefings and the debriefs, and there will also be a daily communication meeting to talk about here's the testing that happened over the past day, here's what we plan on doing the next day, here's the data analysis that we need to perform before we continue on. The data will be -- the flight cards will be transferred daily back to Savannah. PDFs, time histories of every single run will be created, and the data will be sent back to Savannah so that it will be available in Roswell and Savannah the following morning and everything will be a significantly more coordinated effort in terms of supporting field performance, focusing primarily on safety, and then after that it will be the data collection.

And the plan is to -- we'll have a safety review board coming up in a few weeks and there'll be a -- as part of the safety review board, we'll document everything, all the processes and procedures that will be in place for the flight testing, what we did in the past and how we're doing things differently, and also we'll review all of the findings that Gulfstream internally had from the accident and how we've addressed every single one of those findings before proceeding forward with any field performance testing and all. That's in a short nutshell what we're planning on doing, but that will be expanded to several days of safety review boards.

Q. Good. Fantastic. Thank you very much for your time.

A. Again, we're doing a lot more CFD analysis, more in ground effect stall analysis, a lot more dynamic modeling so that we'll have a better definition of our speeds before we actually do our tests. We've already got build-down procedure start-off at higher speed and work our way down, making sure we always take into account our main ground effect stall angles. We also account for our abuse cases where there were lower speeds for rotation or over rotation. Trying to think of something else that I missed. But that's generally the process. We're doing a lot more things to make sure that safety is a priority in this program.

We're also modifying the in ground effect shaker, the shaker on the ground, and instead of a constant fixed value, it will be a function of height above the ground. So as you transition from in ground effect to 35 feet, the shaker will move appropriately and keep it suppressed closer to the ground where your in ground effect stall angle is less. We've already got that programmed. It will automatically be programmed into the FCC. It will be part of the actual testing that we do. Currently evaluating that in the ITF, and so far it's working fairly well.

MR. RAMEE: Can you speak to the aviation safety logs?

MR. LAVRISA: Yes. Three weeks ago or so we created -- Gulfstream has created an aviation safety office, which is headed up by John Salamankas, who's one of our senior test pilots, and it's three different teams underneath them. It's Tom Rothermel from flight sciences will be handling the engineering part of safety. Chris Licavoli from flight test will be handling the flight test part of safety. And Bud Ball, who's another test pilot, will be handling the flight operations side of aviation safety. They just formed a few weeks ago. They will be participating in all the safety review boards, and it will be a separate independent office, independent of engineering and independent of flight operations; directly report to Larry Flynn, who's our CEO.

BY DR. BRAMBLE:

Q. Can you go back over just briefly -- the three different sub-grounds under John will be what?

A. Engineering, flight test, and flight operations.

Q. And the --

A. The names?

Q. -- names again were Chris -- or Tom Rothermel?

A. Tom Rothermel, who's the acting director of flight sciences. They felt it was -- instead of taking somebody from structures or systems, they felt it was better from a safety perspective to pick somebody from flight sciences. So Tom Rothermel will be handling engineering. Chris Licavoli will be in charge of flight test, L-i-c-a-v-o-l-i. And Bud Ball will be in charge of flight operations.

MR. O'CALLAGHAN. V-a-l-l?

MR. LAVRISA: B-a-l-l.

MR. O'CALLAGHAN: Okay.

MR. LAVRISA: They're all acting positions, I believe, at this point, and they might be -- requisitions may be open for them, but they're all in an acting role right now.

DR. BRAMBLE: Okay. Good. Anything else you want to add or --

MR. LAVRISA: No.

DR. BRAMBLE: -- should we move on.

UNIDENTIFIED SPEAKER: Thank you very much. Appreciate it.

DR. BRAMBLE: Okay. Mitch?

BY MR. GALLO:

Q. In reference to the flight test safety review board on

October 7th for 6002 field performance, beginning with that SRB do you recall, when field performance testing was finally decided upon to begin and that in the beginning would be the initial SRB. So was a decision made in September to begin field performance testing, or can you provide a date?

A. I can't recall. I'd have to get out my original flight test schedule as to when it was planned. But field performance was always -- always tried to tailor it as soon as possible, but you always run into issues with flight control computer and other issues that seem to push it out farther. We like to get field performance done earlier because it's quite a significant effort to create a flight manual in order to get your certification. So we try to pull it in as soon as possible, but it drifted out further towards the end.

But Reece was hired in specifically to do field performance, and he had been working -- I mean that was his primary job, was to work field performance. So he had been preparing for the safety review board for quite a long time. I don't think it was a -- him doing the work for the safety review board, I'm sure, took several months. It wasn't a, you know, good 2-week effort to prepare for a safety review board. He had a lot of material. He had everything very well organized. He had all the test plans identified and all the TSHAs identified and he was -- he did a very good job on the safety review board in terms of identifying all the tests that needed to be done, all the TSHAs that were associated with each particular test, and any follow-up actions that came as a result of that.

Q. As an estimate, do you think it was decided upon in the summer of 2010 to go ahead with field performance testing?

A. No. I think it was decided well before that. In terms of nailing down the actual schedule of when it was -- is what you're trying --

Q. It's essentially, okay, we're ready to do field performance testing. Do you remember when that decision was made?

A. No. I can't recall.

Q. Do you have that on your calendar somewhere?

A. I mean it's always been in the schedule from day one, and like I said, we would decide on a weekly basis where to float things around. I'd have to go back through my notes to find out when we'd pin down exactly when we'd do a field performance.

Q. Okay. And in regards to this SRB for field performance on October 7, did you get -- well, did you get an advance copy of the material that was going to be presented?

A. Yes, I did. It probably -- but if anything, it was maybe just a day or two ahead.

Q. And the slides, I have been told, were made by Reece, and Reece presented those slides.

A. That's correct.

Q. As then as far as all the attendees from flight sciences, how is that arranged? Do they just get an invite or do you assign people to go there?

A. It's typically an invite. It's arranged by Barry McCarthy and his admin. He puts together a list of who needs to attend the SRB, who the board members are. If there's any disparity in that list, I always check to see who the invitees are. If he's missing somebody that I feel needs to be there from flight sciences, I'll make sure that they're -- they get an invite also.

Q. But, for example, Ms. Shelly Brimmeier. Her invite would have come from Barry McCarthy?

A. That's correct.

Q. But not from you?

A. No. He would arrange the invites for the safety review boards, and I would just double check the invites to make sure all the appropriate flight sciences engineers were invited.

Q. Do you know why anybody from applied aerodynamics did not attend the SRB? And the reason I ask is because within the slides there's discussion about in ground effect and about CL versus alpha and the basis of stall speed based on previous stall tests. So there's a lot of references to aerodynamics, so in that context, the -- tests or even TSHAs talk about stall. Why wouldn't somebody from aero -- or flight aerodynamics, such as Bob Mills or Grant Martin, be invited to attend?

A. No. They should have been.

Q. They were not on the list.

MR. RAMEE: We don't have the invitation list here. Do you have an invitation list?

MR. GALLO: I have one invitation list. This is what I have.

MR. RAMEE: That's an attendance sheet. Yeah, the invitation would have been something different.

BY MR. GALLO:

Q. So, based on the attendance sheet from the 6002 field performance SRB on October 7th, there isn't anybody from applied aerodynamics?

A. That's correct.

Q. Now, going back to the stall test program, was somebody from applied aerodynamics and flight sciences, did they attend the SRB for that?

A. Oh, yes. Yeah, that would have definitely been Bob Mills.

Q. My next question is as far as -- going back to 088 and 132 as examples, why do you think Ms. Brimmeier did not tell you about the roll-off events?

A. We've actually talked about this, and she, based on pilot comments, she didn't feel that it was a significant event enough to tell me about. So it was not played on as, wow, this is a stall, and this was just a roll-off that was corrected and it didn't -- I've said it wasn't identified as a significant event to her and she didn't think twice about it.

Q. And the way you obtain information about the status of the program from various disciplines is broken up within applied aero, aero performance, flight dynamics, propulsion performance, and thermal dynamics and the such. Do you typically talk to the group heads of each of those departments to get an idea of the status of the aircraft and what the issues are?

A. Yes. It's usually a -- well, it's -- I have a weekly staff meeting on Mondays and I have a daily phone call every day, every morning. Not long. Just a few minutes to touch base on what's going on for the day, any significant issues, and I'm always open. They can send me an e-mail or I can call them or they can call me at any given time if there's any problems.

Q. Do you ever go outside of those group types in terms of contact as a double-check? For example, would you go to the non-G650 flight sciences people to double check what you're being told as far as specifics or generalities in terms of the certain disciplines that are at issue?

A. Yeah, if I have to. Obviously, Grant Martin is not as senior of an engineer as Bob, so I'll rely on one or both of them in case there's any things that come up. If I have a question with Shelly and needs further explanation, I'll call Pat on an occasional basis. There's quite a few other resources I can use to contact in case there's any questions. You know, we have other managers that are available and have experience on other aircraft programs. If there is a question, we call them in. Nobody's pigeon-holed into one specific thing. If there's additional help that needs to be gained, we'll run a go-cross program or back to the core department to talk to anybody that we need to.

Q. And if one of the group heads within the G650 flight sciences organization called you up and said, "I believe there's a hazard," whatever that is, how would you initiate the process to stop testing? Can you pick up the phone and tell them to ground the airplane, and who would you contact?

A. I could if I needed to. I haven't been to that point yet. I would contact Barry McCarthy directly if there was an issue, or any of my engineers could do the same. It wouldn't -- it doesn't -- there's not a specific chain of command. If somebody had a problem and they said, "Barry, I think we've got a problem. We need to look at this" -- the majority of time they'd come through me if there was a problem, but if they needed to, there's no reason why they couldn't go above me to talk to either Brian Durrence (ph.) or Curt or Pres or Barry to stop something.

Q. After Roswell-1, did you have an upper management meeting to discuss their plant's inability to achieve performance guarantees? And that would have been attended by Mr. Ken Obenshain.

A. There was probably discussion on April 1st, the day before, and there was a flight science -- weekly flight sciences certification issues meeting. We would bring up anything that we have issues with, and it was always in attendance with all the directorates and also by flight test, and a majority of the time Ken would attend. But do I remember one specifically that he would have attended with regard to performance? No, I don't.

Q. And this was after Roswell-1 and Pres Henne would have been in attendance.

MR. RAMEE: Yeah. Can you elaborate on that? Give him some more things to jog his memory? It's in RBC 1, so either in Beta or the conference room with the --

MR. LAVRISA: Epsilon.

MR. RAMEE: Epsilon. It's a large group. It involves Jake, the three or four top guys, some flight test engineer -- the flight test engineering people, Barry. Between Roswell-1 and Birmingham?

MR. GALLO: Correct.

MR. RAMEE: And they're talking about the Roswell-1 results.

MR. GALLO: Right.

MR. RAMEE: Do you remember something like that?

MR. LAVRISA: The one I remembered was the one after Roswell-1 and after Birmingham, and then having a discussion in that particular meeting. I don't recall a previous one. I do have all my slides from that particular meeting, but I'd have to dig it up. I could find it if there was one earlier this year. I could find it.

BY MR. GALLO:

Q. And that meeting you remember as the one the day before on Flight 153?

A. Right, and there was a discussion about Roswell-1 and Birmingham during that meeting.

Q. Okay. And do you remember who from flight operations attended?

A. I'm 99-percent sure it was Jake Howard.

Q. Did Mr. Vivan Ragusa or Mr. Ted Crenshaw attend that meeting?

A. No. They would have been in Roswell at the time or traveling out there at the time.

Q. And did Mr. Bob Mills attend that meeting?

A. Yes. He was there.

Q. And what was the discussion about? You may have answered this question, but I don't remember your answer.

A. The discussion was about takeoff technique and how do you fly this airplane to get the maximum performance out of it, and the discussion centered about, you know, the way to get maximum performance is to keep the airplane on the ground for a longer period of time and pull hard to climb out of -- and transition out of ground effect and capture V_2.

Q. Was there any discussion for alternate means to capture V_2, such as increasing the speed, brought up during the meeting?

A. Yes, there was.

Q. How about any discussion regarding changes to the wing, the wing devices?

A. Not at that meeting.

Q. Was there any discussion that the Flight 153 had to progress because the deadline for the airplane certification was nearing?

A. No, I don't believe so. I mean it was well known that you had to complete this testing in order to generate an AFM. But at that point in the program it was not the long pole in the tent. There was plenty of time to finish the field performance and to generate the AFM in time for tech certificate. It was tight, yeah, but it was doable.

MR. GALLO: That's all the questions I have. Thank you.

MR. LAVRISA: Sure.

DR. BRAMBLE: Jeff?

MR. BORTON: Tom, go ahead. I'll back up and ask him any questions --

MR. HORNE: Okay.

MR. BORTON: -- you haven't asked him.

BY MR. HORNE:

Q. You mentioned that it would be appropriate to do a build-down too on the Roswell testing?

A. Yes.

Q. I guess that's based on hindsight.

A. Yes.

Q. But if I remember some prior testimony correctly, the V_2

or V_{SR} numbers for the GV program were on the order of 1.2 to 1.25, depending on your thrust to weight.

A. Yes.

Q. So, since we are going right to 1.13, why didn't we have a build-down?

A. I don't know the answer to that.

Q. Okay.

A. I think the other major differences on the GV and the GIV is that you were tail limited, so you couldn't rotate, so your speeds were naturally higher. And now on the GVI, you've got to trim a little stab, so you can definitely rotate at an earlier speed. So previously you couldn't achieve those speeds, and now you can with the tail, so that might have driven this to a problem.

Q. Okay. I guess it's kind of two questions here, which -- on your e-mail. Are you aware of an e-mail that generated a PR to change the referral log default setting to 0.9 on low tack?

A. Not until a few minutes ago.

Q. Okay.

A. No, I was not aware that that came up.

Q. I believe you guys also have this March 24th e-mail and I was just reading this, and it appears that the control log people did an analysis of whether the alpha limiter would have engaged or not with the default settings and would have prevented the over-rotation of Flight 88.

A. Um-hum.
Q. And the conclusion was that it wouldn't have done that. Do you have any idea why the control log group didn't just take this and say, "Hey, you know, maybe we need to get Bob Mills involved"?
A. Well, I mean, you know the control log group. They're under a lot of pressure to answer questions and resolve problems quickly, so if they were told to look at one specific thing, they looked at it and gave them the answer, and they were probably done and moved on to the next thing.
Q. Okay.
A. Typically if they -- and anything regard to alpha limiter, they've been in close contact with Bob Mills at all times. Whenever his schedules change or there's anything that's involving the alpha limiter, they've been working closely with Bob on that.
Q. Was Bob on a long vacation during this period of time, field performance?
A. No, I don't think so. Don't think so.
Q. You mentioned that in one of the meetings that they decided that the technique was benign?
A. Um-hum.
Q. The takeoff rotation technique. Can you tell us who decided it was benign?
A. I believe it was performance. I can't remember the

person, whether it was Shelly or Pat, that came up with that. And that was based on the field performance values that came out, the field performance. Their target was 6,000 foot, and the actual values coming out of Roswell-1 were 7,000, sometimes I think even maybe close to 8,000 foot for a balanced ceiling.

Q. In the test plan for a continued takeoff, you talked about rotating the normal rotation rate between 3 to 5 degrees per second.

A. Um-hum.

Q. After, I believe, Birmingham, that disappeared from the flight test cards. Was that discussed in this meeting?

A. No, not that I recall.

MR. HORNE: Okay. That's it.

BY DR. BRAMBLE:

Q. Okay. I think it was Mitch asked whether during that meeting that you recalled, the big one that you thought might have occurred on April 1st, he asked whether or not increasing speed was an option -- was discussed as an option. You said yes. But which speed are we talking about?

A. On your rotation speed primarily.

Q. And how about V_2?

A. I can't recall if that was discussed, but I assume it would go hand in hand.

DR. BRAMBLE: Okay. All right. John, do you --

MR. O'CALLAGHAN: Nothing further from me.

DR. BRAMBLE: Marie?

BY MS. MOLER:

Q. The personnel who were in the TM trailer from flight sciences, depending on who we talk to and kind of what lens you look at it through, it seems like they had two sets of responsibilities. They had responsibilities to themselves in flight science to make sure that they were getting the data they needed in order to do the manual expansion, --

A. Um-hum.

Q. -- but then they had another responsibility to be helping flight testing analyze their data, and those two sets of responsibilities kind of had different things that they would have been looking at. For just looking at it for flight sciences, you just want to make sure that you're getting your targets and they're making sense. But if you're looking at them for flight testing, you're trying to make sure that, you know, they're doing things safely as well as do these values make sense, --

A. Yes.

Q. -- are they progressing the way you think. So what I'm wondering is when flight sciences was kind of loaned to flight testing, who scoped their work and how did they decide what their responsibilities were?

A. The decision as which -- who would be there, like you said, it was staggered between Shelly and Pat with an overlap. So you would always have a DER there at all time with an experience who had been part of flight testing previously. But the supporting engineers were agreed to between Pat and Shelly as to who would be out there at a specific time, and we tried to focus to have at least one person that was 650 engineer and somebody else that was from core or from the other AAP program as also backup training for them as we go further on and do other test programs.

Q. And who helped Ms. Brimmeier scope her own work?

A. It was a coordination effort between herself and Pat Connor.

Q. So she didn't have the aid of another manager to kind of help her decide where her responsibilities lay?

A. I believe at the -- let's see. I'm trying to think who the -- the manager of propulsion and performance was Tom Rothermel, who was also the acting director of flight sciences. So he -- if they had any specific questions, they could have talked with Tom or they could talk to myself or they could talk amongst each other between Pat and Shelly.

Q. Okay. So --

A. And she coordinated the effort between leads, but we came up with the names and said -- and she said, "These look like -- this is what I'd like to have. I've agreed upon this with Pat. We're in agreement that these are the right people to be there at the right time." And they're the ones that coordinate the effort, exactly what their responsibilities were on site for those engineers.

MR. RAMEE: But Marie is asking you who's telling your guys what tasks they're to be doing in the TM trailer --

BY MS. MOLER:

Q. Does Shelly have someone who tells her, you know what, that's --

A. No.

Q. -- that's too much; like you're doing too much? Or is someone telling her, you know, you can't have two masters to a certain degree? I mean because it does kind of feel like she kind of did.

A. No. I think it was -- the ultimate decision was hers and Pat's.

Q. Okay.

A. With oversight from me, and I agreed to their plan. She didn't feel like she was overwhelmed by that responsibility at all. She embraced that responsibility, actually. She was glad to make all the arrangements and she was kind of the primary driver between her and Pat, and she had participated in field performance testing before, so it wasn't new to her. She knew what she needed to be doing out there.

Q. She had participated during --

A. In the G450, the field performance

Q. During the G450 when she had been doing her performance work, were they doing that sort of dual responsibility work then too where they were, you know, checking, making sure that the manual expansion was being, you know, completed and they were also aiding flight testing?

A. At the time it was primarily just aiding flight testing and making sure -- keeping track of all the data that's being collected and checking for data quality.

Q. Okay.

A. The manual expansion would happen after the tests were completed back in Savannah. That's a similar process that we had at Roswell also the first time around --

Q. Okay. Great.

A. -- on the 650.

MS. MOLER: Thanks.

MR. RAMEE: Off the record.

(Off the record.)

(On the record.)

BY DR. BRAMBLE:

Q. Tom, what's your best guess at what the field length estimate will be going forward for G650?

A. My estimate is it will be about 6,600 feet. Based on the recent testing that we've done, our performance guarantee is 6,000 -- for the G650 product spec is 6,000 plus or minus 8 percent. So worse case is 64 to 80 feet. Right now our estimates are somewhere in the 6,600 foot range. But again, that's still depending on all the testing that we do at Roswell. If there's a shortfall, there's ready plans in place.

We've already been talking to Rolls Royce about increasing thrust 5 percent across the takeoff envelope. There's also talk of -- some discussion on wing treatments; is there anything that we can do to improve in ground effect stall angle, improve lift and stall in ground effect, and up and away, which will allow us to climb out at higher angles and improve our field performance in that direction. There's also additional discussion on what else can we do to improve field performance, can we improve our braking coefficients, can we have an alpha limiter on the ground so that it will protect against in ground effect stall angle and optimize your pitch attitude, and that could be a significant improvement on performance.

So there's -- we're stacking up all these risk mitigators in case we do have a problem, what can we do going forward; what's our best path forward. And actually setting up a -- Rolls Royce has given us what they call a trim file that we can implement into the EEC, which -- light truck and engine control, which will allow us to get ACs (ph.) or 2-percent thrust at Roswell coming up. So we plan on using that, and if we need it, we'll use it. If we don't, we'll give it back to them.

Q. Let me just ask one follow-up, which is, so there's a possibility that you might be able to bring the field length back down into the 6,000 plus or minus 8 percent?

A. Yes. I mean, right now it's conservatively yes at about

6,600 feet, and after the Roswell testing we'll see if there's any improvement that can be made with the basic airplane. And if not, we'll go after improved thrust, wing treatments, or control launch changes.

DR. BRAMBLE: Okay, John.

BY MR. O'CALLAGHAN:

Q. Yeah. Just one question from past discussions on the subject was that the number was very much in flux at the moment, so, you know, the 6,600-foot value that you have now doesn't really have much significance for the future probably because there's all these things that you mentioned are in play. Was that fair to say? Meaning that, you know, the number 6,600 and that's it. I mean that's not a take-away we can say right now because there's all sorts of work to be done on that; --

A. Right.

Q. -- is that right? Okay.

A. It's 6,600 plus or minus --

Q. Yeah.

A. -- the few percent.

Q. Well, you add 5-percent thrust and it would probably come down to --

A. Yeah.

DR. BRAMBLE: Great. Are you done?

MR. O'CALLAGHAN. Yeah.

BY DR. BRAMBLE:

Q. Okay. Prior to the accident were you set to receive any kind of monetary bonus or compensation if the plane was certified according to the date, the existing certification --

A. No.

Q. -- schedule?

A. No.

Q. Okay. All right.

A. At least they didn't tell me about it.

DR. BRAMBLE: All right. Mike.

BY MR. BAUER:

Q. Just a few questions. With regards to the TM trailer in Roswell, was it your understanding that it was required for the testing, the performance testing?

A. Yes.

Q. Was it your understanding that if the TM trailer was not available, that continued takeoff testing would not be -- would not proceed?

UNIDENTIFIED SPEAKER: If it was broken.

MR. LAVRISA: If it was broken? I would think we would not do the test if it was broken.

BY MR. BAUER:

Q. The reason I'm asking is in some previous testimony from flight performance -- or flight sciences, Ms. Brimmeier, it was her understanding that the TM trailer was not required for the testing. So I just wanted to understand from you, being at the

SRB, what that --

A. Can I look at the SRB? Because I think it probably had them in there.

Q. I guess the other question I would ask to that is, should that be something that would have been in the TSHA as a requirement for the testing for the risk mitigation?

A. It should be in there.

Q. Okay.

A. It should be in there for V_{MU}'s and CPOs. It may not necessarily be required for landings or -- for landings possibly, but everything else I would think it would need to be there for, --

Q. Okay.

A. -- available.

Q. Just from a general flight test perspective with regards to performance flight testing or aero science flight testing, do you receive notifications for all of the pre-flight or post-flight briefs or debriefs?

A. Yes. All of them. I receive a daily e-mail that says everything that's schedule for the day by airplane. I participate in every -- every morning there's a 7:30 phone call. They go through that and identify any problems with the airplane and when the briefs are scheduled, if they've been weathered. I'll receive an e-mail notice for every single briefing. I even receive an e-mail when each aircraft takes off and each aircraft lands, when the debrief is. And then I'll receive -- at the end of the day there'll be a summary of the activities that were done on every single airplane. And then additionally, when the flight test engineers issue reports, I will get a copy of every single flight test report for every single airplane for all the tests that were performed.

Q. Is that information rolled down to both the -- and I'm just going to use the two examples of Mr. Mills and Ms. Brimmeier --

A. Yes.

Q. -- to include the rest of your team.

A. It doesn't include every engineer in my organization, but it includes all my leads so they're aware of everything that -- everyone -- every lead from every department get a copy, and there's some others that get that, including Bob Mills and some other key folks in flight sciences who will get those reports on a need-to-know basis. We don’t send it to everybody.

Q. Okay. Kind of my last question and this is speaking post-accident from a flight sciences perspective. Has there been any changes, processes or procedures to your group that you, say, asked for or implemented regarding if there was, to use an example, of a wing drop at upcoming testing, as to what type of, say, action plan might go into effect for analysis or data review or reporting of incidents?

A. Not -- I guess everybody knows --

Q. I use wing drop as an example.

A. Yeah.

Q. But I'm just saying if something comes up in a performance test that is suspect, to have them report that information.

A. Not a formal process, if that's what you mean. I mean everybody knows that if there's an incident, to bring it to attention. And if it's brought -- if it happens in flight test and it's brought to our attention, we act on it and, you know, we can address the problem in an expeditious manner. But is there a formal process in place in how we address incidences? I'd say no. the way we handle a lot of things, if there's a problem that needs to be addressed immediately, we have a war room that's attended every Thursday all the way up to the program manager and senior VP, and it gets put on your board and you talk to it and address it until it's resolved.

Q. Okay. That's all I have.

A. The other avenue for addressing problems is through the problem reporting system. There will be a problem report that's issued. You'll receive an e-mail that somebody wrote this problem report. You need to address it. Is it a priority one? Does it have to be fixed before next flight? Does it have to be fixed for certification or is it just a lower priority action? So there is a system in place that can -- that addresses any issues like that.

DR. BRAMBLE: Mitch?

MR. GALLO: Yes. I have about eight questions, and hopefully eight.

BY MR. GALLO:

Q. Going back to the meeting date for Flight 153, is there a name for that meeting?

A. It's called a flight sciences certification issues meeting. It's been held every Friday since the beginning of this year.

Q. Okay. So that's a regularly-scheduled meeting?

A. Yes.

Q. Where was that meeting held?

A. It's in RBC-1, the Epsilon conference room.

Q. Do you recall who all the attendees were?

A. There's about 50 people in there, so it's hard to say. But, yeah, I remember a majority of them.

Q. Can you kind of go through the list?

A. Myself. Jake Howard was there. Bob Mills, Pat Connor. Shelly was not there because she was at the -- in Roswell at the time. Kurt Erbacher would have been there. Brian Durrence, Phil Burton from flight test. Those are probably the major players. Can't remember if Pres was there or not. Sometimes he comes, sometimes he doesn't.

Q. Mr. Rick Truse (ph.) was there?

A. Don't think so.

Q. Barry McCarthy?

A. He usually is, but I can't recall on that particular meeting.

Q. How about Mr. Tim Farley?

A. No.

Q. There was approximately about 50 people?

A. Yes. It's various disciplines, a lot of structures and systems and other departments, avionics, that will attend those meetings.

Q. How about Mr. Randy Gaston?

A. No.

Q. But it was just then Mr. Jake Howard that was the only representative on flight operations?

A. Yes, and he normally comes to every one. He's the project pilot for 650, so he attends -- typically attends every one of those meetings unless he's flying.

Q. And does Mr. Bob Mills typically attend all those meetings?

A. Yes.

Q. It wasn't a special invite just for that day because the next day you were --

A. No. He typically attends every one.

Q. During that meeting did anybody express a concern that the V_2 speed could not be captured?

A. No. I don't think it was recognized at that time.

MR. GALLO: That's all the questions I have. Thank you.

DR. BRAMBLE: All right. Jeff.

BY MR. BORTON:

Q. Just one question. I wanted to clarify a little bit on your perception of the schedule, you know, beginning of April, end of March.

A. Um-hum.

Q. At one point you were saying that it definitely was aggressive. It looked at a working level like you wouldn't make it, but you weren't quite to the point to work an extension or work debt.

A. Right.

Q. You said something just regards to the performance tests and I'm not sure where the question came from, but it seemed like you were looking at what was needed. As you were immersed in Roswell-2, you saw that, yeah, we needed to collect this data still and do the data expansion and the AFM production and all that, and I got the impression that that looked reasonable to you. Maybe that was a disconnect on my understanding.

A. No. I --

Q. I just wanted to make sure I understood your perception of the schedule at that time.

A. At the point, once we collect the data and the time to collect the data and to process it and generate an AFM, is usually like a 3-month process, all hands on deck. It's quite involved to get to that point. So my thoughts were, yeah, if we finished up the testing in April and we collected our data and had everything in hand, there shouldn't be any problem to meet our certification dates.

Q. And that would include FAA involvement and verifying and all that kind of --

A. Yes. It was a little bit tight there. I know there were some concerns on Shelly's part and Pat's part that, you know, this is not -- they didn't think that it was doable to get it in that time. But, you know, usually at Gulfstream when we have a problem, we see there's a problem area, we'll throw a lot more resources at it. We won't necessarily yell at people, but we'll at least help them out as much as we can and give them resources that they need. We pull them from other programs if we have to and we get support from flight test if we need to.

Q. So you thought there was enough capacity to do that, at least based --

A. Yes.

Q. Okay. Thank you.

A. Yes.

DR. BRAMBLE: Lorenda?

MS. WARD: I have no questions.

DR. BRAMBLE: Tom?

MR. HORNE: I just have one quick one.

BY MR. HORNE:

Q. Did you know that there's a policy letter that came out after the accident that talks about what types of incidents need to be reported and how they're reported that came through Barry McCarthy? You were not an addressee.

A. I heard it. I can't recall if I've seen it. No, I don't think I have.

Q. Since you're talking about instituting that for your people as to whether incidents -- you may want to review that letter. I have a copy of it.

A. Okay. Yeah. Can you send it to me?

Q. Sure.

A. Okay.

DR. BRAMBLE: All right. Anybody else? John?

MR. O'CALLAGHAN. Just one that Jeff inspired.

BY MR. O'CALLAGHAN:

Q. Regarding the FM, how does it get approved by the FAA and isn't there -- don't they take some finite time to get that done, and how does that affect things in terms of schedule?

A. Right. They need a -- well, the process that we have here at Gulfstream is you issue the company report or the AFM and then you have to allow the FAA one month to review that, and that's an agreement that we have with them.

Q. So if a certification ends at the end of July, that means --

A. The testing --

Q. And if the FAA's on the ball, then they have to --

A. It will take them at least a month before they can review everything, approve it, and then issue a final piece.

Q. So you have to have it to them by the end of June.

DR. BRAMBLE: Well, the last TIA was due end of July, and then the final cert date might have been a different date.

MR. LAVRISA: It would have been a little bit later. That's correct.

MR. O'CALLAGHAN: All right.

MR. LAVRISA: I can't remember in April when our cert date was.

BY MR. O'CALLAGHAN:

Q. But you have to get them the AFM a month before you want to deliver the airplane or say --

A. Yes.

Q. Yeah.

A. Yeah, before we get a typed certificate on the airplane.

Q. Yeah.

A. Yeah. The general process is we do all the company testing. We could at that point start developing an AFM, but then the FAA has to get on board the airplane and fly several of the maneuvers and you have to confirm that an FAA pilot flew it very similar to a Gulfstream test pilot; that their data falls within the scatter of our data. And once you finish that, then you can go ahead and issue the AFM, and the once you issue the AFM, the FAA takes one month to review it and approve it prior to TC. And that goes the same for all the flight test reports. Our agreement is that we give them a month to review and approve reports.

DR. BRAMBLE: If I can jump in.

MR. O'CALLAGHAN: Sure.

DR. BRAMBLE: So when was the -- as of that April 1st meeting, when did you expect to have the AFM ready to submit to FAA for review that would come out of the performance testing effort?

MR. LAVRISA: Let's see. It was probably April finished the testing. May, June, July. Maybe at the end of July.

DR. BRAMBLE: Okay. All right. Any other follow-ups? Okay. I think we're done.

(Whereupon, at 5:38 p.m., the interview was concluded.)

CERTIFICATE

This is to certify that the attached proceeding before the

NATIONAL TRANSPORTATION SAFETY BOARD

IN THE MATTER OF:	AIRPLANE ACCIDENT ROSWELL, NEW MEXICO N652GD Interview of Thomas Lavrisa
DOCKET NUMBER:	DCA11MA076
PLACE:	Savannah, Georgia
DATE:	October 26, 2011

was held according to the record, and that this is the original, complete, true and accurate transcript which has been compared to the recording accomplished at the hearing.

Letha Wheeler
Official Reporter

Karen L. Banks
Transcriber

UNITED STATES OF AMERICA

NATIONAL TRANSPORTATION SAFETY BOARD

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Investigation of:                  *
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AIRPLANE ACCIDENT                  *
ROSWELL, NEW MEXICO                * Docket No.:  DCA11MA076
N652GD                             *
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Interview of: BARRY McCARTHY

Gulfstream Corporation
500 Gulfstream Road
Savannah, Georgia

Friday,
October 28, 2011

The above-captioned matter convened, pursuant to notice, at 10:09 a.m.

BEFORE: WILLIAM J. BRAMBLE, JR., Ph.D.
Senior Human Performance Investigator

APPEARANCES:

MITCHELL GALLO
Air Safety Investigator
National Transportation Safety Board
31W775 North Avenue
West Chicago, Illinois 60185

WILLIAM J. BRAMBLE, JR., Ph.D.
Senior Human Performance Investigator
Office of Aviation Safety
National Transportation Safety Board
490 L'Enfant Plaza East, SW

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ALAN J. (JEFF) BORTON
Flight Test Pilot
FAA Aviation Safety
Aircraft Certification Service
Wichita Aircraft Certification Office
1801 Airport Road - Room 100

THOMAS M. RAMEE, ESQ.
Deputy General Counsel and Risk Manager
Gulfstream Aerospace Corporation
500 Gulfstream Road, M/S B-06
Savannah, Georgia 31407

TOM HORNE
Experimental Test Pilot
Gulfstream Aerospace Corporation
P.O. Box 2206, M/S A-12
Savannah, GA 31402-2206

APPEARANCES (Cont.)

JOHN O'CALLAGHAN
Aircraft Performance Group Chairman
Vehicle Performance Division (RE-60)
Office of Research and Engineering
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

MICHAEL BAUER
Aerospace Engineer
Vehicle Recorder Division (RE-40)
Office of Research and Engineering
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

E. LORENDA WARD
Air Safety Investigator
IIC and U.S. Accredited Representative
Office of Aviation Safety
Major Investigations (AS-10)
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

MARIE MOLER
Mechanical Engineer
Office of Research and Engineering
Vehicle Performance Division
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

I N D E X

I N T E R V I E W

(10:09 a.m.)

INTERVIEW OF BARRY McCARTHY

BY DR. BRAMBLE:

Q. And what's your date of hire at Gulfstream?

A. February 1997.

Q. And your current position title?

A. Director, Flight Test.

Q. Which office do you direct? The title of the office is?

A. The title of the office is? You mean the ones that report in to me?

Q. No, the overall office, Flight Test Engineering.

A. I'm Flight Test. We are within the Engineering Organization.

Q. Okay.

MR. RAMEE: All Flight Test organizations report. That's what he wants.

MR. McCARTHY: Okay. Then, I'm not sure I've answered your question. But all of the elements of Flight Test report in to me. So I have responsibility for the flight test engineers, the Instrumentation Engineering Organization and the Maintenance Organization, along with the group that does all of our coordination.

BY DR. BRAMBLE:

Q. Okay. And what previous aerospace employers have you worked for?

A. When I left college in '87, I started with Douglas Aircraft. Started as a flight test engineer, working their test programs on the MD87, MD11, MD90 and a few others in between. And then in 1995, joined Lockheed and spent almost a couple or 4 years working on the C130 J program before I came to Gulfstream in '97.

Q. Okay. And what prior certification programs at Gulfstream have you worked on?

A. When I arrived in '97 the company had just finished the provisional certification on the GV. That was in December of '96, so I was able to join the team on the very last part of the full certification, which I think was April of '97. And then after that, we did a number of entry into service programs and reliability programs that were certification, obviously, to include the enhanced vision system, which was somewhere in the late '90s, early 2000s when we got that into service. And then the major programs after that would be the G5SP, the G4X and the special mission programs, CEMA, CAW, Hyper, HALO, and that transitions into the 650.

Q. And when you first came to the company and you were working on the GV, were you -- what position were you in then?

A. I was a manager within Flight Test working under Lee Johnson.

Q. Which group did you manage?

A. I was the manager of the coordination group at the time.

So, it was myself and the aircraft coordinators and we were responsible -- the coordinators were responsible for the daily coordination of all the activities on the airplane and I handled not only that but the project coordination through the rest of engineering.

Q. Okay. And from there, did you hold other positions between the manager of the coordination group and the position you hold today?

A. No. I went from manager to director probably in 1999, I want to say.

Q. Okay. How well did you know Reece Ollenburg?

A. Fairly well. Reece started the same time I did at Douglas Aircraft. So we both started out there working on the MD87 program. Reece was a performance flight test engineer and I was a stability and control flight test engineer. And when we went to the MD11, I became one of the flight test engineers that focused on flying the airplanes and Reece stayed a performance engineer. And so we worked together on some of the performance aspects of the MD11 program. And we had similar paths. He went -- I believe had some time on the C17 but then, Lockheed. And after Lockheed, he went to a couple of other companies before he came back to Gulfstream -- not came back, but joined Gulfstream. So I've known him and his wife, Jean, for 24 or 25 years.

Q. And what kind of engineer was he? What's your opinion of his skill level and competency?

A. Reece was extraordinary. He was extremely good at what he did and not only great technically competent, Reece's interpersonal skills, I think, allowed him to work effectively with pretty much anyone. We've worked through the years with the typical -- no offense to Tom -- but crusty pilots, and he handles those quite well and arrogant engineers and he handles those quite well, and he knows the flight test engineer goes out and does his job on a day-day-day basis. He has to work with them all and everybody has to do the right things at the right time and Reece was always able to do that. But he had a very good expertise, high level of expertise, in aerodynamics and was one of our DERs and well-respected by his counterparts with the FAA.

Q. Okay. At the time of the accident, what policies and procedures did Gulfstream have in place to manage the safety of the Flight Test program?

A. Within Flight Test I think, as you know, we have a Flight Test Standards Practice Manual. That was the official housing for the processes that dealt with our risk management practices.

Q. And could you describe those practices in a little bit more detail. Tell us how that was supposed to work?

A. Sure. The Flight Test engineer, when he's in the planning phase of conducting a test, goes through the risk assessment process and he has to think through for each of the tests the hazards that are associated with the tests. And when I say he, the risk process or the risk assessments are done typically between the flight test engineers and the pilots. And so, they go through identifying the hazards; they make subjective evaluations on probabilities such that you can get a feel for the risk levels.

And so once those relationships are known, those tests that aren't considered low risk -- the tests that are the day-in/day-out what I would call normal operations; those that are medium and high risk are the tests where we go through a formal mitigation procedure with our test safety hazard analysis. And so the FTEs and the pilots sit down and go through the steps that would be prudent to take to mitigate the hazards and keep the overall exposure to the hazards as low as we can make them.

And for the medium and the high risk tests, those are the ones that we convene our Flight Test Safety Review Board. So the FTE comes in and he presents all of that information in addition to a few others such as the aircraft configuration, the number of test points that's going to be done. And that's reviewed amongst the Safety Review Board. And that's co-chaired by the head of flight operations and that's our VP, Randy Gaston, and the head of Flight Test, which is myself. And the board also consists of a senior member of the management team and that's typically our vice president of Engineering. So, it was Dick Johnson for a while and his predecessor now, Tim Farley. And the other board members are our chief experimental pilot, the project pilot. We bring in our senior flight test staff. Our staff scientist, Ken Obenshain, usually sits on the board along with the chief engineer of the program and then the other engineering directors that we think are necessary to have a good review.

Q. Okay. And the, just to make sure that we understand this correctly, was there one SRB held prior to the field performance testing, or were there two SRBs?

A. Specific to field performance or the 650 program?

Q. On the 650. Yeah, field performance.

A. Okay. The field performance program was one Safety Review Board. And field performance is a term, but the testing that rolls into that is the V_{MU}'s, the CTOs, normal/abnormal, AEO, all engines, one engine inoperative, and landings. And we probably covered the braking tests. We did cover the braking tests. And so that was held, if I can get my timing right, somewhere around October, which was 2 or 3 weeks before we went out the first time. But through the 650 program, we had held multiple Safety Review Boards for the medium and the high risk tests.

Q. And has the SRB process changed since the accident? Or the, I guess I should say broader than that, have the safety management policies and procedures changed?

A. We're working hard on the policies and the procedures because obviously on hindsight there are many changes to the existing Flight Test Standard Practices manual that have to be incorporated so we're finishing that up right now, as a matter of fact. So, the written documentation is certainly getting attention. It may change some behaviors, but the overall process isn't going to change. It's a fairly robust process that we've used throughout the years and it's similar to what we did at Lockheed and what we did at Douglas. I think what's changed, obviously, is the sensitivity and the focus that goes into it.

Q. And who created that manual, the Flight Test Standard Practices manual?

A. That was done by my predecessor and I'm told that he did it right before or right after the start of the GV, after Lee went and benchmarked a couple of other companies. And Lee and a few others within Flight Test contributed to put out the first portion of the document.

Q. And how is the document, or who championed the document after Lee left?

A. After Lee left, it's a document that belongs to Flight Test, so it's my responsibility. And we went and revised it in a couple or minor ways and I forget exactly why. The last one had to do with incorporating the memo of understanding between us and the FAA. Our written risk management process was accepted by the FAA as being sufficient for their needs when they do their certification programs with us. So, we agreed in writing how that would be, how that relationship would be in place. And so that was recognized in their MOU and we incorporated that just for reference in the standard practices.

Q. How were the engineering personnel who participated in flight tests familiarized with the document?

A. Let's see, my staff is obviously aware of the document because each one of them have a principal element of that and so the document should flow from them to the newer employees. Obviously those that have been in Flight Test for years are aware of the document. But as we've gone through this exercise, it's apparent that those that come in are not using or training themselves with that, so that's part of what we're addressing as we go forward.

Q. All right. And did the management levels above you receive briefings on the safety-related matters from your department or -- I'd like to get a feel for sort of what their role was in the safety management process?

A. They're apprised of our activities related to Safety Review Boards because, as the chairman, right now I'm the one that publishes the records and distributes that. So for people like my immediate boss, the vice president of engineering, the program manager, Kurt Erbacher; and their boss, Pres Henne, our senior vice president, they see the SRB notes and that's always beneficial because each one of them, especially the senior vice president, is very technically able and he asks some pretty good questions after we've run the course. As a matter of fact, when we finish one of these and I don't get questions, I'm always pleased with the outcome of the team that did all the work. But they stay tightly connected with what goes on, so they see -- outside of the SRB, I mean, I'm responsible for the hangar operations as well. So, if we have any incidents that occur on the floor those have to be formally reported and investigated so they see those as well.

Q. Do you mean on the manufacturing floor?

A. Well, I wouldn't call it the manufacturing floor. The flight test hangar facilities that house the test fleet; it's in hangar 9 and 10. For this week, we're actually moving into our new facility. But we have a environmental health and safety program just like manufacturing that includes everything from tool control to FOD control and what we do in case we do have an incident where we have accidental damage and somebody bumped the airplane where they shouldn't have. So that behavior or those activities are also controlled and reported and followed up and corrective actions put in place.

Q. And has the role of upper management changed at all in the safety management process since the accident? The levels above you?

A. The first thing that comes to mind, obviously, is yes because we've just stood up a independent safety organization that reports externally up to our president, so there's one significant change. But part of the SRB is also trying to stay away from implied or perceived management pressures. We really don't look for the senior management to come and participate in the board. We do want the engineers and those that supervise the engineers and are responsible for the engineers to feel free to address anything that would be a test safety issue. With that said, as I mentioned before, people like Tim, Curt and Pres are -- Tim's involved directly as the board, my boss. And Pres is extremely knowledgeable in just about all areas of airplanes and testing, so his input is usually obtained. And as we go forward I expect to have some of his direct participation, especially with the return to field performance SRB, that we'll be doing.

Q. And in terms of who is most knowledgeable about the new independent safety organization, would that person be Randy?

A. Randy would have certain knowledge. It's brand new for us. It's been in existence just for a few weeks and probably the best would be people like Pres. But as I think Gulfstream's probably made you aware, there's not only a position that reports directly to our president, but there are people that report to him. John Salamankas is the leader of the independent safety organization. So John has Chris Licavole from our Flight Test Organization -- Chris is a staff position to me -- Bud Ball in Flight Operations and Tom Rothermel from Engineering.

Q. And do you have a feel yet for how Mr. Licavole will -- what's the role he will play within Flight Tests with the new program yet?

A. I certainly have expectations. I'd be surprised if they vary from how it will play out as we get ourselves organized here. But Chris has been with Flight Test as long as I've been with Gulfstream and he came from the Flight Sciences area of Engineering, so he knows a great deal about what goes on within Engineering and Flight Test. And as I've mentioned, we're in the final throes of updating the Standard Practice Manual to not only reflect how we currently do business so we get up to speed, but also it will incorporate what we've learned, obviously, through the accident to date. And so once we stand up our documentation, we'll be better able to periodically audit our performance, incorporate changes and improvements and also have a resource that will spend time out amongst the industry. So, I'm expecting that there's broader industry interaction.

UNIDENTIFIED SPEAKER: The specific question was, what's Chris's -- how do you see Chris's role? You didn't answer that.

MR. McCARTHY: Chris's role actually would be aimed at performing many of those tasks, and he would be the one that would be coming in and independently auditing what we are doing on a periodic basis; find out if we're complying with our procedures or if we're not, why not; and if the procedures need to change or our behaviors need to change. So he would be making those recommendations back to myself and my management.

And Chris would also -- Chris's office is within Flight Test right now and I don't see that changing because having that geography will also give those that work within Flight Test a direct point of contact for issues that they for some reason may not feel comfortable addressing their immediate supervisor or myself. And Chris's role within Flight Test has been to help us manage many aspects of the test program, and as we go forward those activities will go down as his activities within the safety office go up.

Q. Okay. All right. And at the time of the accident, what procedures did the company have in place for reporting and investigating perceived hazards or safety-related incidents that occurred during flight testing?

A. I think we came to the conclusion internal to Flight Test that we didn't have anything formally written down if we had had an incident. What has happened through the years if the flight test engineers come across something that they are concerned about that represents a hazard, then they notify either their manager of myself. And as we look back through the 650 program that had happened before, but the incidents that, you know, happened prior to Flight 153 didn't get escalated to myself in any formal sense. That's one of the things we changed kind of immediately in the aftermath of the accident and we're incorporating into the Standard Practices Manual. And obviously for formal accident response, the company has corporate procedures in place to do that.

As I say, informally what would occur is if the airplane or the test came back with a result or something that concerned the test crew from a safety perspective, they would report that back either through their -- on the pilot side, back up through Jake and John and Randy or myself. And we had an instance that occurred with our nosewheel steering system and the flight test engineer wasn't satisfied that performance of the system was able to do what we wanted it to do and we'd go out and do the next test series. And so he asked that we reconvene an SRB and that's what we did to review the technical conditions and the hazards and how we can deal with it. And in that case, if I remember it right, that resulted in rescheduling the tests until we had made a change to the nosewheel steering tilt.

Q. That was the informal procedure before -- that was an example of how things were handled informally before?

A. Correct.

Q. Okay.

A. And as I've looked back on it, you asked about the programs that I've been involved with Gulfstream. We've done somewhere between 10- and 15,000 flight hours over the last 15 or so years. And we've had the hard landing on 503 that happened in the GV program and we obviously have had a few things that, you know, we could have done better. But for the most part we've been able to keep a fairly clean safety record up until this event, which has caused us to look hard at what we do and how we control it. And so a lot of the behaviors that we had in Flight Test had served us well. Our documentation probably didn't reflect that; that's what we're fixing. There's a lot of things that we've learned since that we'll be taking advantage of as we go forward.

Q. Okay. On the yaw damper incident, the FAA sent a letter to Anthony back on March 9 expressing concern about that incident and asked the company to perform an internal review of the company's change approval process to ensure that all concerned parties will be informed of changes to the flight control systems and other systems with direct pilot interface. Was this type of review performed? And what lessons were learned and changes implemented as a result?

A. Is this the one about the nosewheel steering when Clark -- to Clark Walker?

(Off the record.)

(On the record.)

MR. McCARTHY: Your question again?

BY DR. BRAMBLE:

Q. The question was, the FAA after that incident requested that Gulfstream perform an internal review of the company's change approval process to ensure that all concerned parties would be informed of changes to the flight control systems and other systems with direct pilot interface. And so the question is, was this review performed and what lessons were learned and changes implemented as a result?

A. There was a thorough review that was performed and one that involved -- it may have been a couple of briefings with the FAA to make sure they understood what we were doing to both investigate it and then address it going forward. I'm fairly sure that the outcome of that was to gain formal concurrence on the change by having multiple sign-offs on the engineering direction that goes from Gulfstream to the suppliers to make the change, which means that pilots and the engineers sign off on the change.

Q. So that was a change from how things were done previously? There were more people involved in the sign-off process afterward?

A. Yes, sir. Correct. And I think really, the intent there was to mitigate an engineer who thought the change was going to be benign, transparent and not affect anything that maybe a pilot would see. But formally requiring the signatures at least allows the pilot to agree that it is not going to be significant. Or for the items that are significant, the pilots agree that that's the right design change to be made.

Q. Regarding the SRB, how was the SRB supposed to give its approval of the package presented at the meeting? Was it a vote, or was it sort of unanimous acclaim, or how did that work out?

A. It is a vote. As the director of Flight Test, I've co-chaired all of these and I don't recall where we have ever had an instance where one of the board members had a concern. We've always been able to have a fairly easy consensus reached amongst a board that can be 6 to 8 to 10 people. And so we get the pilots and engineers and some of us managers to all agree. It has actually been a fairly straightforward task. And so once the flight test engineer completes the briefings and any questions that the board has have been answered, we've been satisfied that steps will be in place to keep the risk at something that's acceptable to Gulfstream, because you can never eliminate the risks; you just have to accept them and manage them.

Q. So the voting members of the SRB, who are they?

A. They're the board. It's a board voting panel and it is co-chaired by the head of Flight Test and the head of Flight Operations. And it's consisted of a senior management member, senior flight test engineers, senior pilots and senior engineering managers, the director levels or senior technical staff that can come in and have experience with the airplane and the test.

Q. Okay. So those people are all included in that 6 to 10 people on the board that vote?

A. Yes, sir. Um-hum.

Q. Okay. Do you know whether the lead air dynamicist for the G650 program, Bob Mills, was present during the field performance SRB?

A. Not without going back and checking on it, but I would expect that -- can I reference before I say something that is wrong -- okay.

UNIDENTIFIED SPEAKER: You also have some invite -- some e-mails that have invite lists back here --

MR. McCARTHY: Okay. No.

BY DR. BRAMBLE:

Q. And were you aware of whether he was there at the time, or can you recall?

A. At the SRB?

Q. Um-hum.

A. I cannot recall.

Q. And would it have concerned you if he was not present?

A. When we had this meeting probably not, with the participation that we had there. Obviously on hindsight, that's probably somebody that we should have had participating.

Q. Okay. Were you aware that Mr. Ollenburg was looking at wind tunnel data and estimating in ground effect stall angles prior to Roswell-2 using data from the V_{MU} test results?

A. I was aware that he was using the CL data that he got during the V_{MU} tests for the CTOs.

Q. And to your knowledge, was Bob Mills involved in that work?

A. I do not know.

Q. Okay. Would you have expected that he would have been?

A. May or may not have been. For the field performance effort, Reece would have been working closely with Shelly Brimmeier and Pat Connor, and if there were significant questions, that got back into the aerodynamic performance, then Bob would have been brought in.

Q. Prior to the accident when trying to meet flight test certification date, how did you try to ensure that the company wasn't pushing its people too hard and safety was not being compromised?

A. I would have to say that the schedules and the pushing on the 650 are consistent with just about every test program that I have been involved in going back to the MD87 program. It seems to be inherent in any major product development program that the best of schedules are not going to be met and work is going to slide and compress. And so what we try to do is just stack it up in the proper sequence and make sure we know what has to be done and the best way to go about getting it done.

And Reece laid out a phenomenal plan that detailed out every test point that had to get done. He provided a very good breakdown of which tests would be done in which order and had a very -- had a good reason for how many points he thought he could get done at Roswell on a given day, which is going to vary as a function of how hard the wind is blowing at any hour during the day. So, he had a good plan when he went back out and shared that with management on how long it was going to take him to get through all the points. And we used that frequently to status how well we were doing.

Q. And did you feel that the schedule permitted enough time for him to ensure that all the necessary analyses were being done prior to the start of Roswell-2.?

A. It was absolutely my expectation. As you have the opportunity to talk to those in Flight Test, they tend not to be very bashful. So I hear from them if they're not ready to go. Reece never voiced a concern that they were not technically ready to go do what they needed to do.

Q. Did he ever voice a concern about the schedule at all?

A. No.

Q. Well, that's pretty broad, I understand. Did he ever say the schedule was unworkable?

A. Not Reece. Reece was fairly pragmatic. He knew what he had to do and he was going to go do his best to get it done in the most efficient manner possible.

(Off the record.)

(On the record.)

BY DR. BRAMBLE:

Q. Should we move on or do you have something else you want to talk about?

A. I think what Tom is stating is that we obviously have schedules that we communicate back up to management on how we're going to go about executing the program. And as time scales shift and change based on a number of variables, that's what we use to status management. And the schedule that I was referring to that Reece kept was part of what we were showing to management at that time. We had X number of points and X number of days. And so we were tracking to that. We were tracking to what Reece had because

I remember the status reports that were kept by Reece's manager.

Q. Prior to the accident, were you aware of the wing drops that occurred during Flights 88 and 132?

A. Yes, I was.

Q. And how did you find out?

A. Actually, informally. I was to find out about 88 well after Kent had taken the lead to pull together all the relevant information and brief the pilots. And that was just a side question, I think, that I had asked or that was shared. And then for Flight 132, that came to my attention just a couple of days before Reece went back out to Roswell prior to Flight 153. And that came to my attention because Curt Cromwell, our manager of flight test engineers, had made me aware when he was informed that same day.

Q. How did he find out?

A. I believe he was talking to Reece about some of what was being done before they went back to Roswell. And so in the aftermath of both of those I went and had a meeting with Reece, and had him walk me through those events.

Q. Do you remember what day that meeting occurred?

A. No. Other than the one that occurred prior to Flight 153 was, I believe, on -- they left on Saturday or one of those days and it was mid to the end of that week, because what I recall in the discussion with Reece is the event of Flight 132 was a CTO that had gone about 3°, I think, higher than what they were intended and ended up with some yaw excursions along the way and so he had informed me that that was due to a couple of reasons. Obviously, the technique was one of the them and at the time we were flying with the yaw damper off. So both of those were going to be addressed through some ITF sessions and reducing the pitch attitudes for the next series of test points.

Q. What did he say about -- oh, I'm sorry, you told me how you found out about 88. Cancel that. What's your understanding now of the cause of those incidents?

A. Well they both were -- in Flight 88 and 132, they both were rotated beyond where the test point was set up to do. Flight 88 was a V_{MU} point that was targeting 9 or 10, I forget. But in that case, they found themselves a little over 13 and the same for Flight 132 where they were targeting 9 or 10 and then ended up a little over 13 again. And as we now know, with both of those occurring very close to the ground, that the in ground effect stall angle of attack is down around that angle.

Q. Who is responsible for analyzing those incidents, and to your knowledge what analyses were performed?

A. It would have been our Flight Test engineer, Reece, along with the Flight Sciences counterparts.

Q. And do you know if Flight Sciences assisted in the analysis?

A. No, I don't.

Q. Do you know what analysis was performed to determine the root causes?

A. I do not.

Q. In your opinion, should 88 and 132 have resulted in a reconvening of the SRB?

A. In hindsight, obviously. And that's something we'll work hard to do as we go forward. I do know because I had the FTE walk me through both of those events. And as a previous flight test engineer I probably would have used the same judgment that they did. Those were two test conditions where they wanted to rotate to an attitude and hold an attitude and it just wasn't done correctly. And so the steps that they took after Flight 88 were prudent. They had a very good review amongst those that were involved in the test and the pilots. So the steps that they did following Flight 88, as I say, seemed to exercise good judgment. And the same thing with 132. And at the time I believe for both of those that we were encroaching on what even we thought at the time was the in ground effect stall angle of attack.

Q. Thought that they were or --

A. Were. We're talking about 13-1/4 and 13-1/2.

Q. Pitch angle or angle of attack?

A. Angle of attack.

Q. Did you attend a January or February meeting at the RDC 1 after Roswell-1 to discuss the airplane not being able to meet takeoff field performance guarantees?

A. I don't recall being in that meeting.

Q. Do you know what solutions might have been discussed in the meeting for solving the problem?

A. No, I don't.

UNIDENTIFIED SPEAKER: Can you answer those questions without knowing about a specific meeting? This is what's going on in February?

