NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

April 8, 2015

Attachment 2 – Interview Transcripts

OPERATIONAL FACTORS

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Contents

UNITED STATES OF AMERICA

NATIONAL TRANSPORTATION SAFETY BOARD

Investigation of:	*	
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CRASH OF VIRGIN GALACTIC	*	
SPACESHIPTWO	*	Docket No.: DCA-15-MA-019
MOJAVE, CALIFORNIA	*	
OCTOBER 31, 2014	*	
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Interview of: KENNETH WONG

National Transportation Safety Board
6th Floor Conference Room
490 L'Enfant Plaza East, S.W.
Washington, D.C.

Wednesday,
January 14, 2014

The above-captioned matter convened, pursuant to notice.

BEFORE: DAVID LAWRENCE
Operations Group Chairman

APPEARANCES:

DAVID LAWRENCE, Operations Group Chairman
National Transportation Safety Board

MICHAEL HAUF, System Safety Group Chairman
National Transportation Safety Board

LORENDA WARD, Investigator-in-Charge
National Transportation Safety Board

MICHAEL BAUER, Systems Group Chairman
National Transportation Safety Board

KATHERINE WILSON, Ph.D., Human Performance Group Chairman
National Transportation Safety Board

CHRISTINE HELGESON
Representative to the Human Performance Group
Federal Aviation Administration

BRETT VANCE, Test Pilot
Los Angeles Aircraft Certification Office
Federal Aviation Administration

BOB WITHROW
Scaled Composites

NICOLETTE DUGUE
Scaled Composites

WILL ROBERTSON
The Spaceship Company

BRADLEY PREAMBLE, Office of the Chief Counsel
Federal Aviation Administration
(Representative on behalf of Mr. Wong)

I N D E X

I N T E R V I E W

(9:35 a.m.)

MR. LAWRENCE: Good morning. My name is David Lawrence. I am the Operations Group Chairman for the spaceship investigation the NTSB is conducting; I'm with the NTSB.

The NTSB is an independent federal agency charged with determining the probable cause of a transportation accident and promoting transportation safety. The NTSB is not part of the DOT or FAA. It has no regulatory or enforcement powers.

You had an opportunity to meet everybody, and we'll go around the room for the record. If you would state your name as I point to you and then just -- and your affiliation.

MR. ROBERTSON: Will Robertson, Virgin Galactic System Safety.

MR. WITHROW: Robert Withrow, Scaled Composites.

MR. HAUF: Mike Hauf, NTSB System Group Chairman.

DR. WILSON: Katherine Wilson, NTSB. I'm the Human Performance Group Chairman.

MR. PREAMBLE: Bradley Preamble from the FAA, serving as the witness's representative.

MR. LAWRENCE: On the phone, if I could get Brett, first to introduce yourself?

MR. VANCE: Brett Vance, test pilot in the Operations Group.

MR. LAWRENCE: Christy?

MS. HELGESON: Christine Helgeson, FAA representative for the Human Performance Group.

MR. LAWRENCE: Great. Lorenda?

MS. WARD: Lorenda Ward, Senior Investigator In-Charge. I am the IIC or Investigator In-Charge for this accident investigation.

MR. LAWRENCE: And Nikki?

MS. DUGUE: Nicolette Dugue, Scaled Composites Systems Safety Group.

MR. LAWRENCE: Great. Did I forget anybody?

DR. WILSON: Mike Bauer.

MR. LAWRENCE: Mike Bauer, sorry.

MR. BAUER: Mike Bauer, NTSB, Systems Group Chairman.

MR. LAWRENCE: Great. Today we'll be using the services of a court reporter who will record and then transcribe the interview. The transcript, not the audio recording, will be made part of the public record.

The purpose of the investigation is safety to determine probable cause and prevent reoccurrence. Our role is not to assign fault, blame or liability. This interview is a part of the fact-finding phase of this investigation. We are here to ask questions about your involvement in the permit and waiver for the SpaceShipTwo program. We cannot, however, offer any guarantee of confidentiality or immunity.

Each of the group members will have a chance to ask

questions. We will ask questions one at a time, and everyone has been instructed to not interrupt the person who is asking questions at that time. There will be an opportunity for each group member to ask follow-up questions after each person has had a turn.

Please answer all questions to the best of your recollection. If you do not understand a question, ask to have it repeated or explained. If you realize you misstated or need to modify a previous answer, please do so.

You're entitled to have one representative of your choosing. Is there someone you would like to have as your representative?

MR. WONG: Brad.

MR. LAWRENCE: Okay. Mr. Preamble, you may direct to not answer -- direct your client not to answer a question or to request a short break to confer with him or her, okay?

MR. PREAMBLE: Okay.

MR. LAWRENCE: The FAA will have the ability to review the transcript prior to inclusion in the docket.

Mr. Wong, do you have any questions about the process?

MR. WONG: No.

INTERVIEW OF KENNETH WONG

BY MR. LAWRENCE:

Q. Great. Before we get started, first off, do you mind if I call you Ken or --

A. Ken is fine.

Q. Ken's good, thanks. If I could just get your full name and job title?

A. Full name is Kenneth Wong, W-o-n-g. My title is, I'm the manager of the Licensing and Evaluation Division.

Q. Great. Would briefly describe your roles and responsibilities?

A. I manage the division. Once an application is accepted for either a launch license or a reentry license or for operation of a launch site, my division leads the evaluation. And then after the evaluation is completed, I'm the one who signs off on the license. But, having said that, it's based on the other divisions providing support.

Q. Great. Thank you. Who do you -- who's your immediate supervisor? Who do you report to?

A. Mike Romanowski.

Q. Okay. And prior to your work with the Scaled permit, what previous experience do you have with commercial space permits and waivers?

A. While I was division manager?

Q. Um-hum.

A. Yeah. As division manager, other than the Scaled waivers, there's other waivers that we've assessed in the past associated with other launches.

Q. With other operators?

A. Yes, with other operators.

Q. What other operators?

A. Other operators would be just Wargo Science, Lockheed Martin are just some examples.

Q. Okay, good. And if you could just briefly describe your role in the Scaled permit application?

A. Okay. So, as I indicated earlier, I manage the division that oversees the overall permit evaluation of the Scaled, so the project team lead resides in my division. But as I indicated earlier, other divisions support the analysis such as the system safety analysis, the flight safety analysis. So after the evaluation is completed, we'll have a management review board with the other managers, and once the determination is made to issue a permit or license, I'm the one who signs off to issue the license or permit, in this case, the Scaled permit.

Q. All right. Who was the project team leader for you?

A. Ray Jenkins.

Q. All right. During the Scaled permit application process, was there any tolling of Scaled's initial permit to address any issues identified in the application?

A. Yeah, at this time I can't recall any tolling of the initial -- I can't recall any at this time.

Q. Okay. Do you recall if there were any sources of human error or software error that were identified in the initial permit?

A. No.

Q. Okay. Did the FAA contract with any third parties to review the Scaled permit application?

A. Yeah, I believe we did, yes.

Q. Okay. Do you recall who that was?

A. I can't recall exactly, but I think maybe in the flight safety analysis area we may have had some support.

Q. Okay. Are you familiar with Great Circle Analytics?

A. Yes.

Q. Who are they?

A. There was a gentleman, Terry Hardy, that used to work for the Office of Commercial Space Transportation.

Q. Um-hum. And?

A. And he worked in the system safety area, so he -- I believe he may have been involved in the system safety review too.

Q. Okay. Terry Hardy is with Great Circle or is --

A. I don't know where he is today, but at one point I know he was with Great Circle.

Q. Okay. All right. Do you recall what service Great Circle provided for the FAA?

A. Maybe just to help out in looking at some of the system safety evaluation parts of the applications.

Q. Okay. Do you recall if they identified any issues with the initial application during their evaluation of the permit?

A. Not at the time when we issued the initial permit, I

don't recall.

Q. Okay. So you don't recall -- and I don't want to put words in your mouth, but you don't recall if there were any issues identified with the hazard analysis that Scaled had done?

A. At the initial permit issuance, but later I became aware, yes.

Q. Okay. What were those issues?

A. I don't recall any detail. I would have to -- that was contracted out, the system safety, under another division.

Q. Which division was that?

A. AST-300 division.

Q. Okay.

A. Because the other division is the one that provides the system safety support.

Q. Gotcha. Yeah, thanks. Do you recall if Great Circle identified any issues with the fault tree analysis that Scaled had done?

A. I don't recall specifically without looking at their report, yeah.

Q. Okay. And finally just, and I'll get off this topic, but first, do you recall if there were any FAA responses to the evaluations that were made by Great Circle?

A. I know that we talked about it, had discussions about it.

Q. But you don't recall if there was any FAA actions based

on that third-party analysis?

A. I mean, eventually, a year after the first issuance of the permit, we did issue a waiver, so that -- I'm not saying that was the primary reason for it, but that might be related to it.

Q. Okay. Well, that kind of segues through into my next question. If you could just -- what was your role in the Scaled waiver application?

A. Scaled waiver application, I was involved in the review and discussion of whether or not a waiver was needed.

Q. When did this occur?

A. This occurred during and after the first renewal of Scaled's permit in 2013.

Q. Who did you talk to at Scaled or who did you liaison with at Scaled in discussions about the waiver?

A. I normally didn't talk directly to Scaled even though I participated periodically in meeting. Normally it was the project team lead that interfaced with Scaled. But periodically I would sit in some telecons, discussions.

Q. Was that project team lead also Ray Jenkins at the time?

A. Yes.

Q. Okay. Do you recall if Scaled requested the waiver?

A. No, Scaled did not request the waiver.

Q. Then who wrote the waiver?

A. Wrote the waiver? The waiver that was published in the *Federal Register* in 2013, the names -- the contact persons,

technical person, Mike Kelly, and then the attorney is Sabrina. So their names show up in the *Federal Register* notice. So, but in terms of who actually wrote it, so definitely they had inputs, but others within the office reviewed and had discussions and had inputs with regards to it.

Q. So if Scaled did not ask for the waiver, what was the origins of the waiver? Who determined that there was a waiver necessary?

A. It was based on discussions within the office about certain deficiencies where some felt that Scaled did not adequately address all of the hazards per the regulations.

Q. I just want to be clear, the drafting of the waiver came from the FAA, correct?

A. Yes.

Q. Okay. Is it unusual for the FAA to write a waiver for an applicant?

A. Usually the waivers that we issue is normally a waiver that an applicant requests, but it's not unheard of for the FAA to waive a requirement.

Q. Okay. But just to be clear, Scaled did not request this waiver?

A. No, Scaled did not request the waiver.

Q. Okay. Going to the waiver -- by the way, I have a copy if you would like to have for reference, you know, if you flip to the letter. That's the waiver and this is the *Federal Register*,

if you want to have copies.

In the waiver there were several mitigations identified. Did the FAA verify these mitigations that were provided by Scaled identified in the waiver?