MR. McCARTHY: Yeah, that's where I was going to comment. What I was made aware of as we went through the Roswell-1 experience, was that they were not able to get what was described to me as the procedure to work out. So their procedure and their speeds were not giving them what they were looking for from a performance standpoint and most of the concern that Reece had made me aware of had to do with the initial rotation technique, which as I'm sure you know, as the pilot rotates initially he's trying to capture an early pitch attitude and so overshooting and undershooting that initial attitude or "the bobble", as it's been called, was one they were trying to minimize. So that was what I was aware they were focusing on.

BY DR. BRAMBLE:

Q. All right. And did you attend a quarterly review about the field performance testing that was held the day before the accident?

A. I don't recall it being a quarterly review. The day before the accident was Friday. Friday at 11:30 we have a weekly meeting to discuss the certification issues with Flight Sciences and so the field performance was part of what was discussed. And Pat Connor did address that the performance numbers were coming out, were coming out long. And the crew was back out with a procedure that had been refined.

Q. Can you describe -- I'm sorry, I didn't mean to cut you off.

A. And that -- because I remember commenting that yes, we would have Reece and Kent flying those points as we go into the weekend.

Q. And did Pat discuss what the procedure was that had been refined?

A. I can't recall that specifically. But obviously, that's one of the things that we were focusing on, so it would have been appropriate that we were talking about the column force through the initial rotation and the initial pitch attitudes. I just don't remember if that was the detail that had been presented that day.

Q. And do you recall discussing this issue with anybody other than Pat in the days before the accident, or maybe earlier in 2011?

A. No, I did not. My communication on the field performance program would have been with Reece. And outside of the issues that they were having with the technique and making the speeds, that was what we would be discussing.

Q. So did Reece have additional comments, or did you guys discuss this in addition to what you heard about at the meeting on Friday?

A. No. The discussions I had with Reece before he left were that, as I said, that Wednesday or Thursday, and he seemed very confident in the latest technique to minimize the bobble, which was one of the concerns, and the reduced attitudes at 9° for flaps 10 seemed to be a good step. And at the time we were talking, you know, and he was planning out the ITF sessions that he would have before he left, which was all good, what we would have expected.

Q. Do you guys want to take a 5 or 10 minute break?

(Off the record.)

(On the record.)

BY DR. BRAMBLE:

Q. Okay. The Friday meeting that we were talking about before the accident, I had the title of that wrong. So can you tell me what that meeting's called?

A. We call it the certification issues meeting. And Friday is Flight Sciences. Every major element of Engineering has their own meeting such that Engineering Flight Test and the program management side are calibrated on the significant issues and what the corrective action plans are.

Q. So each major element of Engineering has one of these meetings every week?

A. Correct.

Q. Okay.

A. Systems is on Monday and Wednesday, actually. And they pick up the engine side as well and the avionics. And then Flight Sciences has Friday.

Q. Okay. And who attended this Friday meeting on April 1st?

A. If I recall, Pres, Pres Henne and Kurt Erbacher were both there. The meeting is typically attended by both of those, along with our chief engineer, Brian Durrence. And Brian Durrence is direct report. So the person in charge of systems, for instance, would be his director, Joe Ireland, and for Flight Sciences, his director, Tom Lavrisa. And obviously, their appropriate engineers that can speak to the material. And Flight Test is involved in those meetings, obviously.

Q. Okay. And how did the other managers who attended that certification issues meeting respond to the information about the field performance links and the plan to try and address the issue?

A. I don't think there was any elevated concerns. We recognized that we weren't getting the field performance numbers that we were expecting and so we were looking forward to getting the next set of data at the procedures that they were going to be using.

Q. Before the accident, what was your understanding of the reduction in stall AOA in ground effect compared to free air, and how did you come to that understanding?

A. It was mostly based on the discussions with Reece just prior to the accident and his explanation of what he calculated as the shift based on the CLs that he had for the V_{MU} data compared to the free air data.

Q. And do you recall how much of a shift it was?

A. He was using 1.6.

Q. And had there been any other estimates of the difference in the stall angle for ground effect versus free air?

A. I was trying to remember when I was first made aware of the aerodynamic bookkeeping of a couple of degrees, whether that was an item that Reece talked me through when we looked at his CL data, but clearly that's what I was made aware of right after the accident.

Q. Okay. So definitely you were made aware after and then you may or may not have prior?

A. I guess we were talking about the events of 132 that all factored into that.

(Off the record.)

(On the record.)

BY DR. BRAMBLE:

Q. Okay. Was there a discussion of this difference in stall angle and ground effect versus free air during the SRB for field performance?

A. I don't remember, not sitting here. I'd have to go back and look through the material.

Q. Okay. Does anybody have that slide handy?
A. Um-hum. It's right in here somewhere.
(Asides while looking for the slide.)
DR. BRAMBLE: All right. Barry, do you want to take a look at those real quick? And Mitch, see if there's another one that you --
(Asides.)
DR. BRAMBLE: Well, while you guys are looking for that, why don't I move on and we can come back to that.
Oh, you found it? What's it look like?
MR. McCARTHY: Well, I have to just confirm that -- I'm just paging through right now.
DR. BRAMBLE: You know what I think would be -- so we don't take too long -- do you think you could find it and then take it up during the follow-up round of the questioning? In terms of addressing --
(Asides.)
BY DR. BRAMBLE:
Q. All right. So, in looking at the material that we have found from the SRB notes, can you describe what information was presented?
A. Your question is specifically what was discussed in terms of the in ground effect?
Q. Whether the difference between in ground effect and free air stall was briefed?

A. What I recall would be the target pitch attitudes that we would be building up to and using.

Q. I guess what I'm getting at is, and I thought it was in the slides, but I may be wrong, was whether or not there was a 2° difference briefed during the SRB?

A. That I don't recall.

Q. Okay.

A. But we would set our -- yeah, it would have been 2. It's part of the test safety hazard analysis for V_{MU} where we talk about the maximum pitch attitudes to be limited by a margin to the free air stall to account for in ground effect. So, if you were to look at the TSHA for V_{MU}, that would be one of the mitigation steps.

UNIDENTIFIED SPEAKER: This is a early -- this is a TSHA from the V_{MU}.

MR. McCARTHY: Pitch attitude limit will be based on buildup testing and will maintain an in ground effect AOA margin similar to the free air AOA limiter margin not less than 1.5°.

MR. RAMEE: And why don't you explain what that document is you just read from so they can find it later when they need it.

MR. McCARTHY: Okay. If you haven't -- totally familiar with our items, this is the formal test hazard analysis form. So if you look for the one for V_{MU}, one of the mitigations would be to limit the maximum pitch attitude, which is step 10, and the TSHA number would be 83.

BY DR. BRAMBLE:

Q. Okay. All right. And coming out of the field performance SRB, what was your feeling about the shaker settings for 6002 and how it would be set and how the shaker would be used as a learning for the crew?

A. Just that, that the shaker would be used by the crew. The initial shaker setting was set at .85.

Q. Okay. What did you know prior to the accident about any changes made to the shaker settings for aircraft 6002 during the field performance test program?

A. The FAA requirements are such that when you do your takeoffs you can't have activation of the stick shaker. So when the team went out with the shaker setting at .85, there were a couple of runs where, at least that I can recall, where the crew encountered shaker onset. And so subsequent to that there were discussions amongst the flight test engineers as to whether .85 could be moved to something a little higher, .85 being the normalized angle of attack, I think as you know. And so based on where we were on previous programs, it's not unheard of for us to adjust the shaker setting schedules as we optimize the takeoff performance procedure and so the decision was made that we had enough margin to move from .85 to .90.

And so that was implemented after Roswell-1. When the team went back out for the second phase of Roswell, they had used .90 and then when they came back there was a review with Flight

Test and Flight Sciences to formalize .90.

Q. When did they start using .90 again?

A. It was during the -- I should know the flight number but I don't. It was the second time that we went out to Roswell. The first time we went out in the latter part of 2010, we were using .85 and then we went in the time frame that starts in March --

Q. Okay.

A. -- we were using the .90.

UNIDENTIFIED SPEAKER: Excuse me. Call that Roswell-1 and 2.

MR. McCARTHY: Okay. Roswell-2.

BY DR. BRAMBLE:

Q. Okay. And do you know who performed the analysis that determined that there was enough room to move the shaker up?

A. It was Reece working with Nathaniel Rutland and Ken Obenshain. And to the extent of the technical discussions, I am not sure. I know now, obviously, that it was based on their understanding of the free air stall. Backing off that, you know, the 1.6° that Reece had analyzed and the .85 and .90. When they moved it to .90 they still believed at that time they had sufficient margin for both the normal takeoffs and the abused takeoffs.

Q. Okay. Why do you think the change in the PLI and the shaker setting from .85 to .9 resulted in the reconvening of the SRB when it was a change to a less conservative state? Why do you think it did not result in a reconvening of the SRB?

A. The change from .85 to .90 was done in Flight Test. And, as I say, the flight test engineers have had to adjust the shaker values during the field performance program on prior programs. And so I can say that, at that time they didn't feel that it was completely out of the ordinary to use that additional shaker margin, and at the time didn't feel like it introduced any significant risks to the test.

Q. What kind of working relationship did Mills have with Mr. Ollenburg? Do you know how they got along as colleagues or whether they interacted frequently?

A. The frequency of their interaction I can't speak to, but I can assure you that the working relationship with Reece and just about everybody was very effective. As I say, one of the unique traits about Reece is his ability to work well with just about anybody. And I think if you had the opportunity to talk to Bob Mills, you'll find the same with Bob. Probably some of the best in the business with regard to their level of expertise and their ease of being able to work with them.

Q. Okay. Getting back to the 1998 Standard Practice Manual, what was your understanding of how the roles of data review, reduction, analysis and expansion tasks would be divided up among Flight Sciences and Flight Test personnel during field performance testing?

A. Back in the days of the -- in the early part of the 650 and how we will continue doing business going forward, flight test engineers are responsible for doing the data reduction. So with Gulfstream, the flight test engineers not only measured the data and can process it and calculate parameters, we will also do the processor reducing the data to a level whereby it can be expanded. And so on the Gulfstream side for the flight test engineers that work for me, when they finish with conducting the flights they see to the processing and the analyzing and the reducing. And all of that is captured in a flight test report. So our flight test engineers put the certification deliverables into the FAA, in addition, obviously, to sharing the data with Engineering.

Q. Okay. And with respect to the takeoff testing that Mr. Ollenburg was supervising on site, which FTEs were assigned to assist him with that? Or was he doing it from start to finish?

A. No, no, no. He had several that were working with him. At the time of the accident Reece was working with Valerie Thurston and Cynthia Townsend. So those were the flight test engineers. And obviously we had others from Flight Test out there. And during the deployment, I think as you know, we had our performance engineers out there with Shelly and a couple of others.

And as far as the takeoffs are concerned, V_{MU}'s and CTOs, Reece, Valerie and Cynthia were consistent and Shelly was consistent through most all of the takeoffs. And Paul Donovan was doing landings and brakings along with Nathaniel Rutland.

Q. And so what part of the analysis responsibility did the Flight Sciences air performance engineers have that were on site with him during the testing?
A. They were monitoring also the quality of the runs. They were working with the flight test engineers on the procedures so we could get the best performance out of the airplane. And so they would be working reducing the data with the flight test engineers trying to make sure that we all agreed on what the right events were to pick the data and then process it.
Q. And back in Savannah were they supposed to analyze the data in parallel with Mr. Ollenburg, or did their responsibility largely diminish when they came back from Roswell?
A. Flight Sciences?
Q. Um-hum.
A. Flight Sciences' activity actually increases when you get back to Savannah because they have to take the data that's reduced and obviously expand it. Our job is to reduce the data and most of that goes on, on site in Roswell. So we have to not only take the flight test engineers and the folks that have to support the teams regular, but we also need the computer and the database part of our flight test engineering organization to make sure the data is processed and flowing.
Q. And it's our understanding that Mr. Ollenburg was doing the primary analysis of the V_{MU} data and would be also writing the report and that that would go to Flight Sciences. Was that

typical to have the Flight Test do the analysis back in Savannah when they came back from testing?

A. I think the answer is yes and no. If they have the opportunity, obviously, to analyze and reduce and write the report in Roswell, that happens. And given the schedules the way they worked out and the activity when they came back after Roswell-1, that's when it appears most of the work that Reece did on the V_{MU} data and the report was accomplished.

Q. And do you feel that Mr. Ollenburg had sufficient time to analyze the data from the V_{MU}'s between Roswell-1 and 2?

A. I did. As I say, Reece did not make me aware that there was any pressure in digesting the data from the V_{MU} before he went out to the CTO. And when he went back out for Roswell-2, the V_{MU} report was fairly mature.

Q. And what was its status at the time when he went back to Roswell -- the status of the report?

A. I'm trying to recall if it had been distributed to those that had to review and sign it. So I guess I'll have to say that I know that based on what I saw after the accident, most of the report was finished. The level of review of the formal report, I think, had not started.

Q. Okay.

A. But the level of the processing and analysis of the data and how much of that was shared with Flight Test and Flight Sciences, the majority of that probably happened at Roswell when the team did the test.

Q. Was it your understanding prior to the accident that TM was required during any high risk testing?

A. I wouldn't say any high risk testing. We use TM for -- we have used TM throughout the field performance program. And I think most if not all of those tests points are high risk.

Q. Did you say you would say any, or you would not say any?

A. I was trying to think if we -- we TM frequently. TM coverage was in place for pretty much -- well, TM was in place for all the field performance programs. When we've done --

UNIDENTIFIED SPEAKER: Comment on whether required would mean that you couldn't go on with the flight if TM was broken around the servers for some reason. So expand on what required would mean.

MR. McCARTHY: Okay.

UNIDENTIFIED SPEAKER: Continue with your answer.

MR. McCARTHY: All right. Well, as I say, we've used -- TM was used extensively for the field performance program. And we've used it extensively for high-risk tests. I'm not sure if I can make a global statement that it is used anytime we do high-risk testing. And that the requirement to have TM up and running is one of those items that we talk about in the SRB. If the safety of flight parameters can be monitored effectively with our FTE on board, there are situations where we could say TM will be used, but it wouldn't be mandatory. And then there are cases where the testing deems that we have to have TM up and running for the mission or we bring the airplane back.

BY DR. BRAMBLE:

Q. All right. Who developed the organizational structure for the flight test program for the G650 group in terms of position, skill and relationships among the personnel involved in the program?

A. That would be my responsibility, and it did change during the course of the 650 program. In the first part of the program, I had the responsibility of Flight Test and the Labs organizations. And in the first quarter of 2010, my position was changed to allow me to just focus on Flight Test. And so previously, Flight Test was being managed by Dale Coulter and then when I was asked to just look after the Flight Test organization, then we changed it subtly. We added a couple of manager positions, but the basic shape has always been there where we have a organization that handles the maintenance and the operations of the airplane, the instrumentation area, and then the Flight Test Engineering area.

Q. Okay.

UNIDENTIFIED SPEAKER: I think that the intention of the question is to expand on when you're in a test, what's going to be the relationship between FTEs and engineers and who's organizing, who does what in the TM trailer like that?

MR. McCARTHY: Okay.

UNIDENTIFIED SPEAKER: I don't know that you would get to that level so it's just --

MR. McCARTHY: No. That's a totally different subject then.

UNIDENTIFIED SPEAKER: Why don't you expand on that, and whether Bill wants it or not, it will be good on the record.

MR. McCARTHY: Okay. And what we were discussing was not just the structure within Flight Test, but how Flight Test works with Engineering. And as we go forward with planning a test and executing a test, our flight test engineers work with the engineering counterparts to get the level of involvement correct. And so oftentimes when we go do an acoustics test for instance, our flight test engineer will bring along the acoustics engineer. And in this particular case when we're doing field performance testing, Reece would bring along the engineering counterpart responsible for field performance. So the interaction between Flight Test and Engineering is something that we pay attention to.

UNIDENTIFIED SPEAKER: Who manages the roles and responsibilities during Roswell? Talk to that point. With those two groups.

MR. McCARTHY: As far as the roles and responsibilities, the flight test engineer has the responsibility to plan and execute the mission. We put additional flight test engineers out there for monitoring the data real-time and then taking the data and reducing the data. The engineering responsibilities would be supporting the flight test engineers and monitoring the quality of the run and then overlooking how the flight test engineer is reducing the data such that when they go about expanding it, they know how it was reduced so it can be expanded. And plus, as much as you'd like to think the data is always black and white, it rarely is and there's always negotiations, and where the best engineering judgment is applied to which time slice makes the most sense to use during a takeoff or landing or whatever.

BY DR. BRAMBLE:

Q. All right.

A. Did I answer your question?

Q. Um-hum.

A. Okay.

Q. Where did the test requirements document requirement come from? And did you expect that a TRD would be submitted for each proposed test request coming from Flight Sciences?

A. In the 650 in the early part of the program, Flight Test went forward with a formal process to collect the engineering requirements from Engineering and it was a test requirements document. The end product of the requirement definition phase is a release test plan. And so we got there through either a formal test requirements document that was released or through the normal process of working with Engineering and reviewing the regulations and the guidance to make sure -- and the design, to make sure that we've got the tests defined correctly, and that's the test points, the conditions, the instrumentation required. And so, for my level the test requirements were agreed and approved through the release of the flight test plan.

Q. Okay. The daily Flight Test reports -- we're provided copies of those reports for Flights 88 and 132 and noted that they were fairly brief and we wondered if there were any other ways that you might obtain information about how testing was going on a daily basis during the field performance testing?

A. Aside from periodic calls engineer-to-engineer, the primary means to communicate the results of the flight is through the FTEs flight report, or at times the status reports that come back from the aircraft coordinators. And if we sent the airplane out to do 10 cards for takeoff testing, then many times if there wasn't anything that the team felt worthy to communicate, it was usually that the 10 points were conducted and the next day's test would be A, B, and C.

Q. So if everything was routine then they wouldn't necessarily provide a lot of details?

A. Correct.

Q. Okay. And how about in cases where they had an incident like that with 88 and 132, would you have expected that they would include that -- I mean obviously in retrospect it would have been a good idea, but at the time would you have been surprised that they hadn't included in the daily?

A. The report, the status report?

Q. Um-hum.

A. You're correct. In retrospect, obviously, it could have been communicated or will be communicated in a better fashion, but realizing what the test team looked at and concluded then it seems reasonable that that is something that could have been managed within the test team.

Q. And how was it decided how many engineers were needed on site in Roswell during the field performance testing?

A. It would have been the responsibility for the flight test engineer. So Reece would have defined how many people that he would need to help him with the monitoring and the data processing. And the same thing as far as the Flight Sciences support. And that was part of a much larger plan. As we said, field performance is both -- has got a number of tests associated with it and so the team worked up a plan to do takeoffs and then the plan to do landings and RTOs. And so there were several activities that were being coordinated, but as far as who determined the number of people and the types of people, that was left to the flight test engineer and their counterparts in Engineering.

Q. Did you participate directly in field performance testing during your previous phases of your career when you were more of a line engineer?

A. Yes. Um-hum. MD11 and the MD90.

Q. And has technology changed significantly since that time in terms of how the on-site testing and data reduction and analysis occurs?

A. Absolutely. It's tremendous. Back in the early '90s, the monitoring capabilities that we had on the airplane were fairly primitive and today's tools, especially the ones that we use, are very flexible, easily adaptable and have a lot of power to them. So, the ability to capture a test point and then do, what I'd say is the first pass analysis, is leaps and bounds better than it was, say, 20 years ago, especially in terms of what it takes to process the data and import it into your analytical applications.

Q. And how has that affected staffing requirements for field performance testing teams, engineering teams?

A. Well, as I think it's been noted, we had less on the 650 than we've had on previous programs, but, as I say, with the tools that we have in place now to handle the data and import it into the analytical scripts, if the FTE needs two, three or five people that's one of the things that he just lays out.

Q. So the decision on staffing level on site in the trailer and into the airplane, as far as the engineers are concerned, was Reece's role?

A. That was one of Reece's responsibilities. And when you think back to what it used to take and the way we handle it now, by the time the airplane comes in it's only a matter of a few hours before all of the data is accessible to the engineers, and the process to look at the data from card 1 is almost immediate compared to what it took on previous programs with previous tools.

Q. And did anyone ever ask for more staffing, say, hey, we need more people? Ask you for more staffing, say we need more engineers to analyze the data or anything like that?

A. No.

Q. Okay. And what was your understanding of the roles performed by each engineer working in the TM trailer during the field performance testing? In particular, on the day of the accident, I guess if you can speak to the positions that were manned?

A. Okay. I don't think I can speak to them specifically as to who was at what station watching what parameter, but the primary focus was on the primary variables. Everybody was looking at the speeds at which the pilot was achieving at rotation and at 35 feet, the column forces, the rates, the attitudes and our ability to control at those attitudes.

Q. And who was responsible for monitoring those parameters?

A. It would have been Cynthia and Valerie in the TM trailer.

Q. Or Shelly if she was there?

A. Correct. And I believe Shelly was in the TM trailer. And as I say, as I sat in the three stations, whether they had divided up their duties, I can't speak to. I just know that after each run they were comparing the speeds they hit at rotate and at

35 feet and how they were doing in terms of capturing the initial attitudes and what pitch rates they were seeing and stick forces that were being used.

Q. And going forward into the next field performance testing effort, is there going to be any change in terms of how those duties are allocated?

A. We'll be more precise, especially in terms of the success criteria and the safety flight monitoring. And so, those will be clearly established and rehearsed. And, you know, as we have put work towards what we're going to be doing in our upcoming completion of the field performance exercise, and all of our speed schedules are being refined in our ITF, and so we have a very high level of understanding and confidence of what angles of attack, pitch attitudes and speeds we will be flying. And we've also developed new tools such that we can monitor in ground effect, angles of attack and stall, which varies as a function of height above ground, I think as everyone knows. And so, we now have more sophisticated tools that can monitor the takeoff throughout the entire phase, not just the first or -- yeah, throughout the first and second segments.

Q. So are the monitoring duties going to be divided up more among the personnel, like some people monitor certain parameters and others are primarily responsible for monitoring different ones in the trailer, that sort of thing?

A. Well, what I envision to hear from the engineers that will do it, is we will have a set of duties for those responsible for the safety of flight monitoring and those that are responsible for looking at the data and looking at it from a success standpoint as to whether the maneuver was conducted successfully and what the resulting performance is going to be. So, there's two different tasks that need to be handled separately.

Q. And will those be Flight Test personnel? Or do Flight Sciences personnel do each of those duties?

A. I anticipate we'd use both. We will have Flight Test engineers and Flight Sciences engineers in the trailer again. Flight Sciences Engineers will include both the Field Performance Engineers and our aerodynamic engineers, as well. Bob Mills would be out there with us so we'll have a more seniored staff, both from Flight Test and Flight Sciences along with the other flight test engineers that will be monitoring the data.

MR. RAMEE: Do you want to take 5 while this is going on?

DR. BRAMBLE: Yeah, this is a good time. And I'm getting fairly close to the end of my list.

(Off the record.)

(On the record.)

MR. McCARTHY: We'll certainly use this going into future programs, primarily the planning work prior to getting to Roswell. The last 6 months have been some of the most intensive engineering work I've seen out of Flight Sciences in terms of understanding the airplane in ground effect and how we go about establishing our speed schedules and maintaining our margins.

BY DR. BRAMBLE:

Q. On the day of the accident, who was in charge of the TM trailer?

A. Valerie Thurston, if I recall this right, was the test conductor in the TM trailer that was communicating with the airplane.

Q. We have information indicating that she had rotated out and that Shelly was actually there that day. But if she was --

A. Okay.

UNIDENTIFIED SPEAKER: Cynthia Townsend is a flight test engineer. Valerie Thurston's a flight test engineer and Shelly is aerodynamics.

DR. BRAMBLE: Yeah. Yep, yep, that was a mistake.

MR. McCARTHY: Okay.

BY DR. BRAMBLE:

Q. So, Cynthia Townsend, the representative from Flight Test is the person who's in charge of the trailer; is that true?

A. That is correct. They're normally more experienced in the protocols with communicating with the airplanes, so they will be the one typically that's talking from the ground station to the airplane. That's not to say that Flight Sciences or other cognizant engineers who support the test don't have radio contact abilities with the airplane, because they do.

Q. Okay. Did you feel that the team in the TM on the day of the accident was sufficiently experienced to provide full support to the on-board test crew during high-risk field performance testings, such as the testing conducted during Flight 153?

A. At the time of Flight 153, yes. Valerie specifically did not cause me any concern about her experience or expertise. She had been with the program since the beginning; Shelly as well.

Q. And how about since the accident?

A. Since the accident, I think they'll be fully able to do what needs to be done to support the program. They will be able to monitor the safety of flight and the test parameters. We're just going to give them more seniored support on what the data means and how close we are or not to the margins and what that means to the next test point and the point after that.

Q. But looking back, do you feel like the team was sufficiently experienced in the TM at the time or not?

A. That's a hindsight question and they probably would have benefited from more senior people being on site. Reece was a very seniored engineer. He had 25 years in the business. And so, he was in command of the subject matter and the testing that needed to be done. And Valerie and Cynthia were more than able to support what Reece needed to be done. And at the same time with the composition with the Flight Sciences team, from my perspective, we seemed to have a good team in place at the time of the accident.

UNIDENTIFIED SPEAKER: You only have Cynthia there, not Valerie, at the time of the accident.

MR. McCARTHY: For Flight 153?

UNIDENTIFIED SPEAKER: Um-hum. Valerie's come home.

MR. McCARTHY: Okay.

UNIDENTIFIED SPEAKER: I thought. Do you have a different memory?

MR. McCARTHY: That's not what I recall. I thought we had -- I know we had Cynthia there. Okay.

BY DR. BRAMBLE:

Q. Would you normally have more than one engineer from Flight Test in the trailer at a time for field performance testing?

A. I would say we would. But if the composition of what was in the TM trailer could have been -- the number of people could have been shared between Flight Sciences and Flight Test.

Q. So your expectation was that in the trailer would be Shelly and Cynthia working together to support Mr. Ollenburg?

A. Correct.

Q. Okay. And did you have any concerns about Reece having too many duties for one person during the field performance testing?

A. No, I did not. As I say, Reece was experienced and able and was working the takeoff program and the V_{MU} program. And he had not expressed any concern about having a workload that was too high to support the testing we were trying to do.

Q. All right. And how was the original field performance Flight Test schedule and staffing requirement benchmarked?

A. I can't tell you it was benchmarked. It was established based on what the flight test engineers thought they needed to support the testing. And that was something that I'm sure was discussed between -- or I would have expected it to be discussed between Reece and Paul Donovan.

Q. And how is the Flight Test schedule revised in the year preceding the accident, in sort of broad terms?

A. In the year preceding the accident?

Q. Leading up to the accident? Yeah.

A. The test schedules get continuously managed. Also, we kind of know that the various blocks of an airplane's test schedule is going to move based on the prerequisites that we needed to have in place.

Q. Okay. And who had a hand in creating that schedule and revising it as needed?

A. Most of that's done by Phil Burton, who is our lead over the coordinations element of what goes on at Flight Test. He reports to me, and Mark Twibell is our PDT leader for the G650 Flight Test program. So between the two of them and myself, we kind of see all of the moving parts in terms of the airplane configuration so then we have the right components available for the testing; and then, based on the inputs from instrumentation and the engineering and our operations when we can have the airplanes ready to test and how long it's going to take to test.

Q. And in the week prior to the accident, did you have a sense of whether the Flight Test schedule end-date would have to be pushed back?

A. Which end date?

Q. The -- do you need a clarification?

A. Are you talking about the end date for the program, the end date for pure performance side, or --

Q. For the -- my understanding is that the final TIA for Flight Testing was scheduled sometime in late summer.

A. The schedule that we had in place at the time of the accident was set up with our understanding of when the final software loads were going to be available and when the final hardware configurations were going to be available. And they were sequenced to support that. And whether or not we knew it was going to move is just anyone's insight as to how successful we will be getting software that works and hardware that's going to show up on time and actually function correctly. So, I think we all knew there was great risk on the dates that were on the piece of paper.

And, of course, we always put the FAA in the unfortunate corner because their work is the last. And so as we take longer during the company test phase, then all of the FAA tests queue up right at the end of the program, across all the airplanes, which presents a significant challenge for them, and they're pretty consistent about reminding us about that. We reviewed -- and we meet weekly with the FAA and talk about schedules. Actually, through the years they've been, I would say, very supportive of the program. I think they recognize our schedules are what they are as we try to get through all of the work. But even the last time we went through a major schedule review with them, they just say if Gulfstream will continue to put their best efforts forward the FAA will usually do the same. And they do. They rarely are reasons to slow us down. They'll just support us directly or delegate some of the FAA work to the DERs and the ARs.

Q. And so as of the time of the accident given the TIA schedule --

A. I think I've got a copy of that here, actually.

Q. This is the TIA schedule that was presented during the April 1st weekly Webex with FAA and I just wonder if you could comment as to whether or not you thought that the schedule is achievable for completing all of those TIAs as scheduled?

A. It's certainly aggressive. I would say that trying to get that at 100% is not realistic. That would have been quite a challenge to work through 11 TIAs in one month with our FAA counterparts. But trying to get through all of them by the end of July was a reasonable objective for the team. And as I say, I think we work extremely well and have worked over the last 15 years very hard at trying to keep a good working relationship with the FAA in terms of how we go forward with some of the schedules. And we just continually stay in touch with one another as we finish our company tests, provide them the results and then start the process of the certification tests. So they remind us they'll always have problems with, you know, trying to do 11 TIAs in one month and we just ask them to support us the best they can.

Q. Okay. And on March 31st, they sent a letter to Kurt Erbacher expressing concerns about the schedule and saying that it didn't reflect the true status of the program and was unrealistic and urged the company to reconsider the schedule, specifically saying that their decision not to allow the breaking out of TIA 15 into two parts would be a good opportunity to be considered as scheduling. Do you recall that letter?

A. I am aware of a letter such as that.

Q. Did you ever see it?

A. I probably did.

Q. And do you recall if any discussion ensued prior to the accident regarding that FAA letter?

A. Nothing different than what I probably mentioned. You know, the sequence of the tests and the stack-ups of the TIAs is just the end result of when the final configuration is going to be ready for us to do our company tests. And so just putting in normal lead times and extending the schedules wasn't anything that we were considering. We at Flight Test just continue to ask the

FAA to do what they can to support us. What they look for from us to make sure that we're proceeding at an acceptable pace is the quality of the deliverables that we send into them. So we're held accountable for making sure that we can move only as fast as we can complete the tests, thoroughly document the results and make sure that they've had time to review and accept the results. And that's as fast as the program is going to move. And those schedules are difficult to pinpoint with any certainty, just based on the complexities of what we do.

And, of course, as part of that, when they release the TIAs to us they have to be comfortable that all of our safety steps have been done. So our safety reviews have to be finished, our TSHAs have to be in place, and they have to make sure that we haven't run into any significant issues by the time we get to the TIA tests. And we've had issues with them before. The FAA will point to reports that we've given them that weren't accurate in terms of errors that had gotten into the report. And so we're very sensitive about making sure the engineers go through the process of writing the reports, reviewing them, approving them and allowing the FAA to have their time to review and ask any questions.

Q. All right. And what pressures were you under, if any, to keep the G650 certification program on schedule?

A. The same pressures that are inherent in pretty much any test program I've been involved with. You start out with a certain start date in mind and an end date in mind and the company and the business make plans associated with that. So as the start date moves and development issues arise that aren't simple and tend to extend the program longer than anyone wants to realize, then you have to do your best and deploy your resources the best you can and get the work done in the shortest time span that's reasonable. And the focus from a Flight Test standpoint is there are a number of elements that have to come into place to have a successful test flight. And so you're always trying to move only as fast as the slowest member of the team. So everybody's got to come to the table and be ready for the day's mission.

Q. All right. And part of the accident was the Flight Test program progress tied to your compensation in some fashion, such as a bonus for on-time completion or something like that?

A. Well, as an Engineering director I am on an incentive plan that has a percent of my compensation at a bonus. And yes, you know, as part of that your performance is based on achieving certain milestones. But just as measured against the Flight Test program's ability to perform, measured by the safety and incidents that happen in Flight Test. So, as I mentioned, we measure ourselves not only in how many flights we fly or our ability to complete TIAs, but also the incidents that go on, the accidental damage events that happen in the hangar. And so there's both safety metrics in my performance as well as progress metrics in my performance.

Q. The safety metrics were written in prior to the accident?

A. Yes. Um-hum.

DR. BRAMBLE: Mr. O'Callaghan?

BY MR. O'CALLAGHAN:

Q. Thanks, Mr. McCarthy, for your time. Just a quick follow-up on the schedule discussion. You mentioned that regarding the FAA that at times some errors have crept into the reports. I was just wondering were those errors results of schedule pressures or inadequate time for review within the company, or what --

A. My reference goes back to the GV program. I wasn't here but that's -- Neil Berryman is our program manager in the FAA and that's what he's quick to bring to my attention is that in the days of the GV, the Flight Test reports would show up and there would be errors in them. And he says, you know, the quality of the reports are one of the most important things to them and that's what we need to focus on. So as far as the GV circumstances, that was before my time. I just know that they got reports that caused them a lot of additional time, I'll say, for the FAA to review and find things they shouldn't have been finding.

Q. Okay. Thanks. Going back to the discussion on staffing, you talked a little bit about how technology has changed the game in flight testing, and as an engineer I'm just wondering is there like an equation that goes with -- you know, because of the new technology we can reduce staff by X percent? Is there anything like that or how is that evaluated?

A. I wish there was a simple equation that you could apply to that, but there really isn't. When we set ourselves up in the beginning of a program, we have a certain top-level understanding of the tests and how many flight test engineers of certain specialties that you'll need. And it's with that, that you know, you go forward. We know that on the previous program we spent this many labor hours of flight test engineers, so based on the change and the complexity and the new tools in processes, so you're going to be more efficient in certain ways and you may have to do more or less work in certain ways. So that's kind of how we get the idea for the proper staffing. And then as we go through the program we try to respond. I mean, even now we're trying to continue to add to our flight test engineering staff, just because not only the work continues to be a little higher than what we anticipated, it's now to a point where we could just benefit from the additional hands helping out.

Q. Um-hum.

A. And as the director, that's part of my job to make sure there is an adequate staff. And when I would talk with Paul Donovan about the FTE staff up to the point of the accident, what I recall is he was comfortable with the workload and the distribution of the work through the flight test engineers.

Q. And sort of along those lines, not just for field performance testing, but for the Flight Test staffing program in general, do you recall any conversations with Ken Obenshain along those lines where he expressed any concerns in terms of number of people or experience of people or anything like that?

A. Ken, not directly, but Ken usually has a higher number of FTEs, if I remember the discussions right, than what we ever have planned or budgeted. And looking back on the 650, I think he and -- as I say, when I talked to Paul he wasn't overly concerned about his FTE band-width going through the program. So I would say that Ken's input is always a little bit more than what we end up with.

Q. Okay. I'd like to talk a little bit more about Flights 88 and 132. You mentioned that Reece walked you through those events. Can you describe what that means; how he walked you through them, what he talked about; do you recall?

A. For 88, he walked me through the V_{MU} test point itself and that it was a point that was aimed at rotating to a certain pitch attitude and holding that, obviously, through 100 feet, just a classic V_{MU} maneuver. And he showed me the time history trace and explained how other than hitting the target, it was either 9 or 10, that the initial target was overshot considerably. It went up by, if I remember right, beyond 13. So they were 3° off their target, which for a V_{MU} run is huge. And so the crew in the front aborted the maneuver and flew out of it. And so the corrective actions that were behind us, you know, he had told me what the pilots did to review the maneuver to introduce the build-ups and change the TSHAs the way they did, and all of that seemed appropriate.

Q. So the walk-through that included presentation of time histories was primarily pitch angle and angle of attack we're looking at. Any other parameters?

A. For 88, no. That's what I remember is the pitch trace.

Q. Okay. And how about for 132? It's the same question for 132.

A. Similar kind of discussion where we looked at the intended pitch target and where the crew ended up. So to me it seemed very similar to 88. So, rather than having a maneuver that hit their initial target, they went several degrees beyond it and when you look at the video you can see the roll excursions and yaw excursions that come with that one. And so as we discuss that maneuver Andy reminded me that we were going to be -- well, it was conducted yaw damper off. And so, as he explained that and told me that in the go-forward plan on, they'd stop doing takeoffs until they better understood what had been done, really, to date and that they would be adjusting the pitch attitude targets down and testing with the yaw damper engaged, and rehearsing all of that in the ITF before they would go back out. It all seemed like a proper response to what had happened.

Q. Um-hum. Okay. So based on these conversations, then,

then at the time was it your impression then that both events, 88 and 132, the roll was produced by the full separation stall, if you will, on one wing?

A. We did not get into those details. In my perspective when I looked at the data and what they did, there was a test that was attempted but not conducted the way they wanted to and they were significantly over where they needed to be.

Q. So what's the significance of going over the pitch target?

A. Well, in this case it was, as you know, right where the airplane didn't want to be flying.

Q. Meaning close separation stall? Is it the one flying it because the pitch attitude is too high; is that what that means?

A. I'm not sure I can talk to flow separation or stall, only that, you know, at that point on the ground and at that attitude the wings weren't kept level.

Q. Okay.

A. And, of course, in hindsight we know very well that in those conditions it's right about the point where the airplane was at stall in ground effect.

Q. Right. Okay. I won't belabor this too much more, but in a general sense, if one says that we pull the pitch limit because we don't want the angle of attack to get too high and then we overshoot that and as a result we get uncommanded roll, is it reasonable for somebody to infer from that that a stall event had occurred?

A. I'm not sure I can answer that one directly. The roll that occurred doesn't occur at a real sharp rate that I would directly equate to a stall. Obviously, the roll is uncommanded and something is going on aerodynamically at the tip of the wing in terms of its ability to, I'd say, fly normally. So, yes, I guess you've got some flow separation at that region of the wing.

Q. So that's your understanding of the basic physics underlying those events, is some flow separation?

A. Yes. The airplane can roll also for a number of other reasons.

Q. So, with that, were there any hints from these events that the stall in ground effect estimation or that the stall in ground effect was occurring lower than what was being expected?

A. Not in the discussions that we had with Reece. And again, I think, as you know, that's an internal discussion within Flight Test and that he did not make me aware of or one of the concerns that I particularly identified.

Q. Do you recall if stall warning occur in either of those events of the shaker?

A. Not without going back and looking at the data.

Q. Would it have been expected, you think, given the maneuvers that Reece took you through?

A. Yes.

Q. So in the discussions that eventually resulted in the stick shaker threshold being raised from .85 normalized angle of attack to .90, were the Flight 88 and 132 events considered in those discussions that you recall?

A. I do not know. As I say, when you -- the consideration to go from .85 to .90 was done with the flight test engineers and the understanding of where aero stall was, the back-off in ground effect. and where .85 and .90 and AOA would put them. And at the time, they thought they would still have adequate margins.

Q. Okay. So the two roll incident entered into that discussion?

A. Not that I'm aware of.

Q. Did Reece go over his methods for computing the increment and the stall angle of attack to ground effect based on the V_{MU} testing, the adjustment from, I guess what was previously a 2.0° to a 1.6°? Did he step through that with you?

A. I recall Reece explaining that and, of course, he had that data in his V_{MU} report. I don't remember to the extent of how he walked me through those other than, you know, this is what he thought it was.

Q. So I guess it's obvious that whatever he presented to you, you found it was appropriate?

A. It was credible, yes.

Q. Do you have a feel for, based on your prior experience in flight testing and field performance testing and these sort of things, what reasonable uncertainty value one could attach to that sort of an increment from the reduction in stall due to ground effect? So, it's a few degrees plus or minus a percentage, a degree; do you have any feel?

A. No. And it's something that, you know, I've thought about since the accident. Now, when we did the field performance programs back at Douglas where it was a twin jet or a tri jet, the ground effect performance wasn't one that -- wasn't certainly of an elevated concern. And so when we go through the safety planning, we talked about the uncertainty around those margins. And it just wasn't addressed.

Q. Okay. And I think you mentioned that in terms of Reece's collaboration with Bob Mills, that if a significant aerodynamic question arose, that you would expect Bob to be brought into the conversation. So the adjustment on the in ground effect stall increment, does that rise to the level of a significant aerodynamic question?

A. Say your question again?

Q. Basically, I understood you to say from previous questions regarding the Reece's collaboration with Bob Mills that Reece would handle a lot of things on his own or in collaboration with some other folks in Flight Sciences, but that if a, I think the words you used were "significant aerodynamic question", if that came up, then it would be appropriate for Bob Mills to --

A. Um-hum.

Q. -- get involved?

A. Correct.
Q. So my question is whether this adjustment of the in ground effect stall angle rises to the level of a significant aerodynamic question in your opinion?
A. Is your question when Reece analyzed his data and came up with a delta of 1.6 that that might have varied significantly from what Bob had determined from the wind tunnels?
Q. Yeah, along those lines. I guess what I'm driving at is if refinement of that number is something that, in your opinion, Bob should have been involved with?
A. Yes. It should have been. Some of the questions are difficult because we know so much more after the last time I had a chance to talk to Reece.
Q. Sure.
A. And so I can state that -- I'll say from an engineering involvement standpoint, if anyone within Flight Test had an aerodynamic question they know that the truth source would go to our chief scientist, Bob. They know how to get a hold of Bob. He's very accessible. And, frankly, if there's anything of an aerodynamic nature that happens at Gulfstream that isn't correct, Bob's very passionate about it and will come over and address it.
If I'm considering what Reece is doing with his analysis and he's looking at in ground effect deltas and he is aware that the wind tunnel data suggests there's a 2° shift on CL -- or alpha, excuse me, and his data's showing 1.6, it's reasonable to

think that's not a significant enough data that would say, ah, I better get my chief aero guy and we'll go scrub on these numbers a bit. But what he was, I'm sure, trying to do is to make sure that as the stick shaker settings are adjusted and as the pitch attitudes are adjusted, he still had margin to stick shaker so he could pass the regs and margin, obviously, to the stalls because when he went in and did the abuse we would still have adequate margin. So when you look at all the stack-ups today in hindsight, with the information that Reece had, he still had a justifiable margin to continue to go do what he was doing.

Q. I understand. Thanks. Oops, I missed one on Flight 88 and 132. It's kind of a broader question. And understanding that how there's the, as you mentioned, the benefit of hindsight, and so I'll ask you to do something difficult, is perhaps put yourself in the frame of mind at the time before the accident. So the question is, can you identify anything in the way the Flight 88 and 132 roll events were handled or reviewed that you would have expected to have been done differently given the procedures and the knowledge in place at the time?

A. Well, I think with the procedures and knowledge in place at the time, the crews took what appeared to be a reasonable approach at handling both of them. They concluded that in both events they were related to how the test crew went about performing the maneuver and that not performing, it got the levels where they shouldn't have been and they took steps to correct that. And obviously in hindsight, there were things to be learned out of where the airplane went those days that we didn't learn. So as we go forward, that's part of what we're putting in place.

And both of those events became -- I became aware of those well after the fact, but the point being right up before Flight 153. So it's incumbent not upon just the people doing the test, but those of us that's going to be responsible for getting the tests done successfully are given the benefit of agreeing that that's what happened and this is what we're going to do. So, we'll get better at addressing and learning from all of those kind of incidents in the future.

Q. Thank you. That leads nicely into the follow-on which is, how would something like that be handled today, those sort of events be handled today?

A. In the incidents that we have now in Flight Test, we've published guidance to the pilots and the FTEs that if we were to encounter an incident during a test mission, then we will formally notify a group of people. And notification will now go out to myself, the chief test pilot or head of Flight Operations, the program manager, the chief engineer and our senior VP. So, the appropriate management will be apprised and we'll work together as a team to make sure that, yes, we know that this occurred and if there's any initial restrictions we need to put on the test operations as a result of that, we'll do that immediately while we do our due diligence in understanding it and addressing it.

MR. RAMEE: And that was published before the aviation safety office.

MR. McCARTHY: And as Tom reminds me, we put that in place pretty much after the -- I don't remember the exact dates, but it became apparent as we looked hard at our own processes. Aside from them not being well documented to reflect how we currently did business, we needed to make sure a few things were explicitly addressed. And so when I say we published guidance, we put a memo out to everybody that this is the way we're going to behave in a few areas, and reporting incidents during missions was one of them we had to address quickly.

BY MR. O'CALLAGHAN:

Q. Okay. Thank you. Switching topics a little bit to the V_2 difficulties that were -- the difficulties in capturing V_2 that were experienced through the program. I've asked some of the pilots this and I'd like to ask you as well whether you'd seen anything similar to that in previous programs you've worked, either here at Gulfstream or other places? And what I mean by difficulties is this persistent troubleshooting or difficulty in getting the airplane to slow down or quit accelerating by the time you got to your 35-foot point so that you'd be at your V_2 speed?

A. I don't believe so. You know, you go through the early phases of the takeoff performance program and you get your procedures just right and once you do that the speeds are going to be what they're going to be. There's only so much you can do between rotate liftoff and 35 feet. So we, I think on Flight 153 when we flew the flap 10 single-engine maneuvers, we were still 2 to 4-ish kind of knots high on V_2 and then the flap 20, of course, we were 10 knots high.

Q. Um-hum. And again, it's hard to remove the hindsight bias from an answer in this area, but do you recall if there were any -- that these difficulties led to any discussions or conversations that were suggested at the fundamental physics underlying the generation of the numbers was -- had something to do with the reason this wasn't coming together?

A. I can't answer that one directly because I don't know the specifics of what might have been discussed between, say, Reece and his counterparts involving physics. I know they weren't getting their numbers and they were in the process of trying to optimize the procedure to get as close as they could to the numbers they wanted.

Q. Okay. And -- getting to the end here -- Bill asked some question in this area regarding the flight test requirements document versus the -- it's sort of how it ends up ultimately in a flight test plan. My question is whether in your experience you've perceived any differences in approaches from different disciplines within Flight Sciences, say, the flight aerodynamics group that was going to go out and test for stalls versus the performance group that was going to go out and test for field performance in how they prepared or briefed the Flight Test organization for the test in terms of predictions for what to expect and -- just if you perceived any cultural differences or other sort of differences in the way different disciplines approached flight test, different -- your customers approached you in preparing for a test or soliciting your support for a test? If that makes any sense?

A.   No, I'm not sure. Can you, one more time? If you're asking how we approach test planning?

Q.   Well, I guess from some of the conversations we've had today, I get an impression that Flight Sciences is going to be a customer for Flight Test. Did they determine numbers of tests they want accomplished to obtain data, and Flight Test working with them in collaboration, of course, will work to provide them the date that their seeking. But in that process a test plan is developed and in some cases something called a test requirements document may be generated by Flight Sciences delivered to Flight Test from which the flight test plan is constructed.

In other cases, the Flight Sciences engineers may sit down with the Flight Test engineers and develop the test plan in conjunction without -- and sort of skipping the test requirements document. That on the one hand. On the other hand, we've heard that some folks come to the test with a very, perhaps, detailed predictions of what they expect the results to be and sort of provide the Flight Test personnel with those predictions so that the test ends up being more a check of the predictions more than a sort of a data gathering exercise from which to produce predictions. But that that approach may be different within different disciplines within Flight Sciences. So I guess the question is, if any of that makes any sense and if you can follow it, if that resonates with you or if you've witnessed differences in approaches to flight testing from the Flight Sciences side or not?

A. Oh, wow. Yeah, I'm not sure exactly of your question, but I know when we work with Flight Sciences most of the top level requirements will come out of the regulations and the guidance. So we kind of know already what to do. The Flight Sciences engineers will have the predictions, just like we had for performance. And so when we go out and we test, all we're going to be doing is measuring and gathering the data and if it's not correlating with the analysis or the estimates, then it's like okay, well you can't argue with the results that you have so is there -- are we doing the tests correctly or can we actually achieve what's coming out of the analysis? And so I don't think there's a pat answer on how you do that other than making sure we have the right limits and boundaries established for how much we can push the airplane trying to get a number that may or may not be right.

Q. Thank you, Ed. That's all I have.

A. Okay.

DR. BRAMBLE: We may want to take just a quick break and meet amongst ourselves here to see if there's a way we can get through this, the rest of it and expedite it?

(Off the record.)

(On the record.)

DR. BRAMBLE: All right. Go, John.

BY MR. O'CALLAGHAN:

Q. Thank you, Mr. McCarthy, for your time. And, as you know, we're concluding the factual portion of our investigation. We'll go back to Washington here shortly and start analyzing working towards a report and, as I described at the beginning, the purpose of the investigation is to come up with -- obviously find out what happened, the probable cause, but then, perhaps even more importantly in my view is to generate safety recommendations to help improve the industry and safety of the industry.

So, I have two questions for you. One is, if you think we have not covered an area that needs to be looked at, as you've gleaned from our question, if there's something else we should go pursue, please point that out to us. Secondly, if there's anything you think that the NTSB should recommend or consider for recommending to the industry to improve safety and flight testing, or in other ways, we'd love to hear those ideas as well. So with that, the floor is open to you for whatever you'd like to provide.

A. Okay. I'll probably address both of those if we can in sharing some of the internal work that Gulfstream's been doing since the accident and that probably will, as I say, address both of the questions that you had. And we've gone through our own Engineering Safety Review Board at a -- I don't want to say large level because it's not a large number but, we had that and then we had an executive Safety Review Board where 5 or 10 senior personnel participated because there were so many factors into the accident it's difficult to come to the true items that we needed to focus on. And even these items weren't 100 percent of the consensus and for each item you could have varying degrees of input. So it probably would be good -- I'd like to walk through these and give you what I believe we're going to be doing going forward and what we think was significant in regards of the accident.

And, you know, first and foremost was the stall angle of attack in ground effect. I mean, obviously, the engineering that we had in place at the time was not conservative. We had this one over-estimated. We had a couple of hints to that in Flight 88 and 132 that we didn't learn as much of that we could have to help us understand that earlier. And so that's, as I say, one of the things that we're addressing ourselves by just how we respond to incidents that come up in flight tests. So, I think we've got some internal processes that can help us when we come across items unexpected when we go do particular test missions.

We know that the stick shaker setting that we had at .90 didn't put us in the right spot. And again, that was a change to the configuration of the test article that was done in the test program that, in hindsight, was more significant than what the flight test engineers had thought. And so, as we go about having a plan when we start changing the test article configuration, that's something that's always got to get stepped back and revisited. We know when we went out for Flight 153 for the flap 10 maneuver, we had changed the pitch attitude from 10° to 9°. And those of us that looked at that at a point considered that that was a movement in the direction of being a more safer procedure. But, it's also something that you normally change the pitch attitude on takeoff. We have to go back and re-look at what that does to the liftoff speeds and how we're going to arrive at the V_2 speed. So that's something more tactical as it pertains to doing takeoffs.

On the day of the flight, we flew the accident test point just prior to the accident. We were run 7A1. There was the same flap 10, single-engine point, but we missed observing that the liftoff speed was pretty much on top of the speed we wanted at 35 feet. And so, we missed at that point the opportunity to learn that what we were trying to do wasn't reasonable. And the 7A2 run was flown in a different fashion, more aggressive in maintaining or adjusting pitch, trying to capture the speeds that we wanted to at 35 feet. But as we conducted run 7A1, there were things to have been learned that we didn't. So, we'll focus more on what it means from a success criteria standpoint from run to run.

When we did our safety planning for the field performance, we recognized in the TSHAs for the V_{MU}'s that over-rotation and inadvertent aerodynamic stall cause a hazard. And so, we had identified that we had some fairly concise limits and some abort procedures identified. One of the things that we haven't talked about was the recovery procedure that was or wasn't used by the crew when we did run 7A2. When you look at our safety planning, we did not have any specifics in terms of when to abort the test point. We approached the normal continuous takeoff as something that wasn't presenting a hazard of over-rotating or encountering an inadvertent stall. Now, you're more exposed to that as I think as, John, you and probably Mitch know, you're more exposed to that when you do your abnormal CTOs, when you're doing the rapid rates when you're going to the higher attitudes. We did not specifically call out this hazard for the normal CTOs.

So, when we're working with a speed schedule that has to yet be defined, that's one of the things that you just have to recognize. And when you're talking aborts, it's not just pitch and angle of attack, it's also the roll attitudes. And especially for us with the 650, the ground contact envelope's going to be a little different than what our pilots might be used to, say, on the legacy airplanes. So when we think about going back and doing the field performance program, being very precise on the recovery for the abort criteria and the recovery procedures are things that we'll focus on.

When you go out and do performance testing for development certification, I mean, the OEM is -- in Gulfstream we're very conscious about trying to precisely perform the maneuver just to get the performance out of the airplane, which obviously is part of what makes it marketable. And when you try to fly the maneuvers precisely -- so, when we ask Tom to go fly a maneuver and we give him a target speed and we tell him 135 knots, well, we're looking for 135 knots. We didn't want 137. We don't want 133. We want 135. And when we have atmosphere conditions where the wind starts picking up and it becomes difficult for the poor guy flying to fly precisely to his speed because his indicator's bouncing around a couple of knots, you know, that we have appreciated as very important when we go and we try to get those performance points up and around the edges of the envelopes. So, we're going to be more sensitive to the type of limits. Everybody knows of headwinds and crosswinds and tailwinds that you can accept when you go do the performance maneuvers, but you also need to pay attention to, and we'll pay attention to, the gusty conditions and the variations that you get in your sensors.

When you look at how we crewed with the pilots and the test team, the FTEs and the Flight Science engineers there was a good amount of consistency with the flight test engineers and at least one of the pilots. Reese had flown most all of our takeoffs. Valerie Thurston was involved in most all of the takeoffs in the V_{MU}'s, and Cynthia, Shelly, as well. But at some point there was someone new, either introduced into the cockpit or maybe into the engineering team. And so we're going to be paying attention to keeping our crews consistent as we go through the critical tests where we're dealing with part of the airplane that we haven't seen before.

I talked a minute ago about the abort criteria and the abort procedures, but what I also should have touched on was the test procedure itself. There's been a lot of debate internally about the test procedure that was written to pitch to an attitude, hold that to V_2 and then increase your pitch attitude. And given what we're working with in terms of being, you know, either on the ground or at the point of liftoff or going through 35 feet, it's very important as to how the pitch attitude adjustments are managed to make the speed schedules. And so as we think about being precise on the abort criteria, it's also important to be precise on how you're going to manage your pitch and your attitudes as you go from rotate through liftoff through first and second segments. And so we can do a better job on being very precise on how we do that from a test standpoint.

There's a couple of other observations that we made. On the day of the accident it was actually a good day to be testing in Roswell. The crew started early and the winds were very calm, but they started to pick up as we got through 10, 11, 12 runs. Monitoring the winds is important. We have our own equipment to monitor the winds. If, as we have learned in looking back at the data, the way we were measuring the winds wasn't -- how can I say this right -- wasn't totally accurate because we experienced some lockups. And so the refresh rates weren't exactly what we expected. And that's just an observation. The crew had limits to do the test. We had a crosswind component at or below a certain number. It turns out we were just on that number as we did the run. But we need to be sensitive as to how we're measuring and monitoring winds.

And one of the last things we noted was the test team rotation and continuity. We stepped through the program doing V_{MU}'s and then takeoffs and then landings and then back to takeoffs. And as I mentioned, we were rotating at one point in time maybe a pilot and maybe an engineer. And so continuity and consistency from a test execution standpoint's always in the direction of goodness.

So, as I say, there's many factors that we've learned about this particular accident. And as I think about what to share with the industry, those are some of it and the critical takeaways, at least from my standpoint, obviously is the engineering that goes behind the in ground effect angles of attack, the maximum angles of attack, how the performance engineers go about building the speed schedules. Because even though you may comply with the minimum margin requirements for V_{MCA}'s and V_{MU}'s and stall speeds on your speed schedule, you can't ignore through the liftoff and early phases of the takeoff where you are relative to your in ground effect stall.

And then really, as any other hazardous test, it's important to be concise on when the team just needs to stop testing and fly the airplane. And so what constitutes aborting a test and how you go about aborting it are important to think through before you go out and test it.

So, that's just a quick summary from my perspective of what we've done internally and, as we've mentioned, I think there are a number of items we're addressing kind of in a safety sense, kind of in a different area. So we're working those to institutionalize some of the improvements that we know that we can take into the future.

Q. Thank you.

DR. BRAMBLE: Okay. Great. Mike?

BY MR. BAUER:

Q. This is mainly for clarification. Bill asked you about the use of telemetry. Based on the SRB and your knowledge, was telemetry required for continued takeoff testings, in specific probably, Flight 153?

A. Mike, I should know that, but without looking at the TSHA I don't remember if we mandated it. It was certainly our expectation that we would have the TM up and running with both Flight Sciences and other FTEs looking at the data.

Q. If it was required for testing, it would be something that would be in the TSHA?

A. That's how we would mandate it. Yes.

Q. Okay. Is it going to be mandatory for the upcoming round of performance testing?

A. Yes, it will be.

DR. BRAMBLE: Mitch?