A. For each launch we have safety inspectors. And the division that does safety inspection is the AST-400 division, and they go out for each permitted or licensed launch; they do the safety inspection.

Q. Okay. But in the waiver there are some mitigations that were identified, like pilot training.

A. Yes.

Q. The two chase airplanes, some -- the use of a simulator in the training.

A. Yes.

Q. Those are identified as potential mitigations that allowed the waiver for 437.55, correct?

A. Right. Right.

MR. LAWRENCE: Okay.

MR. PREAMBLE: Mr. Wong, I just want to remind you not to --

MR. WONG: Okay.

MR. PREAMBLE: Just so the transcript is clear, just wait until he's finished, then you can answer.

MR. WONG: Okay.

BY MR. LAWRENCE:

Q. Okay. Those mitigations to 437.55 that were identified in waiver, did anybody at the FAA verify that information that was provided by Scaled identified in the waiver?

A. Definitely the training, the crew training, the pilot training, especially where Scaled -- they had the ground SpaceShipTwo simulator. Yes, we did have people actually see the crew and pilots do a lot of SpaceShipTwo simulator training, yes.

Q. Okay. Were those the safety inspectors, or anybody from your office?

A. We have some people that normally reside in California. I'm not sure if it were those folks or safety inspectors, but I know within the office we definitely had people be there present when Scaled conducted SpaceShipTwo simulator training, yes.

Q. Okay. And just a couple of little details I wanted to ask about those particular items. The simulator in the waiver said that it was being run -- one of the mitigations was that it was being run at 1.4 times.

A. Um-hum.

Q. Are you familiar with that?

A. Yes, as written in the waiver.

Q. Okay. Was that verified by anybody? Did they actually do that?

A. I can't recall that specifically.

Q. Okay. What about the use of two chase airplanes in the previous boost flights?

A. During the launches, I'm physically not there, so I can't tell you the exact number of chase planes. But typically from what I've seen, there's chase planes. I can't tell you the exact number because I physically was not -- the safety inspectors were there.

Q. Okay. And just one last question on that. Do you know if -- are you familiar if Scaled pilots do centrifuge training?

A. I'm familiar with the Scaled pilots doing training in aerobatic aircraft for g-tolerance training.

Q. But specific centrifuge?

A. I'm not aware of centrifuge.

Q. Okay.

A. Other than the aerobatic aircraft training for g-tolerance.

Q. Okay. I want to go back real briefly, because you mentioned a little bit about the timeline for the permit and the waiver. Correct me if I'm wrong, the first permit was in May of 2012, does that --

A. Yes.

Q. Okay. And then the first renewal was in May of 2013; is that correct?

A. A year, a year later.

Q. Okay. And the waiver was in 2013 on the first renewal?

A. After. It was published later, yes.

Q. Okay. What changed between the first permit and the

first renewal that requires a waiver?

A. During the first renewal of the permit, Scaled also submitted in their application for renewal there were some SpaceShipTwo modifications accompanying the renewal. So during the renewal evaluation, the system safety team also assessed some of the SpaceShipTwo modifications, and based on those discussions, it was determined later that there may have been some deficiencies in terms of the hazard analysis.

Q. Okay. But the waiver wasn't on spaceship modifications, was it?

A. No, not per se. But as you do modifications you also assess the hazard analysis to see if the modifications could affect public safety.

Q. Okay. On the waiver for the human performance considerations, had anything changed between the first permit and then the first renewal?

A. In terms of human performance?

Q. Well, the waiver was on the first renewal. So the first application was in 2012.

A. Right.

Q. And the renewal was in 2013. And then the waiver cites that there was a lack of human performance and systems errors identified.

A. Software errors.

Q. Right. Through 437.55.

A. Right.

Q. Was there any change in that? Did Scaled do anything different that required the waiver for those particular items between the first permit and the first renewal?

A. If I understand the question correctly, were there any -- is the question, were there any mods associated with human error or software error?

Q. Yeah, right.

A. Is that the question?

Q. Yes.

A. None in relation to human error that I can recall. In terms of software, the only thing I can remember maybe associated with software, was maybe some software changes associated with a rocket motor controller. But in particular, I don't recall any mods that in particular were really human error or software error.

Q. Okay. You mentioned earlier the safety inspectors. Are you familiar with the safety inspection plan that they use when they go out and take a look at Scaled operation's boost flight?

A. In general.

Q. Did your evaluators from your office as they were developing or doing background for the waiver, did they take into consideration any of the inspection plans from the inspectors?

A. All I can say is when we were having discussions with regards to the waiver, the manager of the -- that leads the safety inspection division was involved.

Q. Okay. Do you recall if there were any issues identified during any of the inspection plans that the safety inspectors identified?

A. I don't recall any.

Q. Okay. Do you know the results or are you made aware of any of the results of the safety inspection plan items?

A. Yes. Normally after a safety inspection is conducted, the AST-400 safety inspection division normally holds a hotwash, and I generally participate if I'm available.

Q. And do you recall when that occurred --

A. No.

Q. -- for this particular event?

A. I don't recall.

Q. Did you participate in that?

A. Is the question whether it was held? I cannot recall whether I was actually there. All I'm saying is I normally attend them, but I can't say for sure I was in that particular hotwash. And it depends on -- are we talking -- there were like several launches, powered launches. Prior to the mishap there were three powered launches, so --

Q. Let's stay with Powered Flight 4 for the accident. Did you participate in that hotwash or participate in those --

A. Yes, yes, yes. That one I recall.

MR. PREAMBLE: Okay. Wait till he finishes.