BY MR. GALLO:

Q. After Flight 132, you mentioned that you heard the 088 and 132 roll-offs for the first time from Curt Cromwell. After your discussion with Curt Cromwell, was that ever discussed in the certification issue meetings held on Friday?

A. No, it was not.

Q. During the certification meetings, which pilots attended after 132?

A. Mitch, typically, the Flight Ops participation is through Jake Howard, our chief pilot on the 650, and when Jake is not available or when matters of, say, flight controls are being discussed, then we may see Tom or Scott Bufee (ph.), who are heavily involved in the Flight Controls element program.

Q. And who decides who attends the certification issues meeting?

A. There's a broad invitation for engineering participation. So, it depends on the topics that are being presented and those of us that attend that feel additional representation should be there. But it's Engineering program office, Flight Test and Flight Operations.

Q. Do you recall if Reece Ollenburg attended those meetings during the field performance development testing?

A. I don't recall.

Q. Do you recall who from Flight Sciences attended?

A. Well Tom Lavrisa would be participating, who is the director of 650 Flight Sciences. For matters of performance, it would have been Pat Connor.

Q. Do you recall it Pat Connor attended any of those meetings?

A. Well, yeah, Pat. As I mentioned, the Friday prior to the accident, Flight Sciences was up and Pat was in attendance that day.

Q. And did Shelly Brimmeier attend?

A. I don't recall if Shelly was in that meeting but it would not be unusual for Shelly to be in that meeting. She was in the last meeting.

Q. Okay. You mentioned earlier that the change in the shaker setting 6002 prior to Roswell-2 did not prompt an SRB because such changes in shaker had been done in previous programs and previous flights. And in those previous occasions where the shaker was changed, was there an active pusher or AOA limiter that would have triggered if the airplane reached the settings that those two systems were set at?

A. I'm not sure. I believe on the legacy airplanes the stick pusher would fire. But, Mitch, just for clarification, the adjustment that the FTEs agreed to was done on prior programs but that adjustment was done with the knowledge of what they understood to be the margins that they had to work with.

Q. Okay. But in the prior programs you had a shaker and a AO limiter active?

A. On the legacy airplanes, it's a stick pusher. And technically, I'd have to go back and check to see if the stick pusher is on full-time from liftoff or at what point in the envelope it comes on. I'm not 100% sure. We have a full-time stall warning, but I do not know about full-time stall definition.

Q. Have the settings during the 650 program for the shaker, have they been changed previously?

A. Not to my knowledge. I think it was at .85 throughout until it was decided to go to .90.

MR. BAUER: That's all the questions I have. Thank you.

DR. BRAMBLE: Okay. All right. Lorenda?

MS. WARD: Did you say me or did you say Jeff?

DR. BRAMBLE: Jeff said he didn't have any questions after our discussion.

MS. WARD: I just want to do one quick follow-up question. I apologize.

BY MS. WARD:

Q. Dr. Bramble asked you about staffing and staffing levels for the program and I think you had said that no one had raised any concern about the amount of the people dedicated to the program?

A. My comment is based on discussions with Paul Donovan about the flight test engineers, because I had my own concerns about the workload with the Flight Test engineering staff. And at the time, he felt that the flight test engineers that he had and the work load that he had distributed was not a big issue.

Q. Did Ken Obenshain at any point in time in the development of the program come to you and say that he needed more people and more experienced people to be dedicated to the program?

A. As I said, Ken is one that would say we would need more people, yes.

Q. Do you recall him telling you that?

A. Yes.

Q. And there was no change?

A. When we go through the process of asking or estimating and coming back with what we can live with as a budget, that's what we manage to -- what I recall from his comments is usually what we get as a budget is not what he thinks is needed to do the program. That's not unheard of. And so we end up staffing to that and determining whether or not we have any issues that we need to go resolve with more staffing, which is one of the reasons I was trying to make sure that Paul was comfortable with his level of staffing. You can always use more FTEs and you can always use more staffing levels. So we try to get what we have been given staffed to those levels and then work the issues.

Q. Who did you go to, to adjust the budget?

A. You have to go to the program manager and if the program manager has the budget to afford it, then he can authorize it. If he doesn't have any additional funds, then it goes above him to our senior VP.

Q. And this might -- would that be Curt?

A. Curt is our program manager. So if -- on flight test, I mean, we're obviously spending a lot more on flight test than we had envisioned. Budgets are sensitive. We look at that all the time. And so if I had to have X additional heads, I'd say to Curt, this is what we need. And then if he has additional reserve that can cover it, it comes to -- and he agrees, and then he can allocate it to us and we can go post and hire X. If he doesn't, we go talk that over with Pres. And in the course of -- I would say even before the accident, I would say Pres was more concerned about a sufficient number of staff for the maintenance people on the floor. We had more work than planned maintaining the test fleet. And so we were hiring maintenance and material people to help handle the test fleet. That was our biggest concern at the time. And at the point of the accident, obviously, the FTE staffing became a big concern, and we're trying to hire additional flight test engineers.

MS. WARD: That's all I have.

DR. BRAMBLE: Tom?

MR. HORNE: Okay. I have a fairly quick one.

BY MR. HORNE:

Q. I just wondered, since you did work for another aviation manufacturer, could you just tell us if there are major differences between the way they did safety planning and execution versus the way we do it here at Gulfstream?

A. From a risk management standpoint, I don't think that Gulfstream would do things markedly different from either Lockheed or Douglas Aircraft. From a test risk standpoint, it focuses on identifying risks, formalizing a safety analysis to establish the mitigation, review that with a board and agree that what you have is acceptable. I know at Lockheed they had a independent safety function, which we didn't have up until recently. That's probably the one big difference that comes to mind. And when I remember going through the process at Douglas in the early '90s, we did that as at the start of a program. Oftentimes what I remember is either before first flight or early in the program, we would collect up everything we felt was hazardous and review it all at one time. And that kind of stood as we went through the program.

Q. Okay.

DR. BRAMBLE: All right. Barring any other -- okay, John?

MR. CALLAGHAN: Quick follow-up. Sorry to --

DR. BRAMBLE: That's all right.

BY MR. CALLAGHAN:

Q. Thank you for your presentation or your discussion and suggestions for -- that was very helpful. I did have one quick follow-up on that. I was very interested in the abort recovery procedures you mentioned.

A. Um-hum.

Q. And I was just wondering if you could just briefly describe how those, if they had been in place, might have affected the outcome of Flight 153? Either before the maneuver was commenced or afterwards. I wasn't quite clear if it was to prevent the maneuver from starting or something within the maneuver as it was proceeding that would activate --

A. Well, the test team, I'll say in a generic sense, if we're trying to go here and we know that there is an aerodynamic limit here, you're going to have some test variation amongst your target so we're going to go around it. But you have to allow yourself for an overshoot of some significant magnitude. There's got to be a point there where you just stop and abort and it needs to be clear. When you look at the test team's preparation, there were discussions about limits and not exceeding certain attitudes, but it wasn't very precise in terms of when during the course of the maneuver if they were at that attitude they would recover.

And so that's the type of precision that we need to be careful of when we talk about establishing abort criteria because once we see that we've hit the parameter, it's time to abort. It's wings level, whatever you have to do to recover the airplane and just simply fly it out and try it again.

Q. So, in terms of Flight 153, would that mean that they wouldn't have pitched above a certain pitch attitude before achieving some top mark -- some altitude or something like that?

A. Well, what I expect to see is when the final analysis is done in terms of this will be our speed schedule, this is the procedure we'll use, and when you use that this will be margin that you'll have. And we always want to maintain a minimum margin. So if we're going to have a minimum margin, then that will translate into some maximum attitude or parameter that we'll closely monitor, and if we get that, then we will recover.

Q. And so the final follow-up on this. It is my impression that there were similar things in place at the time. I mean, there was a pitch target and we've had a lot of discussion about what exactly that means: Is it a target? Is it a limit? If it is a limit, when is it no longer in force? Is it immediately after liftoff? Is it at 35 feet? Is it somewhere in between. And so I'm not exactly clear from your description where the precision -- where the limits say no longer apply, where that enters into the equation. Do you understand my question?

A. Well, I do. We, obviously, have had a lot of discussion about this one. The procedure was written to rotate to a pitch target, but from that pitch target it was -- the objective was to adjust pitch to arrive at a speed at V_2. We didn't have any clarification whether that pitch adjustment should occur before or after liftoff or should be at some point during the phase. The team knew, based on the V_{MU} results and, frankly, the results of 88 and 132, they didn't want to go above 11 or 12°. Well, 11 or 12° is probably fine if they were at 15 feet, but if they're on the ground or at 2 feet, it's probably not. So, that's the precision that has to be put in both the procedure and considerations for when to abort the maneuver.

Q. Okay. Thank you.

DR. BRAMBLE: Okay. I guess we're done. Thanks very much, Barry.

(Whereupon, at 1:42 p.m., the interview was concluded.)

CERTIFICATE

This is to certify that the attached proceeding before the

NATIONAL TRANSPORTATION SAFETY BOARD

IN THE MATTER OF:	AIRPLANE ACCIDENT ROSWELL, NEW MEXICO N652GD Interview of Barry McCarthy
DOCKET NUMBER:	DCA11MA076
PLACE:	Savannah, Georgia
DATE:	October 28, 2011

was held according to the record, and that this is the original, complete, true and accurate transcript which has been compared to the recording accomplished at the hearing.

____
Letha Wheeler
Court Reporter

____
Vanita Tildon
Transcriber

UNITED STATES OF AMERICA

NATIONAL TRANSPORTATION SAFETY BOARD

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Investigation of:                  *
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AIRPLANE ACCIDENT                  *
ROSWELL, NEW MEXICO                * Docket No.:  DCA11MA076
N652GD                             *
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Interview of: BOB MILLS

Gulfstream Corporation
500 Gulfstream Road
Savannah, Georgia

Tuesday,
October 24, 2011

The above-captioned matter convened, pursuant to notice, at 10:40 a.m.

BEFORE: WILLIAM J. BRAMBLE, JR., Ph.D.
Senior Human Performance Investigator

APPEARANCES:

MITCHELL GALLO
Air Safety Investigator
National Transportation Safety Board
31W775 North Avenue
West Chicago, Illinois 60185

WILLIAM J. BRAMBLE, JR., Ph.D.
Senior Human Performance Investigator
Office of Aviation Safety
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

-

ALAN J. (JEFF) BORTON
Flight Test Pilot
FAA Aviation Safety
Aircraft Certification Service
Wichita Aircraft Certification Office
1801 Airport Road - Room 100

THOMAS M. RAMEE, ESQ.
Deputy General Counsel and Risk Manager
Gulfstream Aerospace Corporation
500 Gulfstream Road, M/S B-06

TOM HORNE
Experimental Test Pilot
Gulfstream Aerospace Corporation
P.O. Box 2206, M/S A-12
Savannah, GA 31402-2206

APPEARANCES (Cont.):

JOHN O'CALLAGHAN
Aircraft Performance Group Chairman
Vehicle Performance Division (RE-60)
  Office of Research and Engineering
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

-

MICHAEL BAUER
Aerospace Engineer
Vehicle Recorder Division (RE-40)
  Office of Research and Engineering
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

E. LORENDA WARD
Air Safety Investigator
IIC and U.S. Accredited Representative
Office of Aviation Safety
Major Investigations (AS-10)
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

MARIE MOLER
Mechanical Engineer
Office of Research and Engineering
Vehicle Performance Division
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

I N D E X

I N T E R V I E W

(10:40 a.m.)

DR. BRAMBLE: So we have a fair amount of material to cover and some of these questions you may be able to answer simply and quickly and others may require a little more explanation but if you feel like it's clear cut and you just need to say something brief, that's fine. On the other hand, if you've got some sort of issue or something to say that you'd really like to expound upon, then we'd be happy to hear it.

MR. MILLS: Okay.

INTERVIEW OF BOB MILLS

BY DR. BRAMBLE:

Q. Could we start with your date of hire and your current position and what department or office you work in?

A. My date of hire was September 1997. I'm a staff scientist in applied aerodynamics and technical fellow. I work in flight sciences.

Q. What are your responsibilities?

A. Responsibilities, contour development of aircraft design, wind tunnel testing. I work in flight testing. We support the service center, takeoffs and service issues. We support flight tests when we're asked. We do computational aerodynamics. So we use different analytical methods, back gliding. General external dynamics on the aircraft.

Q. What previous Gulfstream certification, new airplane certification programs have you worked?

A. I worked on the GV. I have worked on the backend of the GIV program. I worked on the GIII program when I worked at Graumand. I have participated in a couple supplemental programs for aircraft.

Q. What is your opinion of Shelly Brimmeier's technical competence as a performance engineer?

A. Shelly started as a clerk at Gulfstream and she was hired back in. She worked a number of years in performance before she was put into the lead position there. I would class her as early level experience. I wouldn't class her as somebody who has gone through detailed performance issues or problems to that extent. I think she understands the methodology that the performance groups use and follows that.

Q. How do you view the aero performance group's responsibilities, Ms. Brimmeier, Mr. Connor's group's responsibilities during field performance testing?

A. Complete. They are responsible for supporting the flight testing of the aircraft. They're providing information where they need to. They should be giving them direction on what type of testing they need to see, what quality the data should be, how they evaluate the data, see if the data is what they want it to be, look at how the aircraft is performing. So they should be overseeing the program. Field performance testing is part of their charter.

Q. Have you observed a difference in the role of your group versus the aero performance group in terms of how your groups interact with flight tests during the flight tests process?

A. As far as their interaction, I can't say. Usually in terms of their testing, we don't usually cross paths. I guess you are asking how do they follow up relative to the way we do it?

Q. Yes.

A. I mean, our general role is that we need to provide a clear definition of what a test needs to be, what information we want, how the aircraft is to be configured, what safety issues need to be involved. We support the preparation of the test plane by providing a requirements document. We attend the briefings. If there's telemetry, we try to have a representative there during all testing, particularly if it's hazardous testing. We support the debriefing. If there's any questions, we support that as well. So, I mean, we tend to be fairly involved with the tests. I'm assuming performance to a similar task. On the Roswell visits, they send a team out. I'm not sure what the day-to-day running of it was but I would expect it to be of a similar level.

Is that what you're asking?

Q. Yeah. The portion of flight testing that you support directly is stall testing?

A. We do stall testing, buffet boundary, lateral stability work, high speed performance work. Usually the way flight sciences is set up, it's built up from several departments. They each have their own little areas of testing. We tend to handle aerodynamic stalls and sort of high ends of the envelope in terms of buffet boundary and those types of things.

I will get called in for things like if there's a vibration on the aircraft, for example, or something abnormal. We may get right in to look at that.

Q. Were you familiar with the range of duties that Reece had been assigned?

A. No. I knew he was the flight test engineer that was handling the field performance work. I had worked with him. He had also had the responsibility for the artificial life shapes testing which was coming up and I'd worked with him on the test plan for that. I had worked with him on field performance test plans and things like that. I wasn't sure, I assumed that as the flight test engineer for field performance he'd be doing the plans, doing the cards, be involved with the overall running of day-to-day running of the tests but I didn't have the exposure to the field performance testing.

Q. It's our understanding that in addition to those responsibilities, he was also the data analyst for large portions of the testing and responsible for writing the reports. Would this give you concern of assigning too many responsibilities to one person or do you think better to have one person take portions sort of from start to finish?

A. I think it's okay to have the responsibility for it. It doesn't necessarily mean you've got to do the work yourself. You can always delegate the work and have people assigned to you help out.

For example, if you are generating a report, you could have somebody develop the data, write the report and you could oversee the report and it doesn't necessarily mean you've got to do the data reduction and write the report yourself. Or you might have the responsibility for the reports, you don't necessarily have to do everything on the report. I would think even during flight test entry, I mean you're going to have to delegate some work to people or otherwise you'd be a little overwhelmed I would think.

Q. Are you familiar with the 1998 Flight Test Practice Manual that Reed Johnson developed while he was working the GV?

A. No.

Q. Did it seem to you that during the GV program test conduct that analysis was divided among more people?

A. Yes, it did.

Q. How did that come to be, why was it different then?

A. I can't answer that question.

Q. Do you know why it was not that way on G650?

A. Again, I can't answer that question. That would be with inside the flight test organization.

Q. Are you aware of the GIV and GV wing drop incidents?

A. Yes, I am.

Q. Do you know how those incidents were analyzed and what lessons were learned from them?

A. The GIV incident occurred I think before I came here. I may be wrong. It was just before I started. They were testing at Roswell. I believe they were doing V_{MU} testing and they over rotated the aircraft. The analysis, I think there was a fairly detailed effort done after the fact where they looked at a wing enhancement program to provide sufficient margin for it. There was quite a bit of work done at the time.

The flight sciences participated in that post-incident work but at the time, flight sciences a collective group. They really hadn't divided in to groups. So I mean, you had aero dynamics involved in that work and I think the guy that ran the group, Bill Murphy, was instrumental in development work as well.

The GV incident I think you're referring to, I think it's flight was Flight 297, that had an FAA pilot on board and one of our pilots and my recollection of the incident was during takeoff, the pilot was holding opposite aileron in a crosswind and when the plane lifted off, the wing started to drop and the copilot pushed forward and did a heavy G landing.

We went back and looked at the analysis and looked at several -- there was a report done on it and there was also a presentation done to do the FAA on it and the general conclusion was that the aircraft had stalled at that point.

Q. Do you know how that conclusion was made based on the actual physics of what was going on with the airplane?

A. They had, I believe they had trace data. There was an onboard data system and I believe they extracted the data from that system.

Q. How many of the key players from GV are still around in the G650 program?

A. That's a hard question. In what area?

Q. Well, in flight test and flight sciences at senior levels.

A. In flight test, I know there's Barry McCarthy, Ken Obenshain, Bill Osborne. I think Pete Hendy was here. Preston King was here. So it was probably about half a dozen maybe at least. In terms of the instrumentation support, there's a lot of those guys that are still around.

In terms of flight sciences, in terms of the performance work, there's Pat Connor, Len McCummin in the performance areas.

In the aerodynamics area, there would be myself. There's another chap that was here at the time. He's moved across the PD called Don Howell. There is Mike Foster who is the head of the aero and S&C group, I believe. There's Dave Roberts who is an S&C type as well. I guess you could probably say there's at least half a dozen. I can get you a list if you need to.

MR. RAMEE: Do you want pilots?

DR. BRAMBLE:

Q. Yeah, pilots.

A. You had John O'Meara, Gary Freeman. I think Tom Horne came towards the end of that as well. There were several pilots. Brian Newton had done some work. Laine (ph.) Altman, John Salamankas, Randy Gaston.

Q. I wanted to get a feel for whether we had the right people in mind who had been around a while and who hasn't. That helps.

A. Actually John O'Meara was on the GV plane, he was flying right seat on it.

Q. What was done to ensure that aerodynamic performance lessons and safety lessons were carried over from the GIV to GV to G650 programs? How did that corporate knowledge sort of get retained?

A. I think that would be, I mean it tended to go through the flight test department as how they conduct the tests. I mean are you talking about field performance?

Q. With field performance and I guess I should have broken that up really because I think what you're saying is in terms of safety in conducting the test. It tends to go through flight tests.

And then on the other hand with respect to lessons learned with aerodynamic performance like understanding stall characteristics.

A. Are you talking free or in ground effect?

Q. Well, I guess both because that was an issue with GIV I guess if I recall correctly.

A. In ground effect. I mean in terms of the stalls, what we normally do or what we've done on the 650 is there was requirements to put in a document which was a flight test requirements document I believe its title was and it could be a form of a report or it could be a form of a memo. And if you wanted to do a test, you would provide the information on the test.

So for example, I did the aerodynamic stalls one in free air and that document basically outlined what test we would want to do, how the aircraft would be configured, what data we would need, what units the data would be in. It would also talk about some of the safety issues which would be involved in terms of whether a stall shoot would be required. It would lead into some of the TSHAs and key features would want to be identified in the TSHAs. It also talked about how the aircraft would perform at certain parts of the envelope, how the stall characteristic would change and it would provide data that would give you an indication of what some early estimate of the speeds would be.

So you're giving the flight test engineer the data that he needs to perform a right of flight test plan and it would also give him an idea of some of the TSHAs. Now, some of that data that was put in the aero stalls report was carried across from GV experiences.

So I would expect that if you are responsible for a test, you would provide some level of documentation which would outline your test. Flight test's responsibility is to perform that test and collect the data and provide you the information.

Q. How much of the strategy for establishing margins between shaker and aero stall carried over from the GV to G650 program?

A. In terms of free air, you got to look at the programs. On the GIV program, the stall margin between aero stall and the reference stall speed was dictated to a large extent by that wing scrape incident in Roswell.

On the GV, the margin was established principally due to our CG testing with I-shapes on the wing and it was a little larger than what we had on GIV simply because at one point we had inadvertent shaker activation as a result of atmospheric turbulence and a filter was applied to the system which filtered that turbulence out. However, what it did do is introduce a lag into the system which required an excessive margin.

GIIs and GIIIs, their margins are typically one degree. 4 and 5 were basically the margin group not necessarily because it was needed because of the aerodynamics of the wing. Part of the problem was, at least on the 5, was the introduction of a filtering system which caused a lag problem.

When it came to G6, the margin was originally at one degree and that was keeping with our earlier aircraft other than GIVs.

Q. How about the in ground effect reduction in the stall angle? Was that sort of lessons learned from programs that sort of contributed to the estimate of 1-1/2 degrees?

A. Well, the estimate of in ground effect was originally on GIV was taken at 2 degrees and to some extent we carried the 2 degrees over into 650.

In addition, we had some low speed wing tunnel test data which indicated that 2 degrees was about normal. 1-1/2 degrees margin was developed by Reece during V_{MU} testing in November from what I understand. And what they had done at the time was the took off, well, they did V_{MU} testing at various attitudes and using that data, he developed an in ground lift curve and from that developed a margin between alpha max free air and alpha max in ground effect, which was around about 1-1/2 to 1.6 degrees.

Q. So before the accident, what was your understanding of the reduction and stall AOA in ground effect compared to the free air in the 650 and how did you come to that understanding?

A. Primarily we thought it was around about 2 degrees and we thought it was that based on our previous experience on an earlier aircraft and some low speed wind tunnel testing.

Q. Was there a discussion of the in ground effect reduction and stall angle during the SRB for the 650 field performance testing?

A. I don't recall. In fact, I don't think I was in the SRB for the field performance testing.

Q. Did you expect that the in ground effect stall angle reduction would be further refined as part of the field performance testing effort?

A. Are you asking whether I thought we could get a value out of field performance testing for it?

Q. I guess what I'm getting at is did you feel the 1.6 was sort of the best estimate that you were going to get or did you expect that that was a preliminary estimate that might evolve somewhere with the field performance testing somehow?

A. I didn't expect we'd get an estimate out of the testing because I didn't think we'd get close enough to stall. We shouldn't be that close to stall that we get a number from it.

Q. So did your group provide the 2 degree estimate initially over the flight test?

A. Yes, we do. The 2 degree number was a general accepted number that was based on previous experience from the GIV program and I think flight test tended to agree with it.

Q. Are there other factors that were known to potentially increase that that one would have to take into account during testing?

A. You mean widen the margin?

Q. Well, I guess in terms of what I'm getting at is side slip. Is that something that was sort of factored in terms of setting margins?

A. Usually, that's taken account of in the margin.

Q. In terms of building in the margin between the shaker and aero stall?

A. Correct. The use of shaker in takeoff is a little new to me. I mean, what I'm used to seeing in field performance is the setting of a pitch attitude that you don't go past.

Q. Is it your understanding that that pitch attitude would remain constant until 35 feet or that it could be adjusted to avoid the V_2 exceedance, it could be increased further to avoid V_2 exceedance?

A. You might go beyond it once you get off the ground but on the ground, it's the critical part, one of the critical factors.

Q. On the ground or in ground effect?

A. Typically the ground effect, you're going to get the angle. The margin is going to reduce fairly quickly as you come off the ground.

In previous programs, we usually sit and angle or pitch attitude and the intent was not to violate that pitch attitude at least on the ground and you might go through it as you climb through 35 feet.

Q. Was it your understanding that if you adhered to that pitch attitude and your rotation speed that you should be at V_2 at 35 feet and the target pitch?

A. I guess the question is what are you defining as V_2. I mean, it's my understanding if you have a set of speeds, the plane will fly a certain way. I mean, in this particular case, for example on the GV program, there were different margins used in terms of the reference speed. So our V_2 speed may be in exceedance of the FAA minimums. So what you would expect is, I guess to answer your question, if you do rotate the aircraft to that certain pitch attitude and hit the rotation speed, you should hit your targeted V_2 speeds.

Q. Prior to the accident what did you know about changes to the predicted stall margins that occurred during the field performance test program as a result of the shift from the K1 to LC speeds?

A. You have to expand on that one. A K1?

MR. RAMEE: I never heard of K1 or LC speeds before.

DR. BRAMBLE:

Q. I guess those were labels that Ms. Brimmeier used to describe the stall or the V-speed stall speed tables. I think that's how she described them. And she said there was an update I think like February, early March to a new set of speeds that came out of aerodynamics.

A. That's correct.

Q. So you guys don't use that nomenclature.

MR. RAMEE: Sounds like labels of the spread sheet.

MR. MILLS: It could be. I don't know. What had happened at the time we did our aerodynamic stall testing sometime in the second half of 2010 and then from that, we set up a series of margins between aerodynamic stall and the reference stall speed and you went did two types of stall speed testing.

The first was to establish that those stall speeds didn't cause the aircraft to roll off, which is basically the performance part of it. And then there was a series of testing that was performed to check the stall characteristics.

And when we went and did that, there were several revisions of those speeds based on changes based on the Alpha limiter schedules.

For example, in the first testing we found that we had problems with our maneuver margins given the stall speeds that we had picked and so there were some adjustments to stall speeds to accommodate maneuver margins so that would require a second revision.

Now the revision that Shelly indicated, there was one that came in, she was right, there was one that came out in January, February of that timeframe. The changes in those speeds, however, were usually within a knot or two.

BY DR. BRAMBLE:

Q. So could this potentially reduce the margin between the shaker setting and the aerodynamic stall or am I mixing apples and oranges?

A. I don't believe so. I think basically you had a margin, you had an aerodynamic stall angle of attack at altitude. You applied an in ground effect correction and then you apply some margin to that would be the way I would interpret how you would work it.

So as the angle of attack aerodynamic stall didn't change, what changed was the angle of attack at the reference stall speed.

Q. As a result of the new speeds?

A. As a result of the new speeds, yeah.

Q. Did that bring the reference stall speed closer to the free air stall angle or the angle at the reference stall speed closer to the free air stall angle?

A. It might have moved the speed around a little bit, but I think it still comes back to when we generally set a reference stall speed, you've got evaluate those speeds that the aircraft will take off of at. If I adjusted the stall speed down while my V_2 speed, I don't know, 113, if the speed came down, the calculations I would expect would show that the reference speed or the V_2 speed may have gone up to accommodate it. It's the ratio.

Now if the regulations call out minimums for your reference speeds like the 113 V_{SR} but it doesn't say that you have to be at 113 V_{SR}.

Q. So the net effect could have been to increase V_2 if you increase the reference speed?

A. Right, that's correct. You've got to be able to -- I mean, the stall speeds, the reference stall speeds, they are basically to show that you select a set of speeds, they can be anything you like really, the reference stall speeds, so long as they are no less than V_{S1G} or the aerodynamic stall speed.

So in our case, we had a margin in free air between aerodynamic stall and the reference stall speed. And we went and did a series of tests which showed that the aircraft didn't roll off, that it had suitable stall characteristics and that was set.

When you came along to do your field performance testing, you generate a set of reference speeds in which the aircraft can liftoff and safely transition to 35 feet. That you've got to establish. Now they may do that at some margin and that margin can be anywhere from anything greater than 113 but it cannot be less than 113 per the regulations.

So, it's acceptable to have an aircraft with a takeoff reference speed of V_2 of 1.2 or 1.3. It's no acceptable to have one that's less than 113.

MR. O'CALLAGHAN: Can I interrupt here for just a minute?

DR. BRAMBLE: Sure.

BY MR. O'CALLAGHAN:

Q. Back to the speed update, I think some of the questions we're getting at, we understand there originally was a one degree margin between in angle of attack off the speed reference, off the SRSA and off the stall and then somewhere along the line, I think somebody characterized it to us as lift was lost somewhere between one test and another. And so in order to maintain the speeds, the margin was reduced to half degrees. Is that sort of the same thing?

A. That's correct. And once the margin was reduced, they went back and they repeated the stall speed testing where they checked the stall speeds in one knot per second entries and returning flight to establish that the aircraft would not roll off at those margins.

Q. Can you describe again, the characterization to us was the lift disappeared, is that what it was or was that related to the maneuver margin that you talked about earlier?

A. I don't think the lift disappeared. There may have been some change in the airspeed calibration or something. A lift is a lift unless we've changed the aircraft at some point while it was sitting in the hangar. The aircraft would still be doing the same thing. So I would suspect that it might have been in the airspeed calibration or the AOA calibration that was provided.

Q. That's not related to the maneuver margin issue I mentioned?

A. Where the maneuver came in is when you take off. I mean, you've got to provide a certain margin between a climb-out, a turning climb-out, that you don't get into shaker or pusher or stall activation.

In our case, we were getting into angle of attack mode. We have an Alpha limiter system which operates inside this separate mode. And when you change across from the normal flight mode to the angle of attack mode, the stick forces tend to increase and the pilots were finding it uncomfortable flying at increased stick force gradients whenever the plane went into AOA mode during the maneuver margin.

So in that particular case, we adjusted some speeds to get us around that problem. In fact, I think Tom was involved during that testing.

MR. O'CALLAGHAN: Thanks.

BY DR. BRAMBLE:

Q. Okay. When was it that the updated speeds were provided so that we have sort of a time point?

A. I think the updated reference stall speeds were provided sometime in January or February, early February timeframe.?

Q. Of 2011?

A. 2011, yeah.

Q. Prior to the accident what did you know about changes made to the PLI and shaker settings for aircraft 6002 during the field performance test program?

A. PLI program, I didn't -- the PLI changes I wasn't aware of that. I know there was some question on the shaker whether or not the shaker was activating or was even active. That was questioned and I think there was a meeting a couple of weeks before the accident where they were talking about it.

Q. Did you attend that meeting?

A. Yes, I did.

Q. What was discussed?

A. Principally, whether they were getting to a point where the aircraft -- whether they were seeing the shaker coming on or not. I think there was some question as to its responsiveness. There was some talk about the 1½ or 1.6 degree angle that Reece had extracted.

Q. Was there talk about nuisance activations?

A. In what I can remember, only insofar as a nuisance activation would negate the particular test run so they were conscious about having nuisance shaker inhibiting or preventing or causing that data point to be rejected.

One of the requirements or one of the FAA requirements is that you can't have shaker activation during your test point.

Q. When did you first hear about the occurrence of nuisance shaker activations?

A. I don't think I heard the occurrence of it. I heard there was a concern about getting it as far as the data. I wasn't aware that they had gotten nuisance shaker activations.

Q. Was the Flight 132 video shown during the meeting that you were talking about which I think occurred on March 24th?

A. I believe it might have been. I don't remember.

Q. And what discussion ensued?

A. The general discussion on 132 was that the pilot rotated the aircraft, he over rotated it. It seemed like the maneuver was dismissed as a bad test point.

Q. Did that factor into a discussion of stall protection system settings or shaker setting that also might have been discussed at the meeting?

A. I don't remember on that one.

Q. Was Flight 88 brought up during that meeting as well?

A. I can't remember. I did hear about Flight 88 sometime before that 132 incident but it was through a third party and that they had a wing drop and it was again an over rotation problem.

Q. Did you ever participate in any discussions about the root causes of Flight 132 or heard anyone trying to determine what the root cause might be beyond the rotation in terms of the physics of what happened?

A. No.

Q. Are you aware that the shaker setting was increased from .85 to .9 normalized Alpha?

A. I was made aware of it. Since that time, I wasn't aware that it had gone up. My recollection on the meeting was there was some question on whether the shaker was even activating.

Q. Did you learn about the increase in the setting after the accident or just after the meeting?

A. I think it was after the accident.

Q. Do you know how it was decided to bump up the shaker activation threshold?

A. Prior to the accident or after the accident?

Q. Prior. Well, you weren't aware that it was increased so since the accident have you come to an understanding of how it was decided to bump up the shaker activation?

A. I think it was based on the 1½ degree increment to the best of my knowledge.

Q. All right. In your opinion, should this kind of change resulted in the reconvening of Safety Review Board since it was a change to a less conservative state?

A. It probably would have been a good idea. At a minimum, it should have had an audience with the people that were involved in the testing.

Q. Do you know who initiated the change or have you learned that?

A. I believe it was Reece initiated it through the flight control system, the flight control all group.

Q. In your opinion, could the team in the telemetry trailer have analyzed data in real time or after the previous run, the run that preceded the accident to determine that the V_2 speed that they were targeting was unattainable and stopped the takeoff testing prior to 7A2?

A. I think if you assume that the nine degrees was the maximum angle that you were supposed to go to, the answer to that would be yes. If you feel that the nine degrees was just an area that you target, probably no. My view in looking at the data since the accident was that within the confines of what the card said, my view of what nine degrees meant, 7A1 was the best you could do.

Q. What do you think lead to the idea that target pitch was more flexible under 35 feet and was that a reasonable decision at the time?

A. I don't know where the requirement or where the thought came from that nine degrees was flexible. To me, we've had discussions since the accident with some of the pilots and my view on a pitch attitude target is it's a limit that you're not supposed to go past.

BY MR. O'CALLAGHAN.

Q. Till lift off?

A. At least until liftoff. I mean, you probably have got to go through it somewhere between liftoff and 35 feet but the problem that you get into is that the margin between stall and ground effect and stall and free air changes very quickly with the first few feet off the ground. By about 10 feet, you've recovered about 50 percent of that margin.

So if you're going to make an excursion above nine degrees, you had better be off the ground by at least several feet.

BY DR. BRAMBLE:

Q. You Say you recover about 50 percent?

A. Depending where in the climate you are but around about 10 to 12 feet, you've got about 50 percent of the margin because I think some of the calculations have shown it since then.

Q. So how would the pilots know how high off the ground the airplane is?

A. That's a good question. I think as far as maneuver -- I guess the question is if the maneuver -- I can't answer that question.

Q. The V_{MU} test results were sort of analyzed in draft form but not really fully disseminated until after the accident. Was that appropriate or should that report have been finalized prior to the second phase of the field testing?

A. I guess it depends on who's looking at the data. I mean, the report is just a culmination of the testing. As far as I'm concerned, if you're out on that test, whether you're the flight test engineer or supporting engineer, you should have been able to reduce that data in some form that you could look at at the time of testing. I mean, reducing V_{MU} data is relatively straightforward. I think the timeframe on the release of the report should be an indicator of the first time you saw the data.

Q. So as long as he's got it available and can look at it, the fact that it's not out in final form is not such a big deal.

A. It's irrelevant. If you're performance engineer, you should be able to pull up that flight and extract the data.

Q. Is it unusual to -- let me rephrase that. Would it be beneficial to take data, such as the November V_{MU} testing, and use that to sort of refine 3 degree of freedom simulation models to help refine performance predictions for the next phase of testing as you go along in a program?

A. Yeah.

Q. Why do you think that wasn't done in this program?

A. Well, I guess the question I'd have is what tool were you using to refine the predictions for it or what was your understanding of the tool. My understanding is that the speeds were set and I'm not sure that there was a tool that was used to verify them other than the aircraft.

Q. And are such tools available?

A. At the moment, we're using tools. Since the accident, there's been a lot of simulator work done on evaluating pilot technique. Within aerodynamics, we've also written a simulation at a desktop level that is used to evaluate speeds. We did that to take a look at the speeds that were developed and to also get an idea of what the speeds would need to be to provide a successful takeoff. And we also did it as a second check of the simulator speeds.

MR. O'CALLAGHAN: Since the accident?

MR. MILLS: Yes.

BY DR. BRAMBLE:

Q. Is that considered sort of above and beyond what normally is done in a flight test program to do all this modeling?

A. Usually in a program, I mean, when you come up with an estimate or something to that effect, in this case, speeds, you usually have a tool to model the physics of the takeoff and it could be a super sophisticated simulation but you can get away with it with something to be a lot less aggressive, something like a 2 or 3 degree of freedom model. And using that model, if you can develop a set of speeds, you should be able to check those speeds out on that model and see whether or not they're achievable.

And then I would think the next progression would be to go from that model to a simulator and see if the pilot can fly. If the pilot can't fly them, then you go back and adjust your model. If the pilot can fly them, then you take them out and test them

Q. But that was not happening in this case prior to the accident?

A. I don't believe so. I can't answer that question. You'd have to ask the performance people.

Q. Why do you think that flight sciences personnel didn't recognize that Flights 88 and 132 were stall events?

A. Flight sciences personnel, flight sciences as a group, is a department containing several groups and usually those groups, they can work together but on particular items, you might have certain responsibilities.

For instance, in this particular case, this is a takeoff program or the takeoff testing was handled under the performance group.

So I think the question really comes to being -- the question should be pointed at the performance group.

In terms of the aerodynamics group, if there are problems on the aircraft, we usually ask to look at them. We weren't asked to look at this.

Q. Then where does the responsibility lie between the flight test and the aero performance people and flight sciences? Who should take the lead? When you have an event like that, if you're going to look at the performance of the airplane from a physics standpoint?

A. It's the aero performance group and the flight sciences. The flight tests are there to perform a test which should be spelled out by the performance group. The performance group are asking for a series of tests to be completed to collect information to support their models. All flight tests are doing are performing those tests. So the responsibility for explaining the physics of the tests or any problems of that relies on the group that asks for the test. Now, that doesn't say that flight test can't turn around and express a concern.

Q. All right. So, just to clarify, you didn't play any role in reducing or analyzing data from Flights 88 or 132?

A. No.

Q. Did you know that those roll-offs occurred at .86 and .87 normalized angle of attack?

A. No. Prior to the accident on 153, I didn't know.

Q. Why do you think Flights 88 and 132 didn't result in a reconvening of the Safety Review Board?

A. I don't know. Actually, I'll step back. I would assume that part of that was that they may have been dismissed as a bad test point. However, in terms of a stall, it should have reconvened the Safety Review Board.

Q. Did you have in-depth discussions with anyone about 88 or 132 before the accident?

A. Not in terms of roll-offs, no.

Q. In terms of anything else?

A. Well, we had that meeting that was discussing whether or not the alpha-limiter was functioning?

Q. That on March 24th?

A. Yes.

MR. HORNE: Point of clarification. You said alpha limiter but you meant shaker?

MR. MILLS: Shaker. Sorry, you're right.

BY DR. BRAMBLE:

Q. Did you feel that the schedule and staffing levels in the aero performance and flight test groups permitted enough time for data analysis and information sharing in preparation for the next envelope expansion point or block of testing during the filed performance flight test program?

A. Are you talking prior to 153?

A. Prior to 153.

Q. I wouldn't know because I wasn't involved in any of that. I would assume that the support crew that was sent out there was deemed reasonable but I wasn't aware of the scope of testing.

DR. BRAMBLE: John?

MR. O'CALLAGHAN: Just some clarifying details about the flights and testimony.

BY MR. O'CALLAGHAN:

Q. You mentioned that the performance group on scene during testing was basically responsible for overseeing how the aircraft is performing. So does that include stability and control issues in your mind?

A. Stability and control issues is probably outside their scope but I mean in terms of the general behavior of the aircraft, they could make an assessment as to whether it was responding normally through levels of acceleration and things like that. Was the aircraft taking off in a reasonable fashion? As far as S and C type based evaluation, probably not

Q. So I'm thinking specifically of 88 and 132. There was a roll off.

A. In terms of Alpha stall, yes. They should be able to look at that and say that there's a problem that we need to look at further.

Q. So along those lines then, we've heard from several folks that those events were classified as over rotations and bad test points. So I’m wondering, is that a sufficient, and it may be rhetorical in hindsight, but without the benefit of hindsight, could one say that classifying the event as an over rotation is a sufficient explanation or analysis for what went on then?

A. It's a question I can't answer. I mean, I guess it depends on how far the person onsite wanted to take it. If they felt that it was truly a pilot over rotation and it was a poor test point, they could dismiss it. But I mean, there's some that may want to dig a bit further.

Q. Was over rotation in your mind, implied stall, or it could be something else?

A. Over rotation of the aircraft in my mind leads to a stall.

Q. And while we're on the subject, to put it kind of bluntly, could anybody have been reasonably expected to recognize Flight 88 and 132 as stall events at the time it occurred?

A. Yes.

Q. Who? What group would that be?

A. Flight test, flight ops and performance.

Q. You mentioned you provided a document for the free air stall results with all the speeds. Is a similar document prepared for in ground effect?

A. I guess the short answer is no.

Q. You talked about how Reece looked at some V_{MU} data and on the basis of that saw 1½ degree angle of attack shift in the lift curves because it's been implied that he concluded that stall

angle attack would be reduced by that same margin?
A. That's correct.
Q. Again, with hindsight the answer is a little bit obvious but at the time, was that an appropriate analysis for V_{MU} data? Is that a reasonable approach to take?
A. No. You would have to have the stall angle of attack and the free air have established the stall angle of attack in ground effect and that would be the true delta. So if your data hadn't gone up to aerodynamic stall as you recognized it, then the Delta would be less than what it should be.
Q. So in the March 24th meeting, I think Reece presented his 1.6 degree conclusion. Did he step into the methodology behind that?
A. No.
Q. And would Flight 88 and 132 have provided the data point?
A. Yes, 88 would have certainly because it was V_{MU} testing and they were developing a C-alpha curve in ground effect from Reece's testing.
132, it was a single engine takeoff point. It may not have been as clean as the 88 flight would have been I guess.
Q. You mentioned that developing the takeoff speeds, one would take your estimate of in ground effect stall and then add a margin to stay away from that. What minimal margin in your mind would be appropriate between what you want to go to and what you

thought the in ground effect stall was?

A. I think probably around about a degree.

Q. One degree?

A. I think in reality, you shouldn't be getting up to those for normal takeoffs. You shouldn't be getting up to those margins anyways.

Q. How close would you get to them in your opinion?

A. In a normal takeoff, you'd probably be a couple of degrees lower. You've got an abused takeoff case which you've got to look at and that's going to be the one that puts you closest to the aerodynamic stall and I think that's like 1½ or 2 degrees that you've got to pull on.

Q. Would that one degree margin, would that include things like pro-tolerance?

A. That's correct.

Q. Or would you add that in?

A. That would be pro-tolerance.

Q. So the one degree would be including everything.

A. Right.

Q. Regarding pilot recognition of when you're in the air, would positive rate, collective gear call out be appropriate?

A. Gear call out, I mean not having sat in the pilot's seat on takeoff on this aircraft, I would assume there would be some level of vibration which would cease when you lifted off. That may not -- I'm only guessing. There have been comments by the pilots after the accident that it is difficult to know the point of liftoff.

Q. I'll go back to some of my earlier ones since we have a little bit of time. Have you done takeoff performance flight testing in your career?

A. Yes.

Q. Can you just describer your approach as a flight test engineer on scene for takeoff performance, how you would prepare and maybe compare and contract with how you perceive it was done this time?

A. Did field performance testing in Australia in the late '70s and we also did it again in Graumand around 1980 on the GIII. In general, we're all using some kind of a desktop calculation. You use that tool to develop your speeds and to show that the aircraft takes off, safely takes off and gets to 35 feet and you usually set up the data, which is your reference speeds from those calculations and that's what you use to perform the tests.

You would go into the testing -- if you had a simulator, you would probably put the pilot on the simulator and let him give you an indication of whether those speeds were achievable. When you went to the testing, you would usually provide some method of stepping down to those speeds. The days we tested, you used to use a ground theodolite method to track distance and that was a little bit more antiquated than what they have today.

And you would be always looking to correlate that field performance against what your predictions were. The beauty of that method is that you can use everything that's flying. You don't have to discard points because the pilot overshot or you think you can come back glean a lot of information out of it and then you adjust your model to match those speeds and your model should be within a certain estimate or certain range of values of what flight tests are showing. And then once you've got that correlation, then you expand that data to generate your field performance for your AFM.

Q. Prior to the accident, was it your assumption that similar things were being done or were you surprised later by finding some of these things you described weren't in place?

A. I was a little surprised by some of the things that weren't in place.

Q. Last question for me is --

DR. BRAMBLE: Can we just elaborate on that?

MR. O'CALLAGHAN. Sure.

BY DR. BRAMBLE:

Q. Which things were you surprised about?

A. I was surprised that there was no desktop calculation to verify speeds. I was surprised that the dynamic part of the maneuver was modeled by average speeds over timeframe and not an integration of a differential equation. I was surprised that they went and tested those speeds at the value that they were calculated at and didn't come down in speed. It seemed like we had a set of speeds and we know the theoretical basis and then we went straight into flight tests with them. In other words, we were using hazardous testing to extract data which is the wrong way to go on any testing. If you go back to the point where you look at performing a test, a department will request a set of testing. They should have some estimates of how the aircraft is going to perform and the flight testing is just a verification of that data. If it doesn't verify the data, then you stop and you adjust your model or you see what is going on with your model.

DR. BRAMBLE: Does that answer your question?

MR. O'CALLAGHAN: Yes, thanks for the follow-up.

BY MR. O'CALLAGHAN:

Q. I asked the same question to Mr. Connor. Obviously, we've been thinking about the accident and I know you guys have for many months now and we're probably going to go back after this and start compiling our analyses and recommendation and so we would just like to ask you if there's anything that we asked here that isn't hitting the target or if you think there's things we should explore further or look at more or if there is any recommendation that you would have for the industry, a less that we can communicate to the industry through this investigation, if you can just open the door for that, anything that you'd like to offer?

A. Not off the top of my head. I think your questions pretty much hit the target. I kind of get the feeling the preparation for the testing should have been a little bit more extensive. I think there needs to be a clear understanding of what limits, when limits are imposed, what they mean. Those types of things I think would help.

There seems to be an emphasis on ground effect and its effect on stall. I guess my answer to that is planes have been taking off and landing for years now and I guess my conclusion would be is if your reference speeds are correct, the plane should transition safely at 35 feet. I think the problems we had show that the plane was laboring and I guess we didn't recognize it at the appropriate time.

MR. O'CALLAGHAN. Thank you. That's all I have.

DR. BRAMBLE: Mitch?

MR. GALLO: I have a couple of questions unless somebody else wants to go first.

DR. BRAMBLE: Jeff? Tom?

MR. HORNE: I had a couple but go ahead.

MR. GALLO: I'll go ahead.

BY MR. GALLO:

Q. What prompted you to attend the CFD conference in Chicago?

A. A CFD conference, it was a NASA sponsored or NASA initiated it and it was set up by the AIAA and it was a collection of people working in high lift and the purpose of the workshop was to evaluate tools that we used in high lift. And by high lift I mean, usually in free air.

And so it was a series of research facilities and companies that had developed CFD codes which would predict CL-max. It was also a collection from industry who had been using some of these codes and it was a general get-together to evaluate those codes on a fixed problem which was a wind tunnel test which was done at the MTF several years earlier.

And during the 650 development in the aero side with CFD, we had been developing our tools continually. One of the problem areas we've had has been CL-max prediction in free air. It tends to be very computationally intensive both in processes and time. So we're always looking for something faster.

And so we sent two of the staff to that workshop to take a look and see what the results were like. And so our main purpose was for future development for free air maximum lift predictions.

Q. What were you using at the time prior to this?

A. Prior to that, we had been using a code which was developed at NASA Langley. The code was principally developed for high speed work, tran-site work. It was an unstructured code. We had one of the guys working stall prediction and at the time, I believe it was around 2006, 2007 timeframe, I mean, to get a full flaps settings out over a couple of Mach numbers took about a year. Our computer capability was very limited. We had about 300-odd processors. And the code was particularly slow.

The code identified at the Chicago workshop used a form of multi-gridding which is basically a way of decomposing the grid that you have to smaller levels so that you get a core solution in a very quick time and then you develop it as you refine the grid. That provided much lower compute times. It didn't require as many reiterations to solve and also at the time we were getting an influx of processors on our machines. So it was getting to a point where we were starting to be able to make these predictions in a relatively production type environment rather than just pure research type area.

So the guys who had come back from the workshop, it was around June, July of 2010, we put in monies into the budget for 2011. When the budget came through, it was approved. We put the order in for it and that was approved and the code was brought in-house around the April timeframe. So when we came to the accident, we were on the ground so one of the first things that we did was to start trying to model in ground effect and CL-maxes.

Q. How are you finding its precision in its use?

A. It's a good code. There is a lot involved in convergence criteria. You've got to be very careful on it. Any of the CFD work, you want to be extremely careful with taking absolute data. I think it's a good tool for looking in terms of Deltas so that if you do free air and in ground effect, the Delta change and Alpha-max would be reasonable but the absolutes you'd want to be a little bit leery of.

Q. Do any of the test pilots ever contact you for tests that you are not directly involved in to get your advice?

A. Yes. I had a call from Tom, or an email from Tom, 2 weeks ago on a problem.

Q. After flight 132, did anybody contact you?

A. No.

MR. GALLO: That's all the questions I have.

BY MS. WARD:

Q. I want to follow up with what Mitch just said because you mentioned that Gulfstream and aerodynamics' role is that if there's a problem with the aircraft and you're asked to look at it you would but in this case you weren't asked. Who would be responsible for doing that?

A. Usually anybody on the test could do it. I've had asked, I mean usually in terms of, I think it's pretty well established that Gulfstream is small enough at least in the general environment that if there's any phenomena in flight tests, questions can go through to those departments, either flights ops or flight tests or during the reporting of the flights. If there's a report of the problem, it's usually picked up in the management level and it's pointed to the appropriate areas. There are several vehicles for doing this.

Q. Just to make sure, you said flight ops or flight tests or if it goes up to a management level, management level can also bring it back down?

A. That's correct. I mean they do daily reports on testing and if there's a phenomena or some problem, it's usually identified or can be identified in those daily reports and those daily reports are distributed to most of the people on the program.

MR. O'CALLAGHAN. Can I follow-up on that?

BY MR. O'CALLAGHAN:

Q. Did anybody that saw the Flight 132 video, the roll off, would they have had an opportunity to raise their hand and say, wait a minute, that doesn't look right?

A. That's correct.

Q. And that video was widely reviewed?

A. I don't think it was widely reviewed. I don't know what the range of the review was. I think the question really was it was more proposed that it was just a bad test point. Those points do occur from time to time and they do repeat points. But I guess the importance of that flight wasn't recognized.

Q. When it happened on the GV, it ended up in the analysis?

A. That's correct.

BY MS. WARD:

Q. They also had a dihedral effect?

A. Not on the GV, no. On GIV it was described. They just scraped the right hand wing on that aircraft. GV, basically the pilot pushed over. As they went down the runway, there was a wind from the left and the pilot holding the right wing down and so the aircraft was imbalanced until it lifted off. It came off on its right gear and the plane just continued to go over because of the dihedral effect from the wing. And the pilot pushed forward on the stick and brought the plane down. I think it exceeded a 2G hit on the ground which required an inspection of the aircraft. But at the same time, the flight test did a report of the incident and documented it. And I believe there was a presentation later made to the Atlanta ACO. We had the FAA pilot on board. He was actually flying the plane.

MR. BAUER: Just a quick question since you're talking about the video from 132, was the video from the cockpit reviewed or was it just the external video that was reviewed?

MR. MILLS: I think it was the cockpit. I think it was the cockpit.

MR. GALLO: I have one question.

BY MR. GALLO:

Q. Has the roll rate effect on an AOA, has that been looked at?

A. No, it hasn't. The premise on roll rate term is that the -- I mean, basically the takeoff of the aircraft, if it's a proper takeoff, we shouldn't be developing roll rates to the levels that we saw in the 153 flight. I mean the reference was to attain 10 degrees per second. You've got a 10-degree angle between your wheel, your outer wheel, and the tip of the wing. So it's within a second that you would develop that roll rate.

If the plane is flying the way it should be flying, even in crosswinds, you shouldn't be developing roll rates to that level. And we can put in all sorts of corrections into some of these angle of attack, alpha limiter or stall barrier systems. And I guess there's two views on it that we encompass always compensation and the other view is we don't. And the view is from the people that say we don't, is that you can over complicate the things so much that you create a problem. So there is still some discussion on what that final algorithm ought to look like in this aircraft.

MR. GALLO: That's all the questions I have.

DR. BRAMBLE: Tom, you had some questions.

BY MR. HORNE:

Q. Yeah, I just wanted to clarify first of all, I'll try to do them in the quickest order, but when you were talking about the in ground effect, you have a free air stall in ground effect stall, I just want to make sure I heard it correctly. You would put a margin on that in ground effect also.

A. Yes.

Q. And would you add to that margin your pro-tolerances?

A. I think it depends on what the pro-tolerance was but I think that if the margin was reasonable enough, I'd keep the pro-tolerance in that margin.

Q. The margin they were using up in free air at one degree at stall margin, .34 degrees pro-tolerance.

A. Right.

Q. And they were added it for out of ground effect. Would you also add that for in ground effect is my question?

A. You can do that if you wanted to. Personally I think the .3 is probably sufficient inside the one degree. Although from a pilot's perspective, you probably won't agree with me. My point on the in ground effect is that you're going to get there for an abused case. For the regular LEI takeoff, you shouldn't be at those levels. So you should be a good 2 degrees below those levels anyways. So for general LEI testing, that should be sufficient.

Q. You mentioned a requirements document to send to flight test. Was there on for field performance from flight sciences to your knowledge?

A. After the accident, I found out that none was written.

Q. My other question is, this is really pretty much for my part, if Reece calculating the effect of in ground effect stall reduction, do you have any insight as to why he wouldn't run that by you?

A. No. In fact, after the accident, I went to one of the flight test engineers to try to extract Reece's notes. They had boxed his records up at that time and it took me a couple of weeks to get them but we recovered the data and he had been looking at wind tunnel test data and he had some free air data as well. I mean, his analysis was -- I saw his analysis but I hadn't seen it before that flight. I was kind of curious why he was looking at wind tunnel data.

MS. WARD: Whose responsibility was it create the requirements document?

MR. MILLS: In terms of those documents, basically the proposal was if you had a test that you were responsible for, you would generate the document. So, if you're looking at field performance testing, it would be the performance group.

DR. BRAMBLE: Any more, Tom?

MR. HORNE: No, that was it.

MR. O'CALLAGHAN: I was going to jump in here real quick.

BY MR. O'CALLAGHAN.

Q. Talking about wind tunnels, this occurred to me. Up to the San Diego test, it's a low Reynolds number and it's a very smooth folding over of the lift curve versus the high roll number testing has shown. So seeing the difference that the high Reynolds number makes, how useful is anything about stall coming out of the low speed? Can it still be used for like a Delta from in ground effect to out of ground effect or would the Reynolds number affect preclude using it for anything like that?

A. I think you'd need to make a Reynolds number. If you made the traditional Reynolds number correction where you just slid the non-linear range out, that could be useful from that respect. It could be useful in terms of developing an in ground effect with curve. I mean, there was some focus on V_{MU}. V_{MU} is a speed that's selected by the candidate. It can be anything you really want it to be. The lowest it can be is at in ground effect stall. But the requirement is that your liftoff speed can't be any lower than 105 times V_{MU} single engine operation. In essence, V_{MU} testing shouldn't be driving anything. So the files are fairly clearly. They give you different margins for different speeds but the key factor in those files is that those speeds can't be below these minimums. It doesn't say that it can't be above them. The implication is that they should be at or above them and it's up to the OEM to determine what speed is necessary for the aircraft to transition safely out of ground effect and past 35 feet.

Q. That being the case, is setting a V_2 target at 1.13 V-stall and defining V_2 as it's going to be this reasonable?

A. The files say you can't be less than 1.13. It's got to be up the manufacturer to determine whether that class of aircraft can takeoff to those speeds. If it can't and it accelerates V_2 at a reasonable pitch attitude and all the rest of it, then your V at speed will be some multiple or some factor than 1.13 but you have to determine that. To start off at 1.13 and assume that that's going to be the speed of the aircraft, you would have to introduce other means of showing that you could get there and you would start maybe at a higher speed and work your way down.

Ideally, you'd start with some analytical tool but if you didn't have that tool and you would probably work your way down until the point at which you couldn't go any further. Now if you got 1.13, then it would be acceptable.

MR. O'CALLAGHAN. Thanks.

DR. BRAMBLE: Anybody else or are we done.

(Whereupon, at 12:11 p.m., the interview was concluded.)

CERTIFICATE

This is to certify that the attached proceeding before the

NATIONAL TRANSPORTATION SAFETY BOARD

IN THE MATTER OF:	PLANE ACCIDENT ROSWELL, NEW MEXICO N652GD Interview of Bob Mills
DOCKET NUMBER:	DCA11MA076
PLACE:	Savannah, Georgia
DATE:	October 24, 2011

was held according to the record, and that this is the original, complete, true and accurate transcript which has been compared to the recording accomplished at the hearing.