MR. WONG: Okay.

MR. PREAMBLE: You guys are stepping on each other.

BY MR. LAWRENCE:

Q. Did you -- do you recall when that occurred?

A. Last year.

Q. Okay. And has the FAA AST office done any post-accident or post-mishap review of the Powered Flight 4 operations and its compliance with the risk mitigations that were identified in the waiver?

A. No.

Q. Okay.

BY DR. WILSON:

Q. I have some follow-up. One is a clarification. David asked you if you -- and I don't have the exact brain, but if you recalled whether there was any human error analysis in the initial application from Scaled, and you said no. I wanted to clarify, no there wasn't any human error analysis or no you didn't recall if there was?

A. What I would like to say is, is that this is sort of related to what -- like Scaled believed that it had enough mitigation measures in place, such as especially the crew training, the remoteness of where the SpaceShipTwo launches were occurring, redundancy in terms of pilots. So in terms of those mitigations and controls in place, Scaled didn't believe a waiver was needed. And so a lot of that rationale was used in eventually approving the waiver. So I just want to put some context on it.

So, even though, looking back, one could say the initial evaluation didn't look at human error per se as causing some hazards, but the mitigation measures and controls were assessed.

Q. Were those explicitly stated in the application or did they come about just in the waiver?

A. Definitely the crew training and all that was definitely in the application, because part of the regulatory requirements is -- under part 460 they have to address crew training for nominal and non-nominal events.

Q. Okay. David had asked you who basically ensured that Scaled met these waiver mitigations that they did the training -- or the simulator at 1.4, that they used two chase airplanes. Do you know -- so the waiver was issued. Is there any follow-up after the waiver is issued to ensure that they are still meeting these requirements? And if so, who would be responsible for doing that?

A. I mean, the safety inspection division was who do the safety inspections and actually go out to the launches. In terms of simulator training, we just knew that that was ongoing, and I was aware of simulator training was ongoing, that Scaled had always did that. So --

Q. If Scaled decided to no longer run the simulator at 1.4 times faster, would they be required to let the FAA know that?

A. Yes. We would like to know if that's not the case, yes.

Q. Okay. In your division is there anybody who has a human

factors background?

A. I have on my -- in my division who work for me, there's two experienced pilots. So, I mean, they don't have degrees in human factors, but they are experienced pilots and instructors that -- I mean, they don't have degrees on it, but they have certain aspects, familiar with certain aspects related to human performance, but no specific degree in human factors.

Q. Okay. Are those -- so as I'm reading through these mitigation strategies, specifically the training and the simulator being run, would those be the individuals that you would rely on to ensure that this was adequate? What guidance were you using to say that the training that they did in running the simulator at 1.4 times, that this -- these were good mitigation strategies?

A. It was inputs from the staff, inputs from management, inputs from our chief engineer.

Q. Okay. Was there anything in the permit or the waiver that you were not comfortable signing off on?

A. In the permit?

Q. Right.

A. Or the waiver?

Q. Or the waiver.

A. No.

DR. WILSON: Okay. And that's all that I have for now. Thanks, Ken.

MR. LAWRENCE: Mike Hauf.

MR. HAUF: Okay. Thank you.

BY MR. HAUF:

Q. So a couple questions. At the beginning of the program were you involved in any of the pre-consultation meetings with the -- or with Scaled Composites or were any individuals in your organization involved?

A. Yes. Prior to accepting -- formally accepting the permit application, there's a phase called pre-application consultation, and that's currently being led by another division. But, yes, I am -- also, my division is also involved in the pre-application consultation period before we formally receive and accept an application.

Q. Okay. What was the other AST division that would perform that typically?

A. Currently today it's the AST-500 division, Operations Integration Division. I can't recall, back in 2010 when it started, I don't believe that division was actually there. But we had people located out in, like, California involved with it, yeah.

Q. Okay. Can you describe kind of how the pre-application process works, what's entailed, any regulations or requirements for how that all works?

A. Yeah. Per our regulations, we require all applications to have pre-application consultation with AST, our office, before submitting a formal application, and the purpose is twofold. It

helps the applicant to identify any potential licensing or permitting issues, and then at the same time provides an opportunity for AST, the Office of Commercial Space Transportation, to provide any guidance if we see any concerns or issues. And it's to help the applicant to develop an application that eventually we can accept.

Q. Okay. Do they -- are all the regulations kind of explained to the applicant at that point or do they usually have questions on the regulations and how they would demonstrate compliance to those regulations; are those type of issues discussed then?

A. Yes, during pre-application consultation, yes, those are discussed. AST discusses what are the regulations. Such as for the Scaled permit, the regulations are under part 437, and there's opportunity for Scaled or any applicant to ask questions if they have any questions with regards to the regulatory requirements.

Q. Okay. If an applicant is going to -- or intends to deviate or would like to demonstrate compliance in another way, say, other than the advisory circular, what kind of guidance does the FAA provide them or oversight or review to understand their -- how they plan to do something different?

A. We would listen to what the applicant is proposing and then we would provide guidance on what the applicant is proposing. If it's not meeting a regulatory requirement, I mean, the options are issuance of waiver, or in certain regulations we have what we

call an equivalent level of safety. Some of our regulations do spell out an equivalent level of safety. If the applicant can demonstrate either qualitatively or quantitatively an equivalent level of safety then a waiver may not be needed.

Q. Okay. Do you know if there were any -- or if Scaled's approach was different than the advisory circular had stated? If there are any -- if any changes or differences?