Letha Wheeler
Official Reporter

Lourie J. Brown
Transcriber

UNITED STATES OF AMERICA

NATIONAL TRANSPORTATION SAFETY BOARD

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Investigation of:                  *
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AIRPLANE ACCIDENT                  *
ROSWELL, NEW MEXICO                * Docket No.:  DCA11MA076
N652GD                             *
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Interview of: KEN OBENSHAIN

Gulfstream Corporation
500 Gulfstream Road
Savannah, Georgia

Tuesday,
October 25, 2011

The above-captioned matter convened, pursuant to notice, at 2:05 p.m.

BEFORE: WILLIAM J. BRAMBLE, JR., Ph.D.
Senior Human Performance Investigator

APPEARANCES:

MITCHELL GALLO
Air Safety Investigator
National Transportation Safety Board
31W775 North Avenue
--------------------is 60185

WILLIAM J. BRAMBLE, JR., Ph.D.
Senior Human Performance Investigator
Office of Aviation Safety
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

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ALAN J. (JEFF) BORTON
Flight Test Pilot
FAA Aviation Safety
Aircraft Certification Service
Wichita Aircraft Certification Office
----------------------om 100

THOMAS M. RAMEE, ESQ.
Deputy General Counsel and Risk Manager
Gulfstream Aerospace Corporation
500 Gulfstream Road, M/S B-06

TOM HORNE
Experimental Test Pilot
Gulfstream Aerospace Corporation
P.O. Box 2206, M/S A-12
Savannah, GA 31402-2206

APPEARANCES (Cont.)

JOHN O'CALLAGHAN
Aircraft Performance Group Chairman
Vehicle Performance Division (RE-60)
  Office of Research and Engineering
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

-

MICHAEL BAUER
Aerospace Engineer
Vehicle Recorder Division (RE-40)
  Office of Research and Engineering
National Transportation Safety Board
490 L'Enfant Plaza East, SW

E. LORENDA WARD
Air Safety Investigator
IIC and U.S. Accredited Representative
Office of Aviation Safety
Major Investigations (AS-10)
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

MARIE MOLER
Mechanical Engineer
Office of Research and Engineering
Vehicle Performance Division
National Transportation Safety Board
490 L'Enfant Plaza East, SW

I N D E X

I N T E R V I E W

(2:05 p.m.)

DR. BRAMBLE: Let's go on the record.

INTERVIEW OF KENNETH OBENSHAIN

BY DR. BRAMBLE:

Q. Ken, for the record, can you please state your full name?

A. My name is Kenneth Obenshain.

Q. What was your date of hire with Gulfstream?

A. Good question.

Q. Or your year is good enough if it's a long time ago?

A. Hard to say, 1969 if you start with Grumman, which was the parent company of Gulfstream at the time.

Q. What is your current position, title and department?

A. My title is Chief Flight Test Engineer. I am in department 340, which is Flight Test manager.

Q. In that regard what are your roles and responsibilities?

A. My major role is to oversee the flight test engineering group, to try and maintain a safe program, try to modernize and upgrade our methods and systems.

Q. Do you directly supervise anyone?

A. No.

Q. Did you work for any other aerospace employers besides Grumman?

A. Yeah, I left Grumman, Gulfstream in 1990, went to work for D. Howard Company for about a year-and-a-half. And then I went over to Fairchild Aircraft in San Antonio for about a year and a quarter or so before they folded, then came back to Gulfstream.

Q. What, I was going to ask what previous Gulfstream cert programs you have worked on, I assume it is most, if not all?

A. GI modifications, the full GIV flight test program, GII-B flight test program, GII tip tank program, GV program, GIV-X, GV-SP and various modifications to almost all of them.

Q. How did Reece Ollenburg, Bill Osborne, yourself, and Phil Burton relate to one another with respect to the GVI50 flight test program, share responsibility during it and interact?

A. It gets a little confusing. At the start of the GVI program Phil Burton was in charge of the aircraft coordinators and Bill had been moved into his department. Reece remained in flight test engineering. And I guess Dale Coulter was the manager at the time. Bill's major duty was also as chief, was the lead flight test engineer for the GVI program and he was probably responsible for assigning crew members, flight test engineers to particular airplanes.

Q. So you were sort of the lead flight test engineer, Reece was the lead FTE or cog FTE for field test, field performance testing for GVI and then --

A. Actually, I think Paul Donovan was the lead FTE for field performance and Reece was working with him or for him in that area.

Q. What is Bill Osborne's title again?

A. Now, it's --

Q. What was it at the time of the accident?

A. At the time of the accident it was principle engineer. But he was also, as I said, the lead FTE for GVI, the GVI program.

Q. And Phil Burton's title was?

A. You know, I don't really know.

Q. Okay. That's all right.

A. I thought he was manager of the coordinator.

Q. Of those individuals who had the authority to make a decision about how to proceed if flight test was running into an obstacle during the field performance testing?

A. It could have been any one of several individuals. Reece, Paul Donovan, it could have been any of the pilots. Anyone out involved with the flight test program could have made a call one way or the other.

Q. What was that?

A. Could have made a call one way or the other.

Q. During the on scene field performance testing what was your understanding of the roles performed by each person working in the TM trailer, sort of the standard people that would be present in the trailer?

A. Let's see. Of course, you have the operator is one station. There is a flight test individual that was relaying information to the flight crew. And then we had Flight Sciences performance people. My understanding was they were supposed to be reviewing data.

Q. Who was the person in charge of that group during the test in the TM?

A. Well, the only flight test person I know of in there would have been Cynthia Townsend. I don't know if she was in charge per se. Shelly I think was in the TM trailer. I wouldn't swear to it. If she was she would have been in charge of the Flight Sciences. With Reece's experience he was probably more in charge of the program than anybody in the TM trailer.

Q. How was it decided how many data analysts and FTEs were needed on site during the field performance testing program and how the roles of the on-site test conductors data analysts should be divided among available personnel?

A. I really can't answer that question. That was mostly a management decision as to who went and how many.

Q. So in your role you are really considered more of a technical expert and less of a manager?

A. Yes.

Q. What role does Flight Sciences play in encouraging Flight Test to meet program performance targets?

A. Well, let's see. I guess they give us the targets, not so much Flight Sciences -- well, I shouldn't say it that way.

They would like us to achieve the targets but I can't really say that they were forcing the issue. We always try and meet the speed goals.

Q. Mr. Ollenburg's duties included COG FTE for field performance, on board test conductor, data analysts and report writer for the takeoff testing and I guess primarily the takeoff testing, and do you feel -- did these multiple roles for Mr. Ollenburg give you any concern about whether he had too many responsibilities assigned to one person?

A. Reece seemed to be able to handle it fairly well. But normally we would have more than one person doing all of those, or you would have on other programs.

Q. How many people would normally have performed those duties?

A. On other programs we would have had like three people doing the data analysis, one doing the report writing, one doing the onboard flight coordination.

Q. Can you cite a specific program when that was the case?

A. I think the GIV program was that way. Actually they had more than three people doing the analysis, GV that was about the number we had I think, GIV actually about the same.

MS. WARD: Can I?

DR. BRAMBLE: Yeah.

MS. WARD: When you say you have got one onboard test conductor, one report writer and three people doing the analysis, is that a total of five or are there collateral duties there?

MR. OBENSHAIN: That's a total of five from flight test.

BY DR. BRAMBLE:

Q. Why were there so many fewer people assigned to the field performance testing for GVI?

A. Well, it's more perception I guess than anything else. The thought was with the data reduction procedures and a TM set up that we had they didn't need as many people to review the data.

Q. Do you know how that decision was made?

A. No.

Q. Do you know who made the decision?

A. I can't say for sure. It would have been Thorn and McCarthy and I think Phil Burton was involved in that one.

Q. When were those staffing decisions made in the program for field performance?

A. Let's see, what year was that? Late 2009, mid 2009. No, 2010, I'm sorry.

MR. HORNE: Can I clarify that?

DR. BRAMBLE: Okay.

MR. HORNE: So late 2010 would have been in planning for the field performance --

MR. OBENSHAIN: Testing.

MR. HORNE: -- that's when the decisions?

MR. OBENSHAIN: I think.

BY DR. BRAMBLE:

Q. So returning back to the original question I asked in this area, you said Reece seemed to be able to handle it fairly well, but were you at all concerned about it before the accident or no?

A. No, I wasn't.

Q. How did Gulfstream's flight test organizational structure policies and procedures conform to the 1998 Flight Test practice manual?

A. I think our procedures had developed from there. They had gotten somewhat better. The practice was set up, or guidelines we followed I think for every program after that.

Q. Do you recall if the Flight Test inner practice manual specified that there would be separate people designated as test conductors and test analysts?

A. If I remember correctly the flight test, the manual didn't go into that kind of detail.

Q. I can pull it out, but basically it specified, it did list a number of positions including test manager, test coordinator, test conductor, test analyst, but it also said that depending on resources those positions might me mined or divided up among more people. So does that sound familiar?

A. Yeah.

Q. So I guess based on that definition any designation would conform to the manual because it says here are some positions and you can follow it or not follow it.

A. Yeah.

Q. So with respect to skill performance testing the position of test conductor was Reece, right?
A. Uh-huh.
Q. And the test analyst I think we already established but just to be clear the duties of test analyst was Reece?
A. That was, I guess you could say it was a combined effort. Reece and Cynthia Townsend were doing the data analysis.
Q. Are you aware of anything specific that Ms. Townsend analyzed to support Reece?
A. Specifically, no. I mean she was doing the data analysis to provide support, the numbers that Flight Sciences required.
Q. The manual also describes a test specialist position. Do you know who that would correspond to in performance testing for GVI?
A. I don't know if we had specified one, but essentially Paul Donovan was the lead for field performance.
Q. How familiar were, in your understanding how familiar were the members of the field performance flight testing team with the standard practice manual?
A. The team Paul Donovan was probably the only one that had really been through it in any detail.
Q. The configuration control engineer who was that; who would that correspond to?
A. Configuration control has got a shared position I think.

I mean when it comes to physical changes to the airplane it's the maintenance group and the test coordinators control the ballast changes and fueling of the airplane that sort of thing.

When it comes to software and some of the components, it's generally an engineering issue.

Q. By engineering you mean which group?

A. Well, it varies. Software is, what is software; electrical systems.

Q. Are you aware of who authored the '98 manual?

A. I believe it was Lee Johnson, or Eric, it might have been Dennis Coulter.

Q. Sort of who maintained that manual after Lee Johnson left?

A. I think it was several attempts to revise it and I know Barry McCarthy was involved in part in doing the revision.

Q. Do you remember when that was?

A. No. I don't.

Q. Were you aware of the wing drop incidents that occurred on the GIV and GV?

A. Yes.

Q. How were the GIV and GV wing drop incidents reported and analyzed and what lessons were learned from these events?

A. On the GIV I can't say there was any written documentation of the incident or accident actually. It was reported back to management and we were on a week stand-down. I guess that's when we first, I believe Flight Test first heard about a decrease in stall alpha in-ground effect.

The GV was a similar, actually there were two reports written against the GV. That was kind of a similar exercise where management was aware of the incident.

Q. What was done to carry those lessons forward, any lessons learned from those incidents forward into GVI?

A. There was a bit of a difference between the four and the five. The five testing was being accomplished on a day they shouldn't been flying, the winds were too high, crosswinds were too high to do a test.

The GIV there was a technique change involved which was to carry through every subsequent program.

Q. What was that change?

A. The GIV we started the V_{MU} testing with stick full out until the airplane lifts off, which means holding a pitch, a large pitch command after the airplane starts flying, which is what caused the stall on the four. When we were standing down we discovered that the Flight Test guide had changed and allowed the airplane to be flown such that stick was full out until the lift off attitude was achieved. At that point you could hold the pitch attitude that you wanted. So we went back and found the angle the airplane was lifting off at and that was our target attitude for GIV. So every subsequent program that was the technique we used, we went to pitch attitude, pitched to that attitude and stopped the rest of the pitch prior to the airplane lifting off.

Q. How did you establish that target pitch in subsequent programs?

A. Initially it was an estimate. Well, it began with free air stall alpha reduced by about 2 degrees and then a margin applied to that.

Q. What was applied?

A. A margin of 1 degree applied to that.

Q. Was that for GV?

A. Uh-huh, GV and GIV-X also. And then we were doing the same thing for GVI initially, the V_{MU} test.

MR. HORNE: Can I clarify that?

DR. BRAMBLE: Okay.

MR. HORNE: When you said stall alpha list 2 degrees, that was out of ground effect stall alpha?

MR. OBENSHAIN: Uh-huh, yeah with a 1 degree margin blow that rating.

BY DR. BRAMBLE:

Q. You describe it as free air stall alpha reduced by 2 degrees?

A. Yeah.

Q. How many of the key players from GIV and GV are still around for GVI50 program?

A. In Flight Test or --

Q. Flight Test or Flight Sciences I guess.

A. Me from GIV, two others that I know of from Flight Sciences for GV. And I guess some of the pilots from GV are still here.

Q. Are you familiar with the data analysis plan for GVI?

A. Uh-huh.

Q. Do you know who wrote about the GIV events in section 81, which talks about --

DR. BRAMBLE: Does it talk about V speed development or --

MR. O'CALLAGHAN: It mentions the GIV -- says that's the reason for being mindful of high pitch attitude something to that effect, I can't recall.

MR. OBENSHAIN: I don't remember who wrote that section but it would have been with my input regarding the GIV.

BY DR. BRAMBLE:

Q. What happened with the flight test organization staffing levels between GIV and GV when Alan Paulson was CEO during the late 1990s?

A. That's the reason I left in 1990. Mr. Paulson decided he didn't need Flight Test anymore. It was down to one individual at one point. Then three months later I think it changed again.

Q. So this was in 1990, then it was built back up for GV?

A. Uh-huh. A lot of contracts went with the GV.

Q. Do you feel like that had implications for the carryover of lessons learned in the engineering culture?

A. Yes.
Q. Can you give any examples?
A. Almost all the people were new. There were two or three individuals, myself, Bill Osborne, I remember who else now, who had been around for the GIV --
Q. This is during GV you are talking about or GVI?
A. GV. Not significantly different for GVI actually.
Q. So on GVI did you feel like the right people plugged in to provide expertise during the flight test program?
A. I guess we had the right people but not enough.
Q. How about specifically with respect to field performance testing?
A. Yes, field performance specifically, we needed, should have had a few more people involved in that program.
Q. Was it just more people or did you need more old hands, so-to-speak?
A. We needed people with experience in field performance.
Q. At the time of the accident what key polices did Gulfstream have in place to manage the safety of the flight test program?
A. I guess the major one is the Safety Review Board prior to initiating the field performance program.
MS. WARD: Could you restate that? I'm having a hard time hearing you.
MR. OBENSHAIN: I'm sorry. It was the Safety Review

Board prior to initiating the program.

MR. RAMEE: Can we go off the record for a moment because I think this is kind of critical?

DR. BRAMBLE: Off the record.

(Off the record at 2:36 p.m.)

(On the record.)

BY DR. BRAMBLE:

Q. Going back to the question that we discussed earlier about whether you felt there were enough people on the GVI program and with enough experience, did you feel that way prior to the accident or only after the accident?

A. That was prior to the accident.

Q. Did you bring that to anyone's attention?

A. When we were in the planning stages of the program, yes.

Q. Who did you tell?

A. Specifically Barry McCarthy.

Q. What did he say, what was his response to your suggestion -- Was this a suggestion or an observation that you made?

A. It was an observation with the intent that it would be taken as a comment on the program not being properly manned.

Q. What was his reaction?

A. I honestly don't remember.

MR. RAMEE: Ken, let me just clarify as the company lawyer. The NTSB wants you to answer the question as fairly as you can and the company does too.

MR. OBENSHAIN: I'm trying to remember. It was something along the lines of, well, that's what we have to support the program and that was all we would send.

BY DR. BRAMBLE:

Q. What was the second part of that sentence?

A. That was all we were going to send.

Q. That's all we have and that's all we are going to send?

A. Yeah.

Q. And are you not sure that's what he said because you can't remember or is that really --

A. I wouldn't swear to those being his exact words, no.

Q. How confident are you that that fairly represents the gist of what he was saying?

A. I'm fairly confident.

Q. Did anyone else suggest that staffing should be increased?

A. That I don't know.

MS. WARD: Bill, if you are thinking, I would like to just add on because I know that you will be going back to field test performance testing here shortly.

Do you know if the staffing levels have been changed?

MR. OBENSHAIN: No, they have not.

MS. WARD: Thank you.

DR. BRAMBLE: That was since the accident?

MR. HORNE: Can I clarify that?

MS. WARD: Sure.

MR. HORNE: Are you talking specifically about the staffing going back to field performance to finish the field performance testing the next cert?

MS. WARD: Yes.

MR. HORNE: In other words, has the numbers of people going back to Roswell to finish the field performance increased or are they the same as they were for Roswell-2?

MR. HORNE: To the best of my knowledge, the same number of people just different personalities, different people going from Flight Sciences.

MR. HORNE: Okay.

BY DR. BRAMBLE:

Q. And also to clarify that hasn't happened yet, right?

A. Correct.

Q. When is it scheduled to happen?

A. First week in December.

Q. Has anyone raised any concerns about the size of the team since the accident?

A. I don't believe so. We are scheduled to have another SRB here shortly I think.

Q. Do you plan to raise a concern at the SRB?

A. Yes.

Q. Are you familiar with the safety management system approaches to managing safety in the organization? Is that something you have been trained on at all?

A. We haven't had any training on it. I'm somewhat aware of it.

Q. To your knowledge, did Gulfstream have a written safety policy statement in its official guidance to flight test?

A. I believe there's a corporate safety policy, specifically addressed to flight test not that I know of.

Q. Do you know where that is?

A. That's in corporate policy files somewhere.

Q. Was there an executive or high ranking individual at Gulfstream who was sort of designated as the person, the point person who is accountable for managing safety in the flight test?

A. No.

Q. Understanding that there was no single person designated were there multiple people at high level who were closely involved with the safety, managing safety in flight test?

A. Only, not on a day-to-day basis that I can recall, SRBs, high risk testing, yes.

Q. During the SRB meetings?

A. During the SRB meetings.

Q. The rest of the time no one that you can think of?

A. No.

Q. What policies and procedures did the Company have in place for reporting and investigating perceived hazards or safety-related incidents that occurred during flight testing?

A. I don't believe we had a procedure.

Q. So sort of an informal response?

A. Yes. Well, it's informal in that there was nothing written but any incident was always relayed up through management.

Q. What sort of determined the level of scrutiny that an incident or safety concern relayed up through management would get?

A. If it was dealing with safety of flight issue it went all the way up fairly quickly. If it was in the normal course of testing might have only gotten through engineering.

Q. By engineering you mean flight test engineer, just flight test engineer?

A. Well, no, it depends on the area. Any issues with equipment, software components it would be relayed back to the appropriate engineering discipline, or to the appropriate engineering.

Q. Would it surprise you to know that Shelly Brimmeier did not know when an SRB should become involved as a result of a safety-related event or what the procedure should be for reporting and investigating a safety-related event?

A. I'm not quite sure I understand that question. But doesn't it really surprise me.

MR. RAMEE: Why don't you finish your answer by explaining why you weren't quite sure what he means by that question?

BY DR. BRAMBLE:

Q. I could rephrase it and here is how I would rephrase it. Why in your opinion did she not know when an SRB should become involved as a result of a safety-related event or a procedure should be followed for recording and investigating safety-related events?

A. I guess from an incident standpoint it's usually initiated by Flight Test. If there is an incident -- or Flight Operations -- that occurs, happens where it is very unusual and deemed as a safety-related item it comes from the test side of the organization not from the engineering side of the organization.

Q. Do you know why over rotation was not listed as a potential hazard on the TSHA that applied to OEI CTO testing?

A. Basically, it's our experience with previous Gulfstream models, those airplanes are difficult, if not impossible to over rotate at 4 CG.

Q. So when developing the TSHA the hazards were based, at least this hazard was not considered a high priority because it hadn't been on previous programs?

A. Correct.

Q. You participated in developing the TSHA that applied to, TSHAs that applied to OEI CTO?

A. Yes.

Q. And I believe it was listed for V_{MU} testing?

A. It is.

Q. Why was that?

A. Well, GIV or GV experience says we could over rotate on V_{MU}. Both airplanes even though they were control power limited were ballast at aft to the forward limits so that we could achieve the attitudes we needed. And if the airplane is ballast at aft it is easy to over rotate.

Q. Before the accident what was your understanding of the reduction in stall AOA and ground effect compared to free air and how did you come to that understanding?

A. We initially went out with the assumption that it was reduced by 2 degrees as we were lead to believe on previous Gulfstream models.

Q. So it was based on the reduction you observed in previous models?

A. Yes.

Q. Was there a discussion of this during the SRB?

A. I believe so, yes, reducing the margins 2 degrees.

Q. Did you expect that that decrement or decrease in max AOA and stall AOA and ground effect would be further refined as part of the field performance testing effort?

A. No. We didn't really expect it to get, to run into that issue.

Q. What information was provided to flight test, in particular Mr. Ollenburg about the IGE stall reduction and who do you think provided the information to him?

A. Again, it was part of the SRB, but he and I also had that discussion about reducing the in-ground effect stall by 2 degrees from free air stall.

Q. When did you guys talk about it?

A. Probably again late 2010 before the first field performance exercise that we did.

Q. To your knowledge, did Mr. Ollenburg do any additional analyses to refine that?

A. I think he did, based on some of the test data he had from some the V_{MU} testing where they had the pitch up and roll off. I think he ended up doing some analysis on those data.

Q. Can you elaborate on what type of analysis he might have done on those events?

A. I think he was trying to get from a liftoff conditions what stalling or attack might have been. I know he was working with the V_{MU} data and came up with some reduction in max angle of attack. I don't remember exactly how he did it.

Q. How did you find out about this?

A. It was subsequent to the accident. Somebody showed me a piece of paper that had some calculations on it and I can't remember exactly what the number was. It seemed like it was a degree-and-a-half, but --

Q. Do you think that might have been from his draft report of the V_{MU} test?

A. It might have been.

Q. Was Bob Mills involved in trying to estimate the IGE stall angle?

A. Not prior to the accident that I know of.

Q. Would there have been any reason to bring him in prior or would that have been unusual during performance testing?

A. No, there was no reason to at the time.

Q. Prior to the accident, what do you know about changes made to the shaker settings, specifically the threshold for activation for aircraft 6002 during the field performance test program?

A. Well, the initial program was done with the stick shaker set at a .85 normalized angle of attack or 25 ratio of free air stall. During the first trip to Roswell it trigger shaker on a few of the runs and I believe at the time it wasn't active on liftoff. It was only active after the airplane achieved 10 feet above the ground. As a result of the stick shaker occurrences though since that's a fail for the tests we were doing the shaker from raised from .85 to .90.

Q. Was there any discussion of -- before I go into that. Can you tell me how that decision was made and who was involved?

A. Well, it was mostly, I shouldn't say mostly. It was a discussion between Reece and myself and we had done a similar move on previous Gulfstreams to prevent shake occurrences during takeoff rotation.

Q. Anybody else or just the two of you?

A. Just the two of us. There was one other adjustment to the shaker. I recall it was reduced they the angle of attack tolerances that we were required to use. So it was a .9 minus a couple of hundredths, a few hundredths of the ratio.

Q. Where do those few hundredths come from?

A. The angle of attack measurement on the airplane has a tolerance and it's a fairly large tolerance BSS pressure measurements function of angle of attack and air speed and we took the worst case tolerance we could come up with and applied that in a negative direction so that it would trigger early. Again, the trigger shaker during any of the maneuvers we have to do is a fail for that maneuver.

Q. Is this probe tolerance error that you are talking about?

A. Yes.

Q. Was it somewhere in a .3 --

A. .34, I think was what Reece was using.

Q. So to your understanding then, what was the relationship between free air or air stall and the shaker activation setting at the time of the accident, like what's subtracted from free air stalls? I want to know sort of what's --

A. Gee, at the time of the accident we had free air stall minus half a degree for alpha limit. And the shaker would have been 90 percent of that value, minus the .34.

Q. Minus an additional --
A. The additional .34 for shaker.
Q. This is something that Nathaniel Rutland provided to us to explain how the shaker was set up, if you could just read the title of that document.
A. Shaker Setting Evaluation.
Q. This was the same document identified earlier by him as something he produced and provided to us.
DR. BRAMBLE: John, can you maybe help here and just sort of walk through what this says the shaker setting is.
MR. O'CALLAGHAN: Okay. I was trying to remind myself.
BY MR. O'CALLAGHAN:
Q. So the red line is the actual aerodynamic stall angle of attack at the Mach number of the Flight 153 event. I believe it was 14.6 degrees free air.
A. Uh-huh, okay.
Q. Then the pink dash just under that is the half degree margin to the flying angle of attack stall reference off of that.
A. Yes.
Q. I believe the next line down is the .34 pro tolerance. So in free air, now this is where I get a little bit confused, whether that's the number that is multiplied by .9 to give you the -- I think it is perhaps. Well, no, you take the SR plus .5 multiply it by .9 and then subtract that .34 I think. Maybe you can explain.

A. Yes. I'm trying to remember how this system operates. Normalized AOA would be 90 percent of the free air stall angle of attack, well, it's the stall angle of attack reduced by half a degree. Now, you need to be a little careful because it's not that value. It's that value plus the angle of attack at zero lift and that happens to be a negative number. So it's 90 percent of that range from alpha zero lift to the alpha minus half a degree, stall alpha minus half a degree. Then we subtract the .34 from that value for shaker onset.

Q. So is the shaker onset -- showed on this plot then?

DR. BRAMBLE: I guess the question for us then is does this conform to your expectation of how it was to be set up?

MR. OBENSHAIN: Yeah, if you look at the chart again, the orange line is the expected angle of attack, stall angle of attack in-ground effect. The first blue line below that was where the shaker was set for Roswell, the second Roswell trip.

BY MR. O'CALLAGHAN:

Q. Does that include the .34?

A. Yes.

Q. That's what I was trying to remember. Okay.

A. I keep remembering the way the system operates. The way we have to do this, we took the .34 off the alpha limit schedule. So it would have been .34 off of the red dash line and then the shaker fires at 90 percent of that.

Q. So it's the blue dash dot, the light blue dash dot, third line from the top?

A. Right. And the first solid blue line below the 90 percent line should be 90 percent of that value.

Q. Accounting for the negative zero lift angle of attack?

A. Right.

DR. BRAMBLE: So given that, here's what I'm trying to determine. Did the shaker end up being set up as you guys discussed or was there any kind of miscommunication along the way?

MR. OBENSHAIN: No. It's set up the way we had discussed it.

DR. BRAMBLE: Do you need more time, John, or should I proceed?

MR. O'CALLAGHAN: I have some questions in this area I can ask him now or at the end or when you are done. Why don't you proceed so I don't derail the whole thing?

DR. BRAMBLE: Okay.

MR. HORNE: Bill can you state your last question that u asked, I missed it?

DR. BRAMBLE: Let's go off the record.

(Off the record at 3:03 p.m.)

(On the record.)

DR. BRAMBLE: Let's go back on the record.

BY DR. BRAMBLE:

Q. So did you attend a March 24 meeting about stall protection settings?

This would have been like a week-and-a-half before the accident, it was on Reece's calendar as a meeting about stall protection settings and I think you and several other people were invited. I don't know who actually came.

A. I don't recall the meeting. If it was prior to this trip I probably went.

Q. It was prior to?

A. Prior to the departure for Roswell.

Q. To Reece's?

A. Yes.

Q. So in that case I assume you don't recall what was discussed since you can't recall if you were there.

A. Not in detail. But that was probably where we discussed the shaker margin and the, or reset of the shaker plus the angle of attack error tolerances.

Q. How was that change submitted to actually make a change to the airplane?

A. It's all done by the FTE on board actually through the made function. It's not a firm change. Every time you power up you have to re-initial --.

Q. You may not remember this but, or maybe this will jog your memory of the meeting, but we understand that the video of Flight 132 was shown at this March 24 meeting. Do you recall seeing that?

A. Yes.

Q. Do you recall what discussion ensued?

A. Yeah, 132 was another kind of oddball in that we were testing with the yaw damper inoperative. And the discussion that went on there about that particular maneuver was it was a -- well, a roll caused by yaw excursion with the yaw damper inoperative.

Q. Do you know how that was determined?

A. No. I don't recall looking at the data for that particular maneuver.

BY MR. O'CALLAGHAN:

Q. Were plots of motor trace or slide slip presented during the meeting to support that conclusion?

A. Not during that meeting, no.

Q. Any other time that you are aware?

A. I think some time later we looked at that in more detail after the accident.

Q. Slide slip specifically.

A. Yes.

Q. What was the result of the discussion after the accident?

A. I think we came to the same conclusion.

Q. That 132 was not a stall event but a lateral direction roll --

A. Not a stall event. Yes.

Q. Can you elaborate on that?

A. Again, it was at takeoff with a crosswind component and as the airplane lifted off and pitched up the yaw began to be carried almost immediately. The rudder command went in somewhat late, but without the yaw damper it was a continuing yaw.

Q. It's your understanding that's the consensus now among aerodynamics, applied aerodynamics and flight test and everybody that 132 is not a stall event but a lateral direction roll?

A. I haven't any further discussion with anybody about 132 so I couldn't say.

Q. But even post-accident you still believe that 132 is not stall but a lateral direction roll?

A. I'd have to go back and look at the data. I don't believe the angle of attack got up high enough to call it, at the altitude the airplane was at to be a stall, to be in excess of the stall angle of attack.

Q. Has Bob Mills shared his CFD results with you since the accident?

A. Just in a group setting.

Q. Do you recall what the conclusions of those things were?

A. I don't recall on 132 flight.

MR. O'CALLAGHAN: Okay. Thanks.

BY DR. BRAMBLE:

Q. Were you aware or have you been made aware since the accident that flights 88 and 132 stalled at .86 and .87 normalized angle of attack?

A. No.

Q. When did you first hear about the brief shaker activations that were occurring during field performance test program?

A. About a week or so before the airplane left for Roswell the second time that's when we discussed this here, moving the shaker.

Q. How did you learn about this?

A. From Reece.

Q. Were they regarded as nuisance activations?

A. Yes. They were up and away during climb out well past, well out of ground effect.

Q. So how was it decided that they were sort of extraneous and not meaningful?

A. Well, again, the airplane was at a fair height above ground more so than, I think it was 50 to 75 feet and the angle of attack wasn't approaching the free air stall.

Q. How much margin would there have been when it was activating?

A. I guess actually at that point it was at the .85 setting. So it would have been several degrees, a couple of degrees, I believe it was.

Q. Why didn't the change in the stick shaker settings from .85 to .9 result in the reconvening of the SRB when it was a change to a less conservative state?

A. Part of the initial SRB determined that the stall barrier stick shaker, alpha limiter and stick shaker were not required for field performance.

Q. So that meant that any change to that system would not require an SRB review?

A. Correct.

Q. Which personnel requested -- all right cancel that.

Who did you communicate with on this topic besides Reece about the changes in the stick shaker setting, anyone?

A. Prior to the air plane departing Roswell, no.

Q. How about after that but prior to the accident, anybody?

A. No. I take it back, probably Paul Donovan because we were talking about the field performance program.

(Requested portion stricken from the record.)

DR. BRAMBLE: So let's start with a new question which is, go ahead.

MR. O'CALLAGHAN: All right. So let's just back up a little bit.

BY MR. O'CALLAGHAN:

Q. At the beginning of the interview here you described that traditionally in past programs the reduction in stall angle of attack due to ground effect was on the order of 2 degrees and I take it that's sort of consistent from program to program?

A. It was I guess a number we just carried through from the GIV program, yes.

Q. On top of that there was 1 degree margin applied, so now we are talking about 3 degrees?

A. Yes.

Q. My interpretation of what you said was that that 3 degree margin is about the max pitch angle you would target for V_{MU} testing?

A. Correct.

Q. So for that kind of a set up where is the stick shaker relative to that, to that 3 degrees, is it above or below it?

A. It's above it. I'm sorry. It's below that value. It's above that value but below the in-ground effect stall on a small margin. It's even for V_{MU} we cannot trigger stick shaker and do the test for certification.

Q. So stick shaker would be set at a higher angle of attack than the 3 degrees?

A. Higher than target attitude, but lower than the small alpha. Maybe.

Q. So it would be set between 2 and 3 degrees below the free air stall?

A. Yes.

DR. BRAMBLE: We can take a break?

(Off the record at 3:32 p.m.)

(On the record.)

DR. BRAMBLE: Let's go back on the record.

BY DR. BRAMBLE:

Q. Let's begin by asking were Flight Sciences and Flight

Tests supposed to collaborate to accomplish analysis of company field performance testing?

A. On previous programs it was Flight Test's responsibility to do the analysis of the test data and pass that to Flight Sciences for expansion into the AFM performance.

Q. On this program?

A. That was the intent going out. I think things changed when they were out there with the amount of people, number of people up there. I would assume that Flight Sciences -- in doing part of the analysis or at least the data review.

Q. So in the past there have been more analysts on the flight test side and because there weren't you think maybe Flight Sciences was sort of expected to do some of it?

A. Yes.

MR. HORNE: While you are on that?

DR. BRAMBLE: Your Honor

MR. HORNE: Can we delve a little deeper into what exactly they mean by analysis?

DR. BRAMBLE: Sure.

MR. RAMEE: There is a similarity in the four definitions here.

DR. BRAMBLE: All right. Hang on one second. Off the record.

(Off the record at 3:37 p.m.)

DR. BRAMBLE: Back on the record.

BY DR. BRAMBLE:

Q. So I believe there are a number of different aspects to analysis and these have been described variously as data reduction and analysis, review and expansion. Can you elaborate on what you think the roles were for the Flight Sciences and the Flight Test people on scene in Roswell during the Roswell-2 --

MS. MOLER: Could you define each one, first?

BY DR. BRAMBLE:

Q. Sure. Let's define them and then explain how we think each group was participating.

A. The data reduction takes the Flight Test data and reduces it, corrects it for instrumentation errors, anomalies, into a useable form.

The analysis takes that data and puts it in a form that the Flight Sciences can use for flight manual expansion purposes. Part of that analysis usually entails comparing a flight manual, what would be the flight manual performance with the actual measured performance to show that the airplane meets or exceeds the AFM performance. That part the flight manual part we get from Flight Sciences using the data that we pass over to them.

During the course of testing I would have expected someone to be reviewing maneuvers to see if we are meeting the targets and whether the airplane was performing as it was expected to perform. I think Flight Sciences was looking at the end point and passing that through Cynthia to the airplane. I don't think anybody was looking at what the airplane was trying to tell them during maneuvers. And I think that's a shortcoming on everybody's part.

Q. Why do you think Reece wasn't paying adequate attention to what the airplane was trying to tell him?

A. I think he had too much to do on the airplane, between marking the maneuvers, coordinating with the flight crew, coordinating with the ground crew and the TM trailer.

Q. All right, and along those lines did you participate in meetings amongst group heads or managers to discuss how the flight test data from Roswell were comparing to performance targets?

A. No.

Q. Do you know how often such meetings were held and who attended?

A. There were a number of meetings I think after Roswell-1 to discuss the performance of the airplane.

Q. Do you know if there were concerns expressed in those meetings about difficulty meeting performance targets?

A. There were concerns expressed --

Q. What were they?

A. That we weren't meeting the guarantee condition.

Q. The takeoff guarantee.

A. Takeoff guarantee.

Q. Who was involved in those discussions?

A. (Non-verbal response.)

Q. Is that a very large list?
A. It's a fairly large list, yeah.
Q. You don't have to list everyone.
MR. RAMEE: I would like to hear some.
BY DR. BRAMBLE:
Q. All right. Let's here the high ranked, well, let's hear whoever you can recall who was participating in those discussions.
A. Pres Henne, Brian Durance (phonetic), Tom Lavrisa, I think Barry McCarthy was probably there. Actually I was in some of these meetings. I don't remember if anybody from Flight Ops was there. Jake Howard might have been there, Shelly Brimmeier, Pat Connor and another dozen people besides -- that I can't recall.
Q. When did these meetings take place?
A. They would have been late 2010, just prior to the airplane, sometime prior to the airplane departing for Roswell-2, the second time after we had done some -- after Birmingham, Alabama and that was -- when was that March?
Q. Why didn't you attend these meetings?
A. Well, I correct myself. I did attend some of those.
Q. So what opinions were expressed about how this problem should be overcome?
A. Basically, it was we need to try harder.
Q. Who were sort of the dominant voices in making decisions about how to proceed?

A. That would have been Pres.

Q. Do you remember anything specific that he said?

A. No. I think the suggestions from Flight Sciences and try to modify the technique.

MR. O'CALLAGHAN: Shelly's group?

MR. OBENSHAIN: Yes. It would have been the group she works for.

BY DR. BRAMBLE:

Q. Meaning that the director of Flight Sciences maybe suggested that or that somebody more at Ms. Brimmeier's level suggested it?

A. I think it was kind of a collective suggestion from the group. I don't know, I don't think it was director level initially.

Q. Did anyone express skepticism or suggest an alternate means for overcoming the problem?

A. Not at that time.

Q. Did anyone express skepticism or suggest an alternate means prior to the accident?

A. No. Not that I can recall.

Q. I'm skipping over things. So this is making things shorter even though it seems to make it longer.

To your knowledge, is there anything the team in the telemetry trailer could have analyzed during Flight 153 to determine that V_2 was unattainable and stop the takeoff testing prior to 72?

A. Yes.

Q. What?

A. If one or more of the individuals had been looking at the airplane traces and had observed the prior run liftoff speed was essentially the speed they were trying to target at 35 feet it would have been fairly obvious, again, this is hindsight, but it would have been fairly obvious that they couldn't achieve the speeds they were trying to achieve at 35 feet.

Q. The target V_2 speed, couldn't achieve the target V_2 speed?

A. Yes.

Q. Just to clarify you were saying if they had looked at the liftoff speed and what else?

A. Well, just the liftoff speed initially it would have been obvious that the speed was so close to the target speed, V_2 speed that the airplane couldn't achieve the speed increment they were looking for to reach V_2 at 35 feet.

Q. It would have to exceed it?

A. Yes.

Q. Before 35 feet?

A. (Non-verbal response.)

Q. That was that a yes, I take it?

A. Yes.

Q. Why do you think no one in the trailer noticed that?

A. I think everyone was focused on trying to achieve the target speeds at, the V2 speeds and they weren't looking at what the airplane was saying or telling them.

Q. Do you think that had anything to with the experience level of the people in the trailer?

A. Yes. Although several of the people had been through field performance programs before, one with Gulfstream the other without, some other company I guess. Two of the individuals or so had very little experience altogether.

Q. So the two with little experience are Adessa and Eric Upton?

A. Yes.

Q. And then Ms. Brimmeier had experience with Gulfstream --

A. Yes.

Q. -- and Ms. Townsend had experience with another manufacturer?

A. Yes.

Q. So was the fact that they didn't notice this, did it have to do with their level of experience or did it have more to do with the diffusion of responsibility, that maybe they thought somebody else was handling it or it wasn't their responsibility?

A. I couldn't say. Ms. Brimmeier hadn't been directly involved with looking at the real-time data on our programs and I don't really know what Ms. Townsend's experience had been, other than she had worked at field performance in another company.

Q. If a very senior and experienced person at Gulfstream such as yourself or Bob Mills had been in the trailer, do you think that would have been noticed?
A. I would hope so. I couldn't say for sure, but I would hope so.
Q. If the V_{MU} results from Roswell-1 had been processed and used to model how the airplane would takeoff, would that in your opinion likely have indicated that it was a waste of time, that it was impossible to hit a V_2 of 1.13 V stall during Flight 153?
A. I don't believe so. Maneuvers are so different from our standpoint that the one really has no bearing on the other.
Q. Do you think the 60 pound pull force rotation technique that they were using would have been considered acceptable for certification?
A. Yes. The rules only require that they be less than 75 pounds.
Q. I can't recall to be honest if we already went over this because we might have done it early, but what was your understanding of the cause of Flights 88 and 132 and how did you come to that understanding? Did we already review that with you in detail?
A. Some. 88 was, if I remember correctly, early rotation and an over rotation and the pitch went up into stall.
132 it is a bit nebulous in my mind as to what I believe it was. It ceased testing after the one roll off maneuver. I

guess we were testing with the yaw damper inoperative and was the initial, at least in my understanding that we determined to be a roll caused by a yaw excursion and not a stall event.

Q. Did you come to the understanding of the causes of those events by being briefed by other people or through any kind of analysis on your part?

A. Being briefed by other people.

Q. Do you recall who they were?

A. Bill Osborne was one. There was someone else, but I can't recall who it was.

Q. Was this before the accident we are talking about or were you briefed after?

A. It was before the accident.

Q. Do you know what analysis was performed by performance engineering to determine the root cause of the wing drops during 88 and 132?

A. I don't know if anybody -- No, I do not.

Q. Who was responsible for analyzing performance during those flights and what analyses were performed?

A. It was primarily Flight Test they were looking at the time histories.

Q. Why do you think Flight Sciences personnel or Flight Test didn't analyze the angle of attack at which the roll off events began?

A. For?

Q. For 88 and 132.

A. I couldn't say, 88 was an obvious stall event. 132 not so much but I think it was looked at after the fact.

Q. Why didn't 88 and 132 result in the reconvening of the SRB?

A. 88 again it was a maneuver and situation that we had experienced on prior programs and didn't call for reconvening the SRB. 132, again, the initial response was to cease testing until we had the yaw damper, we were able to test for the yaw damper operative. So, again, it didn't call for reconvening the SRB.

Q. I guess it was, it's kind of surprising to us and with the benefit of hindsight obviously that 88 didn't result in the convening of an SRB. I guess there was a review and Kent made a presentation but to us it seems like a serious event and it's difficult to see how much of that is covered by hindsight. But what I'm wondering I guess is do you think that the history of these events sort of desensitized people to the hazard?

A. I don't believe so. Again, the 88 event it was fairly well understood that the airplane was over rotated.

Q. Wouldn't it be necessary to determine where it stalled, where it began to stall to determine whether it was understood?

A. I guess the angle of attack at which it stalled would have been beneficial just to let us know how much margin we would have had for our target pitch attitudes.

BY MR. O'CALLAGHAN:

Q. Do you know if the shaker activated on the 88?
A. I don't know. Our first trip to Roswell we did not have an alpha limiter, so we probably did not have a shaker.
Q. There was no shaker at all?
A. There may not have been a shaker at all, for out of ground effect.
Q. So maybe this is a hypothetical question but if the shaker had been installed and was operating per design as we just outlined earlier, would it have been expected to have activated on that event?
DR. BRAMBLE: Let me clarify a little bit. We said the shaker setting was changed between Roswell-1 and 2 and he was just referencing Roswell-1. So are you talking about Roswell-1 or 2?
BY MR. O'CALLAGHAN:
Q. Well, 88 was Roswell-1.
A. Yeah and that would have been at the lower .85 percent shaker if it was operational.
Q. I guess what I'm driving at is I think you described 88 as an obvious stall event and, you know, if on that in Roswell-1 the shaker settings were even lower than on Roswell-2 meaning lower angles of attack than what we described, then it seems to me that one would expect a shaker on that event. And following the logic that if it was concluded that it stalled, but there wasn't a shaker then that might have raised a question about whether the estimates of where the stall and ground effect was occurring more

accurately. I'm just saying, is that flow of, is that thought trail fair or does it have problems? If you could just outline where I'm going wrong.

A. No, that's fair. And it's been a while so I don't recall what the trace is from 88, what altitude the airplane was at when it rolled off.

Q. I have traces if you want --.

A. Sure.

MR. O'CALLAGHAN: Can we go off the record a second?

DR. BRAMBLE: Uh-huh.

(Off the record at 4:00 p.m.)

(On the record.)

DR. BRAMBLE: Let's go back on the record.

BY DR. BRAMBLE:

Q. So to clarify you were aware of brief activations of shaker during previous test flights prior to Roswell-2 that resulted in the increase in the shaker settings. Did any of those involve V_{MU} testing?

A. At this point I don't recall if it was V_{MU} or the subsequent testing out of Birmingham or developing the takeoff technique. It seems like about if I think about it more then it probably was some of the V_{MU} testing after the airplane had climbed away from ground it ran into stick shaker for one reason or another.

Q. How high up the organizational hierarchy were the Flight

88 and 132 incidents reported to your knowledge?

A. I know -- the 132 event anyway I know made it up to Mr. Henne. The 88 event I would think made it there but I couldn't be sure.

Q. Do you know how the original G650 flight test schedule and staffing requirements were benchmarked? We talked about this a little bit earlier, but in general for flight testing.

A. Oh, lord. We, Flight Test had done an estimate several years before. The airplane changed quite drastically subsequent to that estimate. Some adjustments were made. I think there were several budget cuts subsequent to that before we started flying the airplane that reduced the manpower in Flight Test.

Q. Do you recall when those cuts occurred?

A. Oh, lord. Not precisely although they all occurred prior to flying the airplane in November of 2009.

Q. Prior to flying the air plane in November of?

A. 2009. That's when we started flying the airplane, November/December. When did we start flying, Tom?

MR. HORNE: November of 2009.

BY DR. BRAMBLE:

Q. How was the long term flight test schedule established and revised in the year preceding the accident?

A. I think the schedule revised several times to try and meet the certification date of December or third quarter of this year by moving tests around from one airplane to another. The airplane wasn't a full up airplane when we received it and we were constantly adjusting the schedule to try and keep on the cert schedule, certification schedule date.

Q. Do you recall any discussions about whether adjustments were needed to the end certification date to reflect the back up of multiple TIAs?

A. At low levels, yes.

Q. Was there any merit to those discussions or was the schedule just a piece of paper and it was just going to change as a result of what happened or did the schedule create any undue pressure?

A. Well, I guess there was always some pressure to try to maintain the date I believe. I mean the airplane was going to be, the schedule was going to be what the schedule was going to be basically.

Q. Do you think that affected the ability to analyze the data?

A. It was some pressure to test if we are not fully analyzing the data.

Q. Could that problem have been solved with more staff?

A. Yes.

Q. Which people had a hand in creating the long-term schedule or changing it?

A. Wow.

Q. I guess who had the authority to modify the end dates for the cert schedule?

A. I think the only relief we would have gotten on the end date would have been from Pres Henne.

Q. Were you under the impression he would move it back if necessary?

A. (No response.)

Q. I guess he would have to if it was necessary. In your opinion what would it have taken -- As of the beginning of March what would it have taken to get the end date pushed back?

A. At the beginning of March I don't think there would have been any decision made to slip the certification date unless something -- well, unless something disastrous happened.

MR. RAMEE: Which certification date are you referring to, the internal, the external?

MR OBENSHAIN: The one we were given, which is the external date, I guess.

MR. RAMEE: What's the date?

MR. OBENSHAIN: It was the third quarter of this year. It wasn't a specific date. It was the third quarter of this year.

MR. RAMEE: Sorry.

DR. BRAMBLE: That's okay. Wait, that's not okay.

BY DR. BRAMBLE:

Q. Are you aware of the memos that were sent on March 9 and 31 to top managers from the ACO in Atlanta expressing concern about the schedule?

A. I was aware of them, yeah. I hadn't seen them.
Q. Do you know what management decisions were made in response to the memos prior to the accident?
A. Prior, I do not.
Q. Did you hear any discussion of them before the accident?
A. No.
DR. BRAMBLE: That's it for the original question list. So, John, what else you got?
MR. O'CALLAGHAN: Short one. Nothing dealing with plots.
BY MR. O'CALLAGHAN:
Q. I think I heard you say that shaker wasn't necessary or wasn't required for field performance testing; was that correct?
A. That's correct. For the initial field performance testing that's correct.
Q. So, in your opinion, how were the pilots to ensure that they stay away from stall if they didn't have the stall warning system?
A. By limiting the pitch attitude on liftoff, at liftoff and then targeting a V_2 or what was going to be a reasonable V_2 speed.
Q. We have had a lot of discussion with several people about the details of the mechanics or the logistics of exactly how that plays out. Could you just briefly outline in your mind how the maneuver would be conducted on that scenario and what role the

target pitch or pitch limit plays and to -- how long through the maneuver it applies, please?

A. Well, the -- I believe I'm going to kind of work it backwards as opposed to -- whatever speed the airplane achieves at 35 feet is considered your second segment climb speed and that's our target speed. Through the initial development we'd pick a pitch attitude for V_{MU} which is higher than we would expect to see during normal operation or the -- that pitch attitude gives us some margin between angle of attack during the climb out and aero stall we thought and ground effect.

It is a dynamic maneuver and a pilot who flies at a frequent basis may tell you better, but initial maneuvers to pit to the target pitch attitude and then as air speed builds transition to tracing the air speed so you achieve the air speed at 35 feet then follow that air speed from 35 feet through the rest of the maneuver.

Q. So now the trim pitch attitude for the V_2 speed in general, is that going to be higher than the initial target?

A. Depending on the weight of the airplane and whether it's all engine or engine out. Generally even engine out will be higher than the pitch attitude at liftoff.

Q. So if you wanted to not overshoot V_2 but settle into it you would have to leave the target pitch, transition to the trim pitch at some point before V_2; is that correct?

A. Yes, except there isn't a target pitch attitude for V_2.

And the reason again is depending on the weight, temperature, or altitude that pitch attitude could be 2 degrees to 15 degrees higher than your target pitch attitude at liftoff.

Q. But as the pilot approaches V_2 and he sees his rate or change of speed, his acceleration is -- he would start to raise the nose to --

A. He would pick up.

Q. So if I understand right if he wants to get to V_2 or get to 35 feet and have zero acceleration when he hits V_2 he is going to have to raise the nose before getting there?

A. Yes.

Q. So at what point then can he, does the initial pitch target no longer apply and he is free to depart from that to settle into V_2?

A. I don't think we have ever had a firm or a hard position on when to transition pitch attitude to air speed.

Q. We have heard some folks describe that the pitch target is held until liftoff and then after liftoff you can do what you want; is that --

A. That's pretty close to the way the maneuver has been flown in the past, yes.

Q. I guess, correct me if this is again me having a jump in logic that's not fair, but then I guess the presumption would be that if you hold that target, once you lift off the way the speeds are set up you can do pretty much anything reasonable with pitch to target your V_2 and you will still be comfortably away from stall to a point where you don't even need a warning system on board?

A. Well, yes. As part of the certification process we have to do a couple abuse takeoff maneuvers, you over rotate by 2 degrees, a rapid rotation, and early rotation and we have to do all of those to show we don't trip the stall warning or obviously stick pusher or upland.

Q. Thanks. That's enough on that I think. Something related. You mentioned that, and we talked earlier about how throughout the programs the delta angle for stall due to ground effect is on the order of 2 degrees. I mean just wondering do you have a feel for a reasonable uncertainty on what that value is in terms of percent or absolute angle?

A. No. That was, again, an estimate that was given to us from wind tunnel data back on the GIV. I think subsequent to that absent CFD analysis on the GVI as it is almost double for GVI.

Q. Again, just to make sure -- well, I can't ask it this way. Is the work statement for Flight Test in your opinion on the G650 different than on previous programs, is it more or less, same?

A. It's pretty much the same.

Q. Pretty much the same. So the volume of work tests and analyses to be done is comparable with, say, what had to be done on the GV?

A. Yes, and maybe more so actually with the flight control system.

Q. So a little bit more work maybe?

A. In some areas. And it's not necessarily field performance but other areas.

Q. So my take away from some of the some of the earlier conversation when Bill as asking about staffing the Reece was doing the job of five people; is that right?

A. Well, Reece, Cynthia Townsend and Paul Donovan were doing the work of five people.

Q. So three people were doing the work of five?

A. Yes.

Q. So it's a program that has a little bit more volume of work than on previous programs because of the flight control system but the ambition is to do it with fewer people?

DR. BRAMBLE: Except you were saying that the bigger volume would be in areas other than field performance testing and that involved a different group of people, right?

MR. OBENSHAIN: Yes.

BY MR. O'CALLAGHAN:

Q. Oh, okay. Let's let that go. Bill asked about the staffing between the GIV and GV and that it dipped way down and then was built back up for the GV program. Was there a similar dip or transition between GV and GVI?

A. Yes. Not as large but there was.

MR. RAMEE: Off the record for a second.
(Off the record at 4:29 p.m.)
(On the record.)
BY DR. BRAMBLE:
Q. So getting back to the number of people doing the analysis and conducting the test for field performance you were saying that Reece, Cynthia and Paul were doing the work of five people. Would it be fair to say that the three Flight Sciences analysts were available to do the additional work that normally would have been performed by the other two people that might have been sent out for that work on the GV program or GIV program?
A. I would have expected them to be available to do all that analysis, yes.
Q. Now, would that have depended upon their being fully engaged in the analysis effort and at the disposal of the test conductor?
A. Yes.
Q. Do you believe that was the case?
A. No.
Q. Why not?
A. I think two of the people were just out there to gain experience not necessarily to do the analysis.
Q. What about the third person?
A. The third I don't know. Just there to I think to see whether or not we achieved the target speeds.

Q. So you think that the people who were on scene from Flight Sciences in the trailer were not as actively engaged as the analyst had been in past programs?
A. Yes.
MR. O'CALLAGHAN: Was there a Flight Sciences support on previous programs?
MR. OBENSHAIN: Yes.
BY DR. BRAMBLE:
Q. So was that in addition to the additional Flight Test analysts?
A. It was.
Q. So normally in the past programs there would have been how many Flight Sciences people on scene and how many additional Flight Test analysts?
A. On the most recent past program there were at least three other Flight Test personnel and I seem to remember about six, I think something in the neighborhood of six Flight Sciences people. They were doing post-maneuver analysis and evaluations.
Q. Were they working in shifts?
A. Yeah, some of them were.
Q. And the rest were located where during the testing and how were they doing, how were they -- When was the analysis occurring?
A. Well, at the time we didn't -- I think the last program we didn't have a telemetry trailer.

Q. Meaning which program was that?
A. The GIV-X. And on the GV-SP, the GV also didn't have a telemetry trailer so we would take the data off the airplane and review it.
Q. But how about for a new air plane program like GV?
A. It's the same. I think --
Q. You think there would be six or seven Flight Sciences people on scene for field performance testing, a test conductor on the airplane and a test conductor on the airplane or in the trailer?
A. Well, again, we didn't have a TM trailer so --
Q. Oh, there was no TM --
A. There was no TM trailer.
MR. RAMEE: The first program with a TM trailer on it.
MR. OBENSHAIN: GIV was.
MR. RAMEE: GIV then none then the G650.
MR. OBENSHAIN: Yes, then the G650. Yeah.
BY DR. BRAMBLE:
Q. All right. Let's go back to GIV then. Let's just do a full rundown to avoid confusion.
A. Oh, my.
MR. HORNE: While you are doing that can we go off the record?
DR. BRAMBLE: Off the record.
(Off the record at 4:33 p.m.)

(On the record.)

DR. BRAMBLE: Let's go back on the record.

BY DR. BRAMBLE:

Q. So Mr. Obenshain could you clarify for us how you think the staffing resources available for data analysis differed for the G650 field performance test program compared to prior programs such as GV and possibly GIV?

A. Okay. On both the GIV and GV I think we had maybe twice the number of flight analysts, Flight Test people involved than we had on GVI several of whom had considerably more experience in the flight test arena and particularly field performance. Similarly with Flight Sciences we had a much larger staff of Flight Sciences people, particularly the GV looking at data post-flight and discussing in more detail what was going on during each maneuver.

On the GVI I think it was very very limited staff to look at data during the maneuvers, computer capabilities were more significantly better that may have let us somewhat astray.

And for the GV it was all collect the data on the airplane and bring it in and look at it after the fact. We actually had more time to look at the data also.

On the GVI I don't think there were enough individuals looking at that data trying to understand what the airplane was doing and, again, the experience level of some of the personnel was really inadequate other than just from a learning standpoint. The two Flight Test individuals had field performance experience but one was busy flying on the airplane, also looking at other items we had to monitor at the time. So he couldn't track the data as well as I would have hoped. And I think the individual in the TM trailer was again looking at the end point rather than what was going on during the maneuver. Again, I think additional people looking at data would have helped a lot.

DR. BRAMBLE: Thank you. Let's go off the record for a moment.

(Off the record at 4:53 p.m.)

(On the record.)

DR. BRAMBLE: Let's go back on the record.

BY MR. O'CALLAGHAN:

Q. So Mr. Obenshain, in this vein about staffing I recall you mentioned there was going to be another SRB and you will raise this subject again there. So my question is, how many people would you like or need, what will you propose in the SRB and will it, do you think there is enough staff on hand or will it require hiring to fulfill what you think will be necessary for the program?

A. Well, most of the individuals in Flight Test right now have very little to no experience with field performance. Paul Donovan is going out. Cynthia Townsend is going out. Myself and Bill Osborne neither of us are going. It would require hiring some people with performance experience. About another at least two more to look at the data while the airplane, while the maneuvers are being performed.

Q. And if you were king of the world and could specify any number you wanted, how many would that be?

A. Along with our current capability in the trailer at least three more people.

Q. Okay. Thanks.

DR. BRAMBLE: Is that in addition to the test, to the person on the radio?

MR. OBENSHAIN: Yes.

BY MR. O'CALLAGHAN:

Q. Let's just clarify the total number of additional people the minimum that you think you need and the ideal number that you would like.

A. The minimum additional number would be three more in addition to the person on the radio in the TM trailer and the person on board.

DR. BRAMBLE: And in addition to the Flight Sciences people?

MR. OBENSHAIN: Yes.

BY MR. O'CALLAGHAN:

Q. You were about to say something about the ideal number?

A. Ideally we would have two or three more for a second shift until they get the data more closely after the fact.

Q. Do you have an idea what you are going to propose for the SRB?

A. Well, it would be the minimum of three more.

Q. An ultimate question what was the length of the flight test program on the GV compared to the scheduled length for the G650, if you can recall?

A. I don't remember that one. The original estimate for the schedule I think was 15 months for GV. It ended at about 18 for the full type certificate. G650 was basically a 14 month scheduled program.

Q. Thank you. My last question is the one that we have been asking everybody. You know we are entering ending the near of our fact gathering probably our week here will be the last time we will probably interview you folks or talk to you, not talk to you but at least gather this level of facts. You can probably surmise what we are focusing on and what we are looking at hard based on our questions. When we go back we are going to start analyzing all that and the end of the process and the purpose of it all is to end up with some recommendations to the industry, the FAA whoever to improve things. So two questions are is there anything you think we should be looking at that we haven't hinted at in the course of our conversation today, and then secondly, is there anything you think we should recommend or bring to light to the industry that could improve flight testing in general? Anything in those areas is free game if you would like to offer anything.

A. It seems like as far as Gulfstream is concerned I think you have hit most of the high points that I can think of. The one -- it's not really a factor on this one. One area for us I think is we need a better understanding of the differences in the airframes. I don't think any of engineering or Flight Test was made aware or of how different the G650 is compared to any of the previous Gulfstream models.

A lot of the early testing was based, the wind tunnel testing was based on previous wind tunnel tests of other Gulfstream and they didn't really show some of the differences that we are seeing. It was only after the fact where we found out what we were getting into or what we had gotten into.

As far as recommendations to the industry a little more, I shouldn't say a little more, a more in-depth analytical process prior to getting to flight test and having that information passed through from engineering to the flight test groups.

MR. O'CALLAGHAN: Well, thank you very much. That's all I have. I appreciate it.

DR. BRAMBLE: All right. Mitch?

MR. GALLO: I just have a couple questions.

BY MR. GALLO:

Q. On the change in the stick shaker settings when that decision was made was anybody from flight operations also involved in that decision? I think what you said was you were and then Mr. Ollenburg.

A. Yes.

Q. Was anybody else, Flight Ops involved in that?

A. I don't recall we discussed it with Jake Howard or not. If anybody was involved he would have been. I don't recall if he was or not.

Q. Then since the change from .85 to .90 in normalized AOA that was a smaller margin, and I don't recall what your answer was, why that didn't prompt a SRB review again?

A. The SRB had originally made a determination that stall protection wasn't required for field performance. So since we made the change it didn't necessarily require recalling the SRB.

Q. I just want to clarify something because at the Safety Review Board meeting minutes cover sheet that I received that was for the October 7, 2002, field performance there is a set of slides and other material attached to this cover sheet and the group of slides was the SRB Action Review 6002 for Roswell Deployment/Field Performance November 1, 2010. And the one slide says it has a bullet point, FCC 4.22 and 6002 stick shaker protect held feedback for the AOA limit to the air crew.

Correct me if I'm wrong my perception is that that is a required item to be present to define the AOA limit to the air crew. So if a shaker setting gets changed then shouldn't that prompt an SRB meeting based on this slide? I could --

MR. RAMEE: I think he probably needs the whole -- do you have the whole SRB report there?

MR. GALLO: I have the digital version.

MR. RAMEE: you have the digital version. Does anyone have a hard copy?

MR. O'CALLAGHAN: Which one is this?

MR. RAMEE: The SRB, field performance SRB.

MR. GALLO: Can we go off the record?

(Off the record.)

(On the record.)

MR. GALLO: Let's go back on the record.

BY MR. GALLO:

Q. So the question is then based on the slide is the stick shaker a required item to provide an AOA limit to the air crew?

A. (No response.)

Q. And even beyond based on the slide do you recall the discussion of this with the SRB?

A. Again, if it was listed as an item that was on the airplane the limits we had chosen were chose in order to prevent shaker from going off. So we didn't trigger shaker. I suppose that was my error in that we maybe should have recalled the SRB.

Q. Well, before you say it was your error, did you understand, do you remember did you understand that as a required item at the SRB?

A. No. My recollection is that that was just, was on the airplane. I guess that's why the airplane --

Q. Since we are talking about normalized AOA why is that term being used rather than angle of attack and do you think that normalized AOA is a more difficult term to deal with than just using AOA because in talking to Ms. Brimmeier and Mr. Connor it seemed like they didn't understand the correlation? So for everybody to be on the same page a more useful term would be to use AOA that's indicated in comparison to your AOA limit?

A. Yeah, you are correct NAOA is not an easy term to come to grips with. We have been using that term since GIV days. That's the value we display in the cockpit to the pilots. And what it is intended to present to the flight crew is where you are in relation to, I don't want to call it aero stall, but it is the stick pusher, or in this G650 case alpha limit.

The other reason we use NAOA is because it's kind of a constant value. When you look at the alpha limit in stall warning it's not at a constant angle of attack. The only that got a constant angle of attack was GII.

I don't know if I answered your question. It's just not an easy term to come to grips with.

Q. But do you think from a flight test operational perspective AOA would be a better term to work in when you are out field testing or does it depend on the type of test you are doing?

A. It depends -- well, it depends more on what engineering chose as the alpha limit scheme. Earlier Gulfstreams GIIs, GIIIs and GIVs had, for a given altitude had a fixed angle of attack so you could always work with an angle of attack in a fixed stick shaker value. With the advent of GV we went to mock-based angle of attack limit schedule that -- it's never a constant value even in an altitude depending on the weight you are never at the same angle of attack. So we just kind of gave up talking about fixed angle of attack value.

Q. You mentioned regarding the rotation technique that the forces being used would have been accepted for certification. How about the associated rates, the associated rates of those stick forces, because with those stick forces I don't remember the specific values, but it was greater than 5 degrees per second.

A. No, it could have been up to seven I think.

Q. So would the rates be certifiable?

A. The maximum pitch rate during rotation has never had a limit on it. We do have to, again, demonstrate a takeoff at max, max achievable, no max achievable but a high pitch rate higher than what would be normal in service. So 7 degrees per second was the normal. We would have to demonstrate something higher than that to be safe. Again, by the regulations there is no limit on the pitch rate during the takeoff rotation.

Q. It's just defined as normal rate?

A. Yes. It's just defined as a normal rate.

Q. My next question is the margin between in-ground effect stall angle on the GV program free air was 2 degrees and then for GVI it was 1.6?

A. We I think initially went with 2 degrees as part of Reece's analysis I think he determined, he came up with 1.6.

Q. The next question is, well, it's probably twofold. When you are talking about in-ground effect my understanding is there is really certain way to determine what the difference is. It's all based on estimation at delta between stall in-ground effect and free air. So how can you be so confident down to a precision of a tenth of a degree when you are talking about stall angle of attack in-ground effect?

A. We can't be. I think whatever data Reece was working on he came up with something at a 1.6 degrees.

Q. This is a question we presented to Bob Mills regarding using V_{MU} tests to determine stall angle of attack and I think the answer was you can't determine that from V_{MU} testing.

A. No. The definition of V_{MU} is the minimum speed at which you get the airplane to liftoff and continue out of ground effect safely. So maximum stall maneuver.

Q. With the uncertainty that comes with in-ground effect stall angle of attack difference from free air doesn't the industry typically work with a range such as 3 to 5 degrees? And it doesn't have to 3 to 5. There's a range is what I'm looking for.

A. Until subsequent to the accident I think Dr. Mills did a lot of work with CFD and it's actually a function of the height above ground and I think he came up with a number somewhere in the neighborhood of 3.5 to 4 degrees somewhere in that range with the airplane on the gear, I don't believe full extension and the airplane pitched up.

Q. Let me go to my next question I'll probably come back to this topic. But you mentioned that I think the lack of understanding and the differences between previous airplane models from GVI to GV to GIV to GIII. The GIV in-ground stall effect I think was a result of, at that time people relying on what was learned at GIII in terms of in-ground effect so that reduced the amount of wind tunnel testing for GIV and then they came upon this in-ground effect stall.

Now, does this lack of understanding also translate into the V speed ratios that we being used on GVI in comparison to GV?

A. Whoa. Some of the differences -- Yes, they were different. The previous Gulfstreams were what we call control power limited at forward CG, there's not enough elevator authority to rotate the airplane at very low speeds.

GVI is a different animal. With the turnable stabilizer there is a lot more power to rotate the airplane. Consequently I think the target speeds for GVI were set much lower than the GV, GIV and GIII or GII.

Q. Going to a GV program, did the GV originally have a pitch up tendency at high pitch rates and was that corrected after that?

A. The character of all the Gulfstreams are on takeoff is once you get it rotating about the CG as opposed to rotating about the gear pitch rate goes up drastically. The, I can't say the technique because the technique was different for the GV than it was for the GIV and the GIII also. That characteristic is accounted for in the normal takeoff procedure.

Q. Because my next question would be looking at 083 and 132 grated everybody came to the conclusion it was pilot technique but that was --

DR. BRAMBLE: You mean 88?

BY MR. GALLO:

Q. Yes. I'm sorry, 088 and 132 that was attributed to pilot technique. But then if somebody acknowledged that GV characteristic wouldn't they at least be a little concerned saying well, maybe this is a pitch up tendency? There would be another reason to look at the data to do an analysis based on maybe it's a pitch up tendency not necessarily a premature stall?

A. I'm not quite sure I can answer that one. The technique that causes the pitch up is to hold aft column at fairly high courses once the airplane begins to rotate. If the column is relaxed obviously during the pitch up phase the transition rotation phase, the pitch rate is reduced. But it does become a pilot technique issue more than anything else.

MR. GALLO: I think that's all the questions I have for now.

DR. BRAMBLE: All right, Jeff?

BY MR. BORTON:

Q. Mr. Obenshain, I'm Jeff Borton, from FAA. I didn't introduce myself before. I had a couple questions. My first one is a follow on to the question on the pitch up tendency just for my own education.

A. Yeah.

Q. Is it a change in control power or something that's happening or do you understand --

A. It's a change in moment arm. The gear obviously is aft to the CG so when you try to rotate the gear, about the gear you have got one moment arm so as you begin to lift off now you transition to the CG your tail arm as far as your center of gravity is now your pivot point. So you have a much larger moment arm to pitch the airplane.

Q. So it's the design of the design of the airplane --

A. It's any airplane. Not just Gulfstream.

Q. With that design?

A. Any tricycle -- airplane.

Q. Just a question again on rotation technique for the 650 when you are developing it and the rotation rate again. There really is no regulatory guidance on rotation rate other than, you know, normal and it doesn't take exceptional skill for the pilot to repeat the data. But if the advisory circular does try to bound that, you know, anywhere from the 3 degree to 5 degree per second just for a typical rotation rate. Did you ever get any feedback in discussions with Flight Test on that development and how that would play or not play into the framework of that?

A. I don't recall any discussion on that but the reason, I guess; we went up to Birmingham was to try to develop the technique that stayed within the bounds of 143 to 75 pound pull with some reasonable pitch rate. But I think they were up higher, toward the higher end of that 3 to 5 degree --

Q. And then just a final question again on the -- you have expressed some concern about when you move forward into doing, finishing up your certification going out to Roswell making sure you have enough people to do the job. Is this a concern enough that, and I don't really know exactly how the SRB works in terms of voting or go, no go, or whatever, but if you have those concerns do you --I mean do you feel confident enough in bringing that forward to the SRB as a concern, are there other ways to mitigate that based on pacing of the program or have you kind of tried to work that problem already or is it kind of a work in progress?

A. Well, I hadn't really thought about pacing the program. Other than having -- I'm sure if pacing or slowing the program other than maybe a little more time between maneuvers to look at what was going on would really have much of a benefit. I think having few additional individuals looking at the data while a maneuver is being performed or shortly after the maneuver is performed would help a lot.

Q. Maybe to ask my question a different way. In terms of just classifying it's importance do you feel it's important enough as a safety, test safety concern versus just a technical efficiency concern?

A. To add additional people?

Q. Uh-huh.

A. Yeah, at this -- in hindsight yeah it's more a safety concern.

MR. BORTON: That I have for questions.

DR. BRAMBLE: All right, Tom.

BY MR. HORNE:

Q. Can you explain a little bit of the difference between what the flight test analyst would analyze and what the Flight Sciences analyst would analyze in field performance at Roswell?

A. Uh-huh. The intent was, and this is pretty much the way it was on previous programs, the flight test would take the test data, evaluate it for hitting the various targets, V_R, well targets are V_R and V_2 there is no other intermediate target, and reduce the data to the point where we get the acceleration factors and the timing points that Flight Sciences need to do the flight manual expansion.

DR. BRAMBLE: I don't think that came through. It was hard to understand.

MR. OBENSHAIN: I'm sorry. I'll have to face the microphone I guess. Flight Test would take the data from a particular run to evaluate it for hitting the target speeds, make adjustments on the target speeds as appropriate. After some discussion, you know, with the flight crew to see if we hit the rotation speed or we hit the second V_2 speed at 35 feet. Subsequent to the flying for the day, I guess, it is also our responsibility to take that data and reduce it to the form that Flight Sciences would need to do the expansion so we get the appropriate time delays for flight crew reaction if flight crew reaction was required. Also, get the other, the acceleration factors and the other terms that Flight Sciences used to do the expansion process with.

On previous programs Flight Sciences was also looking at some of that same data. So we had a backup group looking and checking on the answers.

BY MR. HORNE:

Q. I guess the follow-up question -- are you done with that?

A. Yeah. On G650 I'm not sure who is doing what frankly.

Q. If, let's say you are a Flight Test analyst and you were having trouble meeting the V_2 speed and you were meeting the V_R speed what do you think would be the outcome of the analyst in the trailer?

A. That was basically I think what happened with Roswell-1 and why we went out to Birmingham. Nobody was actually looking at the maneuver itself to see, I think they were looking at V_R, and V_2 but not what was going on in between. And that's where another, at least one more body, maybe two more bodies should be looking at the data to see what the airplane is really doing. I think in A1, the airplane pitched up and rotated and lifted off at about 2 to 4 knots below the V_2 speed. And they rolled for a while at the target pitch attitude.

It should have been pretty obvious from that run that there was no way to achieve V_2 with that V_R and that technique.

Q. In your opinion flight test analysts who had some experience would have been able to recognize that?

A. Should have been able to.

Q. This is just a follow on to the number of months that the flight test program. What was the difference in the size of the fleet between GV and GVI as far as test airplanes? Was there a difference in the time of the program?

A. GV we had four airplanes, GVI we initially had four airplanes.

Q. So really no difference then?

A. In the number of airplanes, no, in the complexity, plots.

MR. O'CALLAGHAN: GVI being more complicated?

MR. OBENSHAIN: Yeah, GV basically is a GIV with a larger wing and a larger fuselage. The flight control system was the same. It's all hydro-mechanical direct linkage. G650 is all fiberwire, it's all knew.

DR. BRAMBLE: But at the time of the accident there were five operating airplanes, right, for G650?

MR. OBENSHAIN: I'm sorry you are right. Well, yeah, we had five. Although five was late in the program we didn't really, hadn't really flown as much.

MR. HORNE: Okay. Thanks.

BY DR. BRAMBLE:

Q. All right. I just have one more follow-up and then I'll pass it around. Bob Mills said he developed a requirements memo for the field performance test program --

MS. WARD: Test requirement document.

DR. BRAMBLE: Test requirement memo he said.

MR. RAMEE: He said it was in a memo form. A test requirements document it was in a memo form is how I remember it.

DR. BRAMBLE: He emphasized that it was a memo because if it was a report that it would be, have to go through more review channels.

MR. HORNE: Did you mean to say field performance or did you mean stall?

DR. BRAMBLE: I meant to say stall, yeah.

BY DR. BRAMBLE:

Q. So there was a document of some kind that was not called a report, it may have been a memo that was test requirements that was submitted to flight test and it was in addition to -- I don't know that for a fact. Now, moving from the stall testing where this requirements document was submitted, to field performance we understand that there was no requirements document or memo submitted to Flight Test and there was instead a collaborative effort between Flight Sciences and Flight Test to develop the test plan, which would normally be a document developed subsequent to the requirements document or memo.

So my question is: Was this a breach in protocol and do you see any disadvantages to this?

A. Test requirements documents for a GVI were new for the GVI. I think they got a third or less of the test requirements documents we were supposed to have gotten form engineering. The field performance was based largely on what we had done on previous programs since this is a fairly well understood gamut, although we began to change it as we progressed through the GVI because of the security systems changes that were different than GV. I guess we did, I -- the breach of protocol since we had so few test requirements documents we did a lot of our test plans generation in collaboration with engineering.

Q. You did a lot of your test plans plural in collaboration?

A. Yes.

DR. BRAMBLE: Okay. John?

BY MR. O'CALLAGHAN:

Q. Ask you this about previous air planes. I understand the difference between previous airplanes and the GVIs that those airplanes had pushers.

A. Yes.

Q. And the stall off of SR was basically defined as pusher point.

A. Yes.

Q. So can you just briefly in ballpark figures give me an idea of what the increments and angle of attack are from aerodynamic stall to the pusher angle to the shaker angle?

A. It varies a bit --

MS. WARD: Stall noise or stall indication?

MR. OBENSHAIN: On the four, threes and fours bring that up to about 1 degree margin between stick pusher and aero stall.

Stick shaker is a bit of a variable, I don't really recall. There is a requirement in speed that it be 7 percent below the pusher angle. That's a bit of a variable too, but -- I'm drawing a blank on a word. The five is a little different in that the margin between, for various reasons the margin between pusher and aero stall vary from 5 degrees to about 2 degrees at one point.

MS. MOLER: Five degrees?

MR. OBENSHAIN: It wasn't so much -- it was more a display issue.

BY MR. O'CALLAGHAN:

Q. It was that filter that was in there?

A. It was probably filter and partly we had just instituted a low speed awareness cue that would come up and drop down and come up and drop down as the airplane decelerated.

Q. You said delta 2 to 5 degrees between stall and pusher and then the 7 percent on shaker on top of that?

A. Yeah.

MR. O'CALLAGHAN: All right. That's good thanks.

DR. BRAMBLE: Marie, do you have any questions?

MS. MOLER: Yes.

BY MS. MOLER:

Q. There has been a fair amount of discussion about how anyone in the trailer or near can call an end to testing. Is there anyone in particular who has to give their yeah for testing to continue or does testing kind of have its own momentum if no one says no?

A. If there's nothing untoward no one is required to simply say continue. If there is a subject brought up that causes even a temporary halt to testing it's initially a discussion among the test crew as to whether to continue or not.

MS. MOLER: That's all.

DR. BRAMBLE: Okay. Mike, have you got anything?

MR. BAUER: Just a couple.

BY MR. BAUER:

Q. One to follow-up on Bill's question when we were talking about the test requirement document. Was the lack of TRDs from engineering an engineering decision, was it a scheduling issue, was it a manpower issue, all of the above?

A. All of the above. Basically, I think engineering was so far behind they didn't have time to generate the TRDs in time for us to generate our test plans. So there was more need to regenerate our test plan, there was a lot of revision of work.

Q. And now sort of switching gears. Was the TM trailer use required for the testing in Roswell?

A. My recollection was no.

Q. So the testing could have continued with the trailer not being used or issues with TM?

A. Right.

MR. BAUER: That's all I have.

DR. BRAMBLE: All right, Mitch?

MS. WARD: Mitch already had a turn.

MR. GALLO: I have just a couple of questions.

DR. BRAMBLE: Did you not get a turn?

MS. WARD: No.

DR. BRAMBLE: All right. Lorenda.

MS. WARD: Thank you.

BY MS. WARD:

Q. I just want to follow-up on something that was said very early in the interview and we spent a lot of time talking about resources and roles and responsibilities. So could you just refresh my memory on what the role is of the chief flight test engineer?

A. It's essentially an oversight position. It's intended to be a position that reviews, guides, and instructs the newer flight test personnel and do the job safely is a major part of it, how to do it correctly, accurately.

Q. Now, is that a formal process? Like is there a formal training program set up for incoming flight test English?

A. No, there's no formal training program.

Q. You also stated earlier that when the program was in development that you had made to observation that more people were needed for the program and you said that you had said that to Barry McCarthy, right?

A. Yes.

Q. And he happens to be the director of Flight Test?

A. Yes.

Q. I'm looking at the org chart for the Flight Test organization and it looks like you report direct to Mr. McCarthy?

A. I do now, yes.

Q. Did you not at the time when you made the observation?

A. We have had several changes since then. I'm trying to remember. I may have since we had a manager come in sometime early in the program. I was under his report rather than directly to Barry. I don't recall when that occurred.

Q. Who sits on the SRB?

A. Let's see, right now it's Barry McCarthy, Randy Gaston, as the two chairmen, co-chairs, generally I'm on it, the pilot contingent varies usually it's John O'Meara or his designee. A number of varying individuals from engineering depending on what the SRB subject is. Usually a presentation by the flight test engineer who is responsible for that particular item.

Q. You mentioned that you are also a resource to be used for new engineers but then also oversight. Did Reece, did you oversee Reece's work?

A. I reviewed some of it, yeah.

Q. Have you seen the V_{MU} report that he was generating, the draft report?

A. I saw that just prior to him leaving for Roswell.

Q. Have you had a chance to review it?

A. Not in detail, but yes.

MS. WARD: That's all I have.

DR. BRAMBLE: Can I just clarify what you said, which was you saw it just before Reece left for Roswell?

MR. OBENSHAIN: Yes.

DR. BRAMBLE: On April 1st?

MR. OBENSHAIN: Yes. It was that week.

DR. BRAMBLE: Mitch?

BY MR. GALLO:

Q. Just a few questions. If somebody like Mr. Ollenburg came to apply for a job here who would have the hiring authority to say he's hired, who would that be?

A. Back then.

Q. If it doesn't come to you --

A. It's not me. It would have been Barry McCarthy, or at the time Dale Coulter. I think. Barry McCarthy at least.

Q. Do you use chase aircraft during your flight testing?

A. Yeah, on occasion.

Q. What kind of aircraft do you use?

A. It's usually a GIV or GV one of our other, the other in our test fleet.

Q. Going to the meeting that was held where the decision was made that to fix the problem whatever it was to meet the performance guarantees for takeoff, when was that meeting held in terms of Roswell-1 or Birmingham, Roswell-2?

A. Well, it was in between the two, but I don't remember the dates.

Q. It was between Roswell-1 --

A. And Birmingham.

Q. Birmingham. Do you recall who called the meeting and where it was held?

A. It was either right next door here or one of the conference rooms here in this building.

Q. So it could have been the Omega room or one of the other rooms?

A. It would have been the Beta or RDC1. It's the conference room right by the other door. I can't remember the -- it's a split conference. You can pull the partition out of the middle and make it into one. As far as who called it, specifically I don't. It would be -- the issue probably would have been raised by Tom Lavrisa to Brian Durance and Pres Henne and my guess is that Press Henne would have called it.

Q. Do you recall who from flight operations was present?

A. No, I don't. It would probably have been Jake Howard, but other than that --

Q. Do you remember if Mr. Ragusa or Mr. Crenshaw were present at that meeting?

A. I do not believe so.

Q. Two more questions. Was it ever discussed as one of the solutions to improve performance would be a use of a wing fix such as a -- as it was done on the GIV program to get the 2 degree increase in AOA?

A. I don't believe so.

Q. Are you familiar with the SAE paper <u>Development Of A Stall Improvement Package For Gulfstream IV</u> by Hugh Bruner?

A. I was made aware of that two days ago.

Q. And then the second paper I have its an SAE paper, it's <u>The Effective Wing Leading Edge Contamination On Stall Characteristics Of An Aircraft</u> and it talks about in-ground effect and the margin they use an error I believe 2 to 5 degrees for a difference. Were you aware of that paper or that estimation?

A. No, I was not aware of that one until two days ago.

MR. GALLO: I think that's all the questions I have. Thank you. I have another question. I'm sorry; Ms. Ward will ask the question.

MS. WARD: Why did it come to your attention two days ago?

MR. OBENSHAIN: Barry McCarthy put it on my desk and Paul Donovan's and somebody else's.

MR. O'CALLAGHAN: Are you talking about both papers?

MR. OBENSHAIN: Yes.

MS. WARD: Was there an impetus purpose?

MR. OBENSHAIN: I couldn't tell you. I don't know.

DR. BRAMBLE: Any indication where it came from? I mean where he got it?

MR. OBENSHAIN: There was a note attached to it. I'm trying to remember what the note said. It was something along the lines that the NTSB had these papers, but that was about it.

BY MR. GALLO:

Q. I have one more question. Do you find the information in those two publications useful?

A. The Bruner paper no. Having been through the whole process it was an interesting paper. But it actually didn't benefit the airplane at all. As mentioned earlier lowered the CL mas because we have the stick pusher, so we stayed away from that area anyway. In-ground effect it wouldn't have had enough effect to do anything. But it was a reaction to the in-ground effect stall we had on GIV.

Q. I was going to provide you a paper if you didn't have it.

A. The contaminated, the paper on contaminated leading edges, the only thing that would have been of benefit would have been the 2 to 5 degree range. Although we were initially allowing 2 degrees in-ground effect also.

Q. But it also discusses slide slip and rolling too.

A. I think we found subsequent that small slides of angles don't mean a whole lot.

MR. GALLO: That's all the questions I have.

DR. BRAMBLE: All right. John, anything else?

MR. O'CALLAGHAN: I might but let somebody else first?

MR. OBENSHAIN: If you have any more questions can we take a 5-minute break?

DR. BRAMBLE: Can we call it?

MS. MOLER: I have no more questions.

DR. BRAMBLE: All right, John do we need to call him back after the break or should we just say?

MR. O'CALLAGHAN: This will be very quick.

BY MR. O'CALLAGHAN:

Q. The Bruner paper just jumping right to the conclusions here one of them says the stall characteristics of the Gulfstream GIV were successfully improved with vortilons and a stall strip which controlled the spreading of the airflow separation.

A. Yes.

Q. But then did I understand you to say that it's really irrelevant, really didn't have a benefit to the airplane; can you explain that?

A. Where the vortilons and stall strips really have an effect is at aerodynamic stall. With the stick pusher we preclude the airplane getting to aerodynamic stall.

Q. But wasn't the point that the angle of attack at which the stick pusher could be set was moved up a bit because of the aerodynamic improvements?

A. That was not.

Q. Was not?

A. In fact, we had a subsequent program a year later where we increased the length, we pushed the stick pusher further down than it was for the initial program.

Q. So the paper I think at the beginning, it's been a while since I've read it, but it seems like motivation for this was sort as we are seeing on the GVI of improvement in speeds and field performance. So then was a hit, quote, unquote, hit take on field performance?

A. Yes. We did two series of field performance tests. The initial field performance program which was, again, a relatively abbreviated program with the set of stall speed of the same length. When we went back the following year we did it with the same of vortilons and stall strips and I have the data we generated that shows the stall speed increase with vortilon and stall strips but the same sticker show up. So even though we pushed the aerodynamic stall out normally, what it really did was reduce the roll rate at the aerodynamic stall it shallowed it with the curve so we took a hit --

Q. So you improved the stall characteristics but you lowered the CL max?

A. Correct. CL at the stick pusher.

Q. At the stick pusher. All right. I think I understand thank you.

A. I think the curve show that. If you pick a point some shy of the aerodynamic stall where the stick pusher operates --

Q. Yeah, I see. I see what you are saying.

MR. RAMEE: Aren't you glad that he actually had it ahead of time so that he can explain.

MR. O'CALLAGHAN: Yes, indeed.

MR. OBENSHAIN: I could have explained it not having seen because I was there when we did it.

DR. BRAMBLE: So are we done? All right, off the record.

(Whereupon, at 5:55 p.m., the interview was concluded.)

CERTIFICATE

This is to certify that the attached proceeding before the

NATIONAL TRANSPORTATION SAFETY BOARD

IN THE MATTER OF: AIRPLANE ACCIDENT
ROSWELL, NEW MEXICO
N652GD
Interview of Ken Obenshain

DOCKET NUMBER: DCA11MA076

PLACE: Savannah, Georgia

DATE: October 25, 2011

was held according to the record, and that this is the original, complete, true and accurate transcript which has been compared to the recording accomplished at the hearing.

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Letha Wheeler
Official Reporter/Transcriber

UNITED STATES OF AMERICA

NATIONAL TRANSPORTATION SAFETY BOARD

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Investigation of:                   *
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AIRPLANE ACCIDENT                   *
ROSWELL, NEW MEXICO                 * Docket No.:  DCA11MA076
N652GD                              *
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Interview of: JOHN O'MEARA

Gulfstream Corporation
500 Gulfstream Road
Savannah, Georgia

Thursday,
October 27, 2011

The above-captioned matter convened, pursuant to notice, at 1:08 p.m.

BEFORE: WILLIAM J. BRAMBLE, JR., Ph.D.
Senior Human Performance Investigator

APPEARANCES:

MITCHELL GALLO
Air Safety Investigator
National Transportation Safety Board
31W775 North Avenue
--------------------is 60185

WILLIAM J. BRAMBLE, JR., Ph.D.
Human Performance Investigator
Office of Aviation Safety
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

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ALAN J. (JEFF) BORTON
Flight Test Pilot
FAA Aviation Safety
Aircraft Certification Service
Wichita Aircraft Certification Office
---------------------oom 100

THOMAS M. RAMEE, ESQ.
Deputy General Counsel and Risk Manager
Gulfstream Aerospace Corporation
500 Gulfstream Road, M/S B-06

TOM HORNE
Experimental Test Pilot
Gulfstream Aerospace Corporation
P.O. Box 2206, M/S A-12
Savannah, GA 31402-2206

APPEARANCES (Cont.)

JOHN O'CALLAGHAN
Aircraft Performance Group Chairman
Vehicle Performance Division (RE-60)
Office of Research and Engineering
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

-

MICHAEL BAUER
Aerospace Engineer
Vehicle Recorder Division (RE-40)
Office of Research and Engineering
National Transportation Safety Board
490 L'Enfant Plaza East, SW

E. LORENDA WARD
Air Safety Investigator
IIC and U.S. Accredited Representative
Office of Aviation Safety
Major Investigations (AS-10)
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

MARIE MOLER
Mechanical Engineer
Office of Research and Engineering
Vehicle Performance Division
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

I N D E X

I N T E R V I E W

(1:08 p.m.)

DR. BRAMBLE: Let's go on the record.

INTERVIEW OF JOHN O'MEARA

BY DR. BRAMBLE:

Q. Can you please state your full name, please?

A. Including middle name?

Q. At lease middle initial.

A. John N. O'Meara.

Q. What is your date of hire with Gulfstream or at least month and year, if you can recall?

A. September 30, 1985.

Q. Your current position?

A. Chief test pilot.

Q. Your office and department is Flight Operations?

A. Yes.

Q. What are your roles and responsibilities as the chief test pilot?

A. It's to make sure guys like Tom do their jobs right.

MR. RAMEE: Tom Horne.

MR. O'MEARA: Tom Horne. I also watch Tom Ramee.

BY DR. BRAMBLE:

Q. So you supervise all of the pilots that work for Gulfstream?

A. All the experimental test pilots and production test pilots, yes. They all report to me.

Q. Have you personally been involved in flight testing?

A. In this program you are talking about?

Q. In general.

A. Yes.

Q. Can you describe which certification programs you have worked on?

A. I did the follow on certifications on GIV. I was heavily involved in GV, G550 or GV-SP and GIV-S. And I have done some flying in G650, but not as much as Tom or Gary or Jake.

Q. Getting right to G650 issues. Prior to the accident what was your understanding of the causes of flights 88 and 132 and how did you come to that understanding?

A. I think 88 is the over rotation on the V_{MU}. After that occurred Kent talked me about it via e-mail and also on the phone from Roswell and I tried to reassure him that, you know, that you have learned a lesson and it wasn't going to happen again. And he felt compelled when he came back to give the entire flight department, or at least the test pilots a briefing on what happened including video.

And 132, I got a briefing from Gary. It was just a, he thought it was a, I'm trying to think of what he said. They are doing testing with the yaw damper off because of a limitation that we discovered and he thought it was a yaw damper event as I recall. He didn't think they stalled was his initial impression.

Q. Did you receive that data for those flights like traces from flight parameters?

A. Well, Kent briefed the flight and showed us data and showed us the video. I did not see any data or video from 132 until after the accident.

Q. Why do you think Flight Sciences 88 and 132 did not result in the reconvening of an SRB, or the convening of an SRB?

A. Well, we already had had an SRB for V_{MU} and field performance and the 88 event was understood. It was Kent's first I think left seat event for V_{MU} in this airplane. He has done V_{MU} in other airplanes before, of course. And I think the event was understood. So we probably didn't think there was a need for another SRB.

And 132 was -- I don't know how publicized that event was, but it was, you know, as I said earlier it was thought it probably involved the yaw damper because of the roll off they had.

Q. What type of incident during flight testing, if any, would trigger sort of a reconvening of SRB or would sort of safety-related incidents typically be handled through some other mechanism if there was an event to be investigated or reviewed?

A. You mean now or then?

Q. Back then.

A. Back then. It would have to be an event that would be serious enough that you would stop testing because of it. And I think when that occurred on 132 that's when he said we wouldn't do anymore testing with the yaw damper off. So the idea was to go back and get the yaw damper fixed.

Q. Did you have in-depth discussions with anyone about Flight Sciences 88 and 132 other than Kent?

A. No.

Q. On to another topic. Before the accident what was your understanding of the reduction in stall AOA in ground effect compared to free air on the 650 and how did you come to that understanding?

A. Well, during the SRB the question was asked, one of our aero guys came back and says 1.5 to 2 degrees. That's kind of the standard answer we thought we understood from previous programs and from the wind tunnel.

Q. Before the accident what did you know about changes to the predicted stall margins between VSR stall and the aerodynamics stall that might have occurred during the field performance test program as a result of some additional analysis by the aerodynamics group?

A. I'm not sure. It was a long question. Can you rephrase it?

Q. Sometime in February, January/February or possibly even -- no, sometime in January or February it is our understanding that Bob Mills' group developed some revised stall speed tables and provided those to Flight Sciences. And I just wanted to find out whether or not you were made aware of that.

A. My understanding was that it was a half degree of margin and I questioned it. I didn't think it was enough, but I was assured that it was run by everybody and was good enough.

Q. Prior to the accident what I don't you know about changes made to the stick shaker settings?

A. I didn't have any knowledge of that.

Q. So you weren't aware that on 6002 the shaker threshold was adjusted from .85 to .9 normalized angle of attack?

A. Only after the accident.

Q. If you had heard about the stick shaker threshold being adjusted from .85 to .90 normalized angle of attack prior to additional continued takeoff testing during Roswell-2 would that have been a concern for you or would you figure that they probably had it well in hand as far as the required analyses?

A. I was not concerned when I first heard, initially heard about it, the .85 to .9 seems benign.

Q. Is that because in the past you have seen shaker margins in that range before for various flight tests?

A. Point of reference for me would be G280 for instance, where the shaker is set at .9, shaker onset. So .85 to .9 to me would not be a big deal and before April 2nd I never thought shaker would kill me.

Q. The Flight Test organization had a standard practice manual that specified processes and positions and that sort of thing. Did you feel like the flight test organization was pretty well organized and had adequate -- how well did you feel that the flight test organization structure, policies and procedures conformed to the manual?

A. I thought it was done very well, to be honest with you.

Q. In your mind, who was responsible for doing the analysis of the field performance testing maneuvers, was it in the Flight Test or in Flight Sciences?

A. Traditionally at Gulfstream the flight test engineers reduce and analyze their own data. It is rarely passed to Flight Sciences unless they need help is my recollection.

Q. So what was the role of the Flight Sciences folks on scene at Roswell?

A. I think they were looking at the data real-time -- well, let me back up. This is the first time we have done Roswell testing with a TM trailer. Prior to that, the Flight Sciences and performance guys would be there to look at data posttest. So looking at the validity of the data and goodness of the data would tell us what had to be repeated.

Q. Did they typically do that in the evening each day after the tests were completed for the day?

A. Yeah, prior to using TM that's what we did on the GV program for instance. I can only make a guess as that was what they were doing on G650.

Q. On March 9 the FAA sent a letter to Anthony Beck as a result of the yaw damper and nose wheel steering malfunction that had occurred and they requested that Gulfstream perform an internal review of the Company's change approval process to ensure that all concerned parties would be informed of changes to the flight control system and other systems with direct pilot interface. To your knowledge, was this review performed and what lessons were learned or changes implemented as a result?

A. That's a good question. I wasn't that involved. I think we went up to Atlanta for a meeting on that. And as a result of the meeting and the letter, which I think followed the meeting -- you know, I don't know to be honest. I would only be guessing. I don't recall the event and recall the meeting and getting the letter. But I was not involved in the, any post meetings after that.

Q. Did you feel that the processes that were in place before the accident were adequate for making sure that the pilots were kept informed of changes to systems during flight testing?

A. I thought so. Tom and Scott Bussey (phonetic) were always involved in any flight control changes and software changes as was Jake.

Q. That's Tom Horne?

A. Tom Horne, yes, I'm sorry, not Tom Ramee.

Q. Tom, Scott and who was the third person?

A. Jake, Jake Howard.

Q. Were you involved in reviewing and discussing the G650 flight test schedule as the test program progressed?

A. No, I just got updates from Jake on the new term schedule.

Q. Were you aware or did you have any concerns about the schedule being too tight or needing to be revised or anything like that along about March of this year, 2011?

A. I think at the beginning of every program I have been on here the schedules have been too tight. So whatever schedule was announced for the G650 was, since it is an all new airplane -- I probably would have thought it was too tight.

Q. How about the level of staffing support in the Flight Test and Flight Sciences areas; did you feel like they had enough bodies, enough engineers with adequate experience working the program to meet required deadlines?

A. That's a good question. In the Flight Test Engineering group the is a corps of people that have been there a long time and with every program they bring in their new hires coming from other OAMs and work for other OAMs or they bring in job shoppers. So their quality of expertise is unknown to me at this time or at that time and also to this time. Flight Sciences I know had done a lot of hiring, but since I don't manage them or get involved with them that much, I do know the corps of people I dealt with for the last 20 years or so, and I know they are quite good. Whether the staffing level was adequate I can't say.

Q. So you mentioned there were some differences in how the field performance testing was carried out on the GV program. Were you a pilot on the field performance testing phase for GV?

A. Yeah. I did the post-initial TC flaps 10 testing at Roswell.

Q. That was the post TC?

A. The initial TC was done with flaps 20 data only because we were in a rush to get the certification. After the initial TC we went back to Roswell and did flaps 10 still.

Q. How did the size of the teams that were sent to Roswell for field performance testing for the GV program compare to the size of the teams that were being sent out for the G650 program?

A. I can only speak to the GV program. They were adequate. It was adequate staffing. We had two company pilots until the FAA pilot showed up. FAA flight test engineer or our flight test engineer, adequate. The people to take care of the airplane, you know, inspector, electrician, mechanic and a couple other people and the engineers that were these were probably two or three performance engineers.

Q. From Flight Sciences or Flight Test?

A. Flight Sciences.

Q. Were there additional engineers there from Flight Test to do analysis in the evenings?

A. I think, I'm going by memory now, the analysis, you know, it was post-process data and Pat Connor and Len McCummin would look at it, review it and tell us if it was good enough or what had to be repeated.

Q. Pat Connor and who was the other person?
A. I think it was Len McCummin.
Q. Did they do that on a daily basis or was that more like when you came back to Savannah from Roswell?
A. Oh, they were there. They would look at the data and, as I said, post process as quickly as possible and tell us what had to be repeated the next day, if anything.
Q. Who was making the decisions between runs within the day to give you feedback on the aircraft performance just with FTE on the airplane or did you also get feedback from people on the ground?
A. Of course, again, it was post-process data so they couldn't see what we were doing real-time.
Q. Oh, I didn't understand what you meant. So you had to collect it and process it after you were done flying?
A. Right.
Q. I see. I thought they had telemetry to some sort of room where they could --
A. No, there's no --
Q. I know there's no trailer, but --
A. There was no TM, the first time we used TM was on the GIV and then the system broke and then we used it on the GV for flutter and stall, aero stalls as long as we stayed in the northwest corner on 3 x-ray.
MR. RAMEE: What's 3 x-ray?

MR. O'MEARA: That's one of the areas in the warning area.
MR. RAMEE: What airport?
MR. O'MEARA: The Navy's areas off the coast of Savannah.
MR. RAMEE: Savannah?
MR. O'MEARA: Yes.
MR. RAMEE: That's important.
MR. O'MEARA: Because we did flutter and aero stalls well before we did field performance.
MR. RAMEE: Bill, I just want to make it clear, he is talking about telemetry based in Savannah for Savannah-based flights, not Roswell-based flights.
DR. BRAMBLE: Yeah, okay.
BY DR. BRAMBLE:
Q. Did you feel in the G650 program that there was an unusual reluctance to push back the end date for the flight test program after there had been repeated delays resulting from obstacles in developing the flight control system or was it kind of typical to leave the end date solid right up until the last possible second and only change it if, you know, coming up in next month?
A. Well, on every one of our programs we had an internal date and an external date, whatever we advertise to the customer. So the customer, the people out there, the prospective buyers the

goal was to get airplanes delivered in 2011. It doesn't matter, on the internal date it doesn't matter when the start date is. If you miss the start date by a week or a month or two months the end date doesn't change, but it always does change as a result of program issues like flight controls or other systems.

MR. HORNE: can we go off the record for a second?

DR. BRAMBLE: Uh-huh.

(Off the record at 1:32 p.m.)

(On the record.)

DR. BRAMBLE: Back on the record.

BY DR. BRAMBLE:

Q. Just to clarify what were the causes of any delays that might have been experienced by the G650 development program in the last year or so before the accident?

A. Well, we had issues with the manger doors vibrating. We had issues with hydraulics, ECS pressurization, the fuel system, fuel pumps, and the brakes. We were back to brake aware with the same supplier gave us brake aware on the GIV and it seemed as though we were, you know, just learning lessons again. Getting all those other things right wasn't as important as well and caused delays in the program.

Q. I think in either May or June or June or July of 2011 the way the TIAs had backed up the economy was scheduled to have like, nine and 11 TIAs completed in each of those months. Do you feel like it wasn't all that relevant to how people were actually doing their work on the ground and, you know, I mean things were going to take as long as they were going to take and if they had to get pushed back they had to get pushed back or do you see that as a problem that the schedule wasn't sort of pushed back earlier to avoid the appearance of the huge back up?

A. Well, generally when things stack up like that events help you with the scheduling of those TIAs, the airplane is not ready, if the FAA has not read the report, if they haven't bless the report, did they come back with more questions, everything tends to delay a TIA. The FAA is good in that respect because they can look at a schedule as well as the rest of us and say it is unrealistic. And they have said that before to us on this program and other programs.

Q. So in particular they apparently sent a letter that was dated March 31st to Anthony Beck and cited concerns about an overly aggressive schedule and said that for some time now Gulfstream had acknowledged that unofficially that things were slipping, but the company TIA schedule continued to reflect a pace that had proven to be unrealistic. Were you involved in any discussions about that and prior to the accident the FAA's concern about that?

A. I don't think I saw the letter. As I said intuitively I can say I could anticipate what they would say in that letter but I didn't see it and so I can't really respond.

Q. Do you know whether meeting the program schedule was tied to compensation for anybody in the Company in terms of like bonuses or anything like that?

A. Well, I do know that we give bonuses. I can only imagine that there was probably some incentive there for completing the program on time, but I'm not really, I'm not privy to that information.

Q. We understand that since the accident there have been some initiatives undertaken to create safety officers and I assume there would be some other activities related to the function of those folks but at the time of the accident we are aware of the SRB and there were also IFRs that could be created and problem reports. And then things could be handled informally and that sort of thing too. Were there other kinds of safety reporting systems that we might not be aware of?

A. Not at that point no. At the time of the accident, no. Afterwards we have made some changes, yes.

Q. What kinds of changes have been made since the accident?

A. Well, we just established an office of aviation safety and a gentleman that has worked for me is now that safety officer. He reports directly to the president of the company. And they appointed three other safety people, one in Flight Ops, one in Flight Test and one in Flight Sciences. We are additionally going after a formal SMS program. The corporation had already started that process I guess a couple years ago and we are becoming an active member of that. We are rewriting our flight ops manual for the test side to incorporate a lot of those changes.

Q. So the role out of the SMS program a couple years ago how is that progressing and sort of what areas of the Company's operations did it cover?

A. I don't know much about it. There was, when we first started talking about SMS we were surprised to find out that Gulfstream already had established an SMS program. I think it's, I'm only guessing my recollection I heard it was in manufacturing. I'm not really sure.

Q. What kind of elements will the SMS program have in the future?

A. Well, there are, first of all, it's going to be a formal program. It has got online reporting. We also have, we are establishing internal safety reports either a ground safety report or an air safety report. There is a process through our aviation safety officer. And we are looking at the flight test standard practices manual to see what changes need to be done there as well, how often you have an SRB, what will trigger reconvening of the SRB, things like that.

Q. The new safety officer, what will his role be in this process?

A. I think they are still writing the job description, but he is going to report directly to the president and he's also supposed to oversee, participate in the SRBs, attend flight briefings for high risk test points, things like that.

Q. Why do you think there was no safety department prior to the accident?

A. In flight ops we have, on the test side we have two people that are identified as primary and secondary aviation safety officers, so-to-speak mainly to keep us abreast of things in safety world at pilot meetings. On the demonstration side they have a safety person for each of the groups, the large cabin demo, mid cabin demo, and parts and they would review incidents and they would also look at data that came from the -- program. On the large cabin airplanes they are equipped with QARs and they get, I don't know if it's monthly or quarterly reports from the supplier that collects the data for us.

Q. Which type of flights was that data recorded for and analyzed by the supplier?

A. Sales demonstration or corporate transportation flights in large cabins, G450 or G550.

Q. So there were some safety officers in flight ops and they were engaged in gathering and disseminating information and holding meetings with the pilots and that sort of thing, basically before the accident?

A. Right. Yes.

Q. It's just that now the structure has been changed and the position, there has been a lead safety officer position created and elevated in terms of his report chain and the structure of what they might do is going to be a little different now and based on an SMS kind of model?

A. Yes. And it was one of the Company's responses to the independent safety review team that we had come in, one of the recommendations or observations and findings was that we didn't have that, that the president of the company was not personally involved in the safety program. So Mr. Flynn took the bull by the horns so-to-speak.

Q. So was it his idea to basically act on this finding and create this department and take the initiative to respond to the finding?

A. I think he had help from above him.

Q. Who is Mr. Flynn again?

A. He's president of Gulfstream. So I think he, Joe Lombardo and J. Johnson who is the chairman of the board and CEO, GD, had a meeting of the minds and came up with that.

Q. When was the lead safety officer position created?

A. That's been within the last 30 days or so, less than that.

Q. Does the safety officer have resources to draw upon either external to the organization or from the industry to sort of help develop these programs and models?

A. Well, he's just starting to get going. He has got the full support of Mr. Flynn. He has been interfacing with the gentleman who has been running the SMS program for the corporation. We got a briefing from that gentleman Pat Manley within the last, it was two pilot meeting ago, I think. So he has been given all the resources he needs so far. I think if he needs anything he will get it.

Q. So at the time of the accident which managers or executives were accountable for managing the safety of the flight test program, to your knowledge?

A. Well, it would fall to Pres Henne the senior VP to whom we all report for engineering, Flight Test and Flight Operations.

MR. RAMEE: There may be ambiguity in the word executive there, Bill. What do you mean by executive?

DR. BRAMBLE: Off the record.

(Off the record at 1:48 p.m.)

(On the record.)

DR. BRAMBLE: Let's go back on the record.

BY DR. BRAMBLE:

Q. Before we proceed with an additional question is there, since you have had a chance to confer with your representative is there anything additional that you would like to say regarding the prior question about at the time of the accident did Gulfstream have an executive who is formally accountable for the safety of the flight test program?

A. Well, I would offer this that the first line of defense so-to-speak in the safety issue is with the test program would be at my level and Randy Gaston along with Barry McCarthy who is director of Flight Test Engineering and then Barry reports up to

Tim Farley and Randy reports up to Pres Henne as does Tim Farley. So the first line of executives, you know, Randy is the vice president so he is considered an executive. And I think pilots and flight test engineers feel comfortable coming to us to express safety concerns.

Q. How is technical knowledge retained across major developmental flight test programs and made available to employees working on new programs, specifically technical knowledge in the areas of safety lessons learned during field performance, flight test, that sort of thing?

A. I'm not sure I quite understand the question. How is technical knowledge retained; is that what you said?

Q. Yes. What I'm getting at is how are lessons learned from past programs carried over to new programs?

A. Well, they are recorded in reports if it's a major lesson learned. There's I wouldn't call it urban legend, but there is tribal knowledge so-to-speak for people that have been around for a while, like myself or Ken Obenshain in flight test engineer, or Bill Osborne or Gary Freeman they have been around, and participated in several test programs. So tribal knowledge is there. Whether it is formally recorded other than for a major incident so-to-speak probably not. We are, that's something we are fixing with our new flight ops manual and a place to formally record lessons learned.

Let me add to that that we did have the beginning of a flight test techniques manual that was started by both Kent Crenshaw and Jake Howard after learning some new techniques for minimum control speed ground testing and a couple others. So we did have, I recall now that we did start that but we never finished it and that's one of our projects to complete now.

Q. Are you aware of the wing drop incidents that occurred during developmental flight testing on the GIV and GV programs?

A. I heard about the GIV. My former boss was the chief test pilot then and he was in the right seat with the FAA pilot flying and heard about that. And I was in the right seat with the GV incident with the FAA pilot flying. So I have firsthand knowledge of that.

Q. How were those incidents reported and analyzed?

A. Don't know about the GIV. GV was a I think a fairly extensive report was written because we had to explain the incident to the FAA even though the FAA was there involved in it, we had to go through the data and come up with an analysis and show a probable cause for that, probable cause and a corrective action, so-to-speak.

Q. Was the analysis more extensive than it was for the wing drops that occurred on G650 for and during Flights 88 and 132?

A. Well, it was a formal report that was I think shared with the FAA on the GV. I don't know what was done on the GIV. Flights 88 and 132 as I related earlier were analyzed internally and not shared with the FAA as I recall. I think Kent probably did the best analysis on 88 that anybody could have done. And 132 was probably analyzed more post-accident than prior to the accident.

Q. What do you think accounts for the difference in the levels of attention given the GIV/GV incidents compared to the G650 incidents?

A. The fact that the FAA was participating in the tests and also at the controls when the event happened.

Q. That was for GV?

A. And GIV, as I recall. I'm going on memory with what Lee Johnson told me.

Q. Can you describe based on your past history with the organization what happened to the staffing levels in the flight test program between GIV, GV, and G650 programs in broad terms?

A. After GIV in the early 1989, 1990, '91 time frame we almost went out of business so there were massive layoffs in engineering and flight test engineering was down to a director, an admin, and one engineer, everybody else was farmed out to, that didn't go to the sub 2000 program, job shoppers were lent out to or reassigned to core engineering.

Q. Who was reassigned to core engineering?

A. The ones that didn't leave to go -- didn't go to work on the sub 2000.

Q. Can you describe briefly --

A. Thank you. Between GIV and GV that's what happened.

From GV is when the company got healthy again and we have been in almost a continuous state of flight test since then, since GV initial cert. The flight test organization, I'm just going on memory, may have gotten a little smaller because all the job shoppers left and we wanted it with the people that we, you know, that we know the best that, you know, stuck around in flight test engineering and then we started ramping up again for the GV-SP and GIV-X and then G650.

So from 1997 when we got the initial TC on the GV until now we have been in continuous flight test something, special missions programs or things like that.

BY DR. BRAMBLE:

Q. Did you feel that there were significant senior personnel that stayed or returned from prior programs to sort of maintain continuity of the corporate memory on lessons learned past programs?

A. Yes, Ken Obenshain who started with Grumman and he's still around. He did leave for a short time. He went to DR for the 727 -- program and he came back when that was over. So he is the resident expert in tribal knowledge on flight test. Bill Osborne is probably the next best person for that and then Paul Donovan who is relatively new within the last 10 years is another person with a wealth of experience in flight testing.

As far as pilots Lee Johnson was a chief test pilot during the GIV program. I took over for GV. Lee was director of flight test at that time he left flight ops. And the pilot core has been stable. Nobody has left. I hired Randy Gaston away from the FAA, he became my boss. Good move. A little sense of humor there. We hired Tom Horne, Kent Crenshaw, Gary Freeman and been trying to get new young talent in, and I say mid-40s to older, to build their experience level up as we progress to the next program and the next program and the next program after that.

Q. I think we have reviewed the flight department's policy, I think it's in the flight ops manual about use of medications. Can you just briefly describe what the policies are for pilot use of medications?

A. I guess I'd have to look at the manual.

Q. I'm not sure I have it with me.

A. I don't take medicine except for a statin.

MR. HORNE: I probably have it; do you want me to grab it?

MR. GALLO: I have it electronically here.

MR. HORNE: Do you want to go on until I find it?

DR. BRAMBLE: I think that's my last question. We could go on to John, I guess while you are looking for it.

BY MR. O'CALLAGHAN:

Q. Thanks again for your time. Going back to, all the way back to Flight 88 --

MR. HORNE: I got it.

DR. BRAMBLE: Do you have the right section?

MR. HORNE: I'm searching through it.
DR. BRAMBLE: Why don't you go ahead, John?
BY MR. O'CALLAGHAN:
Q. Okay. So regarding Flight 88; so our understanding is that it was pretty clearly understood early on that it was an over rotation, some flow separation, wing tip stall and that was the cause of the wing drop and that this was reported and then even reviewed through, when Kent came back and then shared among the flight ops community. My question is whether in the review of that or in the discussions that ensued if stall warning on that event was mentioned or any discussion of stall warning in the context of Flight 88 ever occurred to your recollection?
A. I don't recall that.
Q. Just to follow-up a little bit. Would you expect on an event like that if everything were set properly that stall warning would occur, maybe get a shaker prior to the roll off on that?
A. I'm not sure, I can't say for sure whether or not shaker was enabled on it or not.
Q. But if it were on and if the stall angles of attacks were understood and the system were properly programmed would one expect to have a shaker activation prior to a wing drop as a result of flow separation after over rotating?
A. Well, as a generic question I would say, yes. But in ground effect you may get the stall before shaker or it might be coincidental.

Q. Would that be a normal occurrence or would it be --

A. Well, V_{UM} testing is not a normal event. Most of the testing that we do in production and in flight test is expect shaker before you get pusher. I'm not sure where the shaker was set in that, in the system during that flight.

MR. O'CALLAGHAN. Off the record a second.

(Off the record at 2:48 p.m.)

(On the record.)

MR. O'CALLAGHAN. Let's go back on the record

BY MR. O'CALLAGHAN:

Q. Is it your understanding that the stick shaker settings on the 650 were set to provide at least to some margin to stall even in ground effect?

A. I can't answer that question. I don't know.

Q. In general would stick shaker be expected to provide warning or margin from stall even in ground effect?

A. Well, you asked two questions in general I would think. I would think that shaker would always proceed aerodynamic stall. In ground effect I don't think we understood, you know, in hindsight where shaker, shaker might be coincidental or maybe past aero stall.

Q. I understand that and that's fair.

A. Then I can't say where shaker was set on Flight 88.

Q. You mentioned, you questioned the 0.5 degree margin between where alpha SR was set and alpha stall, I guess can you describe what concerns you had there and -- and then you also mentioned that you were assured that it was fine. So can you just elaborate a little bit on your concerns there and by whom you were assured?

A.   Well, a half degree margin can mean almost a zero margin. So we don't have angle of attack veins anymore, we are computing angle of attack based off the smart probes whose error gets greater the slower you go. And I was assured by Bob Mills.

Q.   You mentioned I think it was on the GV that the air plane received a CC originally with only flaps 20 and then some subsequent testing was done to expand to flaps 10.

A.   Right.

Q.   Was that strategy ever considered for the GVI?

A.   I'm not sure. The GV program started out as an 11-month program because the airplane was originally based on being a GIV with increased gross weight. And we changed everything because of competitive issues with one of our competitors in building a similar type airplane. The ante kept going up about how high and how fast you could go and how far you can go and the airplane changed over time, but the original 11-month program did not change. So in order to make the 11-month program, which took 16 months to do; we only did the one Flap 7.

Q.   There seemed to be similar schedule pressures on the 650 so was the kind of solution that was found for the GV, just doing one flap at a time, to your knowledge, entertained on the 650?