A. What particular advisory circular are we talking about?

Q. Oh, I'm sorry. 437.55-1 for the hazard analysis.

A. I'm not -- at this point I can 't tell you anything specific. I know that Scaled -- I am aware that Scaled does its hazard analysis sort of based on the aviation way. They do fault tree analysis, they do functional hazard analysis, they do common mode analysis and zonal safety analysis. And so under part 437, it just says you have to do a hazard analysis. So, those are some acceptable --

Q. Okay. Do you know if it was part, say, part 23 or part 25 requirements that they were doing it to?

A. I don't know specifically at this point.

Q. Okay. And let's see -- topics here. Going to the experimental permit and the waiver, were the same people, the same FAA AST people involved in reviewing the original permit and the second -- or the first renewal/modification of the permit? Do you know if it was the same individuals?

A. I think we had some different system safety people

involved. The system safety person who initially -- who later was involved, I believe was hired later. So a system safety person may be different.

Q. Okay. Do you know who the original system safety person was?

A. Jay Naphas.

Q. Okay. And the other individual?

A. Later Tom Martin.

Q. Okay. That's good. And do both of those guys, do you know if they have background in system safety or training in system safety?

A. Yes.

Q. Okay. From the FAA side, was there any urgency into releasing the waiver?

A. No, from a public safety standpoint, but for transparency -- but not from a public safety, no.

MR. HAUF: Okay. All right, that's all the questions I have for now.

MR. LAWRENCE: Okay. We'll finish up with the NTSB on the phone. Mike Bauer.

MR. BAUER: I don't have any questions at this point.

MR. LAWRENCE: Thanks, Mike. Lorenda?

MS. WARD: Thanks, Dave. I do have a few.

BY MS. WARD:

Q. Ken, what I'd like to -- kind of go back almost to the

start in a sense, and if you could just state how long you've been with the FAA?

A. Yes. I've been with the FAA since 1996, so going on 19 years.

Q. Nineteen years?

A. Yes.

Q. And how long have you been on a commercial space site?

A. Those 19 years.

Q. All 19, okay. And how long have you been in your current position?

A. As the division manager since 2008. Prior to that I was the deputy manager of the division. So for the current division manager, since 2008.

Q. All right. And how long were you the deputy?

A. Deputy, approximately from -- about 4 years.

Q. Okay. And do you mind telling me what you did before you came to the FAA?

A. Before I came to the FAA, I was a senior engineer and also, I was also a supervisor. I was a support contractor to NASA, supporting NASA's Office of Safety and Mission Assurance, and basically conducting independent technical reviews associated with, as an example, the space shuttle.

Q. I'm sorry, do -- now was that located here at NASA headquarters, then, for your contracting part?

A. Yeah, we were in the -- we were located Washington,

D.C., located here at Capital Gallery, and NASA headquarters was a couple blocks away.

Q. All right. I think Dave did ask about the waiver and if it was typical for the FAA to kind of like self-initiate the waiver, and you, you know, you did say the FAA has the ability to waive certain requirements if they're met other ways possibly. Can you recall any other applicant that you have exercised that right for the FAA to initiate it without the applicant's request?

A. No, I can't recall at this point.

Q. Okay. In general, do you know how often waivers are actually given?

A. They -- periodically.

Q. Okay. So do you mind if you could just give us like a brief description of the, you know, the Office of Commercial Space within the FAA? Could you -- you referred to a couple different divisions, and what I would like to solidify is how those different divisions -- like how do you guys work together?

A. Okay. So within the Office of Commercial Space Transportation, we have five divisions. Okay. So my division is the AST-200, Licensing and Evaluation Division, and I'll describe how the other divisions support my division, such as the permit evaluation, to put things in context. Okay.

So, once -- okay, so once we accept, formally accept an application, my division, the AST-200 division takes the lead in the evaluation of the, in this instance, the permit. Okay. So

I'll assign a project team lead to lead the evaluation of the permit application. Okay. So the 200 is the project team lead, but then within that project team consists of other members from the other divisions. Okay.

So primarily AST-300, which is the Regulations and Analysis Division, they primarily do the flight safety analysis and the system safety analysis, the AST-300 division. So members from the AST-300, flight safety analysis and system safety, will be part of the project team. Okay.

And then from 100, AST-100, which is the Space Transportation Division, they handle the environmental assessment, and also they handle the air traffic agreements, issues dealing with air traffic. So members from AST-100 will also be part of the project team evaluating the permit application.

Then the AST-400 division, which does the safety inspection, they're normally involved -- they do the inspection after the permit has been issued and when the launch actually occurs, they do the inspections then. However, during the permit application evaluation we still have a member from the safety division team to be part of the project team evaluation division so they're familiar with the application and what's going on with the Scaled evaluation, and they also help to review the mishap and response plan of the evaluation.

And then the last division, which is the AST-500 division, is the Operations Integration Division. They're the

ones who primarily do the pre-application consultation, the ones that get involved talking to the applicant before an applicant has been formally submitted, and so during the evaluation process they're also involved. And because we have people out in California close by to Mojave, they do the day-to-day interface with Scaled when they're out there.

So that's how the five divisions interact. And then we also have a chief engineer who provides ground rules and assumptions and weighs in on the technical issues. So, in essence, that describes --

Q. So once the license or permit has been granted, who would be responsible for maintaining -- I hate to use the word oversight. Would it be AST-500 who is maintaining that continuity and check to make sure that they are staying within their permit application or their license application?