A. I don't recall it ever being discussed with me in the room or at a meeting.

Q. On the subject of schedules, I'll ask this kind of candidly I guess. Given the situation you described for schedule pressures across several programs, does anybody take schedules seriously, do you think?

A. I do. If we are given a task to perform we always try to meet the task and the end date. As I said before to Bill's questions sometimes events take care of themselves. If we can't meet the internal date we always try to meet the external date.

Q. You mentioned that the GV report ended up in a probable cause, and corrective action or those were mentioned in the report. Can you describe what those were, the probable cause and the corrective actions?

A. As I recall, I'm going on memory now, that we had a 10 knot limit for everything we were doing including V_{MU} at the time. We were testing at the limit and there was a cross wind. I think the data showed that there was a slight gust, not much, but a gust that occurred at the time of rotation from the left and that's the wing that kept flying and the right wing stopped flying. We showed also that the pusher fired even though the pilot, the FAA pilot beat the pusher by pushing forward, leveling the wings and we landed. That was the probable cause. Testing at wind limits, a gust occurring.

Q. So in terms of corrective actions?

A. Corrective actions were to reduce the wind limits for testing to 5 knots or less, preferably zero and no gusts allowed.

Q. Do you think that the effort spent on that, I think you mentioned that the level of effort had something to do with the FAA being on board. Do you think they made too big a deal out of that event, made kind of a mountain out of mole hill there?

A. I don't know FAA policy, but events like that but I would imagine that a roll off and in-ground effect during a V_{MU} testing would be something that deserved investigation. I don't know I asked the FAA pilot to stop, I suggested and he agreed that he would not do those maneuvers anymore. I did them and we brought a company pilot out to fly with me and the FAA engineer I think participated on the jump seat, I can't remember if she was on or not.

Q. I presume you are familiar with the difficulties that the G650 team were having in capturing the V_2 speeds?

A. Yes.

Q. The question I have asked several of the pilots is whether those difficulties for that particular maneuver, or that demonstration is something they had seen on other programs either at Gulfstream or in other places. So is that particular difficulty is that something you have seen before with other airplanes anywhere?

A. No.

Q. So the follow along would be since that seemed to be unique to the G650 was there any discussion or suspicion that perhaps there was something fundamentally wrong in the fundamental physics of how the V_2 speeds were put together or the speed schedules put together?

A. I can't answer that. I wasn't directly involved in those discussions.

MR. O'CALLAGHAN. We have a general close question but we will leave that to the end. That's all I have.

BY DR. BRAMBLE:

Q. Let's go back to the flight operations manual. So you can just review the policy on pilot use of medications and then provide a brief synopsis of your interpretation of how the policy works.

A. Well, it looks like it's warning the flight crews of the danger of self-medication. Only use drugs that are prescribed. And if you use over-the-counter medicine then you should be aware of the potential affects.

Q. If a pilot was to take an over-the-counter medication how would they determine whether or not the medication is compatible with safe execution of flight duties?

A. Well, he can read the label and/or he call our flight surgeon who is Larry Lynch, works right here in Garden City. He is always available for questions. And if he is not available we have another doctor who is friends with a lot of people in the flight department. He is also an AME, Dr. Rick Roth. He can answer questions as well.

Q. To your knowledge, was any member of the flight crew on the day of the accident taking any over-the-counter medications?

A. I have no clue.

DR. BRAMBLE: All right. I think I'm going to pass it on to Marie.

MS. MOLER: No questions.

DR. BRAMBLE: Mike?

BY MR. BAUER:

Q. You took part in the SRB for the field performance testing?

A. I did.

Q. Was the use of the telemetry trailer or telemetry required for the flight testing, for field performance testing?

A. I don't remember.

Q. In your experience, do you think TM is required for use for field performance testing?

A. Well, it wasn't required for the GIV or GV, GV-SP and G450, so I would say no.

Q. If telemetry was required for use would it be something that would be reflected on the TSHAs?

A. Yes.

MR. BAUER: I don't have anything further.

DR. BRAMBLE: Okay, Mitch.

BY MR. GALLO:

Q. I'm looking at a flight operations organizational chart and it has, it lists John Salamankas as chief production test pilot, and you have Butch Alan as chief production test pilot for G150/G200. Is there a chief experimental test pilot?

A. That's me.

Q. Because it's not listed in the black line.

A. Well, my card says Director of Flight Operations Test/Chief Test Pilot.

MR. RAMEE: Perhaps you would like to share that chart with him and he might be able to explain.

MR. O'MEARA: I can probably picture my name right now.

MR. GALLO: No, it was just the one question. The title was missing out of that block.

BY MR. GALLO:

Q. In the Safety Review Board for October 7 the cover sheet has chief test pilot and has John Salamankas written in there and it is crossed out and there's Kent Crenshaw in there and crossed out and it has your last name written in there.

A. Right, because I was supposed to be out of town and whatever trip I was supposed to go on cancelled. So I had delegated John Salamankas first to act in my stead and he I think had an issue and then I asked Kent to do it and then I showed up.

Q. Have you been involved in any way in previous skill performance testing?

A. Yes.

Q. As a pilot or on the ground?
A. Pilot.
Q. What is your comfort margin between shaker and aerodynamic stall in-ground affect; what would that be in AOA terms?
A. I would look for 1 degree.
Q. And nothing below 1 degree, below that that would make you nervous?
A. That's why I questioned the half degree margin that was stated at the SRB and I have a lot of faith in Bob Mills and he assured me it was okay so I accepted his word.
Q. Who do you talk to within Flight Sciences the most?
A. In Flight Sciences I talk mainly to Pat Connor. And I will occasionally talk to Bob Mills but more on the social nature than a professional nature.
Q. Why don't you talk with Ms. Shelly Brimmeier because she is group head? Why would you choose Mr. Pat Connor?
A. I have known Pat ever since I have been at Gulfstream when I started dealing with performance engineers. So he's my comfort level. I know Shelly very well. Shelly is a good engineer a good second source and I call her for help on mundane things, questions coming from operators.
Q. Did Mr. Connor ever express to you or do you express to Mr. Connor any ideas of raising V_2 rather than pursuing rotation development as a way to capture $V_{2?}$

A. I think I answered another question similar to that where I said I was not involved in those conversations.

MR. GALLO: That's all the questions I have.

DR. BRAMBLE: Do you want to move on?

MR. GALLO: Just one more question.

DR. BRAMBLE: All right.

BY MR. GALLO:

Q. Did any of the experimental test pilots bring to your attention that V_2 was unattainable and they suggested to raise V_2?

A. You mean prior to the accident?

Q. Correct.

A. No.

MR. GALLO: That's all the questions I have, thank you.

DR. BRAMBLE: All right, Jeff.

BY MR. BORTON:

Q. Just a staffing question, John, do you typically for the deployments like to Roswell for the pilot crew parings, is that a decision made by yourself or is it at the project pilot level or how does it --?

A. It was done at Jake's level, project pilot.

Q. And similar then he would decide as well or interact with the decision on flight test engineers and the support that way as well, right?

A. He might be informed of whose going.

Q. But it's a Flight Sciences decision?

A. It's a Flight Test call to decide who is going to go.

MR. BORTON: That's all my questions.

DR. BRAMBLE: Okay. Lorenda?

MS. WARD: No questions.

DR. BRAMBLE: Tom?

BY MR. HORNE:

Q. This may sound similar but it is intended to be a little different. Prior to the accident probably based primarily on the SRB but anything else you may have learned, what was your understanding of how the shaker was to be used in field performance testing?

A. As a do not exceed alpha.

Q. Were the GV corrective actions from the incident, rolled over into the GVI program?

A. Yes.

Q. Less than five knots?

A. Correct.

MR. HORNE: Those are my questions.

MR. O'MEARA: He said he's got a follow-up.

DR. BRAMBLE: Shall we go around? John?

MR. O'CALLAGHAN: No.

DR. BRAMBLE: Mike?

MR. BAUER: No.

DR. BRAMBLE: Mitch?

DR. BRAMBLE: Mitch

BY MR. GALLO:

Q. One follow-up question. You oversee the production test pilots; is that correct?

A. Through John Salamankas, yes.

Q. So in your position and you said the company has been growing since GV and the GVI and you are hiring more pilots, before the accident how much time were you spending day-to-day on production test issues versus experimental test issues?

A. I spent very little time on production test issues because I have John to take care of that. If there is a policy issue or a question about something mundane like how much vibration can be indicated on the instrument before the Engine is called into question for quality, that's when I would get involved.

MR. GALLO: Thank you.

DR. BRAMBLE: Lorenda?

MS. WARD: No.

DR. BRAMBLE: John, you have more?

MR. O'CALLAGHAN: The famous wrap-up question.

BY MR. O'CALLAGHAN:

Q. One thing we have been asking everybody and offering an opportunity to help us out is that you know we are nearing the end of the fact gathering phase and we are going to be going back to Washington, and doing our analyses and preparing reports and this culminates in two things. One is finding probable cause, what happened. But the second and probably in my mind even more important product is our safety recommendations to the industry to hopefully improve things across the board.

So knowing that, you know, the accident has been on the hearts and minds of everybody here probably more than anybody else since the months that it occurred and you have all been thinking about it very hard, I'd like to request that if there is anything we should be looking at that we don't appear to be looking at based on our questions you could suggest it and point us in that direction as one question.

And the other is if there is anything in general that you think we should be considering in terms of recommendations to the industry to help improve things across the board, we would like to hear that too. So it's wide open that way for anything you would like to offer either now or through Tom Horne in the future.

MR. RAMEE: Let's take a break before you answer that question, please.

(Off the record at 3:11 p.m.)

(On the record.)

DR. BRAMBLE: Back on the record. So we are ready for the answer.

MR. RAMEE: I don't think you need to re-ask your question.

MR. O'MEARA: Well, to your first question I don't think

I have anything to add to your method of investigation, no suggestions for improvement.

And the second question for recommendations that I would like to see come out of your report would be that there be more communication within the industry, especially in the flight test of procedures and assumptions and lessons learned in a more or less veiled way of presenting them. If there is some way we can outwardly or openly communicate with our counterparts at different OMs without fear of reprisal from a competitive stand point. For instance, if Bombardier were able to take the information we might give them and use it in an ad campaign against us.

MR. BAUER: May I ask something in follow-up?

DR. BRAMBLE: John, do you have anything else?

MR. O'CALLAGHAN: No, thank you.

DR. BRAMBLE: Yes, go ahead, Mike.

BY MR. BAUER:

Q. From speaking I guess to your production test pilots and your experimental test pilots, how many of them are involved in something say SETP, Society of Experimental Test Pilots?

A. Well, all these experimental test pilots belong to the society and there are a couple of production test pilots like Chip is coming in next, he is applied and I think there is one other that may have applied.

Q. Do you know if they regularly attend, I guess their symposiums or their meetings?

A. Well, the main symposium to go to is the one that is every September/October time frame in Anaheim now. It used to be in Beverly Hills. We do sponsor a table for the dinner every year although we are usually pretty busy and with the emphasis that that symposium is mainly military. So there's not much to learned there for us.

MR. HORNE: Can I follow-up one?

DR. BRAMBLE: Yes.

MR. HORNE: Do you know if there is a publication of those symposium minutes for things that the pilots will be reading to get any lesson on it?

MR. O'MEARA: Yes. There is a report published after that symposium then it is available for reading, yes.

BY DR. BRAMBLE:

Q. One more follow-up on that just in terms of the barriers to sharing information because of the competitive pressures. Is that a concern that you have heard expressed from other manufactures too?

A. I rarely talk to other manufactures other than, for instance, at an industry meeting like NBAA. Or I participate on a GAMA committee that general aviation manufacturers association, flight ops committee or to interface with pilots from other OMs but they are generally demo pilots not test pilots. But some our competitors are very competitive and will use anything whether it's true or false to their advantage to get an edge on us.

Q. Can you foresee any ways -- do you have any ideas about how that kind of information sharing might occur in a way that would relieve the potential downside?

A. I think we would have to be very generic in what we are describing and try not to allude to it as you are hurting the program, for instance. Something I would have to think about for a while and work on it.

Q. Can you envision a way where the information might be somehow stripped of identifying information?

A. Well, that's one way to do it. You know there are flight test safety workshops that occur periodically. We hosted one here in Savannah a few years ago and that might be a forum for doing that if you can do it with a, in a generic way.

BY MR. BAUER:

Q. Do you feel that you learned from or basically you get a lot of -- let's say where you get information about flight test accidents would be from past manufacturer flight test accident in the business aviation world. Is that where you get more --

A. Generally the information that we can glean from other OMs, or accidents or from the NTSB reports.

DR. BRAMBLE: Anybody else? All right. Well, thanks very much for your time, John.

(Whereupon, at 3:20 p.m., the interview was concluded.)

CERTIFICATE

This is to certify that the attached proceeding before the

NATIONAL TRANSPORTATION SAFETY BOARD

IN THE MATTER OF:	AIRPLANE ACCIDENT ROSWELL, NEW MEXICO N652GD Interview of John O'Meara
DOCKET NUMBER:	DCA11MA076
PLACE:	Savannah, Georgia
DATE:	October 27, 2011

was held according to the record, and that this is the original, complete, true and accurate transcript which has been compared to the recording accomplished at the hearing.

Letha Wheeler
Official Reporter/Transcriber

UNITED STATES OF AMERICA

NATIONAL TRANSPORTATION SAFETY BOARD

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Investigation of:

AIRPLANE ACCIDENT
ROSWELL, NEW MEXICO
N652GD

Docket No.: DCA11MA076

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Interview of: WILLIAM OSBORNE

Gulfstream Corporation
500 Gulfstream Road
Savannah, Georgia

Wednesday,
October 26, 2011

The above-captioned matter convened, pursuant to notice, at 9:00 a.m.

BEFORE: WILLIAM J. BRAMBLE, JR., Ph.D.
Senior Human Performance Investigator

APPEARANCES:

MITCHELL GALLO
Air Safety Investigator
National Transportation Safety Board
31W775 North Avenue
--------------------is 60185

WILLIAM J. BRAMBLE, JR., Ph.D.
Senior Human Performance Investigator
Office of Aviation Safety
National Transportation Safety Board
490 L'Enfant Plaza East, SW

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ALAN J. (JEFF) BORTON
Flight Test Pilot
FAA Aviation Safety
Aircraft Certification Service
Wichita Aircraft Certification Office
--------------------Room 100

THOMAS M. RAMEE, ESQ.
Deputy General Counsel and Risk Manager
Gulfstream Aerospace Corporation
500 Gulfstream Road, M/S B-06

TOM HORNE
Experimental Test Pilot
Gulfstream Aerospace Corporation
P.O. Box 2206, M/S A-12
Savannah, GA 31402-2206

APPEARANCES (Cont.):

JOHN O'CALLAGHAN
Aircraft Performance Group Chairman
Vehicle Performance Division (RE-60)
  Office of Research and Engineering
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

-

MICHAEL BAUER
Aerospace Engineer
Vehicle Recorder Division (RE-40)
  Office of Research and Engineering
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

E. LORENDA WARD
Air Safety Investigator
IIC and U.S. Accredited Representative
Office of Aviation Safety
Major Investigations (AS-10)
National Transportation Safety Board
490 L'Enfant Plaza East, SW

MARIE MOLER
Mechanical Engineer
Office of Research and Engineering
Vehicle Performance Division
National Transportation Safety Board
490 L'Enfant Plaza East, SW

I N D E X

I N T E R V I E W

(9:00 a.m.)

INTERVIEW OF WILLIAM OSBORNE

BY DR. BRAMBLE:

Q. So, Mr. Osborne, could you please state your full name?

A. William Mark Osborne.

Q. And what was your date of hire with Gulfstream?

A. It's September 1985.

Q. Okay. And your current position title?

A. Principal engineer, flight test.

Q. And which office are you in, Flight Test Engineering?

A. Flight Test Engineering.

Q. What are your roles and responsibilities as principal engineer, flight test?

A. I report to the manager of Flight Test and, in that capacity, I'm responsible for large projects or first-time projects, basically, primarily in research and development and looking at new product development as well. And it would cover everything from operations -- mostly operations in terms of preparing test plans, approving test plans, test procedures, reviewing basic operations, in some cases, and recently it's been also making crew selections for the G650 for Flight Test Engineering.

Q. Do you mean pilots when you say crew selections?

A. No, sir, flight test engineers only.

Q. Oh, I see. Okay. Do you also approve test requirements documents?

A. No. I am on the review and provide opinion on them, but I do not -- I'm not on the approval process. That's for the manager levels and above.

Q. Okay. And your previous Gulfstream certification programs worked?

A. I've worked at the GIV, the GV, the GV-SP, and the G650.

Q. All right. In looking at the org charts, one of the things that we're hoping to learn a little bit more about this week is how Reece Ollenburg, Ken Obenshain, and Phil Burton, and you relate to one another in the context of the flight test program. I wonder if you could explain that for us?

A. My particular role, I have no direct reports, so my job is mainly in a technical, almost a technical advisor role. But I do get involved in day-to-day operations and I take an active part in being a test conductor and directing that. So I'm actually in that part of it, but I don't have any direct reports in terms of assigning work other than just what has been recently been added to my list, which is to make sure that we have the right FTEs with the right skill sets on the right airplanes for certain tests.

Q. Is that post-accident?

A. Yes.

Q. Okay. And who was --

MR. RAMEE: Can I suggest he finish the answer to the question? Because you were asking about his relationship to those three guys. I think he gave some preamble to it, but didn't really answer the rest of it.

DR. BRAMBLE: Sure.

MR. OSBORNE: So Phil Burton is, in the org chart, is the lead for the Operations Group, which oversees the airplane coordinators; and then Ken Obenshain is the chief flight test engineer. His role is similar to the principal engineer, but he reports to the director of Flight Test, so he's even one level above that. And I think with regards to Reece, Reece was actually in Department 343, which is Flight Test Engineering, which reported to the group head and then to the manager of Flight Test, so through that chain.

BY DR. BRAMBLE:

Q. And who do you report to again?

A. The manager of Flight Test, Curt Cromwell, at the present time.

Q. Okay. So during the flight test program for G650, how did you and Ken and Phil and Reece, Mr. Ollenburg, how did you interact with each other? Did you meet weekly?

A. In the initial stages of the program, there are weekly flight test meetings which were to basically disseminate information to all of the group, and that was run by the flight test group lead, Paul Donovan. And essentially, it was a roll-down of information from the management meetings, as well as we would talk about certain topics of interest that varied weekly, trying to keep everybody up on the latest things.

As far as the rest of the interaction goes, we were each assigned -- each of the test airplanes had primary and secondary lead FTEs assigned to it. And I had 6001; Reece and Paul had 6002 -- or, I'm sorry, Reece and Peter Hendy had 6002. And so in our interaction mostly on that, we were kind of on a peer-to-peer basis with regards to the airplane side of it. But their airplane had different tasks assigned to it and mine had different tasks as well, so it wasn't something that we had to collaborate on in a routine fashion.

Q. And how much of your time was taken up with the sort of overseeing of what was going on with airplane 6001 versus review of these various other things that you look at?

A. For all essential purposes, I was dedicated to 6001.

Q. And did you review the field performance test plan and test cards for 6002?

A. No, sir, not in any detail.

Q. How about the SRB, did you participate in the SRB?

A. I did attend the SRB; that's correct.

Q. Okay. This is the SRB for field performance?

A. For field performance testing.

Q. Okay. All right, are you familiar with the 1998 flight test practice manual, standard practice manual?

A. Yes, sir, I am familiar with it, aware of it.

Q. Let's pull that out here. All right, so the flight testing or practice manual defines a number of different positions and job responsibilities and they're listed on that page and I think the next page there's -- if you could kind of maybe go down, starting with the manager test coordination, and then sort of just briefly talk about how this structure may have paralleled the actual roles and responsibilities on the G650 program?

A. Okay. It's listed here, the manager of test coordination. That would mostly closely fall into the manager of Flight Test, I would -- at the moment. Do you want me to go through each of the roles as well?

Q. No, just sort of in general if you could just briefly summarize sort of what they did and who it was.

MR. RAMEE: And if more than two people are performing a task, then --

BY DR. BRAMBLE:

Q. Yeah, I'll add that the manual states that depending on resources, these roles may be combined or divided, but I'm just sort of interested to see how closely the organization parallels this structure.

A. At the time this was prepared, the manager had two responsibilities: Flight Test Engineering as well as the instrumentation side.

Q. Okay. And real quick, when you first started answering about manager of test coordination, you said he mostly closely --

and I missed the second part of that.

A. This description most closely now maps to the manager of Flight Test --

Q. Okay. Curt Cromwell.

A. Right. The organizational since then has been divided up to where they have split off, where the manager of Flight Test Engineering is solely for that and there's a separate manager now for Flight Test Instrumentation.

Q. Is it post-accident?

A. Actually, it was prior to that, I believe, but it was -- at the time this manual was in effect or when this was released, the instrumentation functions and the engineering functions were covered by one manager.

Q. Okay. And then after the manual came out in pre-accident, the engineering and the instrumentation functions were split out to different people?

A. Correct. The department was reorganized, and I apologize, I don't remember the exact date of that or even the general time frame.

Q. And who does the instrumentation function, or did at the time of the accident?

A. At the time of the accident it was Bob Carpenter as the lead and now currently the manager.

Q. All right. And then the next position?

A. The next one is the test coordinator, and this mostly relates to the airplane coordinator, what we would call the airplane coordinator right now, and they would be responsible for preparing the daily work activity, including maintenance required, configuration changes that are managed through the Flight Test work authorization. Basically, it's closely related to what I consider mostly a configuration control function as well as scheduling for a short work period, like 2 weeks or so.

Q. And so who does that kind of correspond to, who did it at the time of the accident?

A. It varies. Each airplane has its own coordinator. So 6001 has Nick Altomare, and 6002 at the time was Tony Franzel.

Q. Okay. And the next one?

A. The next one is a test conductor. These are what we were considering the lead FTEs and they would be responsible for the actual preparation: taking the test plans, putting them in the test cards, organizing the flights taken from various test points to make an efficient flight, briefing the cards to the pilots and the crew, most likely participating as part of the crew, making sure all the test points were completed, noting any deviations, and then coming back and reporting the flight results would be their primary responsibilities.

Q. Okay. And how about the next position?

A. The next one, this is a test specialist. That would be someone still in the Flight Test Engineering role, but it would be more specific to a role such as a given test, like fuel performance or stability and control or systems -- even within that certain systems. So these are the individual FTEs that would have the responsibility of preparing a test plan, assisting also with the cards and making sure that instrumentation requirements were specified correctly and that they had everything needed and documented for proper conducting of the test and collecting the data and showing compliance with the appropriate regulations.

Q. Would that person also be called the cognizant FTE?

A. Yes.

Q. Okay. And the next one?

A. Test analyst. This one is a function that's specified. In our practice today, it's more combined with the test specialist. We consider basically one of the roles of the specialist is also to take on the analyst functions of the testing that is done. It's not as dedicated or as parsed out as this indicates. It's sort of combined with the test specialist in actual practice.

Q. And was that also combined on the previous programs you worked on?

A. Yes, going back all the way to the GIV. The GIV was a little different. We actually were contracting with Lockheed at the time and they were providing specialist help and also were providing testing analysts specifically for that role. But for all of the recent programs, GV onward, it's been that way, as described here or with the combined.

Q. Okay. Is there one more position left or is that the last one?
A. There's one more, the instrumentation engineer, which we kind of talked about and the configuration control engineer and the FAA coordinator. So three more.
Q. Config control, who does that?
A. As listed here for the task, it's basically been assumed by what would be listed here as the test coordinator, which is the airplane coordinator, what we call them today.
Q. And the last one?
A. FAA coordinator.
Q. Who's that?
A. That role was maintained by multiple people actually. There are project engineers that are assigned, I think, that help with that, as well as Phil Burton used to do that role as well. And it was basically to assign what tests go under what TIA, organize it, and keep the FAA informed so that their resources could be allocated as needed to support the program.
Q. All right. One of the things that has come up in other interviews is the idea that maybe there weren't as many test analysts on the G650 field performance test program as there were on previous programs like, GIV, GV, and I just wonder if you had any comment on that, whether that's consistent with your impression or not?
A. It is consistent with that. I mean, the last field

performance test that I actively participated in was on the GIV, and at that time -- and I don't know how you attribute it, if you attribute it to technology advances or what the reasoning being, but at the time there were a considerable number of engineers present that were doing support roles for the data analysis and that was my introductory job at the time.

Q. It was as an analyst?

A. Yes.

Q. And so, how did that work when you were on scene and -- did you do the testing at Roswell?

A. We were there. I had been with the company about a year and I was assigned to senior FTEs basically to help facilitate their role, and I think my specific function was basically the rolling coefficient of friction, rolling MU.

Q. So during the actual testing, were you analyzing that on a daily basis as they were testing and then providing results to someone?

A. Yes. We would essentially look post-run. The data would come in and we would start pulling the data appropriate to that particular point. The specific items that I was looking at were not considered critical for going on to the next run or looking at data in terms of the things like speed criteria and things of that nature, but that was the assignments as then.

Q. And were there enough analysts to keep up with the pace of testing so that data were analyzed prior to -- or what kind of analysis was done after the end of testing for the day prior to the next day's testing?

A. There were two things. Between runs, we'd have plots that were produced, the time histories that we would look at everything associated with the event times so that you could determine key events, what speeds were obtained that matched with those events. And basically, I think they would run through a quick estimation of what the distance were -- distance, they were determining with that. So they would do a quick reduction of the data mainly to determine the validity of the run, whether a repeat was required, if all of the parameters were appropriately met and all the key targets were asked of the crew were also met within the tolerances.

Following the day's activities, there was a limited after-hours shift that would then further process the data and review the next morning prior to commencing with the activities, is my recollection.

Q. How many people were on that second shift?

A. I think, four or five.

Q. And were they from Flight Test Organization or Flight Sciences?

A. It varied. Most of them were from the Flight Test Organization, and most of them, I think, were actually Lockheed contractors that were also doing other maintenance tasks, such as backing up the data.

Q. Now, what time frame was this in terms of the years that --

A. 1985, 1986. Actually, 1986.

Q. And so, technology-wise, did you need a lot more people just because you didn't have the same kind of technology you have today?

A. At the time it seemed appropriate. I mean, that would be it. The technology on board, there was no real graphical displays that you were capable of generating real time. You pretty much had to get a hardcopy plot of the time history data, which was something you couldn't do very well otherwise. So, I think it was more labor intensive, yes.

Q. How many people do you think it would take to do the same thing today?

A. Somewhere six to eight, I would think.

Q. During the second shift?

A. I guess it depends. Yeah, I think during the second shift, I think it would because you're still looking at -- I guess I'm looking at two different roles in terms of being able to manipulate the data and go back through it. It's a little quicker to go through, but there's more of it to go through.

Q. So you said initially that on the second shift there might have been four or five people and that it might take fewer today with today's technology. But you think it would take six to eight or -- so, initially, were you not including contractors?

A. Well, I think, initially -- I think on the GIV program, and it's going back a long way, but I think that was mostly probably data archive, though I don't know that there was a lot of analysis that was done during the night.

Q. So I guess what I'm wondering, more specifically, is in order to do the same level of analysis at the end of the day prior to the next day's runs, and you can manage the data reasonably so that you have it backed up and you've got it marked and placed in a form that's suitable for analysis, how many people would you need on that second shift given today's technology?

MR. RAMEE: Excuse me. I'm kind of confused by the question, Bill. Are you asking to do the same --

DR. BRAMBLE: Off the record.

(Off the record.)

(On the record.)

BY DR. BRAMBLE:

Q. There's a certain amount of post-test analysis that was considered desirable on GIV, where during the test runs, there was some analysis happening or reduction or something and then in the evening there was some degree of analysis that was occurring, or no?

A. There were two different objectives, I think. The analysis that occurred between runs was to determine the validity of that run and whether we met the criteria that we were attempting, attempting. Stuff that occurred post-process was taking that information that we had basically reduced during that day's flying and applying it back to an expansion, if you will, that would determine if the performance goals were being met with regards to field length and things of that nature, which we commonly refer to as the guarantee points.

Q. Okay. So, you described what type of type of analysis was done during the testing and what type of analysis was done after the testing.

A. Correct.

Q. All right. You talked about how many people were working on that second shift to do that. You haven't told us yet how many people were doing that kind of between-run analysis in the old days. How many people was that?

A. In the control -- no, they weren't really control rooms. But in the rooms that we were occupying at the time, I remember somewhere between probably 10 to 12 people in that room, from the test conductor -- trying to go through each role, from the test conductor to the senior FTEs that were looking at the specific event marks, and there was one Lockheed test conductor on board the airplane, and then there were probably another six or so people behind the scenes of them that were preparing plots and getting the data in a suitable presentation form that they could interpret or read quickly.

Q. Okay. Now let's go to Tom's question, which is, for those same functions of data reduction analysis and putting it in an expansion to put it into a form to determine whether criteria would be met for the next day, given today's technology, how many people would be required during the test runs and/or possibly on a second shift, analyst people?

A. I think with the capability that we've seen so far, I mean, in terms of looking at the data and making the conclusions from what the Roswell equivalent was back on GIV, it's certainly a reduced number. Because the presentations are done ahead of time; you don't have any sort of manipulation of the data that has to occur in order to get it in a presentation form. It's just sort of displayed in a readable format either through time history charts, strip charts, whatever. My feeling would be four could do it adequately.

Q. Is that four total or four in the evening or during the day or --

A. Well, I guess I would look at it the same way. I think the evening analysis would be, again, more associated with taking the day's results and trying to determine if you're meeting the company goals. So that would be more of the expansion side. And I think in terms of monitoring the flight to see that they're meeting the parameters, a couple of people could do that with it properly laid out.

Q. So you'd need a couple of people to monitor during the day and four in the evening? How many analysts per day would be needed?

A. Well, again, I think two would be appropriate for the conduct of the test. And then depending of what level of fidelity you want, I would think probably four people at night to look at the expansion side to see if you're meeting the goals and if there are any other type of issues that could be gleaned from the day's results.

MR. RAMEE: Bill, I'm not --

DR. BRAMBLE: Off the record.

(Off the record.)

(On the record.)

DR. BRAMBLE: Let's go back on the record.

BY DR. BRAMBLE:

Q. So you mentioned that the purpose of having four people to look at the expansion site at night was to see if the testing was meeting company goals and if there were any other issues that could be gleaned from the day's results. Do you think --

A. That's in context, I guess, to what my experience is with the GIV. Now, obviously, I think you could define different roles, as John kind of pointed out, that you could do at night looking for different things depending on what objectives you have in mind for it. But taking it from what I observed with the GIV, that was kind of what they were more interested in, in terms of any post-analysis or post-test analysis, where they weren't necessarily involved in the run to run derivations, but they were taking that information and then trying to see if what we were doing or the data we were finally obtaining were going to meet the guarantee points.

Q. And do you see any potential safety benefit to having that analysis occur rather than just reducing the data and putting it in a format suitable for analysis and taking it up at a later time after the testing is over?

A. I think anytime someone's looking at the data, there is the benefit that something out of the ordinary or something that doesn't look quite right can be spotted. So my personal opinion is the more eyes on it, the better.

Q. So if there's some type of unusual airplane behavior or unexpected airplane behavior, would it be more likely noticed if you have additional people examining the data in the evening?

A. I think just based on the fact that more people are looking at it, that possibility is there. I can't say for certain that it would be.

MR. HORNE: Can we go off the record?

(Off the record.)

(On the record.)

DR. BRAMBLE: On the record.

BY DR. BRAMBLE:

Q. So if the labor is divided that way and you have people in the evening who are responsible for doing the expansion and comparing the airplane performance to company targets, does that free up the attention of the engineers who are directly participating in the test to detect potential exceedances or safety-related issues that may arise during the test?

A. Yeah, I think it relieves them of additional burden that's not related to the conduct of the test, per se. If you're looking at the events that are occurring and you're making sense of it in terms of that small scale and you're not having to be concerned with whether or not you're meeting the overall objective, I think, you're basically measuring what the airplane capability is and that's what you're looking at, at the time.

Q. All right. So are you familiar with the level of staffing for analysis during the G650 field performance test --

A. I am now. I wasn't at the time. I mean, it was basically, like I said, my roles were on 6001, so I was not involved in the staffing or the levels of rotations that were going out to Roswell.

Q. Okay. Now that you know the staffing levels, do you feel that they were adequate for the G650 field performance testing?

A. It's hard to answer that one. I don't know the people that well that were assigned and involved. Reece had been here just a couple of years. I mean, I trust the judgments of those that made the decisions and, based on what I knew, I was comfortable with those people that were out there based on what limited work relationships I had developed with them at the time. I had no reason to suspect anything else.

Q. And you mentioned that your duties now include matching skill sets for the FTEs. Does that include for field performance?

A. No. That's a dedicated test that's already been -- the personnel involved with that will be assigned and dedicated to that test. Basically, what I do now is for day-to-day activities within Savannah just to make sure that within -- if we have a vacancy or we have an absence or something like that, that we get the appropriate person to fill the slot.

Q. Okay. How were the data review reduction analysis and expansion tasks supposed to be divided up between Flight Sciences and Flight Test during company field performance testing, if you know?

A. I don't. I didn't participate in any of the test -- interviews where those type of items would occur.

Q. And how about during GIV, how was it divided up?

A. For the Flight Sciences personnel?

Q. Well, what I'm getting at, I guess, is in terms of reviewing the result coming out of the tests, reducing the data, analyzing it and expanding it, was that a Flight Test responsibility, was it a Flight Sciences responsibility, or did they share it in some fashion?

A. I think sharing it would be the best way to describe it for the GIV program. My recollection is the Flight Sciences personnel were actually loaned to the Flight Test and took direction from the Flight Test engineers in terms of what work they would be doing for that. There was also another contingent of Flight Sciences folks that were basically looking at the expansion results, so it was kind of a two-fold thing. My role at the time was I was actually loaned to the Flight Test group.

Q. Are you familiar with the roles that were being performed by each person working in the TM trailer during the field performance testing?

A. For 650?

Q. Um-hum.

A. No.

Q. On the day of the accident? Same answer; no?

A. Well, since the accident, yes, I'm aware of who was doing what role, at least in terms of the test conductor in the TM room that was communicating back with the airplane. But in terms of the other aspects of it, I don't know -- or the other people that were in the room.

Q. That's the other question I have. The test conductor in the TM was Cynthia Townsend?

A. Um-hum.

Q. Why is she called a test conductor?

A. Force of habit, I guess. Given the way it's structured, the FTM on board the airplane is actually in charge of the test. And the TM room at this particular time would be for assisting that, safety of flight monitor, safety of test run.

Q. So what would you envision that role involving for a continued takeoff testing for the flight test engineer in the TM?

A. I think it would parallel exactly what the FT on board was doing, which would be making sure that all the parameters were within limits with regards to all the safety hazards that were briefed. That would be the primary function, and confirming that the targets were appropriate and correct. So basically, it would be a backup of the on board as a checks and balance.

Q. Okay. So Reece Ollenburg was the cognizant FTE for field performance, onboard test conductor, data analyst, and report writer for the takeoffs on 6002. Does that seem like too many responsibilities assigned to one person for the time frame to you?

A. No. It's kind of the way we were set up to do it. The field performance would have a certain period of high activity, but then the other duties were such that you focused primarily on those related to the field performance side of it so that way you would be prepared for all of it. There are days when you have a lot to do and there are some days when it's more manageable, in terms of being able to prepare upfront, but that was not an uncommon way for us to do things.

Q. Okay. And then considering the fact that there was no second shift of four or five people, does that factor into your assessment at all?

A. No.

Q. So who should have been taking up those duties?

A. Well, as I understand it now, there were two additional FTEs. Cynthia, you mentioned, one, and I think the other one at the time was, I think -- I'm not sure and I better not --
Q. Are you thinking in the trailer or on the airplane?
A. Well, in terms of working with the field performance data or assisting us, I know that there were additional FTEs to help with that besides just Reece.
Q. You mean like such as landings or other areas of field performance testing?
A. Yes.
Q. Okay. And then let's say that for a week, you're just doing takeoff related work, which was Mr. Ollenburg's role, and the other FTE that did landings, which was Paul Donovan, was not there. It was just Mr. Ollenburg on the airplane and Mr. McCollum on the airplane and Ms. Townsend in the trailer, and then Ms. Brimmeier from Flight Sciences and Eric Upton and Adeisa Mobolaji. Who would you expect would be doing the post-test analysis to prepare and do the expansion and comparative targets?
A. I would expect the Flight Test engineers would be responsible for those parts, again, between Reece, David, and Cynthia.
Q. Okay. And so Reece and Dave were limited to certain duty times based on the company flight policy because they were on board the airplane, right?
A. That's correct.

Q. How many hours a day could they work?
A. Current policy, 10 hours for meeting the high-risk testing.
Q. So would that leave them sufficient time to do the work of the four or five people in the evening?
A. No. Again, I'm not familiar with what the day-to-day activities were, how long they tested, whether or not they had time to do that, what the preparation was for. And I'm not familiar with how Reece would have delegated that among -- or how it may have been delegated among others, so --
Q. Okay. How is corporate technical knowledge retained across programs in Flight Sciences and made available for use? And I guess specifically, how were GIV and GV wing drop incidents reported and analyzed and what lessons were learned from these events and shared with the new team involved in G650 flight test?
A. Yeah. I don't know of any summary information that was readily available at the time of the accident and -- or at least for the wing strike for the GIV. I've since learned that there were SAE papers written. But up until a week ago, I didn't have any knowledge that occurred on that particular program. For the GV, there was a rather significant report written on the wing drop, but I don't recall if there was any specific rolldown or rollout of that information with regards to the preparation for the G650.
Q. All right. Do you know why there wasn't a similar kind

of in-depth analysis done for the wing drops in the GVI program, G650?

A. I do not.

Q. And do you know what kind of analysis was performed by the on-scene team after the wing drops on the GIV?

A. My -- I had very limited direct knowledge of it. I think it was the type of thing I heard about, you know, kind of like in passing in the hall, and so I don't have any direct knowledge. Everything I know about it was post-accident.

Q. Okay.

(Off the record.)

(On the record.)

BY DR. BRAMBLE:

Q. Okay, so let's briefly clarify. You said you had very limited knowledge, when we were talking in the hall, about -- and I believe what you were talking about was what kind of analysis was performed after the GIV wing drops; is that accurate? Or you weren't aware of the GIV wing drops at all until after the accident?

A. No, I was aware that the events occurred, but, again, with the duties that I had with the other airplane, I wasn't -- didn't afford the time and there were other people that were looking at that particular thing in detail.

MR. O'CALLAGHAN: I'm still not clear. Are we talking about the GVI wing drops, Flight 88 or 132, or the GIV?

MR. OSBORNE: I'm talking about GVI.

MR. O'CALLAGHAN: Okay, I think you were asking about the GIV.

MR. OSBORNE: Okay. I'm sorry.

DR. BRAMBLE: Good catch.

BY DR. BRAMBLE:

Q. All right, so your start date, your start year was --

MR. O'CALLAGHAN: I still think you're looking for an answer about the analysis on the GIV wing drops, and I think Mr. Osborne was thinking about GVI wing drops.

MR. OSBORNE: GVI.

BY DR. BRAMBLE:

Q. Okay, so let's go back to GIV.

A. Okay.

Q. I'm not sure at which point you switched gears and were thinking about G650. Were you aware of what kind of analysis was performed by the people on scene after the GIV wing drops?

A. No, sir. I knew there was one, but I didn't participate in it.

DR. BRAMBLE: All right, everybody's satisfied? We can move on? Okay, good.

BY DR. BRAMBLE:

Q. All right. What happened to the Flight Test Organization staffing between the GIV, GV, and GVI programs in terms of staffing levels overall?

A. Let's see.

Q. You don't have to give exact numbers, but --

A. Well, I think in terms of overall, after the GIV, there were some other sustaining programs that came along. There was -- I hate to seem like I'm rambling, but -- there was a GII quiets bay (ph.) program, and I think shortly after that the decision was made mainly to -- at one point they had brought the Flight Test Engineering staff down to about two, and when the GV program was started back up, they started growing it back again. So it sort of fluctuates with whether there's a major program or not. So in terms of numbers, it's kind of gone from as low as 2 to peak probably at 50 during the GV, and then down to around probably 30 for the GVI.

Q. And so, how does corporate knowledge sort of get passed from one effort to the next as far as safety related insights or lessons learned from program to program?

A. Most of my experience had been with the senior level reviews and being able to retain people that were involved.

Q. So the key people on that case, who have been around for GIV and GV, were at senior levels who now -- that would have something to do with field performance testing would be who? Who would have knowledge of it?

A. It's only one name that kind of goes through both. That was Ken Obenshain. He was the manager of Flight Test during the GIV program. He was the on site guy running the test for Roswell

GIV. He was not at Gulfstream during the GV, but I think he was -- he did come back and was part of the review of the analysis report for that wing drop.

Q. All right. Before the accident, what was your understanding of the reduction in stall AOA and ground effect compared to free air, and how did you come to that understanding?

A. I think my understanding of it was related what we had determined from the GIV, which I understood it to be 2 degrees. I learned subsequent to that that some flight test analysis was done in G650 V_{mu} data which came out with a different estimate.

Q. And that you learned subsequent to the accident?

A. Yes.

Q. Is that Mr. Ollenburg's analysis that's graphed V_{mu} report?

A. That's correct.

Q. Was there a discussion of the difference in, in ground effect, stall AOA during the field performance SRB meeting or meetings?

A. I don't recall specifically.

Q. Did you expect that that effect would be further refined as part of the field performance test effort or during the field performance test effort?

A. No. I mean, I believe -- you know, it was my understanding there would be an understanding of it which would be set, but I wasn't aware of any other information that was going to come out of the field performance testing regarding in ground effect other than what was already presented that I learned subsequently about after the accident.

Q. Okay. And what information about in ground effect stall angle was provided to Flight Test prior to field performance testing and who provided that estimate?

A. Flight Sciences Aero would have provided it based on estimations, and I don't recall specifically how it was transmitted or if it was just done in terms of meeting discussions.

Q. And by Aero, you mean which group?

A. Flight Sciences Aero, Applied Aero, which would have been Bob Mills, his group.

Q. And would you have expected Bob Mills' group to have been involved in any further refinement of the IGE stall estimate?

A. Yes.

Q. Did you attend a March 24 meeting about stall protection settings?

A. I did not.

Q. Do you know what was discussed?

A. I recall seeing an e-mail subsequent to it where Reece had requested that a PR be generated to change the shaker set value.

Q. And did you see that e-mail before or after the accident?

A. It was before.
Q. And did Reece give an explanation for the request?
A. I don't recall a detailed one in the e-mail.
Q. Do you recall the nature of the change?
A. It was an increase in the normalized AOA activation point for the shaker value from, I think, .85, from .85 to .90.
Q. And was this a change to a more conservative or less conservative state?
A. It would have been less conservative in terms of regards to --
Q. Safety?
A. -- safety.
Q. So should this change have triggered a reconvening of the SRB?
A. Yeah, I think it should. I think what we're looking at now is basically any configuration changes would require that.
Q. Now, obviously, we have the benefit of hindsight, so --
A. Yes.
Q. -- we know it would have been a good idea. But given what was known at the time, would it have been reasonable to think that an SRB should be convened?
A. My feeling is that the folks involved in that decision at the time, I think that based on what they understood and what they believed to be the degradation of the in ground effect stall that I would agree with them at the time that reconvening the SRB

was probably not necessary.

Q. Do you know if the video from the Flight 132 wing drop was shown at the March 24th meeting?

A. I do not know.

Q. What was the protocol for making changes to the shaker setting and how were such changes reviewed, tracked, and communicated?

A. In this particular event -- I mean, to change it in terms of the production software, if you will, the protocol is to generate a PR, or a problem report, which would specify what the change was to be or what the issue was and whether it was a requirement change or an implementation error, and that would be the direction to get the software changed or updated.

Q. And would there be a board that reviews the PR, or who reviews the PR before it's implemented?

A. There is a Flight Controls PR Review Board that would look at it in terms of what the severity level was considered, how it needed to be implemented, and what the schedule for implementation would be, and subsequently would then review whether the PR corrective actions were adequate so that you could close the PR.

Q. Do you know who would have done that for the stall shaker, the stick shaker change request?

A. It's a multi-disciplinary board consisting of the Flight Controls Group, Flight Test, and Flight Operations, and I think the Safety Group's in there as well.

Q. That was Flight Test, Flight Ops?

A. Flight Controls Engineering.

Q. Flight Controls and Engineering?

A. Well, it's the Flight Controls -- specific Flight Controls --

Q. I see.

A. -- part of engineering.

Q. And would analyzing that change for safety implications for shaker set be sort of beyond the scope of that review?

A. Yes.

Q. Because that would have been assumed to have occurred prior to the submission of the change request?

A. Yeah. I don't believe it's considered by that word in terms of it's -- it's looking at how the change is implemented and basically is the change effective, did it satisfy the PR condition.

Q. They're primarily concerned with --

A. Implementation.

Q. -- when it should be implemented, and then whether its done properly, that sort of thing?

A. And whether it actually fixes the issue.

Q. Okay. And in this case, what was the issue that was being fixed?

A. I believe it was cited as there was -- to preclude nuisance shaker during takeoff.

Q. So would the board then have been evaluating whether or not the nuisance shakers were still occurring?

A. That would have been the criteria for closing it.

UNIDENTIFIED SPEAKER: While you're stopped, do you have the PR process document?

DR. BRAMBLE: Let's go off the record.

(Off the record.)

(On the record.)

DR. BRAMBLE: All right. Let's go back on the record.

BY DR. BRAMBLE:

Q. Why didn't the wing drops during 88 and 132 result in a reconvening of the SRB?

A. I don't know. I mean, the -- I don't know exactly.

Q. Do you know how up those events were reported in your organization?

A. I know they were at least discussed at the director level. I'm not sure of the timing, when --

Q. But before the accident, they were?

A. I believe so. Yes, sir.

Q. Do you have the original staffing requirement and schedule or benchmark for G650?

A. With regards to Performance?

Q. Yes.

A. No, sir.

Q. And do you know how the long-term flight test schedule was established and revised in the year preceding the accident and who had a hand in creating or revising the schedule?

A. There were many people involved. I know that we reviewed multiple variants of it. It changed periodically based on everything from supplier issues to test availability or site availability, such as going to Eglin for specific tests and environmental tests.

Q. And were you aware of a back up of TIAs as the program progressed due to delays?

A. We were certainly aware that there was a time compression in the amount of time that was allocated to try to get those done.

Q. And at the time of the accident, was the schedule for the remainder of the flight testing program feasible?

A. Difficult to say. It certainly was feasible. Everything would have had to work as planned.

Q. And was the work schedule going forward likely to be fairly compressed or -- say that.

A. I think that was everyone's expectation, yes.

Q. And was it more compressed than it would be at that stage of a typical start program for a new airplane?

A. Similarly, it would -- I think there were similarities to the other programs. Certainly, there are key times when you have critical things that are needed to be done.

Q. Did you feel that the end date for the Flight Test program reflected the true status of the effort?

MR. RAMEE: Which end date?

BY DR. BRAMBLE:

Q. Let's say the end date for the last TIA, which I think was supposed to be sometime in July.

A. I thought it was aggressive and, again, I thought it did not account for contingencies that were likely to arise based on what we had seen in past programs where you discover things late or during the testing, and there's no contingency in which to incorporate them prior to the completion of the scheduled task.

Q. And did you have the impression that if those contingencies arose that there would be sufficient flexibility to allow the time necessary?

A. Well, depending on the contingency -- certainly, certification issues or safety flight issues, if they were discovered, they will be addressed, and I had no doubts about that and the schedule would suffer accordingly.

Q. Did you get the impression that anybody would be in trouble if that happened?

A. No, not in that context.

Q. All right. Were you aware of FAA memos, March 31st in particular, that described the program as unrealistic and not reflecting the true state of the program?

A. I was aware of it. I did not have a copy of it or I had not read it.

Q. And did you hear any discussions about what the response would be?

A. No, sir.

DR. BRAMBLE: Okay, that's it for me. Thanks.

John it's to you.

MR. O'CALLAGHAN: Thanks.

BY MR. O'CALLAGHAN:

Q. Just a few clarifying ones.

A. Yes, sir.

Q. I'll be a lot shorter, hopefully. Going back to the top, you mentioned your role is more of a technical advisor. Do you have a particular discipline or specialty that you are in? For example, Peter Hendy mentioned propulsion and systems. I was wondering if you had a --

A. My background is mostly flying quality, stability and control.

Q. Okay. And regarding the earlier discussion about staffing and technology, I'm just wondering, is there a formal argument or an argument that has been expressed that kind of details or outlines how advancing technology allows reduction in staff or what that equation is?

A. No, I don't think there's been anything formal, at least not that I've seen, at least, and certainly not that we've subscribed to. I think we've looked at the technology that's available, as well as the task that we are putting in front of ourselves, and then have kind of decided on what would be appropriate in order for us to complete our objectives, and I think that's the approach we've taken.

Q. Um-hum. So, you mentioned that, obviously, with the modern computers and screens you can graph and present results, time histories, a lot easier than strip charts, paper strip charts or something that has to be collated. So I was just wondering if there was any arguments that, for example -- that particular example -- means that because we have this, we now no longer need one or two bodies or something, if there's any equivalence there?

A. I think indirectly that's kind of where it comes from, but I don't know that we ever explicitly look at it from that point of view.

Q. Okay. We talked a bit about the GIV program, differences in numbers of people. I was just wondering if you could also comment, if you recall, about the experience level of the people on the scene in Roswell during the day, at night, compared to, say, on the current program?

A. Yeah, as I think I mentioned, at the GIV program we were using Lockheed. We had contracted basically the portion of flight test program to Lockheed -- or with Lockheed, and they supplied FTEs to assist everything from test conducting on the airplane to data analysis and reporting. And from what I recall, just starting in Flight Test, that those people had some impressive backgrounds. I mean, they were senior people that had worked on everything from DF104 to a lot of airplanes that, you know, you kind of read about, seen about and the most century series at Lockheed were involved in, including some of the Skunk Work projects. So there was probably anywhere from six to eight that had that sort of background that were helping us with the intricacies of the GIV.

Q. And relative to the staff that was on hand for the G650 in Roswell, did they have comparable experience?

A. Well, the experience levels as I knew -- again, I had known Reece barely 2 years, but his resume was impressive and he came with recommendations from a lot of people that I think certainly made him qualified to be there.

Q. Um-hum.

A. And so I think all that were involved, including Paul Donovan -- you know, his background, especially with Gulfstream and Grumman -- yeah, I mean, they're different types of experiences, but I think that they were all suitable for the task they were given.

Q. And the folks from Flight Sciences and the people in the trailer?

A. Not as familiar with those folks, so it would be hard for me to say.

Q. Okay.

UNIDENTIFIED SPEAKER: And there was a flight test person in the trailer too.

BY MR. O'CALLAGHAN:

Q. Do you want to elaborate on that?

A. Yeah. Well, Cynthia is fairly new to the company, so I had not had the opportunity to work with her one on one, so --

Q. Okay. Okay, thank you. And maybe this has been answered, but just for a realm of clarification, if you recall -- and I know it was a very long time ago, but if you recall, on the GIV event in particular, the roll off, can you just describe the events on the ground and sort of the immediate aftermath of that event, just what happened basically in terms of analysis, in terms of what the reaction was?

A. The immediate reaction was that we stopped all testing. And my initial recollection is that the onboard crew wasn't necessarily aware that they even struck the lane. But all the testing was stopped and there was several days where no activity was done and, basically, they made sure that -- inspections took place. And they basically brought the airplane back to Savannah for detail. But they did inspections at Roswell prior to that and then detail analysis then started with the seniors and the more experienced flight test people to try to determine what happened. And that's about basically my extent of it.

Q. Do you have any feel for why a similar effort didn't occur after Flight 88 and 132 GVI?

A. No, sir, I can't offer an explanation on that.

Q. All right, thanks. Okay. And again, Dr. Bramble went into this in some detail and I don't want to belabor it, but kind of just a simple way to put it in my mind is, given the activities of everybody on the scene in Roswell, when would Reece, David, and Cynthia do the analysis expansion work during the field performance testing during the day? I mean, just the logistics of that. How would that --

A. Not being directly involved, it would be difficult for me to say how they would allocate their day and how it was delegated normally.

Q. Okay. I'll skip that one. We talked a little bit about the reduction in stall angle of attack in ground effect and it was originally a 2-degree estimate and then it was updated based on some V_{mu} results. Do you have a feel, based on your experience in past programs, what a reasonable uncertainty value to that 2 degrees would be, either in terms of degrees or percent or --

A. Prior to the accident, I would say, no, I did not necessarily. We would have thought the 2 degrees was -- again, based on what we looked at with the -- what I thought the shift was in ground effect for the GIV, and then the addition of the board allowance was to correct that. I tried to get additional 2-degree margin so that it wouldn't have to suffer in a field performance test. I guess, you know, subsequent research following the accident, I would say the uncertainty is anywhere from probably 50 percent.

Q. Fifty percent? Okay.
A. Based on what I know now.
Q. Right. And I think the number that Reece was calculating was 1.6. Does that sound about right?
A. That --
Q. So it's being refined to within 4/10 of a degree. Obviously, in hindsight with what you just mentioned, you know, that's chopping things pretty thin. But was there a feel, I guess, before the accident for whether the value could be known within tenths of a degree like that?
A. No, I don't think there was.
Q. Okay. And there was some interesting discussion this week about the root causes of Flight 88 and 132 in terms of the drops on those flights. What's your understanding today about the root cause of those wing drops on those flights?
A. The chief conclusions that I recall that they came away with -- and this was what I knew prior to the accident -- was that Flight 88 was an over-rotation, basically, resulting in stall. I don't know that anything was looked at. I don't know if they looked any further into whether it correlated to where they would have expected it or where they would have predicted it for that condition. And for Flight 132, it's my understanding that they were -- because those tests were conducted yaw damper off, they were looking in more at a lateral directional type of event as opposed to a stall.

Q. And in particular with regard to Flight 132, has the understanding of that event changed since the accident in terms of root cause and the physics involved?

A. I don't know. I haven't followed it closely enough to know what the latest thinking is on that.

Q. Okay. And just talking about Flight 88, there seems to be pretty good agreement, even at the time, given that there was an over-rotation that resulted in a stall, would you expect that the stall warning stick shaker would go off prior to a stall event or a roll-off in ground effect?

A. In ground effect? Subsequent to the accident, we know that it was not set based on ground effect decrements. So, I guess what we were expecting is that the Alpha limiter should be active anytime you're airborne, and that was the requirement we were trying to make sure was met. But from what I recall, I don't think we would have -- I think we would have expected shaker to activate, but we would not expect Alpha limiter to activate in ground effect.

Q. And again, trying to remove the hindsight bias --

A. Sure.

Q. -- I'm just trying to make a fair assessment whether it's reasonable to expect a stall without a prior stall warning to have led to an examination of or a review of the expected stall angles. And again, with hindsight, one can say probably. But I'm just trying to -- that's why I'm asking you for a fair assessment of at the time, if you had this sort of event, you had a stall but there was no stall warning, if that could reasonably have triggered a review of where the stall occurred compared to the expected point?

A. Yeah, I think that was reasonable. The other thing too is I also can't say with certainty that that did not occur. So, I do not know the extent of which they looked into that, so --

Q. Okay. If somebody looked into it, who would have -- it would have been Flight Sciences or Flight Test, or who would have looked into that?

A. The means they would have done it -- I'd probably say the first thing would be Flight Sciences in control out there, because it would have been run through the control Alpha limiter to see if it would have activated.

Q. In your opinion, how would that group have been recruited to do that analysis?

A. It would have been requested.

Q. By whom?

A. Probably by the flight test people involved or the people directly involved, would be my guess. But, again, speculation.

Q. I see.

UNIDENTIFIED SPEAKER: It would have been Flight Sciences requested that flight test --

BY MR. O'CALLAGHAN:

Q. So I think your flight -- how they call it, is some flight controls group within Flight Sciences that would do the analysis, but it would have needed to be brought to their attention by people on scene involving the test, likely Flight Test people, if I heard you correctly?

A. Yes, sir.

Q. Okay. We talked a little bit about the resetting of the shaker from .85 to .9. One of the things that I think happened -- and I'm not sure of the timing, what I want to ask you about is -- because of some adjustments of stall speeds, the margin between Alpha stall reference, Alpha SR, to aero stall was reduced from one degree to half a degree. So, the question I wrote here is what changes or reviews associated with this reduction were conducted and what was the timing of this relative to the adjustment of the shaker from .85 to .9? So there's two things going on. Are you familiar with what I'm describing?

A. I'm familiar with the adjustments that were made to the free air stall speeds, yes. I mean, the margin was reduced to half a degree. From the initial testing to when we actually validated with the stall barrier, there was a change in the stall speeds, an increase, and it was not apparent what occurred. I think it was ultimately attributed to a calibration shift in the angle of attack from when we did the pretest to when we actually did the test with the alpha limiter active.