A. Okay. Once we issue a permit or a license to an operator, that permittee or licensee is responsible to maintain the accuracy and representation of their application that they submitted which enabled them to receive the permit or license. So it's incumbent, first incumbent upon the licensee and permittee, the operator, to maintain the accuracy of their application or license. And if there's any changes, it's incumbent upon them to notify the Office of Commercial Space Transportation if there are any changes to determine whether or not there's any need to modify an existing permit or license. So it's incumbent in the operator.

The safety inspections are just inspections during launches or other times maybe to make sure that the operator is complying with the regulations. So it's twofold.

Q. Right. I guess what I'm trying to get some insight on is how the local people, like what their, you know, role is and how did they feedback to I guess your office. Because I guess, you know, they're more closely located, you know, with the applicant, so how does, you know, like their day-to-day interaction or week-to-week, or whatever it is, like how does that get shared back up to you or your group?

A. Well, they facilitate in terms of coordinating with headquarters. What I mean by coordinate, like if there's a requirement to have a technical interchange meeting or discussion or if there's any data requirements that we need, they help to coordinate or facilitate that. So they help the project team lead here in D.C. to facilitate that.

Q. Okay. Do you see yourself as having an open door policy?

A. Yes. I always tell the staff members that if they have any safety issues or concerns to bring them, yes.

Q. So how would they do that? How would a staff member be able to voice their safety issue or concern? Would they go directly to you or would they go to the project lead? Is it like -- like, say, if there was someone within AST-300, would they come to Ray Jenkins, who's the project leader, or would they go to

their deputy or to their division chief?

A. It happens -- all the above, okay? There are sometimes where they let me know, sometimes they let their manager know, sometimes they let the project team lead know. But once it gets surfaced, then the management has a vetting process which listens in to any issues or concerns.

And one of the things I want to do mention is, before we issue a permit, we have what we call a management review board. Okay. And the management review board is where the project team that evaluated the evaluation, they brief management on the evaluation and makes a recommendation and identifies any issues or concerns that any of the team members may have. And management will listen into any of the issues or concerns, and then ultimately makes a decision on whether or not to issue or not issue a permit or license. So, there's --

Q. Now --

A. Go ahead.

Q. I'm sorry. Part of that management review board, then, is that like -- is that an informal process or is it a formal process? Is there a way to --

A. That's a formal process. Go ahead.

Q. Okay. So there's a tracking of an issue or concern that's brought forth and then how that issue is closed out?

A. Yes.

Q. Okay. You mentioned, when Kat asked a question about on

the human performance side, that you had two experienced pilots and instructors. And since we do have some other interviews coming up, do you mind mentioning by name who those two pilots are?

A. Henry Lampazzi and Ray Jenkins.

Q. All right, excellent. We talked about the pre-application consultation meetings, and I was just curious like if there happened to be a typical number of meetings that are held or duration; is there any kind of, you know, like method that we can associate with it or does it depend on who the applicant is and the maturity of that application, or the person who is making the application, I should say?

A. What was the question again? Can you restate the question?

Q. Sure. What I was wanting to know is if there happened to be like a typical number of meetings that are held during that pre-application consultation process, and if there's like a duration associated with that, like is it 2 hours per day or like 3 days, something like that?

A. No. There's no set -- each applicant typically is different, so no, no there's no set in stone that the pre-application consultation has to be this many years or this many hours or this many days or you need this many meetings, no.

MS. WARD: All right, good. Thank you. Those are my questions.

MR. PREAMBLE: This would be a good time to take a quick restroom break or something like that.

MR. LAWRENCE: Let's go off record.

(Off the record at 10:32 a.m.)

(On the record at 10:40 a.m.)

MR. LAWRENCE: Bob.

BY MR. WITHROW:

Q. I have just a couple topic areas, Ken. So, going back to the management review boards, is it correct to state that the function of the management review board is to make a decision on things like permits; is that correct?

A. Permits, licenses, safety approvals.

Q. Okay.

A. And also to listen to see if there are any issues or concerns --

Q. Okay.

A. -- before making a determination.

Q. With respect to the Scaled permit, when were management review boards held?

A. I don't recall the exact dates, but they're held prior to making a determination. Sometimes it could be within a week before making the determination.

Q. Okay. And is the same thing true for a waiver? Does the management review board meet to make a decision about a waiver?

A. We discuss waivers, but some forums we may -- typically we don't have a management review board to review waivers, but we have other forums where management will get together to discuss it. Other than a management review board, we also have what we call a technical review board to discuss technical matters amongst management.

Q. And the function of the technical review board is to make recommendations; is that correct?

A. Yes, hear out what issues and go forward with some kind of determinations, yes.

Q. So for the initial Scaled permit, do you recall who was on the management review board?

A. I mean, it was the division managers, the associate -- our associate, George Nield, his deputy chief engineer, and the division managers.

Q. Okay. And then -- and so those are the functional people, so we can determine who those individuals were at that time. And then -- I guess; is that correct?

A. Yes.

Q. And then the same thing would be --

A. And also, during the management review board, all of the AST staff is also invited to attend also, the entire AST staff.

Q. And then the same thing would be true for the first renewal, we could figure out who those individuals were? There was a management review board for the renewal; is that correct, or

not?

A. Definitely one of the renewals we had a management review board. And the way -- and the reason I'm saying it, not all renewals do we have a management review board. It depends on the extent of the modifications. But definitely one of the renewals we had, yeah.