So the change was made to put it at a half degree to try to regain those speeds. And then we looked at it in terms of characteristics and there were no adverse characteristics noted in the free air regime, which would be 10,000 feet and above for accelerated entries or for turning flight, all done the absentee characteristics, and how that was rolled into the adjustment for the shaker during takeoff, I'm not aware of.

Q. Okay. So let me reiterate to make sure I have it clear. So there was a very deliberate review and analysis and subsequent testing after the reduction of the stall mark, the Alpha SR, Alpha stall margin from one degree to half a degree to ensure that that was still acceptable, and it was?

A. Right. We looked at it in flight and found it acceptable.

Q. Okay. Do you know when that occurred relative to the adjustment of the stall barrier going from .85 to .9?

A. No. I know it happened prior to, but I don't know exactly how far back.

Q. Okay. Just a couple more. At the end here we were discussing a little bit about the schedule concerns and the way I heard it is, towards the end there, everything had to kind of go perfectly if the goal was going to be met and, based on past experience, it could be reasonably expected that things weren't going to go perfectly and that a scheduled problem would arise. So the question is, would that logic or these concerns, were they shared upwards in the management chain from your point of view or were they communicated upwards, and what was the response back if they were?

A. To the first question, yes, they were communicated back and most all of these scheduled reviews generally from the technical side ends up -- you know, there's considerable risk here in terms of meeting the schedule. I mean, you could have, like I said, most of it there's no contingency factored into if you discover something during the testing that there's a method in which to address it. And some of the concerns that we had were related to supplier response and they just -- you know, with software changes and testing that goes with that after a change, you just can't do it quickly. It's not an overnight type of thing. So that was communicated back and --

Q. Was it communicated back or up?

A. Up to management. Sorry.

Q. Yeah.

A. And generally acknowledged, but, you know, said we'll accept the risk and if we have to fix it, we'll fix it and we'll adjust the schedule from there, and that's the general direction that was taken.

Q. Okay, thank you. So the last question is the one we have been asking everybody. This is probably the end of our fact-gathering phase this week here, and we'll going back and doing our analysis. And as Dr. Bramble mentioned at the beginning, the whole point of this exercise is to come up with recommendations to the industry to hopefully improve things. And you guys are the closest to the accident and, obviously, you've been thinking about it very hard for many months. So if there's anything that we should be looking at that you think maybe we're not looking at based on the questions we've asked, please point it out to us now, if you can. And secondly, if there's anything you think that the NTSB can offer the industry through recommendations or through our reports that you'd like communicated, we'd like to hear that too. So, it's wide open for you.

MR. RAMEE: And we want to give you a fair response. Do you want to do that now or do you want to take a break in do it --

MR. OSBORNE: I mean, it's a fairly broad question, so I'm not sure I can give a comfortable answer in regards to that type of thing. Yeah, maybe --

MR. RAMEE: Let's take a break because I want to get you a good answer --

MR. OSBORNE: Okay.

MR. RAMEE: -- okay?

MR. OSBORNE: Sure. Fantastic.

MR. RAMEE: And I'll find the PR log.

(Off the record.)

(On the record.)

DR. BRAMBLE: All right, let's go back on the record.

So, John, do you want to reiterate your question in brief form?

MR. O'CALLAGHAN: Sure.

BY MR. O'CALLAGHAN:

Q. Basically, if there's anything you think that the NTSB should look at that you don't think we're looking at based on our questions or if there's anything you think the NTSB should mention or recommend to the industry to improve flight testing, please feel free to offer it either now, or if there's something that occurs to you later, please communicate it through Tom.

A. Okay. I think with what's transpired today, I think you're looking in a very thorough place in reviewing all of other history of Gulfstream with regards to things that are similar in regards to what we think happened, and I don't think there's any other areas that I could suggest that you're not already looking into.

With regards to the overall safety, I know that since the accident, as you said, you know, hindsight is a tremendous benefit in this regard, but we're taking more steps in terms of trying to look introspectively to ourself and how we conduct things and what can we do differently and better to anticipate such things, and to look at things as they occur and take the appropriate steps that will certainly preclude this type of thing. Because I think, even though I don't know you can do it with 100 percent certainty in terms of testing, every step you can take towards getting there is a worthwhile effort. And I know that we're putting a lot of energy into updating the manual and reviewing processes and even to the point of now instituting independence in regards to a lot of things, that sole responsibility is to the safe conduct of flight operations and flying. So I'm encouraged by those types of things that are taking place.

Q. Okay. Thank you very much. Appreciate your time.
A. You're welcome. Thank you.
DR. BRAMBLE: Anything for you?
MR. GALLO: Yes.
DR. BRAMBLE: Okay, Mitch.
BY MR. GALLO:
Q. During the Safety Review Board, there were some slides that were presented, do you know who was the presenter was of those slides?
A. Reece.
Q. And was Reece the only presenter?
A. The primary presenter, yes, sir.
Q. Did anybody else present any other slides?
A. I don't specifically recall. I don't believe so.
Q. One of the slides says that the stick shaker for tactile feedback for the AOA limit to the air crew --
MR. RAMEE: Do you have the slide number?
(Asides while looking for the correct slide.)
BY MR. GALLO:
Q. And just for the record, can you give the title of that

slide so we know what to reference?

A. It's the GVI field performance testing.

Q. It's the --

A. Phase I testing, November 8th through 19th, 2010.

Q. Okay. And in there it discusses or it states something to the effect of the stick shakers provide an AOA limit to the aircrew tactile feedback. Was that your understanding when that was presented to you?

A. Yes, that they would have -- the shaker would be active during the testing and set to a value that should be honored if it was activated.

Q. And did Mr. Ollenburg say why that was in place?

A. Again, my understanding was -- I don't remember his explicit words to it, but it was to provide additional cues directly to the pilot that would basically not requiring visual or the FTE to monitor and say you're exceeding alpha. It was basically the system limits say don't go any higher than this, honor the shaker if it activates. So it was for an immediate --

Q. And during the presentation, was there a discussion that there were two phases, Phase I and Phase II, of the performance development?

A. Yes, I believe so.

Q. Okay. Was there a plan in place to change that shaker setting between Phase I and Phase II?

A. I don't believe there was any discussion to it, at least

in the SRB.
Q. Okay. You mentioned something about test readiness reviews. Can you tell me how many reviews were there during the field performance testing?
A. I recall at least being notified of two. I was not able to attend either one, but I recall at least two: one prior to Roswell I and one prior to Roswell II.
Q. And how were you notified about those?
A. E-mail or scheduling through Lotus Notes.
Q. And who were the other people addressed on the e-mail?
A. I can't remember all of them. There was the select people -- I think some of the names were mentioned -- from Flight Sciences: Paul Donovan, Ken Obenshain, Valerie Thurston, Cynthia Townsend, Shelly Brimmeier, those people. Basically, it was for the participants in Roswell mainly.
Q. Which of the aircrew were listed on there? I'm sorry. Which of the pilots were listed on there?
A. Jake Howard, Kent Crenshaw, Gary Freeman. I believe that's all I recall.
Q. And who would call the test readiness reviews?
A. Usually the lead flight test engineer for the airplane, which would be Reece in this case.
Q. Then you mentioned there is change review boards. Do you recall how many there were during the field performance testing?

A. Well, the change review boards are more a function of the system. So the Flight Controls would have weekly meetings at least, but it would be talking about various items that affected the flight control software or flight control design, not specifically related to field performance, as I recall. So as I recall, related to field performance, it was just the one for the shaker setting.

Q. And do you remember who was invited to attend the change review board for the shakers having changed?

A. No, sir, I don't.

Q. In reference to the flight standard practice manual of 1998, I believe you went through different job descriptions of manager of test coordination, test coordinator, test conductor, test specialist, test analyst for an instrumentation engineer, configuration control engineer, and FAA coordinator. Were all those titles being used prior to the accident --

A. No.

Q. -- just the title itself?

A. No. I think the test coordinator is more commonly known today as the airplane coordinator and a couple of those functions are combined. The configuration control is rolled up into that task as well. The instrumentation engineer is now part of a different group. It's a different department within Flight Test.

Q. That's all the questions I have. Thank you.

A. You're welcome.

BY MR. BORTON:

Q. Just a historical question. You touched on this. This is back to GIV and maybe GV testing.

A. Yes, sir.

Q. When you were at Roswell and you were doing the field performance tests, for GIV, for instance -- and maybe you can comment on GV of what you know -- was telemetry used on site there in any sort of monitoring or safety test fashion?

A. Yeah. Telemetry was there and we also had -- the Lockheed was also -- the positioning information to determine the distance associated was done by a laser tracker. So it was providing those two pieces of data, but there was a telemetry stream that was coming from the airplane to monitor parameters, such as for gauging the airspeed and looking at basically identifying event marks. And so, that was how we were doing it inside the -- we'll call it control room, but it was the control room setup where that data was coming back and that was how we were assessing it directly for the real time monitoring.

Q. So there was both, I guess, the technical side and the safety side to the use of the TM -- that's how you remember it?

A. Yes.

Q. How about for GV? Do you recall if there was any telemetry for that, or were you --

A. There was telemetry. There's been telemetry for all of the field performance programs but I don't recall the direct stuff. I didn't participate in the GV.

Q. Thanks.

BY MR. HORNE:

Q. I think because of your expertise that I know of for flight controls and the setup in flight test airplanes, I'd like to ask you another question. What's your feeling or what's your best estimation of what roles Reece and Dave McCollum were performing in the accident airplane the day of the accident?

A. There would have been two functions, I think. Also, at the time the maturity level of the flight control system required additional monitoring that was not readily available through the system itself and it was in terms of osscillatory faults. And so that would have been one of the tasks that one of them would have had to taken, and the other would have been mainly concerned with the conduct of the test and meeting of the parameters and scheduling the targets and that sort of thing.

Q. Do you have any idea or what's your opinion of who was doing which task?

A. I don't know. I don't know explicitly. I can guess from where I know that they were -- what station they were occupying that Reece was doing the flight control monitoring.

MR. O'CALLAGHAN: Who would communicate with the pilots primarily?

MR. HORNE: Sorry.

DR. BRAMBLE: Let's just let Tom finish and then go around.

MR. O'CALLAGHAN: Okay, sorry.

BY MR. HORNE:

Q. Okay, that would be -- if I'm correct, that would be the right seat just after the walk-in --

A. That's correct.

Q. -- on the right side of the airplane?

A. That's correct. That's the only station that had the Talis (ph.) Interface computer, the FTI.

Q. Okay. Shifting gears a little bit, you talked about the one degree and the half degree stall margin, and I know you participated in both of those and part of the reason was because the calibration seemed to have shifted. What's your estimation of once we went to a half-a-degree margin, how close were those speeds to the original speeds before the calibration issue?

A. Three knots.

Q. Three knots. Okay, let me ask a clarification. Were the half-degree speeds that were used in Roswell II, do you think they were 3 knots faster than the original 1-degree speeds?

A. Well, I think that the half a degree reduction would get about 3 knots in reduction.

Q. Okay. We started out with one-degree margin. When we went back and looked at them, those speeds had shifted 3 knots faster?

A. What we looked at, those speeds were about 3 knots higher.

Q. Okay. And then when we took that half degree back away --

A. It fell on the original --

Q. So the speeds were essentially the same?

A. Yes.

Q. Okay. And then the third one was just a clarification. The Change Review Board, is that a standing meeting or is that something that would be called specifically for this .85 to .9 shaker change?

A. The Change Review Board at the time, I think, were standing meetings and it would basically address any -- anyone could bring forth a change that they wished to make and it would be addressed at that time, and the criticality and the requirements for it would then be determined and when it would fit in, whether it would drive a special software setting or whether or not it could be scheduled into a --

Q. So in all likelihood, this change referred to in the March 24th e-mail and the PR that we were talking about, the change in shaker setting, would have probably been presented in one of the CRB weekly meetings?

A. Correct.

Q. Okay.

MR. HORNE: That's all I have.

DR. BRAMBLE: Okay.

MR. GALLO: Can we go off the record?
DR. BRAMBLE: Um-hum.
(Off the record.)
(On the record.)
BY DR. BRAMBLE:
Q. You said there were two people on the airplane: one would be monitoring the test data and one would be monitoring the flight controls, looking at this like oscillatory mode malfunctions or something like that.
A. Right.
Q. So would the person monitoring the flight controls on the IADS terminal in the airplane have to be continuously monitoring the flight controls page at all times whenever the airplane was flying?
A. They would have to be up and aware. At that time, with the status of it, the requirements were for us to provide monitoring because of the association of the time with the oscillatory failure required near immediate action.
Q. And was that valid in first flight mode -- that was true in first flight mode as well?
A. Yes. It was an issue with the RUs or the motor electronics used, basically actuation system side. So it was monitoring for oscillation -- oscillatory faults there.
Q. Was it possible to monitor the flight controls and the test data simultaneously?

A. It would be possible, but difficult. I mean, it would require to have a very thorough understanding of the flight control side. Basically, the only the flight control -- the engineers for flight control specialty, myself and one other, would probably attempt to do that.

Q. So given that Reece was the test conductor, why -- could he perform the duties of test conductor and simultaneously monitor the flight control system?

A. Again, it would be speculating. Again, the only reason I say he was monitoring flight control is that he was at that station, so that would be where the data would be available. In terms of once you're on the ground doing the planning for the next run, you know, there's no concern with regards to the oscillatory fault that occurs on the ground. If the alerts go off, you stay on the ground. So in terms, I think, of planning the next run and reviewing the previous run that occurred on the ground, I think that's very feasible.

Q. Do you have any idea why Mr. Ollenburg was monitoring the flight controls and Mr. McCollum was at the other terminal? Or let me back up because you said you weren't certain. So do you have any idea why Mr. Ollenburg would be located at the terminal normally associated with monitoring the flight controls and Mr. McCollum would be located at the other terminal?

A. No. The only reason I can think of is this would have been Mr. McCollum's first field performance or first work on the field performance during this period. I think Reece would have been more familiar with the airplane.

Q. So what do you think Mr. McCollum would have been doing if Mr. Ollenburg was monitoring the flight controls?

A. Monitor results of the test.

Q. Was that normal to have the test conductor on the airplane swap roles with the flight control monitoring FTE?

A. The roles between, you know, monitoring for various parts of test can vary, so it's --

Q. Do you see any disadvantages to that from a safety standpoint?

A. No. Based on what they were doing, I don't think so. That was my understanding at the time.

Q. And is that still your understanding?

A. Yes, sir.

Q. Okay. And you mentioned that now there has been sort of some introspection about how things are done here and that there are going to be some independent safety functions. Can you describe those?

A. Well, I know that they recently started an aviation safety officer which has -- also have delegates working with him specific to Flight Test Engineering and Flight Operations. And I think they're still in the process of actually forming the duties and responsibilities, but the main emphasis is to make sure that there's an independent review of all activities, both in test and production, so that we are -- with regards to safety as opposed to any other concern.

Q. Do you know who that safety officer is or will be?

A. Right now, the acting safety officer is John Salamankas.

Q. And do you know is this sort of new component based on any kind of industry or FAA guidance or -- for the new safety function?

A. I know that it's used elsewhere and military organizations, I think, use it. I know that the recommendation came from an independent audit that Gulfstream itself asked for utilizing outside experts from NASA and industry.

Q. When did the audit occur?

A. This past summer, probably July, August. I don't recall exactly, but I think that's about right.

Q. Okay. Is there a report associated with the audit?

A. There is.

Q. Do you know what it's called?

A. No, sir, I don't.

MR. RAMEE: It's called privileged and confidential.

DR. BRAMBLE: All right. That's it for me.

John?

MR. O'CALLAGHAN: Sure, just a quick follow-up. I apologize for my earlier interruption there.

BY MR. O'CALLAGHAN:

Q. To follow up on Tom's question about which flight test engineer was performing which role in the airplane, I was just wondering can one learn something about that or gain some probability about who's doing what based on who was communicating with the crew?

A. Yes, sir, I think you can. I mean, typically the way we operate, at least in my experience, is that the test conductor is primarily communicating with the crew in terms of providing where we're going in terms of the testing and how we're progressing with it.

Q. Okay, thanks. And one question about the vibration monitoring. I understand it's primarily looking for flight control failures. Is it also looking for flutter? Though I suppose at low speed, you're not concerned about that.

A. No, it's mainly looking at am oscillatory event within the actuation system which could produce a high frequency vibration at the surface. And the concern is fatigue damage on the attach points of the actuator.

Q. I see. Okay, thank you.

MR. O'CALLAGHAN: That's all I have.

DR. BRAMBLE: Marie?

MS. MOLER: I'm good. Thank you.

DR. BRAMBLE: Mike?

MR. BAUER: Just a couple.

BY MR. BAUER:

Q. For the field performance testing in Roswell, was telemetry required?

A. Yes.

Q. I guess to follow on to the telemetry required, would that be something necessarily documented in a THSA as a point of if it's not available, the testing can't continue.

A. I don't know that it would say those exact words. I believe it does say telemetry required, but I'd have to check. I don't recall exactly.

Q. Okay. I think from Mitch's questions, you talked about the shaker system as sort of a limit for the flight crew to advise them. Would that be considered sort of a knock-it-off point for the testing?

A. Not necessarily. I think there are a couple of things that could come into play. If you flew to too high of an angle, it certainly should be honored, where the intent would be that they would reduce the angle of attack based on the activation of it. The criteria as part of the test is that you can't really have activation of it during a maneuver that would basically say the maneuver's no good. So, you know, if you had a gust or some conditions there that would cause it to spike up, that would be basically considered a nuisance, then that would be a reason to discount it and say basically, you know, that's what it's doing. So that would be one of the things that you would look at. So to strictly say if you incurred shaker during one of the maneuvers would you stop for the day; maybe not.

Q. I guess necessarily not stop for the day, but discontinue the test point and then just continue with the same maneuver to safely fly the airplane?

A. Yeah, I would expect that that would occur.

Q. Okay. We've heard discussions over the past, I believe couple of interviews, that Mr. Ollenburg talked about a pitch limit to, I guess, stay away from. I guess, in your experience, whose responsibility would that be for monitoring that pitch limit out of the crew TM versus aircraft versus flight crew?

A. I mean, it's a difficult question. I mean, basically, you know, it's -- in terms of if you're actually setting a limit, then you would depend on the flight crew to do the best they could to stay within that part of it. I mean, that's the direct link to it. In that monitoring or even through TM monitoring, you could identify that it's encroaching and provide a warning for it. But I think, you know, those things being considered and the difficulties involved in those is the reason why you would place emphasis on the shaker being a knock-it-off point.

MR. BAUER: That's really all I have.

MR. GALLO: I have a couple questions.

DR. BRAMBLE: Okay, Mitch.

BY MR. GALLO:

Q. Before you took the role in assigning flight test engineers for flights, who was doing that before you?

A. It was basically the manager function and it was more --

it wasn't a day-to-day type of evaluation. It was these FTEs were assigned to this particular task, such as the field performance or stability and control or some other large scale test, and then they basically would go to the airplane when they were needed or when their testing was scheduled, and the day-to-day activities were covered by the lead FTEs on the airplane.

Q. And you said it's a management function, but then who are those -- who's that person or people?

A. Well, a lead FTE was assigned to each airplane at the time. So between -- you know, there was a primary and a secondary for that and one of those were generally expected to fly with the airplane. So that was basically how it was assigned.

Q. Okay. So who assigned Mr. Ollenburg for this flight, for the accident flight?

A. Well, he was one of the lead FTEs, so he basically, he was assigned for that field performance, so --

Q. Okay. So who assigned him as the lead FTE?

A. That would have been at the management director level, which would have been the group head of Flight Test at the time with concurrence from the director, and that went for all assignments on all the airplanes.

Q. And was the group head Paul Donovan?

A. Yes.

Q. And then concurrence would come from -- does Flight Test have a copy of Flight Sciences Fortran program that's been used to

calculate these speeds, the V_{mu} speeds?
A. I do not know.
Q. So you don't know if Mr. Ollenburg would have a copy of that program and use it?
A. No, sir, I don't.
MR. GALLO: I think that's all the questions I have.
DR. BRAMBLE: Jeff?
MR. BORTON: Just one.
BY MR. BORTON:
Q. Just to explain a little on the oscillatory fault that you mentioned that required monitoring of the flight control system.
A. Yes, sir.
Q. Was that something that the pilot would have feedback through or was it more into the actuator side where you wouldn't even know it was happening --
A. The latter. It was basically a frequency such that couldn't be detected other than through sensor monitoring.
Q. So aircraft response really wasn't affected, it was --
A. Correct.
Q. Thank you.
DR. BRAMBLE: Lorenda?
MS. WARD: I just have one.
BY MS. WARD:
Q. You mentioned you were hired in September of '85. Did

you come straight from college?

A. I did.

MS. WARD: That's all.

DR. BRAMBLE: All right, we're done.

(Whereupon, at 11:35 a.m., the interview was concluded.)

CERTIFICATE

This is to certify that the attached proceeding before the

NATIONAL TRANSPORTATION SAFETY BOARD

IN THE MATTER OF:	AIRPLANE ACCIDENT ROSWELL, NEW MEXICO N652GD Interview of William Osborne
DOCKET NUMBER:	DCA11MA076
PLACE:	Savannah, Georgia
DATE:	October 26, 2011

was held according to the record, and that this is the original, complete, true and accurate transcript which has been compared to the recording accomplished at the hearing.

____
Letha Wheeler
Official Reporter

____
Karen M. Galvez
Transcriber

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NATIONAL TRANSPORTATION SAFETY BOARD

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Investigation of: *
*
AIRPLANE ACCIDENT *
ROSWELL, NEW MEXICO * Docket No.: DCA11MA076
N652GD *
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Interview of: NATHANIEL RUTLAND

Gulfstream Corporation
500 Gulfstream Road
Savannah, Georgia

Monday,
October 24, 2011

The above-captioned matter convened, pursuant to notice, at 1:15 p.m.

BEFORE: WILLIAM J. BRAMBLE, JR., Ph.D.
Senior Human Performance Investigator

APPEARANCES:

MITCHELL GALLO
Air Safety Investigator
National Transportation Safety Board
31W775 North Avenue
West Chicago, Illinois 60185

WILLIAM J. BRAMBLE, JR., Ph.D.
Senior Human Performance Investigator
Office of Aviation Safety
National Transportation Safety Board
490 L'Enfant Plaza East, SW

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-
ALAN J. (JEFF) BORTON
Flight Test Pilot
FAA Aviation Safety
Aircraft Certification Service
Wichita Aircraft Certification Office
1801 Airport Road - Room 100

THOMAS M. RAMEE, ESQ.
Deputy General Counsel and Risk Manager
Gulfstream Aerospace Corporation
500 Gulfstream Road, M/S B-06

TOM HORNE
Experimental Test Pilot
Gulfstream Aerospace Corporation
P.O. Box 2206, M/S A-12
Savannah, GA 31402-2206

APPEARANCES (Cont.):

JOHN O'CALLAGHAN
Aircraft Performance Group Chairman
Vehicle Performance Division (RE-60)
  Office of Research and Engineering
National Transportation Safety Board
490 L'Enfant Plaza East, SW

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-

MICHAEL BAUER
Aerospace Engineer
Vehicle Recorder Division (RE-40)
  Office of Research and Engineering
National Transportation Safety Board
490 L'Enfant Plaza East, SW

E. LORENDA WARD
Air Safety Investigator
IIC and U.S. Accredited Representative
Office of Aviation Safety
Major Investigations (AS-10)
National Transportation Safety Board
490 L'Enfant Plaza East, SW

MARIE MOLER
Mechanical Engineer
Office of Research and Engineering
Vehicle Performance Division
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

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I N D E X

I N T E R V I E W

(1:15 p.m.)

DR. BRAMBLE: Let's go on the record.

BY DR. BRAMBLE:

Q. Nathaniel, your date of hire with Gulfstream was when?

A. Full-time I started in June of 2004 but I co-op'd with them before then when I was in college.

Q. For how many years?

A. Since 2001.

Q. What's your current position title?

A. Flight test engineer.

Q. Which department are you in in flight support?

A. Flight test engineering.

Q. Within that subgroup?

A. I kind of cross-pollinate across a couple different groups. My specialties are systems and flying qualities.

Q. On the G650 program, what were your responsibilities around the accident?

A. Primarily mechanical systems, flight controls and flying qualities. Do you need any more detail than that?

Q. That's okay for right now I think. Previous employers, aerospace employers?

A. Just Gulfstream.

Q. At Gulfstream, which previous cert-programs have you worked on?

A. As a co-op I worked part of the 550 and 450 programs, and then when I was hired full-time, it was at the tail end of the 450 certification effort. And then between 450 and 650, it included a few special missions projects for CAW and CEMA and then some just sustaining effort for the fleet.

Q. Did you participate in any of the field performance testing at Roswell?

A. The testing that I participated in at Roswell was pretty much focused on the brake system evaluations, which carries over with some of the field performance tests, but I wasn't specifically involved in any of the specific field performance flight test points.

Q. When was that that you were out there doing that?

A. I made a trip out there --

Q. Meaning Roswell?

A. Right, out to Roswell over Christmas for just a couple days for brake evaluations on the surface and then went out with the full deployment in March of 2011 because brake system tests were slotted for the first week or so.

Q. That was March 2011?

A. Yes.

DR. BRAMBLE: Off the record.

(Off the record.)

(On the record.)

DR. BRAMBLE: Let's go back on the record.

BY DR. BRAMBLE:

Q. At the time of the accident, what policies and procedures did Gulfstream have in place to manage the safety of the flight test program?

A. Well, the entire process of defining a test and performing it go through -- are, you know, baked into the safety process, but we have a -- I mean, are you talking for specific tests that I defined or the bake process? Because the one that I participate in the most is the Flight Test Safety Review Board process whereby specific tests are evaluated and reviewed by the board.

Q. Are there any other sort of formal processes in place?

A. I would say not that I -- the flight test Safety Review Board process is the one that I am most involved with in my functions.

Q. Have you been involved in others or is that --

A. No, that's it, in as much as what I do.

Q. Do you know if the organization had a written safety policy statement in the documentation in and around flight testing practices and that sort of thing?

A. The Flight Test Engineering standard practices manual that we had defined the Safety Review Board process whereby tests were assigned hazards and then reviewed with the Safety Review Board.

Q. Were you familiar with that manual prior to the accident?

A. Yes.

Q. At the time of the accident, to your knowledge, did Gulfstream have an executive who was formally accountable for the safety of the flight test program?

A. Could you elaborate on executive?

Q. Oftentimes as part of the sort of safety management system approach that sort of become prevalent in the aviation industry, there will be an executive in the company, usually a highly placed individual, who is sort of designated as the accountable executive for safety and I'm just curious if there was one.

A. As I understood the setup prior to the accident, the co-chairs of the flight test SRB would have been responsible. So it would have been Randy, the senior vice president of flight operations and the director of flight testing as the co-chairs of the flight test SRB.

Q. That was the senior VP?

A. Not senior, he's vice president of flight operations.

Q. Who is the other one again?

A. The director of flight tests.

Q. That's Barry McCarthy?

A. Yes.

Q. I understand that the SRB process involves identification of hazards and assessment of risk and development of mitigation strategies. Once that was in place and testing began, were there procedures in place for reporting and investigating safety-related incidents or perceived hazards that might have occurred during the testing?

A. Outside of the normal process of reviewing all flight test operations, data review for maneuvers, I would say that there wasn't a formal process defined that I am aware of.

Q. So things that came up were handled informally at the working level and within the workgroup that was responsible for that particular test?

A. I wouldn't isolate it to within that workgroup. It was often, you know, if things occurred requiring more detailed review, engineering -- you know, colleagues in the related engineering groups would also be consulted and conferred with.

Q. Before the accident, what was your understanding of the reduction in stall AOA in ground effect compared to free air and how did you come to that understanding?

A. Most of my understanding with regard to that decrement prior to the accident was secondhand in conversations with Reece essentially, because, again, as mentioned earlier I was flight controls and part of that is the flight control computer which controls where the shaker is set. So there were discussions about -- I was involved in discussions because of that as to where shaker was set and how it operated. So that came up in some of the discussion that I had with Reece but I would say that my exposure was through secondhand information. I didn't do any analysis or calculations.

Q. Did you participate in the field performance test SRB that was held prior to the Roswell-2?

A. Yes.

Q. Was there discussion of the difference between stall AOA in ground effect versus free air?

A. I don't recall. I would say that I was there specifically for the brake system tests that would be performed as part of that so I had some direct involvement with regard to those specific tests. So I may have missed the details of other discussions.

Q. Prior to the accident, what do you know about changes to the predicted stall margins that might have occurred as a result of the updated stall speeds provided by aerodynamics to aircraft performance just prior to Roswell-2?

A. Could you restate that one? Sorry.

Q. Were you aware that there was a stall speed update provided to aero performance in Flight Sciences just prior to Roswell-2 or was that beyond the scope of what you were dealing with?

A. I was involved in some of the stall speeds flight tests so I was somewhat, again, secondhand-edly in the loop, aware of rather, the changes in stall speeds and the SR angles of attack to get set stall speeds.

Q. So do you recall the specifics of what changed when the speeds were updated then?

A. The update that I was most involved with was the change to the angles to try to maintain the speed schedule and I don't recall specifically which update came out that you are referring to to know if that's the same one.

Q. So the change in angles that you are referring to is the change from .85 to .9 normalized angle of attack?

A. No, I was talking about the Alpha SR schedule program into the FCC to try to attain the up and away V_{SR}'s. Is that what you were --

Q. Yeah. So this may have related to that information that came from aerodynamics but it sounds like it didn't come to you. It probably came indirectly and then --

A. Well, when there's a V_{SR} update, we get it via memo from applied aerodynamics and performance. So I did receive it.

Q. Did you attend a March 24 meeting that was on Reece's calendar that was to discuss stall protection setting?

A. No, I did not attend. I don't recall if I was specifically invited but Reece told me about it and I was busy so I didn't attend.

Q. What did Reece tell you about what was discussed at the meeting?

A. I don't recall specifically what we discussed except that after the meeting, I was asked to generate a problem report to give to control log programmers the action to change shaker from .85 to .9, and then I was given an e-mail to that subject as well. I'm sure I talked to Reece about the outcome of the meeting, I just don't recall the specifics of any conversation.

Q. Prior to the accident, were you aware of the details of the wing drops that occurred on Flights 88 and 132?

A. I'm not sure what details specifically you are referring to. I was aware of both events. I had seen the presentation that Kent put together on Flight 88 and I was aware, I guess secondhand-edly, well, the 132 event, it's hard for me to distinguish what I knew at the time versus what I know now.

Q. To your knowledge, was there ever any effort to establish at what normalized angle of attack that the wing drops began on those flights?

A. I don't think I could say specifically.

Q. What was the reason given for adjusting the stall for the shaker setting up to .9; what were you told?

A. I would caveat this with this is secondhand information and very old memory, so -- but as I recall -- as best I recall, rather, it was driven by a concern about whether shaker would activate for some of the abuse maneuvers that they had to accomplish given the target pitch angles and a more thorough review of where it could/should be set rather than the somewhat carryover nature of the .85 setting from legacy fleet.

Q. Did you hear about nibbles, as the pilots described it,

on the stick shaker prior to the accident, it going off during various maneuvers, brief activations?
A. I had heard about them, yes, but no specific detail or direct exposure to the data.
Q. Do you know when you first started hearing about them?
A. I don't recall.
Q. Were they regarded as nuisance activations?
A. I think I can only speculate on a response to that because I wasn't directly involved in any of the discussions about them. It was more of shop talk around the trailer where I heard about those.
Q. So you probably don't know how the determination was made that they were nuisance and not --
A. Yeah, I would -- I mean, yeah, I wasn't involved in any review of that specifically.
Q. All right. Do you know how it was decided to bump up the shaker threshold? Was the decision made during that March 24 meeting?
A. I would say I believe -- fuzzy memories, but I believe the March 24th meeting was a validation of the decision, but that the decision had been made prior to the deployment of Roswell-2 that 9.0 would be the setting.
Q. Do you know who made the decision? Or who was involved in the decision?
A. Off the top of my head, no. I'd have to refer to

e-mails or other notes that I have but I know -- I mean, I can vaguely remember that Reece discussed it with flight operations. I want to say I believe Jake Howard was consulted. I believe Jake Howard was in the loop on that, but again shooting from old memories and such.

Q. Do you think that the change in the PLI and stick shaker settings, I guess the shaker settings, from .85 to .9 should have resulted in the reconvening of the SRB since it was a change to a less conservative state?

A. Are you asking me personally if I were in charge of the tests would have solicited or reconvened the SRB? I really have no opinion about it.

Q. The place the question comes from for us is, we've sort of been talking to people about what kinds of things trigger an SRB. We're generally told that it's things that are within the bounds of things that have already been tested and are more conservative don't usually require a big formal review. The things are outside the bounds of what's already been tested and less conservative might.

And I guess I'm trying to get a feeling for why the change didn't trigger an SRB review and I guess it would be just based -- you know, the answer that I'm looking for would be sort of based on your understanding of sort of what was going on culturally within the organization at that time or how the change was perceived, why you think there wasn't an SRB review. And it's not just you we're asking.

A. No, I -- I'm not sure. I mean, the decision to reconvene the SRB is, like you say, it's kind of up to the test team as to when the very fuzzy and wide gray line is crossed, but I don't know.

Q. What was the protocol for making changes to the flight control software with respect to shaker settings specifically and how were such changes reviewed, tracked and communicated within the flight test organization and to the crew?

A. Depending on what the change was and how it initiated, the change would either generate as a request from us to engineering as to how to perform a certain change, i.e., effect a certain result, and then engineering, specifically the control log group, would provide us with the parameters and settings required or they could tell us a made file that need to be implemented to replicate a certain functionality. And then we would have files of the parameters and the values that were to be modified to on the airplane that would be loaded and implemented.

And then generally the configuration setup of that is briefed as part of the test and generally the tests where you have the same settings for the entire flight, that's generally handled in the brief, and then for when you're changing it between maneuvers, it's generally briefed to the pilots what they are enabling when they flip the switch.

Q. How about tracking those changes, is there some sort of system for tracking them over time and documenting them?

A. Just as part of the standard course of flight notes, documenting the configuration and then we obviously have the actual files on the computers that are the files that you change.

Q. I guess what I'm wondering is there some sort of like configuration management, like a tracking system, like any change like that, you know, would be entered, like, date and nature of change and then maybe disseminated amongst the flight test organization?

A. The types of changes we used aren't like broad sweeping, you should fly with this made setting change. They were generally test specific.

So to answer your question specifically, no, there was no configuration management tool, but like I was saying, they're generally test specific so the person in charge of the testing ensured that the change was documented in the test setup generally as part of a flight card or a briefing note.

Q. So in the case of the shaker change from .85 to .9, that was, according to your understanding, briefed as part of the flight cards and briefing notes for the Roswell Phase 2 field performance testing?

A. I wasn't specifically in any of those briefs so I couldn't say that specifically.

Q. But in general?

A. In general, it was briefed as part of the test setup or as part of the configuration items.

Q. Was there a configuration control -- was there somebody like designated as a configuration control engineer as part of the 650 program for ship 6002?

A. For the flight control computer parameter-specific changes or for the entire configuration of the airplane?

Q. Well, I'll explain where the question is coming from and maybe that will help. In the GV program according to the SOP, there is a title in there. It's configuration control engineer. I think it was specific to each airplane, but I'd have to check. It might have been for all airplanes. I was just wondering if -- and I know that not all of the titles from the GV program carried over, but I'm just wondering if there was somebody called a configuration control engineer?

A. No, but we have a process whereby the configuration of the airplane is managed and there are several people that have their hands in that and I would say QC is probably ultimately responsible for the update of that.

Q. How do they come into the process?

A. Well, I mean, this is where we're mixing the bags here a little bit. Are we talking about specifically for these FCC parameter changes as part of the test setup or for configuration of the airplane?

Q. This is getting back specifically to changes in the shaker setting. I'm sort of wondering how that would be documented and how what kind of role QC would play?

A. Those changes are test setup changes and were treated as test setup changes. So QC was not involved. So it was more of a configuration for a specific test than the configuration of the airplane because, again, they were not used to broadly change the function of the base airplane. It wasn't like an FCC change was implemented fleet-wide and mandated that it had to be utilized for operations of the airplane. If anything like that would have arose, it would have been driven by an in-flight restriction.

Q. But it was used for 6002 for all the Roswell-2 field performance testing?

A. For the test setup, yes, not before.

Q. So who requested the change? That was Reece?

A. 2.9, the specific normalized AOA shaker?

Q. I'm sorry, from .85 to .9, yeah.

A. I don't recall specifically but I would imagine it originated from Reece. As I mentioned earlier, in general, a review of where it could or should be set for the tests -- or not for the tests, but where it could or should be set by design.

Q. Who actually programed the changes? That's not you; that's somebody else in engineering?

A. It depends. Generally, engineering provides us with the parameters to be modified or they provide us with a specific text file list of the parameters to be modified.

Q. And in this case?

A. In the case specifically, the file they were using for Roswell testing?

Q. For the .9 change to shaker, yeah.

A. I believe I programed that list. I built it on the airplane with Reece during my first week at Roswell and then we evaluated the shaker setting inflight to ensure that it was activating at .9.

Q. You said you verified in flight, in free air to make sure it would activate?

A. (Non-verbal response.)

Q. On the Flaps 10 Alpha schedule chart for Roswell-2, the chart shows estimated IGE stall based on 1.6 degree degradation for ground effect and you explained, I think, in a past presentation that the cross-check used to make sure that the shaker setting was okay was that as long as the IGE stall, which was free air minus 1.6, line was above .9 shaker, the shaker setting was okay. Is that a fair representation?

A. I wouldn't say specifically, no. I would say that the margin between the two lines was assessed and reviewed by the people and assessed whether it was acceptable specifically, and again, although I wasn't involved in any specific discussions, flight operations and flight test engineering.

Q. Do you know why there wasn't a half degree margin, like a safety margin or correction for tolerance error applied to the IGE cross-check to this reasoning in terms of deciding how much space between the lines was adequate?

A. I could only speculate as to what criteria were used.

Q. Who actually was doing that analysis, comparing the lines and deciding how much space was enough?

A. The only data I was specifically involved in was, again, would be what I referenced earlier with regard to changing -- writing the problem report to change it from .85 to .9. And in that e-mail, some margin to aerodynamic stall -- or to in-ground effect stall was quoted. So I don't think I can -- I wasn't involved specifically, so I don't know who exactly reviewed it except that it was an outcome of the March 24th meeting.

Q. Did you mention V_{MU} or did I hear that wrong? Was that in there somewhere? You didn't say V_{MU}?

A. I didn't say V_{MU}.

Q. So to review, to make sure I understand how this worked, they had this meeting -- wait a second. So, the shaker setting was changed the first week in March, okay, and then they had this meeting in March and reviewed it and then the problem report was submitted when?

A. I don't recall specifically. It would have been, judging by how I usually handle requests, 2 days later.

Q. After the March 24 meeting?

A. Yeah. I think there was a crunch to get the problem report written to drive the software requirements change before some drop-dead date for a software freeze, but I don't recall exactly. But again, as I mentioned earlier, just so it's not misconstrued, the March 24th meeting was a validation of the shaker setting and me quoting that e-mail is the only time I was directly involved in a specific review. When Reece was talking with me, I had performed my own back of the napkin calculations, but that wasn't the criteria that was reviewed by the team to decide to set it at .9. So I don't know what specific criteria was used prior to the Roswell-2 deployment. I was just quoting the only bit of information that I was directly involved in.

Q. So you guys developed it the first week in March and then March 24 it was reviewed by a larger group, and then you got an e-mail saying file a problem report, and that sort of took the change that you guys had created and made it a more permanent part of the software?

A. Yeah, at that point the problem report is what would have tripped off the process to actually change the code in the FCC as opposed to just being a test setup change.

And again, because I wasn't involved specifically before the Roswell-2 deployment about where shaker setting was to be set, I don't know if the audience of the March 24th meeting was broader or not than the review that took place before.

Q. Do you need a break?

A. I'm okay.

Q. Did Reece mention to you before Roswell-2 that he decided he wanted to stay away from 12 degrees or any particular pitch or angle of attack upper limit because of the past 88 and 132 incidents?

A. I don't recall a specific angle of attack or a pitch angle being referenced.

Q. Reece had some sort of conference call on Thursday, March 31st, which was a couple of days before the accident and he had taken that day off and was out running errands in the afternoon. And he got a call from somebody and then I think he called you, and his wife said he had to go home and have a conference call for a while at his house. Did you participate in that call?

A. Yes. I was the one that told him about it.

Q. What was the call about?

A. The call was about shortening the Roswell deployment so that they'd be coming home after the last few tests he had.

Q. Why would that happen?

A. I think it was -- again, I don't recall the specifics of what was going on, but they had realized that the max takeoff weight takeoff test needed to be performed at sea level. So that entailed coming back local to do it out of a field nearer to sea level than Roswell and it limited the scope of what remaining tests there were and what value there would be added, and there may have been more factors but I don't recall exactly.

Q. So when would they have been coming home?

A. I think it was the Wednesday following the accident.

Q. Where did that originate from, the discovery that they probably needed to do those at a different field? Who did you hear that from first?

A. I'm not sure. And again, I don't know that that was the only driving factor. There may have been others but I don't recall specifically.

Q. All right. Was there any doubt that week, the week before the accident, coming from Reece about whether he was going to be going out there at all the following week, or starting April 1st, 2nd?

A. I don't recall any, no.

DR. BRAMBLE: John, do you want to jump in or do you want me to pass it to somebody else and let you get your head back in the game?

MR. O'CALLAGHAN. I can go. I'd like to talk a little bit more about the root cause of Flight 88 and 132 roll offs.

DR. BRAMBLE: Let's go off the record for one minute.

(Off the record.)

(On the record.)

DR. BRAMBLE: Let's go back on the record.

BY MR. O'CALLAGHAN:

Q. I'd like to follow up a little bit more on Flight 88 and 132 and the root cause of events, and I understand that you weren't involved in any direct analyses, but just from your understanding of discussing things with your colleagues, do you have a feel for what they thought the root cause of events were?

A. The Flight 88 event was, I would say, disseminated/reviewed broadly based on Kent's presentation. I know he put together that long presentation and then briefed it to flight ops and then he got pushed to flight test engineering and I think briefed again. Not I think, I know briefed again in a flight test engineering meeting.

Then as far as root cause, I guess it was, the presentation, led to a maneuver that was performed slightly incorrectly and then the corrective techniques, if you will, from there, were to address performing the maneuver per the procedures. So when you talk about the root cause, that's what I was privy to as opposed to, say, the root cause of what caused the wing drop. I can make a presumption based on how the maneuver was performed and what then resulted, but as far as the result of an analysis. Is that what you're looking for?

Q. Sure. What would that presumption be?

A. Stall.

Q. Well, when we were here in August, you talked a little bit about it and I think I asked about it back then as well if you had any ideas why it wasn't decided that it was a stall at that time or people weren't talking about stall in those events at that time?

A. Well, for Flight 88, I mean, to distinguish -- for Flight 88, I don't know that -- I never heard anybody say stall.

I should say that. So any perception I may have had, you know, that I'm quoting here, it's just my own perception based on what occurred and how the maneuver was performed.

MR. O'CALLAGHAN: Can we go off the record a second?

(Off the record.)

(On the record.)

DR. BRAMBLE: Let's go back on.

BY MR. O'CALLAGHAN:

Q. So, thank you, you've described a little bit about Flight 88. Can you go through the same sort of answer or process for the analyses that were done for Flight 132 and your perception of how the root causes of that event were analyzed and the conclusions reached?

A. So I'll caveat it with that I don't know that I can specifically throughout the entire dissertation distinguish what I knew then versus what I know now. But specifically what I knew then was that testing was discontinued while the yaw damper was going to remain unavailable. So they weren't going to do any more takeoff testing until the yaw damper could be utilized. And I was obviously aware of the roll-off but I don't recall specifically what I knew before the accident about what analysis or root cause had been established other than the fact that an obvious interpretation would be that because testing was discontinued until the yaw damper was available that it was related to lateral directional upset based on, you know, the unavailability of the yaw damper.

And the post-accident, in compiling the data that I've presented to you all of the sequence of events that transpired, I talked to some of the different parties and that's where I got information about the predisposition of the lateral directional excursions, because it was getting a little bumpier as the day progressed and as they kept flying around the pattern with the yaw damper off, they were getting squashed around.

And then the review, I guess, the on-site post-flight review between Reece and the test pilot, Gary, you know, looking at the data.

Q. Did you know specifically what they looked at in terms of the data, what kind of parameters?

A. I do not.

Q. Thanks. Going to something probably more in your area, the made files, when one defines a made file, does that define the values for every single parameter that can be set or does it just set a subset of those?

A. It's just a subset of the parameters. So you type in which specific parameter you want to type in, whether you're calling a list or however you're utilizing function. You recall what specific parameter that you want to modify and then the specific value that you're modifying it to, but there are thousands or ten thousands of parameters within the FCC that could be modified.

Q. So then the configuration control, how is that maintained? Does it always get reset to a default value, these parameters, and then each made file changes the default or is it a concatenation as time goes on that more of a --

A. There's a switch in the cockpit that enables the gain changes, and whenever the power is cycled to the flight controls or that switch is turned off, it returns to the default value program into the FCC. So it's just a temporary change.

Q. I think I recall from last time that you were limited to something like 20 at a time that you can do?

A. Yes.

Q. We can read charts too, but just for the record I was wondering if you could read the chart there that shows the various stall angle attacks and warning settings and the vertical line for the mach number of the event, and just if you could read for us what the margin that you see there shown between the in ground effect estimate for stall and the .9 normalized AOA value would be?

MS. WARD: John, please who created the chart, the date of the chart, that kind of stuff since you're having him refer to a piece of paper.

MR. O'CALLAGHAN: Oh, okay.

BY MR. O'CALLAGHAN:

Q. Why don't you read the title and where it comes from?

A. This is Shaker Setting Evaluations, the master title of the slide. And then the title of the chart is Flaps 10 Alpha Schedule with Field Performance Settings.

BY MS. WARD:

Q. And the chart was created by whom?

A. Looks like one I created.

And to answer John's specific question about the margin between the AOA max IGE, in ground effect, estimate line and the .9 normalized line, it looks to be about .6 degrees.

BY MR. O'CALLAGHAN:

Q. Last question I have is the one I have for everybody. Likely after our week here, we're going to go back and start doing our analyses and putting together recommendations, and I know that everybody here has thought well and hard, a long time about the accident and you're closest to it, and you can kind of probably tell sort of the things we're interested from our list of questions, but if there's anything that you think we should be looking at that we haven't asked about or we don't seem to be looking at through or questions, or if there's anything that has occurred to you in the months since the accident that might be helpful for us to bring to light to the industry to improve flight testing and all these sort of things, we'd love to hear about it so we can include that in our considerations.

A. Not specifically I don't guess.

MR. O'CALLAGHAN: That's fine too. Thank you.

DR. BRAMBLE: All right. Mitch?

BY MR. GALLO:

Q. In reference to your March 24th meeting regarding the change in the settings for the shaker, you mentioned after that there was a problem report submitted and that was, you thought, was by Reece that submitted it?

A. No, I submitted it. He requested that I submit it because I have access to the tool to generate problem reports.

Q. So somehow Reece contacted you. Was it via phone or something?

A. E-mail.

Q. By e-mail. And you created a problem report, but just for clarification, a problem report isn't always a problem; it's a request?

A. In order for us to make a change to software or -- I'm not an electrical guy, but DO178 or 254, whichever the one for software is, process requires that any software change begin with a problem report, whether it's a problem with the software or just a change, which I guess in effect would be a problem with requirements not being complete enough. So you generate a problem report to start the process of changing the software. So no software changes happen without a problem report being generated.

Q. I'm not familiar with a problem report. What's on a problem report?

A. A lot of it's free form field, but you specify what -- for the problem report system we have for the 650 program it's called Team Track and you can assign it to whichever specific system and subsystem and then assign it a severity. And, quickly, the severities are: severity 1 is a flight issue, a safety of flight issue; and then severity 2 is a certification issue; and then 3 and 4 get into the type -- I don't even remember specifically, but a severity 4 would be a nice to have type implementation. And then free form fields to describe the problem or the change and that kind of stuff.

Q. So severity is just classifies a response time that you're seeking for the problem report to be addressed?

A. Well, not necessarily, because, first off, there's a whole process built around it. The problem report is generated and then it's triaged and then it's implemented and reviewed by a problem report review board. So severity speaks to kind of the timeline in that when it has to be addressed. So a severity 1 would either have to be mitigated and downgraded or an interim flight restriction would have to be generated to avoid whatever the issue was or a fix implemented.

Q. In this case with the change in shaker settings, what severity classification was it assigned?

A. Probably a severity 2 because it affected a specific certification test.

Q. Once you complete this form, where do you send it off to?

A. It's a database. It's an online database tool. So I just fill out and hit submit and it gets logged into the database.

Q. Then it goes to the software people to change the settings and implement?

A. I'm not sure. I think certain people get notifications when a problem report is generated against their system. In this case, it was the people to make the changes. The control log engineers were in the loop. They were actually in the March 24th meeting. So they knew the change was coming. They just requested that we generate the problem report to formalize the change.

Q. Does somebody in flight controls, does somebody review the problem report and then is there a person that authorizes the change?

A. Again, it goes through a triage meeting which is where they would assign it. I believe -- I'm not specifically privy to this, but where they would assign it to a certain person to work, and then before it's closed it's reviewed by a PR review board that consists of flight operations, flight tests and then representatives from engineering.

Q. So in this case was the review board, the March 24th group or was it a separate board?

A. No. That would have been a separate board before the problem report was closed much later.

Q. Do you know who was on the separate board then that reviewed the change?

A. I'd be surprised if that problem report is closed. So the PR review board reviews problem reports with the direct intent of closing them. So, for instance, for this specific change, they would have reviewed it once we received the software from Talis that actually had the change implemented in it. So then it's completely closed out through the whole process.

Q. Well, would Tom Landers be one person that would be reviewing this?

A. Yes.

Q. I don't know if you could speak to this, but once it's reviewed, is there an authorizing person that PR would be forwarded to, to take action?

A. I don't know specifically how that process would -- Tom would probably be a better one to pose that question to. He's more involved in the triage of those PRs.

Q. Prior to the change when you moved the shaker from .85 to .90, did you understand the correlation in terms of angle of attack?

A. Specifically with how much of a degree of angle of attack that was?

Q. Correct.

A. Generally, yeah. I mean, I had run some calculations for a certain log number to see what that correlated to.

Q. Once these changes were made, did any of the pilots contact you directly to ask about the changes in the shaker?

A. No.

Q. So you didn't have any communication with them directly regarding this after the changes were made to discuss the effect of the .85 to .90?

A. Do you mean before the deployment to Roswell in March when .9 was to be used?

Q. Well, let me clarify. Did any of the pilots discuss either before or after the change from .85 to .90 was made, did they understand how much change that was in angle with that?

A. I can't really speak to what they did or didn't know.

Q. Now, if you wanted to, how would you ask for the Safety Review Board to convene?

A. I would send an e-mail to Barry and tell him that we needed to reconvene the Safety Review Board. Generally, that would come after conferring with some of my colleagues. When I say colleagues, some of my seniors like the chief flight test engineer.

Q. Have you ever done that before?

A. Reconvene?

Q. Reconvene or initiate an SRB?

A. Yes, initiate all the time.

Q. Can you provide an example?

A. Well, yes, for instance whenever we write a test plan to define tests, before we do the tests we have to initiate a Safety Review Board process. So I've done that specifically for brakes development testing on the GVI program.

And then as far as to give an example, recently we were discussing the need to do another hazardous test as part of the brake system testing and I let them know that if we proceeded down this path that it would require another reconvene of the SRB.

Q. Was there ever an SRB convened for software development?

A. What do you mean specifically software development?

Q. For flight control software?

DR. BRAMBLE: You mean for changes to the existing flight control software?

BY MR. GALLO:

Q. Changes to flight control software in the initial flight control software load, was there an SRB ever convened to iron out the changes and potential hazards and concerns?

A. Are you talking about specifically from software drop to software drop changes that were coming in?

Q. Yes.

A. It wasn't the Safety Review Board process. Reviews took place between engineering and flight ops and flight tests that throughout the course of the GVI program became more and more formal. And then again, as I mentioned, flight operations and flight tests participate in the PR review board which is the avenue through which changes get implemented. So they are directly aware of changes coming. But it wasn't part of the SRB process outside of the specific functionality that you were testing for a specific test.

So for instance, before the first flight review board, the flight control group reviewed outstanding issues with the software system. Does that answer your question?

Q. Yes.

A. Okay, sorry.

Q. And as far as changes in flight control software, how do you disseminate that information to flight operations?

A. Again, are you referring to flight operations as a whole or members? Because members of flight operations are involved in the PR review board process for flight control software and in the briefing that we get on new software loads. So several participants from flight operations usually attend and depending on the scope of the software change and how broad of use it's going to receive, the attendance is different.

Q. Have there been any changes as to how that information disseminated post-accident versus pre-accident?

A. No. Again, as I mentioned, it has progressively grown -- I'll call it more formal, but we were always briefed on it but then we pushed at one point in the program to have a formal sit-down meeting where the different groups brief us. So that has evolved throughout the program, but the last changes were implemented prior to the accident.

Q. Are you a DER also?

A. Yes. AR now, but yes.

MR. GALLO: That's all the questions at the moment.

DR. BRAMBLE: Jeff?

MR. BORTON: Just a couple

BY MR. BORTON:

Q. Excuse me if you've already explained this to us in a previous meeting, but there's something called a Flight Test Safety Review and then an SRB. Could you distinguish between them, what triggers what?

A. Well, the Safety Review Board process that was convened after the accident, I was never aware of prior to the accident fortunately. The Flight Test Safety Review Board is integral to how we operate so I was intimately aware of that process.

Q. So like when you were telling Mitch about requesting an SRB for some brakes development, was that a Flight Test Safety Review Board or more of this other SRB --

A. Yes. Well, you know, prior to the accident I would have called it an SRB, because I didn't realize there was another process through which we reviewed more broad scope project issues. But yes, that's why I tried to make the distinction of Flight Test Safety Review Board just to avoid any ambiguity.

Q. Just another question again, an educational one. During the conduct of, let's say, field performance testing, if you're changing a made file, that's a subset of everything else that could be changed in the whole flight control software. It gives the selectable areas to change for field performance testing just simply limited to gains, various gains, or are there a bunch of other things you can do just in general?

A. In general, it is only gains or switches, you know, which effect the gains, in the flight control software that can be changed. And each parameter that can be changed has a set range in which it can be changed for gains and then, you know, switches are obviously just 1, 0. But there are specific parameters you can change and defined ranges in which they can be changed.

Q. This is an opinion question on your part. It sounds like it's similar to what might be done on autopilot tests in other airplanes. As a company or as a flight test organization, was there additional training needed in how to use the -- made specifically for the 650 and did it hold well with maybe previous experience that some folks might have had with the autopilot tests --

A. It's similar to autopilot gains except generally with autopilot gains. It's the vendor that actually comes along and changes those gains. For the way our system is set up, we did get experience with it with our flying test for the advanced flight controls because it was a similar implementation with the same vendor, Talis.

And then as far as specific training, yes. At the test labs prior to first flight, the flight test engineers were involved because we're the ones who -- the pilots just flip a switch but the flight test engineers are the ones that actually operate the software. So we did use it in the test labs and then prior to first flight there was extensive ground testing on the airplane where it was used, so -- does that answer that?

Q. Yeah.

A. Okay.

MR. BORTON: That's all I have.

DR. BRAMBLE: All right. Tom?

MR. HORNE: I don't have any questions.

DR. BRAMBLE: All right. Marie, any questions? Mike?

BY MR. BAUER:

Q. I guess a question, one of the things that's kind of come up in the previous talks this morning was about data analysis. I guess this is a question we had to the other individuals, but you're feeling is like the schedule or staffing permitted enough time for data analysis or discussions with other groups?

A. In general or specific to certain severities of --

Q. I'd say within your realm of knowledge or within flight test performance or performance testing?

A. I can't speak specifically to performance testing but I can speak generally that you have to make time for data analysis. Does that make sense? So, for instance, I'll speak specifically to my brakes testing. A lot of my data review I do real time on the flight, but had I not been -- you know, if brakes testing wasn't set up to the point where you do a 45-second test and then a 20-minute cooling flight, it would have been difficult to find time back at the office to do the necessary data review.

MR. BAUER: That's all I have.

MS. WARD: I have some easy questions.

BY MS. WARD:

Q. Does Gulfstream have a mentoring program for young engineers?

A. They do.

Q. Is it a structured program or more informal?

A. It's structured.

Q. Because I noticed you've got a couple of co-ops who come in and are actually direct ties from college, and I was curious.