Q. Okay. So do you recall if there was one for the first renewal?

A. I can't say with 100 percent certainty, but I believe there was.

Q. Okay, thanks. Okay. And then David asked at the very beginning about if you recalled if there was information about human or software error in the application, and Katherine asked about the -- whether -- about human error, whether or not if you were saying no you don't recall or no there wasn't, and I'm going to ask the same question about software error. So do you recall if there was information in the Scaled application about software error?

A. I don't remember seeing specific, specific hazard analysis that specifically said this hazard caused by human error or software error. I do not recall seeing specific hazard analysis --

Q. Okay.

A. -- that specifically said this hazard was caused by human or software error.

Q. Okay. And then with respect to running the simulator at 1.4 time, do you recall if in Scaled's application they stated that they would do that for every sim session?

A. I don't recall that. No, I don't recall that.

MR. WITHROW: Okay. That's all.

MR. LAWRENCE: On the phone, Nikki?

MS. DUGUE: I have no questions at this time.

MR. LAWRENCE: Thank you very much. We'll move over to TSC. Will?

MR. ROBERTSON: I have just s few questions.

BY MR. ROBERTSON:

Q. Again, I guess this also goes back to Katherine's clarification. My question is, in the instance that a waiver or a application is identified to have a deficiency, is there a process by which the applicant is given a chance to correct that deficiency?

A. Yes. We have discussions with the applicants, yes.

Q. Was Scaled asked to correct the deficiencies that were identified with respect to human error and software error?

A. We had discussions with Scaled before we issued the waiver.

Q. Okay. But you don't remember whether or not they -- or do you remember whether or not they decided against correcting deficiencies?

A. I don't recall at this time. All I can say is we

definitely had discussions with Scaled prior to issuing the *Federal Register* notice waiver telling -- informing Scaled that we were going to be issuing a waiver.

MR. ROBERTSON: Okay. That's all the questions I have.

MR. LAWRENCE: Okay. Thank you. We'll transfer over to the FAA on the phone. Brett Vance?

BY MR. VANCE:

Q. Yeah. Hey, Ken, Brett Vance here, test pilot out at the L.A. certification office here. I have a couple of questions related to operations that I'd kind of like to get involved in, but first I need just some background on AST a little bit more. Is Scaled Composites the first company that we had, I guess, apply for manned commercial operations?

A. Yes. Back in 2004, we issued --

Q. Was that basically the SpaceShipOne or --

A. Yes, SpaceShipOne.

Q. -- specifically for -- say again?

A. Yes, SpaceShipOne.

Q. Okay. So, I guess along those lines, you discussed briefly a while ago the pre-application process that companies go through. Is there a difference in the rules and the regulations that are addressed in that process that have to do with manned versus unmanned operations, and is that clear to the applicant?

A. Yes, there are different rules for manned versus unmanned, or crew or non-crew operations. The --

Q. What do those rules generally -- I'm sorry.

A. The primary difference is we have -- if there is a launch operation that involves crew or occupants on board, in addition to meeting the normal launch license or permit requirements, they also have to meet part 460 human spaceflight regulations.

Q. And those requirements are spelled out in pretty good detail in the circular that we previously discussed?

A. No, those regulations are regulations under 14 CFR part 460.

Q. Okay, so part 460. All righty. I'm going to write furiously here. Are there other companies right now in the application process for manned commercial space operations?

A. Yes.

Q. Okay. Don't need to know those names, just wanted to know if they were there.

Let's see. Okay, so with that in mind, one of the things you mentioned a while ago is that with regard to a launch AST-400 would go out and do a safety inspection. Can you characterize that safety inspection for me and give me a clue how far in advance of launch day that was conducted?

A. It varies. Sometimes the safety inspectors go out earlier, before the actual day of launch, because there are typical -- or range safety meetings are typically held, so the safety inspectors normally participate in certain safety meetings

prior to the actual launches. Some of the other launches like happen down at the federal ranges, we have inspectors go out for like flight formation system checks inspections. So it varies.

Q. Is it a formalized process with its own checklist and other guidance or do you tailor it for the particular operation?

A. It's tailored -- I mean, there's specific things that they check in general, but yes, it's basically tailored to the operation, yes.

Q. Right. Okay. Another one here along that same line. So is that inspection a one-time circumstance or does it continue through the launch with a monitoring aspect?

A. No, it's not a one-time. So you have safety inspectors there before the actual launch, and then during the launch and then also while the launch is happening itself, they are there making sure the operator is complying with what they said they would do in the application and they're complying with regulations and statute.

Q. Back to the characterization of that inspection. There's a lot of aspects to at least the training part of getting ready for a launch. You mentioned that one of the things that you focused on during this inspection was training. So, I'm thinking things like pilot recency, proficiency, the spaceship's g-tolerance flights; there's a lot of things that Scaled and Virgin mentioned that they do prior to getting ready. Do you look at all of those aspects? Do you just look at the simulators, because you

did emphasize the simulator? What all aspects do you look at when you're doing the safety inspection prior to the launch?

A. Yeah. The inspectors don't inspect everything. I mean, there are certain things that the inspectors inspect. So I can't tell you the particular ones; I don't have the safety inspection checklist that the AST-400 division has, but they do have a checklist they go out with.

Q. Were there any observance of any flight rehearsals or updated checklist procedures other than watching a simulator session? I guess we can speak of that in a general term too. It doesn't necessarily relate to a specific launch. But in general, is that something that they just observe other rehearsals and look at any checklist procedures?

A. Are you talking about the Scaled, per se, or are you talking in general?

Q. Let's go with both, because that was actually a follow-up question. So since you introduced it, with Scaled and also in general.