A. Yeah, the mentoring program actually initiated with the co-op program because of -- we have a board of former co-op students that oversees the co-op program and serves as mentors to the co-op students as an avenue outside of management. I think that example is extrapolated to engineering broader and now there is a formal mentoring program where senior engineers or young engineers can request a mentor and be assigned to a senior engineer.

Q. So then is there a kind of open door policy where if you have any questions or you're seeking some kind of technical advice, do you feel like that's available here at Gulfstream for you?

A. Yes. I mean specifically in flight test engineering, we have a very open collaborative environment. So ever since I was a co-op, I've been conferring with chief flight test engineers and DERs in day-to-day operations, not just in a very seldom informal process but as part of the normal course of business that you walk into his office and ask whatever salient questions you need.

Q. Do you feel like there is a non-attribution type culture also that if you felt like you saw a problem or issue that you would feel comfortable bringing that to a more senior personnel?

A. Yeah, I would feel comfortable doing that.

MS. WARD: Okay, that's all I have.

MR. O'CALLAGHAN: Just a quick follow-up.

BY MR. O'CALLAGHAN:

Q. Can you just describe where the boundaries of mentor/mentee versus middle; is it by years of experience, years at Gulfstream?

A. I'm not sure how they decided who would be mentors but I believe that anybody who requests can be a mentee. I mean, I'm not part of it, other than the co-op part, but I think they just submit a request and they are assigned a mentor. And the mentors that I know of are principal engineers and staff scientist and technical specialist and of that level.

DR. BRAMBLE: I have one last question.

BY DR. BRAMBLE:

Q. On the March 31st telecon we talked about, who else participated in that?

A. I don't recall specifically.

(Off the record.)

(On the record.)

DR. BRAMBLE: Okay.

BY MR. HORNE:

Q. I believe when you were asked if you ever initiated any SRBs for any instances occurred in flight, you had not; but, clarification, were you aware of other incidents that ended up resulting in the people in the data review somewhat like the SRB process?

A. Yes, I was involved in one and I was privy to another. They were two events, the first being an unexpected roll-off event in flight during a lateral directional maneuver that drove a review where they brought out -- including engineering, flight operations, flight test engineering and some level of the management. And that was the Flight 69 event or -- aware.

And also there was an event on a takeoff roll with the FAA on board that is actually the event that drove the yaw damper unavailability on the Flight 132 that triggered a convening of a review team to review that incident. That was similar, engineering, flight test engineering and flight operations.

MS. WARD: What was the flight number with the FAA on board?

MR. RUTLAND: I don't recall the flight number.

BY DR. BRAMBLE:

Q. That was the yaw damper malfunction?

A. Yes.
Q. While you guys are looking -- what was Flight 69? Do you know what kind of test it was?
A. It was steady heading sideslip at slow speed.
MR. O'CALLAGHAN: What was the outcome of the review?
MR. RUTLAND: That's the one I wasn't involved in.
MR. O'CALLAGHAN: Oh, you weren't on --
MS. MOLER: It was in Brunswick, Georgia?
MR. RUTLAND: Yes.
MS. MOLER: Flight 122, card --
DR. BRAMBLE: Which one was in Brunswick, Georgia?
MS. MOLER: The yaw damper.
DR. BRAMBLE: Do you have an airplane number?
MS. MOLER: 6002. I have the whole --
(Asides.)
BY DR. BRAMBLE:
Q. Maybe we should clarify what was your role in the review process for that?
A. An observer really, and actually I just thought of another event. There was another event where an anomaly occurred with a pitch-up during an FAA flight maneuver that the review ended up showing that the trim switch was activated. There were events where a broader review was initiated across discipline but I would say in most of those, I was an observer. I was more being briefed than participating in the data analysis.

Q. Who had that review, the reviews for 122?

A. As far as I recall, the review was structured around engineering presenting the results of their analysis of the event to the flight operations and flight test community.

MR. O'CALLAGHAN: Did you mention that the FAA was on board on the pitch-up event?

MR. RUTLAND: Yeah.

MR. O'CALLAGHAN: And how about for Flight 69, the steady --

MR. RUTLAND: That was not the FAA. That was company testing.

BY DR. BRAMBLE:

Q. So I noticed on Reece's calendar, there was a whole bunch of recurrences for meetings to talk about the yaw damper event. And I just wondered, did you participate in any recurring meetings about the 122 issue?

A. I was not aware of any recurring meetings.

Q. And who were the people? You said that engineering was presenting results but what part of engineering?

A. For?

Q. For 122.

A. I don't recall specifically. Judging by the type of event it was, I would imagine that the control log group.

DR. BRAMBLE: Jeff?

MR. BAUER: Just one.

BY MR. BAUER:

Q. A little more details on the pitch-up event.

A. I don't remember what kind of maneuver they were performing but it involved a significant amount of rollover pitch input and his thumb was on the trim switch so he inadvertently activated it. I don't recall what the maneuver was.

Q. Was there any assigned changes made as a result of that?

A. No, not that I'm aware of.

DR. BRAMBLE: Anybody else?

BY MR. BAUER:

Q. What was the outcome of the Flight 69 event per the review?

A. I don't recall specifically. I don't think I was involved in that. I was just aware of it.

BY DR. BRAMBLE:

Q. So these reviews were outside of the SRB process. This is a separate type of review?

A. Yeah, somewhat. A lot of the same participants, but generally an SRB is structured to review a specific test hazard and make sure as much mitigation has been applied as is reasonable and that the test hazard has been sufficiently scoped and quantified kind of under the guise of signing off a test safety hazard analysis, TSHA.

So these reviews were triggered by an event that happened that needed review and explanation. So it was kind of a different scope. An outcome of some of these was an interim flight restriction or something. Because I think -- and I'm shooting from memory here, so -- generally that's followed up, but don't quote me, but I know that's the proper way. But the takeoff event with the FAA drove an interim flight restriction that said you had to do a standing takeoff, you had to lineup for at least 10 seconds before a brake release, and then a subsequent discovery in fixing that drove the IFR that precluded use of the yaw damper altogether.

DR. BRAMBLE: Go ahead.

BY MS. WARD:

Q. I'm a little confused now. It was crystal clear before you guys walked out the room and now -- so you're saying that this is a different avenue that they're exploring other events or this was outside the SRB process or was this actually within the SRB process?

A. It's hard to distinguish between the two because it was part of a safety or potential risk assessment by the test team, which inherently is the safety review process whereby the flight test engineers and flight operations review the hazards of certain testing and then initiate a formal review where a test safety hazard analysis is approved. So these were akin to the Safety Review Board process; maybe you could even say it was potentially a subset of it, albeit not a formally documented in the Safety Review Board process step. Does that make sense? No? Did I just confuse matters more?

Q. No. Is it an informal process or is it a formal process, because you said it was not a formal?

A. I hate to get to symantics [sic] here, but by formal do you mean -- I mean, I would say if by formal you mean documented in some process manual somewhere? Yes, it was an informal process, but it was very formal in the nature of the review and the outcome, you know, because as I said, an IFR resulted in one, an interim flight restriction.

BY MR. BAUER:

Q. What was the risk level of those two tests?

A. The takeoff was a low risk test. It was a familiarization flight with the FAA, I believe. The Flight 69 event was a slow speed, steady heading sideslip, so I'm sure that had a TSHA but I don't recall exactly. 69 was pretty early for that.

Q. So if it was a low risk test to start, there wouldn't have been an SRB prior to it?

A. Correct, but like, for instance, for the low risk takeoff test, it wasn't the test that was the hazard; it was operation of the airplane, which is why the IFR was driven as opposed to a TSHA.

MR. GALLO: I have some questions.

DR. BRAMBLE: All right.

BY MR. GALLO:

Q. This informal group, what do you call it? Is there a name that everybody refers to it as?

A. No, I mean, it was a meeting to review an incident.

Q. And the people that attended, are they all from the G650 program?

A. Yes, all from the G650 program.

Q. I have one more question. On the Flight Test Safety Review Board that was here on October 7, you are the first person on the attendance sheet. And the question I have is, is everybody that belongs to the G650 program on this sheet?

A. Let's see.

MR. RAMEE: What do you mean by 650 program?

DR. BRAMBLE: Maybe you ought to say what you think he means by the 650 program.

MR. RUTLAND: When I say part of the 650 program, I mean an engineer assigned to work 650. For a Safety Review Board process, you inherently have to have someone disassociated with it, via management member. So you asked -- I'm sorry, what was your specific question?

BY MR. GALLO:

Q. Is there a distinguishment -- I mean, if I say G650, I mean, everybody on the program is working on developing and certifying this airplane?

DR. BRAMBLE: Let's go off the record.

(Off the record.)

(On the record.)

DR. BRAMBLE: Let's go back on the record.

BY MR. GALLO:

Q. So let's start with the SRB. I'm going to ask you who is not on this?

A. On this Safety Review Board meeting minutes cover sheet for the 6002 field performance test on October 7th, the board consisted of the management member Larry Dallard (ph.), who is not working the G650 program and was not.

Q. Does he sit in on the other meeting, the informal review?

A. No, he did not.

Q. Is there somebody in those review meetings that isn't on the G650?

A. In those, I don't recall every specific participant but I would say probably not, that it was all 650 personnel.

MR. GALLO: That's all the questions I have.

DR. BRAMBLE: You guys have any more? Just real quick to make sure.

BY DR. BRAMBLE:

Q. The pitch-ups, there's 69 and then there was another pitch-up?

A. The other one wasn't -- it wasn't an aerodynamic event.

Q. That was the trim?

A. That was the trim switch.

Q. What was the cause of the 69 pitch-up?
A. I wasn't involved in that --
DR. BRAMBLE: All right. Thanks. That's it for me.
(Whereupon, at 2:31 p.m., the interview concluded.)

CERTIFICATE

This is to certify that the attached proceeding before the

NATIONAL TRANSPORTATION SAFETY BOARD

IN THE MATTER OF:	PLANE ACCIDENT ROSWELL, NEW MEXICO N652GD Interview of Nathaniel Rutland
DOCKET NUMBER:	DCA11MA076
PLACE:	Savannah, Georgia
DATE:	October 24, 2011

was held according to the record, and that this is the original, complete, true and accurate transcript which has been compared to the recording accomplished at the hearing.

____
Letha Wheeler
Official Reporter

____
Lourie J. Brown
Transcriber

UNITED STATES OF AMERICA

NATIONAL TRANSPORTATION SAFETY BOARD

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Investigation of:                   *
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AIRPLANE ACCIDENT                   *
ROSWELL, NEW MEXICO                 * Docket No.:  DCA11MA076
N652GD                              *
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Interview of: DR. ERIC UPTON

Gulfstream Corporation
500 Gulfstream Road
Savannah, Georgia

Monday,
October 24, 2011

The above-captioned matter convened, pursuant to notice, at 3:20 p.m.

BEFORE: WILLIAM J. BRAMBLE, JR., Ph.D.
Senior Human Performance Investigator

APPEARANCES:

MITCHELL GALLO
Air Safety Investigator
National Transportation Safety Board
31W775 North Avenue
--------------------is 60185

WILLIAM J. BRAMBLE, JR., Ph.D.
Senior Human Performance Investigator
Office of Aviation Safety
National Transportation Safety Board
490 L'Enfant Plaza East, SW

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ALAN J. (JEFF) BORTON
Flight Test Pilot
FAA Aviation Safety
Aircraft Certification Service
Wichita Aircraft Certification Office
---------------------oom 100

THOMAS M. RAMEE, ESQ.
Deputy General Counsel and Risk Manager
Gulfstream Aerospace Corporation
500 Gulfstream Road, M/S B-06
Savannah, Georgia 31407

TOM HORNE
Experimental Test Pilot
Gulfstream Aerospace Corporation
P.O. Box 2206, M/S A-12

APPEARANCES (Cont.):

JOHN O'CALLAGHAN
Aircraft Performance Group Chairman
Vehicle Performance Division (RE-60)
Office of Research and Engineering
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

-

MICHAEL BAUER
Aerospace Engineer
Vehicle Recorder Division (RE-40)
Office of Research and Engineering
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

E. LORENDA WARD
Air Safety Investigator
IIC and U.S. Accredited Representative
Office of Aviation Safety
Major Investigations (AS-10)
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

MARIE MOLER
Mechanical Engineer
Office of Research and Engineering
Vehicle Performance Division
National Transportation Safety Board
490 L'Enfant Plaza East, SW

I N D E X

I N T E R V I E W

(3:20 p.m.)

INTERVIEW OF ERIC UPTON

BY DR. BRAMBLE:

Q. Okay. Dr. Upton, let's start off with getting your date of hire.

A. I think it's the 22nd of October, 2007.

Q. And your current position title?

A. Right now, it's environmental performance specialist. That's a Tech Spec-1, I guess the official Gulfstream way of saying it.

Q. Okay. And what department are you in?

A. I'm officially in Preliminary Design. I'm currently on loan to the Performance Group basically to get 650 certified.

Q. And this all was the same situation prior to the time of the accident, too?

A. Yes.

Q. Okay. And in your role at the time of the accident, what were you responsibilities as an engineer on loan to the Performance Group?

A. My primary job, if you want to limit it to Roswell in particular, was to record data in the telemetry trailer, mark specific events that occurred during whatever activity we were trying to record and then post-process the data back in the hangar afterwards.

And more generally, in the office here, IFM development, any kind of supporting tasks to go with that. I've also been doing some work, and had been at the time, on a CO_2 certification standard for aircraft, unrelated to 650, but it takes a lot of my time.

Q. Who did you work for before Gulfstream, which aerospace employers?

A. None of them. I was right out of grad school. I did work, you know, as a graduate research assistant at Georgia Tech but I don't know how that counts.

Q. As a grad student, did you work in a significant capacity for another manufacturer in certification?

A. Not in certification. We did do contract research involving performance analyses and a range of different things.

Q. And your Ph.D. is in?

A. Aerospace engineer.

Q. So at Gulfstream, did you only work the 650 program or had you worked on any other cert programs with like 450, 550, or were you here too late for that?

A. No, no. For cert stuff it's only been 650. And most of the work I did in preliminary design, it's kind of pre-cert stuff.

Q. How were you selected with the team in Roswell on the day of the accident?

A. All the members of the Performance Group generally were scheduled for a rotation. We would be out there for two weeks and then back. I had been out in Roswell for what we call the Roswell-1 trip the prior November. So I was just on a standard rotation. Normally, we had either Shelly or Pat working as sort of the lead. And then, one or two other performance engineers in the trailer as well.

Q. When did you arrive in Roswell last prior to the accident?

A. It was the 24th of March, the Friday before -- well, it was two Fridays before the crash.

Q. One thing that has been a little bit difficult for us to sort out is who on board the aircraft, Reece -- or Mr. Ollenburg or Mr. McCollum, was serving as the onboard test conductor and who was serving as the flight control monitor. We had one person tell us that it was one way and the other person thought maybe it was the other way around. So, what was your impression?

A. I didn't normally break it into those particular distinctions. As far as what the flight test engineers on board the plane did, normally the way I considered it, it was someone in charge and then the other person. And in that case, Reece would have been the one in charge because of his greater experience. But I didn't distinguish it quite like you just described.

Q. Were you familiar with Reece's range of duties and his role as cognizant FTE for the field performance testing?

A. Not entirely. I mean, I had some familiarity as it interfaced with what I did but I understood that there was a great deal more that he did outside of where I would interface with him.

Q. One thing Cynthia Townsend mentioned when we talked to her was that the flight test engineers, one engineer was usually on the ground for fatigue duty. Do you have any idea what she was talking about?

A. Again, not formally. I do know that they rotated out to keep folks fresh. So, my interpretation was she was the one that was, you know, sort of on rest, if you wanted to call it that way, on that day.

Q. So working in the trailer is considered a rest period?

A. Well, sometimes there would be somebody back at the hangar not on active duty, but they did tend to rotate out of the plane into the trailer or out of the plane back to the hangar.

Q. Sometimes the trailer shift was considered the down day?

A. I don't know if they formally considered it a down day or if they had -- they probably had a more sophisticated schedule than that but, yeah, again, I wouldn't be aware of it. But it usually was Cynthia in the trailer when I was there.

Q. At the time of the accident, what policies and procedures did Gulfstream have in place to manage the safety of the flight test program?

A. As I'm familiar with it or was at the time, there was a safety review board that sort of met way ahead of time and developed basically everything in concert with the flight test folks.

When we got to the actual -- up to the testing we were doing in Roswell, the safety procedures again that I would interface with was the TSHAs and we would have preflight briefings, post-flight briefings. I do know that there was a good deal of other safety related stuff that happened outside of what I experienced firsthand. I know Kent, for example, was famous for going to the fire department and inviting them over and handing out Gulfstream caps while he showed them around the airplane so that they would be familiar with the plane, for example, in the case of an accident. So, there was a bunch of other things that happened that I wasn't connected to.

Q. Was there a written safety policy statement and was there an executive who was formally accountable for safety of the flight test program as far as you knew?

A. There is a chain that I don't know who is on the list as you go up. But I do know as part of that safety review board, there's folks that go up to the executive level.

DR. UPTON: (Looking at Mr. Horne) I know you are part of that maybe, but -- appear on that. I see your name on all of those TSHAs.

BY DR. BRAMBLE:

Q. Anyone in particular at the executive level that you know of?

A. Not that I recall.

Q. What procedures did the company have in place for reporting -- for personnel on the program to report and then have the company subsequently investigate perceived hazards or safety related incidents that occurred during flight testing?

A. Again, I'm not familiar with the formal reporting structure for basically anyone other than our little group of performance folks. I do know, though, that there was a way to do that. I know, for example, there was talk after -- I don't remember which flight, but there was in the first Roswell trip, there was a wing dip and there was a lot of talk about that and how it was going to be sort of taken up.

Q. Taken up the hierarchy?

A. Yeah, taken up through the hierarchy to do something about it, to figure out what was going on.

Q. How about the wing drop that occurred during Flight 132? Do you happen to know what happened there?

A. I wasn't there for that one.

Q. Before the accident, what was your understanding of the reduction in stall AOA and ground effect compared to free air and how did you come to that understanding?

A. I knew that there was one and it was my understanding that it was handled in the polar, but -- that it had been accounted for in the low speed polar, but that was about as far as we got.

Q. What's the low speed polar?

A. In this case, there was a polar done that we were using to estimate performance for auto takeoff and landing conditions with the flaps deployed and without -- but all the takeoff and landing speeds.

BY MR. O'CALLAGHAN:

Q. By polar, do you mean a plot of the CL versus angle attack or CL versus CD?

A. I never saw it as here's a sheet of paper with the plot on it, but it was incorporated in the drag polar that our analysis would call. So we have a polar that we -- it's a tabular -- well, it's a smart polar, so it goes through some different subroutines to calculate a CD based on a CL at different conditions.

Q. So sort of independent of angle of attack; is that right?

A. Normally the way we deal with it -- well, actually, it can go either way. We can, I believe -- it's not, but I'm trying to think how we get in there with angle of attack to produce it. Yeah, that is a component of it but off the top of my head I don't remember how it's actually being called physically in the, for example, takeoff program.

Q. You mentioned a takeoff program. Is that predictive program for takeoff performance or what is that?

A. We have a program that will estimate takeoff field lengths based on engine thrusts, the drag polar, normal stuff. And it can be used for predictive purposes. We can, for example, give it a set of speeds and it uses basically F equals MA repeatedly. Say, okay, I'm going to accelerate to this rotation speed, for example, and then rotate and go. And we did use that as part of the analysis for building various speed.

Q. F equals MA part of it, the physics based part, is that just for the ground roll or is that through the rotation and climb?

A. It's for the ground roll and, if I recall correctly, the climb is that way. The rotation gets a bit strange. That's a done a little bit differently and I don't remember the exact details. If I could go back into the code, I could probably do it because I think I'm mixing up takeoff and landing codes in how they're doing it.

Q. Pat Connor described to us something similar. If I recall his testimony in here correctly, he described an F equals MA method for the ground roll and then so the rotation and V_2 point would be based on ratio to stall speed. And I think since the accident, somebody had described that there's more of a 2-, 3-D equation of motion modeling for the whole process. Does that resonate with your experience?

A. The accel factors, as part of that initial climb, do, yeah, as Pat described it. And I wish I could remember how the rotation is handled but it is, if I remember right, a semi-empirical -- you know, you start here, you end here, how do you get there, for the rotation. But most of what we would have been basing that on would have been the stall speeds that we would have gotten from the polar.

DR. BRAMBLE: That it?

MR. O'CALLAGHAN: Yeah.

BY DR. BRAMBLE:

Q. All right. We were talking about the difference between free air and in ground effect stall angle and your understanding of it. And so my question is, do you recall if there was any discussion of the difference during SRB meetings prior to the Roswell-2 or did you participate in those?

A. No, I don't participate in those meetings.

Q. Were you aware of how many degrees the difference was in the predicted stall angle?

A. I don't.

Q. Prior to the accident did you play a role in reducing or analyzing any data from the November V_{MU} testing?

A. Yes. I marked points in November and I assisted in some of the reduction. We also provided V_2 speeds and a number of other things on site during the November testing. But that was mostly just -- for example, we had the V_2 speeds for every 5,000 pounds at Roswell conditions and we built a new table that was every 1,000 pounds. That's the sort of what was done.

Q. After you came back to -- well, either on scene or after you came back, did you use any of that data to do modeling of the aircraft's performance?

A. I didn't. I know it was used. I don't know to what extent. I was shifted back onto the CO_2 task pretty soon after we got back from Roswell.

Q. So did you do any analysis after leaving Roswell the first time, Roswell-1?

A. Some but I don't recall exactly what scope.

Q. And on scene, other than marking the tears and that sort of thing, during the Roswell-1 of the V_{MU} testing, what kind of analysis did you do on scene?

A. Specifically for the V_{MU} testing, I don't recall. I deduced, for example, those V_2 speeds later. I know as a group, we worked on EPRs to get certain thrust weights. There was some -- there were like three or four big things that we did that were analysis right then, because that was one thing that was handy, I guess, to have us there was we were able to do it right away and hand it back to the flight test engineers.

Q. Is that between runs or at the end of the day?

A. Yeah, generally what would happen is we would come back to the hangar after the test and we would post-process the data. Generally what would happen is Reece would poke his head in the room and say, "you know, it would be nice if", and then we would stay until 7:00 at night generally rendering whatever would have been nice.

Q. How frequently did that occur; was it every day?

A. It felt like every day. It wasn't but it was mostly the days we were there, there was some small task, at the least, that we were asked to do. And that was fine. I mean, that's what we thought we were there for, so --

Q. And then did you typically brief those findings the next morning or that evening?

A. In some cases, if it was something that we could accomplish sufficiently fast, we could actually brief it that afternoon. Sometimes the preflight briefings -- we would have a preflight briefing the afternoon before the flight to kind of do a high level overview and other times it would be in the morning when we would give it to them.

Q. Can you give an example of the kinds of things that you might analyze at the end of the day like that?

A. Well, the V_2 speed thing, for example, was handy and that, really, all that was was just V_2 speeds for a more detailed range of weights.

Q. Did you ever do scatter plotting or throwing out data points from the test flights on curves?

A. Yeah, we sure did.

Q. On site?

A. Oh, yeah. Yeah, I'm trying to recall what we were plotting exactly. It's usually speeds and I'm trying to remember what for, but we did do some scatter plots.

Q. Was that process typically directed by Mr. Ollenburg or Ms. Brimmeier?

A. Well, the request would have come generally from Reece and then Shelly would direct it in detail. Either she would do it or she would have Adam or I working the task specifically or maybe both of us.
Q. Then who would brief the findings?
A. We would give it to Shelly, generally, and then she would brief at a preflight meeting. Occasionally, we would brief but usually it was Shelly.
Q. Do you recall finding any difficulty meeting predicted V_2 speeds during that testing?
A. Yes.
Q. What was discussed about that issue during the Roswell-1?
A. We were never quite able to figure out what was causing it, but generally we were blowing right through the speeds, through V_2.
Q. By how many knots?
A. I don't recall, but it was something we were looking forward to fixing at Roswell-2.
Q. Do you remember or to your knowledge how did they attempt to fix it?
A. I don't. But the only thing I do remember is there was going to be some changes in how the plane was being flown for those points but I don't remember what those changes were.
Q. The day-to-day analysis that you describe for Roswell-1,

did that continue for Roswell-2? Was it a similar kind of daily analysis process?

A. It was similar. Since we didn't have Reece there the first week I was there, we weren't asked quite so much for things like those V_2 speeds so we spent more time -- one of the things we noticed in Roswell-1 is that the ability for us to take the data and turn it into something that could be readily used later on was lacking. We hadn't quite tweaked or procedure so it was going to mean a lot more work back here. And so at Roswell-2, we had improved our scripts, we had improved our methods so that we could get, for example, time histories generated that afternoon and plots of all that so we could have a little bit more detailed material to look at. And so we spent more time developing that.

Q. In between?

A. No, actually -- well, yeah, we did --

Q. The first week?

A. We spent some of that time in between, some of that in the Roswell-2 before I got there, and by the time I got there, it was fairly well developed and we were able to generate the week I was there the time histories, for example; not perfectly but we had a pretty good handle on it.

Also, we did have one instance where we realized, for the landings, our sink rates -- we were never getting the sink rates right. And in talking about it with the pilots, we finally realized that we had just miscommunicated and there was a very good a-ha moment with Chip. He realized that we didn't have to hold the glide slope all the way to the ground, that once we were past 50 feet, he could do whatever he wanted. Suddenly our sink rates looked better, our glide slopes looked better and it all seemed to fit. So we were able to make a sort of in-line correction to procedure in that case for landing.

Q. Do you recall difficulty meeting the touchdown speed between the 50 foot point and the touchdown? According to Paul, it was repeatedly a little high on the touchdown speeds.

A. I don't remember the speeds specifically being -- I mean, the problems that I noticed mostly were sink rate related. We could never get the sink rate quite like we wanted it.

BY MR. O'CALLAGHAN:

Q. Was it too high?

A. Oh, yeah. I think we had one out of the batch when I was there that was below 6.

Q. Is that because there was no flare essentially?

A. Well, basically because he was -- yeah, a combination of no flare and trying to hold that glide slope all the way to the ground which you end up playing that game between the glide slope, the sink rate and a flare, and you can't make all three of those things work. And so once, I guess that -- I don't remember if it was Thursday or Friday when we finally got it. I think that was when we got that one point that, hey, look, it works if you do it right. But we were able to nail the -- to get everything to give us a valid point.

BY DR. BRAMBLE:

Q. Okay. In real time, if you are doing a hazardous or high risk envelope expansion point and deciding whether to proceed to the next point, who is responsible for examining the data and discussing with the team so that you could decide whether to proceed?

A. Well, the final call was always on board the airplane. If there were concerns that we had, we could get on the radio and make them known. And then, of course, flight test engineers on board the plane could do that and, of course, the flight crew could do that. The flight from Roswell-1 where that happened, they pretty much said, yeah, we're not going to do that again; that isn't right; we need to figure out what's going on with that before we do that flight again.

Q. You're talking about Flight 88?

A. Yeah, I think that was the number, the "whoa" flight.

Q. The wing drop?

A. Yeah, where you could hear the "whoa" on the tape.

Q. How was the data during the Roswell-2 effort, how was the data being generated on a daily basis being used to validate or revise the airplane performance predictions?

A. It wasn't a great deal because we were having a hard time getting really good points. It was somewhat, like I mentioned the discussion to try to get the landing procedure better so we could get better numbers. And so we did spend a good deal of time in that case, for example, looking at glide slopes and sink rates. But while I was there, that was about the only major question that we had where we actually using the live data. But we did spend a lot of time on trying to figure out why that wasn't working.

Q. How about for the continued takeoffs, do you recall any examples where you are using the data coming off to refine predictions there?

A. I don't just because there weren't many continued takeoffs before Saturday. It was mostly landings.

Q. And on that Saturday, the team paused testing between Card 61 and 62 to reboot the IADs terminals on the computer and both of the pilots got of the cockpit and there was some indication that Kent may have gone into the trailer to talk with Ms. Brimmeier about how the testing was going and that Vivan had discussions with Mr. Ollenburg. Did you witness either of those discussions?

A. I didn't witness the discussions. In fact, I didn't know that Kent had actually gone into the trailer. He did go into the port-a-potty. Actually, when they took their break, I got out of trailer and there's a bunch of Airbus A300s parked next to it and I was taking pictures of the A300s. If he did talk, it wasn't long.

Q. Did Ms. Brimmeier mention anything about conversations she had with Mr. Crenshaw at that time?

A. No.

Q. Have you been made aware of the nature of any of the problems that might have contributed to the accident?

A. Not officially, I mean, I've looked at the telemetry data from the accident in the days immediately after and, of course, I've heard lots of things.

Q. In your opinion, what data, if any, could the team in the telemetry trailer have analyzed during the previous runs to determine that V_2 was unattainable and stop the takeoff testing prior to Run 72?

MR. RAMEE: 7A2.

DR. UPTON: 7A2. Yeah, what did I say?

MR. RAMEE: 72.

BY DR. BRAMBLE:

Q. Yeah, okay. I figured that was the one.

A. I can't think of anything we could have done specifically in the trailer or immediately. There may have been something we could have done back at the hangar with some discussion with the pilots and the flight test engineers but I can't think of anything in the trailer.

Q. Did you notice that the V_2 overshoots with the continued takeoff tests that morning, that the overshoots were higher than they might have been in the past?

A. I didn't. Unfortunately, because of sort of the time compression that happens in the middle of recording the data, it's hard to do any sort of sophisticated analysis between runs. We could do a simple analysis to say, okay, we didn't get our V_2, here's something that may have been obviously wrong, but we didn't notice anything like that.

Q. So in your opinion it really wasn't reasonable to expect that they could have determined that -- well, let me back up.

Should everyone on the team -- anyone one on the team or the team collectively have been able to determine that Run 7-Alpha-1 was performed according to the test card instructions and the airplane was unable to hit the V_2 speed?

A. I think I missed the question part. Should we have been able to figure out that it was not able to? Is that what you're asking?

Q. (Nonverbal response.)

A. Not based on anything that I can think of.

Q. Is that because of the time compression?

A. This is more speculation than anything, which I know you guys don't like. I guess it's just the -- I don't know how to put that into words right now. I guess we didn't know yet exactly where that limit was and I can't think of a way we would have been able to analytically determine it there without more data. But I'm not sure what that data would be.

Q. Who is responsible for saying whether the test had met the criteria and was a good run or not?

A. That again boiled down to the folks on the plane. On that day, it would have been Reece; however, you know, there was input into that from everyone involved. Shelly had a pretty large voice in that since she was doing some analysis on the fly that Reece was not able to perform on the plane.

Q. Such as?

A. In the case of those landings, for example, if we noticed that the sink rate was wrong, he may not have grabbed that as the flight was occurring and so he could say, "Okay, Shelly, did we get it that time?" And she could say, "No, we didn't; we need to do it again." And then he would say, "Yeah, okay, let's do it again."

Q. To your knowledge, if the V_{MU} results had been processed prior to Roswell-2 and used to model how the airplane would take off, would that have indicated that a V_2 of 1.13 V-stall could not be reached at 35 feet during Flight 153?

A. I'm not sure.

Q. Pat Connor said that he did some analyses of the continued takeoff tests that Mr. Ollenburg conducted in the first week or 10 days of March and some plotting of that. Did you collaborate with him at all on that?

A. I don't think I did on that material, no.

Q. Did you collaborate with anyone on analysis of the Roswell-2 test material prior to the accident when you were back in Savannah?

A. I think there was a little bit of stuff from very early in the Roswell-2 but I don't remember what it was and I think it was mostly just helping people understand the scripts. I don't think it was hard analysis.

Q. The scripts that were used to pull the data off the live stream and package it for analysis?

A. Right.

Q. In the trailer the morning of the accident, do you recall any discussions between Ms. Brimmeier, Ms. Townsend, and yourself about how the takeoff tests were working out?

A. Actually, we were extremely pleased with not necessarily the results but the tests themselves. The weather was much better. The flight crew was in a good mood. Everything was apparently going really well. And then we had the IADs thing, but no one thought that that was an issue at all. The way the flights were actually coming together that morning were, I thought, vastly better than they had been in the prior week just because of the weather if nothing else. The winds were a lot lower. The air was a lot smoother.

Q. How about with respect to the success of the tests in meeting the criteria, the V_2?

A. Since we were sort of still in the middle of the testing, I think we were still optimistic that we would be able to get that taken care of, and I think that was why we had the 7-Alpha-2 in addition to the 7-Alpha-1.

Q. Ms. Townsend said that she recalled people in the trailer saying on the morning of the accident -- or said something like we were discussing that the takeoff criteria were going to have to be changed. Do you recall anything about that discussion?

A. I think I do, but I don't recall what was discussed. I know that's not real helpful.

Q. Do you recall who -- or I guess was that discussion between Ms. Brimmeier and Ms. Townsend?

A. Probably. And I could have been involved in that as well but I don't recall.

Q. Okay. Do you recall any discussion in the runs prior to 7-Alpha-2 about modifying Mr. Crenshaw's rotation technique?

A. Not in -- I know we talked about that as part of Flight 88. There had been a good bit of discussion about pulling hard and that may have been also -- I don't remember if it was that morning or not, but that had come up more than once and I know at least once in Roswell-1 and it came up at some point in Roswell-2 but I don't remember where.

Q. What was the solution or what was the technique being used on the morning of the accident during 7-Alpha-2; do you recall what the rotation technique was?

A. I don't because I'm mixing it up with stuff from Roswell-1. Yeah, they weren't pulling as hard and I don't remember when that part of the discussion happened.

Q. How about the target pitch, do you remember anything in terms of changes to target pitch during the testing? I know the day before you briefed that you were going to use 9 as a target pitch.

A. And 10 was we're done.

Q. And then during the testing, do you recall any discussion about sort of when you could depart from 9 degrees as a target pitch?

A. There may have been some discussion like that between the pilots, but again, I could be remembering something that happened at a different flight but that would be on the recording.

Q. Yeah, I guess my primary interest would be in sort of what the associated discussion in the trailer might be because you guys aren't hot-mic'd. And so, if there's any additional discussion -- but it sounds like you can't remember too much about that.

A. Yeah, and that would have been something, you know, sort of generally between pilots.

Q. Yeah, okay.

A. They know how to do that a lot better than I do.

Q. What was your understanding of the causes of the wing drops during Flights 88 and 132?

A. We never had an official statement that said this is what happened. My interpretation was over-rotation but that's again just my interpretation.

Q. And then what aerodynamically was the sort of aerodynamic explanation beyond the over-rotation? Was there more to it than that?

A. I figured that he might be entering the beginnings of a stall as part of that, but again that was just my interpretation of watching the video.

Q. Do you know what type of analysis was done to examine that?

A. I don't specifically. I think they did most of that in Flight Test. It was also my supposition that the lower rotation pitch angle was a fallout of that.

Q. Do you know where the roll-offs began during those flights relative to the -- do you know how many degrees or normalized angle of attack that those roll-offs began?

A. I don't know in terms of angle of attack and I'm trying to remember for Flight 88, I did hear the number. I don't remember what it was. Yeah, I don't remember.

Q. Do you know if there's any comparison of where the roll-offs began in terms of angle of attack compared to where the shaker was set to activate?

A. I don't know. I don't remember what we had set for the shaker on those flights or if it was even on. I don't remember what mode they put on.

Q. So it sounds like your role is pretty sort of confined to marking data and not really so much big picture items like that?

A. Exactly, yeah. Since a lot of my duties have been on the CO_2 stuff, my focus had been primarily on that, sort of outside of the Roswell trips.

Q. Was this considered sort of familiarization detail for you for Flight Test?

A. No, no, no. Actually the way it was kind of supposed to work is that the Roswell-1 trip was sort of the familiarization and then what was supposed to have happened is with the Roswell-2 trip, immediately after I got back I was supposed to be more heavily involved in the post-processing than I had been for Roswell-1. It didn't work out that way, of course, because of the crash. But basically I had been scheduled to be working basically all this stuff for several weeks after my trip out there.

Q. To do analysis?

A. Um-hum.

Q. Were you brought in to help alleviate the workload on other people, certain other people?

A. Originally --

Q. Or I should say were you scheduled to do that, to help alleviate the workload of other people?

A. No, actually for this trip, for the Roswell-2, I was scheduled because I had been out there once already and BJ was going to be out there for the first time and had never done any Gulfstream flight tests. He's a contractor who prior worked at Hawker Beech (ph.). So Shelly wanted somebody in the trailer with her who could help BJ get more rapidly acclimated to the trailer.

Q. When was he supposed to be out there?

A. He basically, I think, came out the Friday before the accident and he was going to be out for 2 weeks. So the idea was we'd get him up to speed my second week there, his first week there, and so we'd always have him overlapped with somebody who had some experience.

Q. Was he in the trailer at the time of the accident?

A. Yes. Mobolaji is his -- yeah, we call him BJ because it's hard to pronounce Mobolaji.

Q. Why did Mr. Ollenburg say he wanted to stay away from 12 degrees during the preflight briefing?

A. That was what I was trying to think of when you were asking about angle of attack earlier. I thought a 12-degree pitch was what we had done for Flight 88, but I don't remember that for sure, but I think that's the basis for his not wanting to go there.

Q. That 12 degrees may have been where the roll-off began, is that what you're thinking?

A. Yeah, but it would be pitch, not angle of attack.

Q. Okay. Do you know what analysis was performed by aero-performance to determine the root cause of the wing drops during Flights 88 and 132?

A. No.

Q. Do you know who was responsible for analyzing aircraft

performance during those flights and what analyses were performed?
A. For regular aircraft performance, we were still handling that. I was under the impression though that for things like the wing drop would be the aero folks in Bob Mills' group.
Q. Why do you think the aero-performance and flight test and flight ops groups didn't seem to explicitly recognize Flights 88 and 132 as stall events?
A. I don't know. I didn't see 132; I just heard about it. So I don't know if it was as dramatic as the 88 was.
Q. Why didn't 88 and 132 result in the reconvening of an SRB?
A. I don't know. Again, since that's sort of outside my realm. It may have and I just didn't know about it, for example.
Q. Did you have in-depth discussions with others about 88 or 132 before the accident?
A. We had some discussion about 88 in Roswell during Roswell-1 and we had some informal discussion about 132 after I got there. They compared it to 88 and I was under the impression that, for example, Reece's resistance to go to 12 degrees pitch was part of the solution that had been done for that and I think there may have been something written into the TSHAs to that effect, too.
Q. Did you feel that the schedule and staffing levels permitted enough time for data analysis of the area skill performing test flights and allowed sufficient information sharing

in preparation for the next envelope expansion point?

A. I can only speak to the work I was doing and it did seem that we had enough time. I'm not sure in terms of the flight test engineers. They were looking at different things than we were. Our focus was primarily on evaluating the test points to make sure that they were good enough for us to use for the development of the AFM, and so from that perspective there was probably enough time.

DR. BRAMBLE: Okay, John?

MR. O'CALLAGHAN: Thanks. Just a few follow-ups here.

BY MR. O'CALLAGHAN:

Q. What was your Ph.D. dissertation on?

A. Basically making sure there's enough room on your airplane for all your stuff, a robust probabilistic approach to volumetric aircraft sizing.

Q. Okay. Thanks.

And explain to me what CO_2 cert -- does that have something to do with carbon dioxide?

A. That's exactly it.

Q. What is that?

A. We are actually working as part of a couple of industry groups within ICAO on developing a CO_2 certification standard for aircraft.

Q. Like a green thing or something?

A. That's exactly it.

Q. So you don't cause acid rain or something?
A. Well, yeah, global warming in this case, but sure.
Q. Global warming.
A. I don't know how much detail you want but basically ICAO is a much better way to do it than just having somebody say "looks good".
Q. Thanks. We've been over some of this, but you mentioned there was a lot of talk about the wing drop on Roswell-1 Flight 88. Could you just characterize the overall tenor of that? Did people come to a consensus on what it was? Describe what the talk was.
A. Well, it was dramatic and one of the things that sticks out to me is the "whoa". Kent said "whoa" in the middle of the wing drop and he said it again in the crash. So even though I was watching the telemetry screen, when I heard the "whoa" I knew what had happened. Of course, it hadn't gotten that bad yet.
So we watched the video and saw the dip and the recovery. And so they brought the video back and showed it to everybody and said, okay, we need to figure out why this happened and not do this because this is clearly not good. And then there was talk then about stick force and how fast you're pulling back and over-rotating. And it was going sort of up the chain from there, but I don't -- you know, once I left Roswell then, I was detached from that until I came back again. It was my impression that they had corrected the procedure somewhat, and I'm not sure

what else they did, but some other stuff had happened in the intervening time to hopefully prevent that from happening.

Q. And I think you mentioned that your intuition about Flight 88, and I guess maybe it's a logical inference to say that if Mr. Ollenburg said, well, we don't want to go to 12 degrees again, that behind all that is the implication of you over-rotated and got too high and the wing stalled?

A. That was sort of how I put it together, yeah.

Q. Right. So was there any discussion or consideration of using the Flight 88 event or the Flight 132 event subsequently to analyze it and pick out the point where the departure occurred and use that as a definition for stall and in ground effect?

DR. BRAMBLE: You mean the point at which separation occurred?

BY MR. O'CALLAGHAN:

Q. Yeah. Just analyze the data for, yeah, stall separation, to use that data as valid data to define what occurred in ground effect and the top of it basically.

A. I didn't hear the discussion made to that level of detail. It was sort of my interpretation leaving Roswell the first time that something like that was going to happen, but again, once I left, that was --

Q. Well, I think you answered previously that if such analysis were to be done, your expectation would be that it would be done by Bob Mills' group?

A. Yes.
Q. How would he have become involved or his group have become involved to do that analysis?
A. Well, he's the guy who designed the wing so I would expect he'd be pretty heavily involved in that.
Q. So who would pick up the phone and call Bob and say, hey, Bob, we need some help?
A. Basically, anybody in that chain. Whenever there is a weird aero thing, they get on the phone and call Bob.
Q. What chain is that?
A. Well, from the flight test engineers or the pilots or anybody on the SRB.
Q. How about the aero folks?
A. If by aero folks you mean the air performance --
Q. Isn't flight sciences under the same umbrella, department as Bob Mills' group.
A. Yeah, if that had been part of our purvey. But at least from my interpretation, that was something that got handled by the flight test folks.
Q. You used this word a lot and I better ask this question explicitly so that I don't go away just thinking it means what I mean. When you say we reduced the data or data reduction in the trailer, what exactly is involved with that; what level of detailed analysis? Are you computing lift and drag coefficients or how extensive is that analysis?

A. Normally, no. For most of the data reduction we did -- for example, for the landings in Roswell-2, it was mostly building time histories and rapid evaluation to look at the sink rates and the glide slopes. We did occasionally calculate coefficients, usually CL, but most of that was Roswell-1 and it was usually -- in fact, I think exclusively in response to requests from Reece or one of the other flight test engineers for additional information.

Q. So reduction could mean plotting or presentation?

A. Yeah. In this case it's -- you know, and I guess it's kind of loose definition of reduction because it's taking a 13 or 20 gigabyte file that IADS produces, extracting the data and just reducing it to something that we're going to then later use within the Performance Group to do our field performance calculations.

Q. Okay. Thank you. Do you know if there are any private pilots among the FTEs or in the aero group, Performance Group?

A. I'm a non-practicing private pilot. I haven't flown in 20 years. Dave Green in Performance is a pilot. Jason Riopelle is a pilot. I don't think either of them had been out yet to Roswell. Among flight test engineers, I don't know. Actually, though --

Q. How about Ms. Brimmeier or Pat Connor?

A. I don't think Pat's got a license and, while Shelly's flown, I think soloed, I don't think she has a license either. Dave McCollum had a license.

Q. And Mr. Ollenburg?

A. I don't know.

Q. Can you describe today after all the work that's been done since the accident where the V_2 speeds stand compared to where they were at the time of the accident and, the other side of that coin, where the field lengths stand?

A. I don't know the actual numbers right now. I know all of those speeds have been increased pretty significantly as part of the return to flight effort, but I don't know what speeds are currently being used for the return to testing at this time. Because I know the speeds that we're using right now for the provisional certificate have a lot of conservatism built into them.

Q. I see. But those aren't expected to be the final production speeds?

A. I wouldn't expect them to be, no.

Q. So it's really not even very relevant?

A. Right. Yeah, there's some speeds but they're probably not going to be the final speeds.

MR. O'CALLAGHAN. I think that's all I have. Thank you.

DR. BRAMBLE: Mitch?

MR. GALLO: I have a couple questions.

BY MR. GALLO:

Q. What was your concentration in your graduate program?

A. Design.

Q. What aspect of design?

A. Actually, everything. It's a fixed wing design concentration at Georgia Tech. I did do some work in high temp cast dynamics but that was just because it was fun more than anything.
Q. Did you attend the testing on Flight 081, which is the --
A. I think that was when I was there, but I don't recall if I was in the trailer that day or if I was in the hangar. Adam Hart and I alternated days during the first Roswell tests.
Q. Do you recall the other flights that you attended?
A. Not specifically.
Q. During the briefing on 153, were you present? There were two briefings there. I think one was the engineering brief and the other was the preflight brief.
A. I was present for the one in the hotel the afternoon before, which I guess -- I don't know which that qualifies as, and I took some notes for that which I forwarded to Tom Latson.
Q. During that briefing was there any discussion of a knock-it-off angle of attack?
A. There's a pitch angle that I recall of 10 degrees but not an angle of attack.
Q. But was there any discussion of a knock-it-off angle of attack?
A. Not that I recall.
Q. Do you recall that being discussed on any of the other

takeoff performance flights?

A. No.

Q. During Flight 153, you mentioned that you recorded parameters. What parameters were you recording?

A. Well, IADS actually records. There's thousands. Stuff that we were looking at since -- for example, as I mark takeoff I look at things like tire rotation speed to designate when the plane has come off the ground. We look at speeds obviously for brake release. And then I measure altitude to get 35 feet. But it's not until post-processing that we look at things like pitch unless someone asks us about it and then we can go back and look at that.

Q. Do you recall who else in trailer was there with you for 153?

A. Well, it was Shelly and BJ and I from performance and then Cynthia and Brian, Eric (ph.).

Q. Do you recall who was monitoring the angle of attack?

A. No. It's likely that none of us from the Performance Group were monitoring it specifically and Brian wouldn't have been monitoring it. He was monitoring the equipment. So if anybody was monitoring it in the trailer, it would have been Cynthia.

Q. Why were you looking at the parameters they were looking at? Did somebody tell you to look at those?

A. Yeah. We were using those to basically determine the parameters we were going to then use to reduce the data and to give us things like rotation time or any of that kind of stuff. And those happened to be very convenient for marking when you come off the ground, for example.

Q. You mentioned that the sophisticated analysis was not done at Roswell. Was it done back in Savannah?

A. That's normally how it works. For example, we've for the provisional type certificate taken the data that we do have access to, so everything except 153 basically, and used that to build the data set for the provisional certificate and that's all happened here. And, in fact, we were not even able to use the time histories we built in Roswell.

Q. While at Roswell, are you sending data back to Savannah for analysis?

A. At the time, the only way I can recall it being sent was when the shuttle would come weekly a hard drive would get sent back with the data from the prior week. And then we would be in communication with, in our case, the other performance folks here. There was a network connection available for folks in Savannah to access some of the Roswell material. I'm not sure how often that happened in Flight Test but it didn't happen very often in Performance.

Q. Going back to Roswell when you worked, was there anybody within the performance preliminary design group looking at that data?

A. There was when we were out there. Right when we came back there were some folks looking at it. I think Pat was looking at it. I'm not sure who else.

MR. GALLO: That's all the questions I have.

DR. BRAMBLE: Tom?

BY MR. HORNE:

Q. During your Roswell -- I guess, 2 would be the most appropriate testing. Did anybody discuss changing the V/V_{SR} ratio or adding speeds? Were there any discussions going on about changing speeds?

A. There were some discussions but I don't recall them. I do remember that there were some but I don't remember the outcome.

Q. Can you give any specifics of some of the data that you had -- did you present any data to the pilots in the preflight briefings based on analysis that was done post-flight?

A. The best example of that was the glide slope sink rate issue that we worked out finally with Jeff where we had -- and some of that happened in the trailer live where we would -- and that was the week before the accident so it was a different third performance person, where we would calculate the glide slope and sink rates sort of rapidly in the trailer, feed that back to them to determine whether or not we had done an acceptable flight. Then afterwards, we took that data and said, okay, we're doing something wrong here, what is it? And because of the results of that analysis we were able to conclude that we were basically overconstraining the problem and weren't able to hit all those things at one time. But once it was understood that we didn't have to follow glide slope all the way to the ground -- oh, okay. Then the next time we went out there and did the landing it was much, much better.

Q. Was there a corollary to that with takeoff performance? Did you ever do any analysis of, you know, the speeds and trying to get to 35 feet and the dynamics of doing that?

A. Not at Roswell-2. We'd had some of that at Roswell-1 but not at Roswell-2 when I was there that I can recall.

Q. You said that Reece said they weren't going to exceed 12 degrees pitch. Did they talk about who was responsible for making sure that didn't happen?

A. Not specifically, but I think that was in the TSHA. There had been some changes after the Flight 88 thing with --

Q. But you can't remember a briefing saying, okay, your job is to monitor pitch to anybody in particular?

A. I don't remember that, not in particular, no.

MR. HORNE: Okay. That's all I had.

DR. BRAMBLE: John, do you have anything else?

MR. O'CALLAGHAN: Yeah, I had one I forgot.

BY MR. O'CALLAGHAN:

Q. Dr. Upton, you mentioned that there was Delta-Alpha stall data in ground effect but you couldn't recall the number.

A. Right.

Q. I think based on some work that Mr. Ollenburg had done the estimate was around 1.6 degrees. Does that ring a bell or anything?

A. It doesn't ring a bell but that certainly sounds reasonable.

Q. Okay. So here's my question then. In your opinion, what would be a reasonable uncertainty band on a number like that?

A. I'm not real sure based on where this is in the process. Obviously, if you're -- you can have a different amount of uncertainty, say, very early on in conceptual design on anything versus when the plane is finally done, and I'm not sure where that would fall at this phase.

MR. O'CALLAGHAN: Okay.

DR. BRAMBLE: Marie?

BY MS. MOLER:

Q. You said that Flight 88 was really well talked about and you had seen the video?

A. Yes.

Q. Was there something similar for 132? Did you see the video for that? Was it discussed?

A. It was discussed informally. I don't think I saw the video. I may have seen it but I don't think so. And the only discussion I had about it was among the performance folks as we were rotating.

MS. MOLER: Okay.

DR. BRAMBLE: Mike?

BY MR. BAUER:

Q. You talked a bit about your analysis out at Roswell. What was your typical work schedule, say, at Roswell-2? Were you there early, working late? How did that --

A. Normally what would happen is we would get out -- if, for example, they were going to have a 6:00 engine start, we'd be out there at 5:30, quarter of 6. If there was anything they needed from us last minute, we could get it for them. That didn't generally happen. So basically we just complained about being cold.

Then we'd go out to the trailer. We'd fly the missions, come back. The data would get downloaded from the drives on the plane. We would have recorded all of our event marks in the trailer and brought them back on a memory stick. Then we'd have lunch and sometime in the afternoon we would generally have a briefing of some sort for the flight the next day. The pilots would generally leave around 3-ish and the flight test engineers who were going to be flying would leave not long after that. In our case, we would generally be there till 6 or 7 depending on what we were doing.

Q. And you'd go out there for 2-week rotations?

A. Yes.

Q. Did you have any rest time in there or was it 2 weeks straight while you were out there?

A. It depended on who it was. In my case, for Roswell-2, it was working the whole time because obviously there was a crash involved. Most of the folks that went out there had at least a day off because whenever the weather was bad, you'd go to the airport but you wouldn't really do anything. Or in some cases, you wouldn't go to the airport. Some of the people went skiing. Some of the other had some rest time.

Q. But if you're out there for 2 weeks, would you have an assigned day where you weren't supposed to show up at the airport?

A. Not an assigned day, no. Now, there's usually the 13-day -- this is how Gulfstream operates; you can't work more than 13 days in a row. But since -- you know, you go out on a Friday; you come back on a Friday. So it's not a workday; it's a travel day.

Q. Then my last question. You were talking about the video that you guys reviewed for 88. Which video were you reviewing, the internal or external?

A. It was the external shot by the guys on the runway. So, yeah, we had the techs who stood out on the runway with a video camera. It was that one.

Q. And then you reviewed the corresponding flight data?

A. Actually, for that one I did not review that flight data. I know it was reviewed, but not by me.

MR. BAUER: Okay. That's all I have.

DR. BRAMBLE: Lorenda hasn't had a chance yet. And then I guess --

BY MS. WARD:

Q. I just want to ask, when you first got hired, what kind of training program did they have for you to be introduced into the flight test side?

A. There was not a formal training. I'm not actually in flight test. There is a segregation between the flight test folks and performance. So we don't have the same level of responsibility in terms of day-to-day flight of the plane. We're more focused just on dealing with the data afterwards. The Roswell-1 trip was designed to help get me up to speed since I had not been out for a flight test thing ever.

And so then Roswell-2 was where we were really going to get -- hopefully by then, we would have developed our methodology sufficiently to actually get the data dealt with out there rapidly and effectively. Whereas Roswell-1 was more of a -- in terms of the performance folks being out there, it was more of a training.

Q. When you were hired in, were you assigned a mentor?

A. No, but preliminary design is a very different place than performance. So I think had I been put into performance initially, I would have probably been assigned a mentor.

DR. BRAMBLE: Jeff?

MR. BORTON: Yeah, just a follow-on to Tom's question.

BY MR. BORTON:

Q. Just to be clear then, when you were in the TM trailer, Flight 153, was there a person who was considered in charge of the activity in the TM trailer; was it more of a test person in charge?

A. In terms of dealing with the plane, that would have been Cynthia for that flight. For example, we weren't on the hot mics. Shelly had a hot mic. But anything that we wanted sent to the plane, we had to tell Shelly and then Shelly would either tell Cynthia and Cynthia would tell the plan or Shelly would call the plane direct.

Q. So it was a known process, you understood how to do that, how to alert people --

A. Yeah. And if I detected something that I thought was seriously out of line, I would have told Cynthia immediately.

MR. BURTON: All right. Thank you.

MR. BAUER: One more for the TM-trailer.

BY MR. BAUER:

Q. You said you basically did marking of brake release, takeoff points?

A. Right

Q. Was that something organized between you and Ms. Brimmeier as to who was looking at which points or was everybody marking their brake release, their takeoff point?

A. Generally the way the process worked is during the takeoff, I would mark the points and then when I was done marking them, I would save them, which allowed her to view them on her screen. She would then take a quick look at them and while the plane -- for takeoff, for example, when the plane was turning around and coming back, I would tweak the points because, of course, you can never nail them right live. I would tweak the points to get them corrected and save it again and then she would be able to assess if we had been able to capture the stuff that we were looking at. So, if we were trying specifically to capture V_2 speed, she'd have a V_2 speed. And then once we were done with that, we would take it back to the -- afterwards.

Q. Did you guys discuss responsibilities of, let's say, which parameters you might be looking at or was it both of you or everybody in the trailer would be looking at the same data set?

A. Well, since I was marking the points I would be, for example, for liftoff would be looking at real speed, and you could see the peak in real speed and when it drops, you mark it. So I would be looking at those fixed set of points and that would have been arranged before the flight. She would be looking at a slightly different set to try -- if, for example, she was looking for a V_2, she would be looking at the speeds.

MR. BAUER: That's all.

DR. BRAMBLE: Okay.

Mitch, you got anything else? Anything else?

BY MR. O'CALLAGHAN:

Q. Something we have been asking everybody because this is probably our final week here in Gulfstream before we go back to D.C. and do our analyses and, you know, the end of the process besides trying to figure out a paragraph description of what happened is to come up with safety recommendations to help the industry. And so you can probably gather a lot of where we've been digging in terms of our questions, but I like to ask everybody that's been involved with the program, since you're closest to it and you've probably been thinking about it a lot over the last few months, if there's anyplace you think we should look or we haven't asked about or if you have any things you think we should be looking at in terms of recommendations for the industry to improve the safety of flight testing in general. It's a wide open question for anything you would like to offer us.

A. There is nothing specific I can really offer primarily because I'm at the performance end of it and not in the flight test end of it. I think the things that are really going to be of benefit are going to be in that end of it, rather than where I was. So nothing that's -- unfortunately, that's jumping out as a great idea.

DR. BRAMBLE: Thank you.

(Whereupon, at 4:30 p.m., the interview was concluded.)

CERTIFICATE

This is to certify that the attached proceeding before the

NATIONAL TRANSPORTATION SAFETY BOARD

IN THE MATTER OF: AIRPLANE ACCIDENT
ROSWELL, NEW MEXICO
N652GD
Interview of Dr. Eric Upton

DOCKET NUMBER: DCA11MA076

PLACE: Savannah, Georgia

DATE: October 24, 2011

was held according to the record, and that this is the original, complete, true and accurate transcript which has been compared to the recording accomplished at the hearing.

Letha Wheeler
Official Reporter

Lourie J. Brown
Transcriber