A. Yes. As part of the safety inspection, yes, sometimes we have safety inspectors go out for rehearsals and see how the operator reacts to nominal and non-nominal situations.

Q. Okay. So the simulator observance that you did was actually for the PF4 profile, right?

A. Yes.

Q. You discussed earlier when Lorenda was talking about the

various relationships of the different offices in AST; tell me once again about AST-300, what do they do?

A. AST-300 is the Regulations and Analysis Division. They do rulemaking. That's the regulations part. In terms of like if the rules need to be changed or revised, they do the rulemaking. And then they also do the analysis for evaluations, primarily flight safety analysis and also system safety analysis.

Q. Yeah, that's what I was looking for again. I just wanted to make sure. Now, are there any human factor specialist types of folks in AST-300?

A. There used to be one, Jay Naphas, used to work in the AST-300 division. Now he works in the AST-500 division out in California.

Q. Yeah.

A. He has human factors background.

Q. Any trained test pilots in AST-300?

A. Not that I'm aware of.

Q. Okay. And the last question I can think of here today is -- I'm thinking again operationally on day of, on launch day, you know, the entire test team is going to go through a series of go/no-go criteria prior to a launch. And in the many years of flight tests that I've done, we also have that particularly for elevated risk testing. Does the FAA have any specific go/no-go criteria day of that you would pay attention to, that you would run some kind of a checklist? If so, who might run that

checklist, and is it based maybe on the waiver or some other analysis that AST-300 might have done?

A. I can't speak for every go/no-go or launch commit criteria, whatever, but when inspectors are out there, they normally -- I'm just speaking in general for launches. Let's take inspectors. They do have like the launch commit criteria that's available for them to look at.

Q. Okay. Real good. I think that's all the questions I have. Thanks a lot.

MR. LAWRENCE: Thanks, Brett. Christy?

BY MS. HELGESON:

Q. I am Christy Helgeson. I am the human performance FAA representative. I am a flight test engineer and human factors specialist out in the Seattle Aircraft Certification Office, just so you have a reference of maybe my background a little bit.

You had mentioned earlier that the FAA has the applicant, Scaled Composite, in this case, proposed meets the compliance to the rules, is that correct?

A. Can you restate that question?

Q. When an applicant comes to the FAA for the permit of a waiver, they have to show that they meet the requirements and the regulations, is that correct?

A. Well, when they propose a waiver, they're proposing because they can't meet a certain regulatory requirement. But there are certain criteria, which is spelled out under Part 404 of

the regulations in terms of the criteria, when we would issue a waiver or grant a waiver.

Q. Okay. I guess where I'm going with this is in terms of the waiver on 430755 since Scaled Composites did not request the waiver, was there any indication that they didn't meet the requirement of that rule in terms of human error to issue the waiver?

A. Yes. The reason, the reason the waiver was issued was because Scaled did not specifically, in their hazard analysis, address human error or software error in their hazard analysis, they did not specifically address human error and software error in their hazard analysis. But, as I indicated earlier; however, Scaled felt like they did have mitigations and controls, particularly the training of the crews and the pilots, the remoteness of where they were launching the redundancy, the pilots and also the vehicle systems and the incremental flight testing, such that Scaled didn't believe that they believe they had sufficient mitigations and controls in place, such that they didn't need to address human error or software error.

So, ultimately -- well, what I'm trying to get at, ultimately from a public safety standpoint we were okay from a public safety, that's why we were willing to issue the waiver from it. But if you were to -- say specifically in the regulation, if they specifically address human error or software error, no, that's why the waiver was issued.

Q. Thank you. That helps put all the pieces in my head together much better. We're talking about human error and software error a lot. Do you happen to know what those mean, what is human error, what is software error?

A. In the context of like if a human does some action that could cause a hazard to the public, would be an example.

Q. Did Scaled Composites identify any specific human errors for which the mitigations they have in place for the waiver? So I hear all of these mitigations were stated, but were any errors, specific errors identified to put the right mitigation in place for that either human error or software error?

A. As I was saying, no one's, no one was arguing that Scaled -- okay, everyone was agreeing that Scaled had in place mitigations and controls with all those things that I mentioned. The argument was that Scaled did not specifically have a hazard analysis in their application that said that this hazard is caused due to human error, did not have a specific hazard analysis that said that human error, software error causes hazards that could affect public safety, you did not see that in the application. But they had mitigations and controls with the training and a lot of the other stuff that I talked about.

Q. Are you aware of any assumptions Scaled Composites makes in their hazard analysis?

A. Yes, certain assumptions, yes.

Q. Can you recall, you know, specifically?

A. Just right off, some dealing with part of the requirement is to determine the likelihood of occurrence and consequence of a hazard that could affect public safety.

Q. And likelihood of occurrence is that specifically maybe associated with the probability; is that what that means?

A. Yes.

MS. HELGESON: Okay. Those are all my questions. Thank you.

MR. LAWRENCE: Thank you, Christy. Anybody on the phone I missed? Okay.

BY MR. LAWRENCE:

Q. I just have just a couple quick follow-ups, and I appreciate your time, thanks. Referencing the initial application for the permit, did the initial application have any human error or software error analysis in it?

A. As I indicated earlier, I don't recall seeing specifically where it was spelled out, human error or software error.

Q. Okay. If it didn't have that, should the waiver have actually been applied or been considered for the initial application, as opposed to until the renewal?

A. It's always difficult going back. At the time, from a public safety standpoint, we didn't see it as an issue.

Q. And just one quick follow-up. Scaled conducts quarterly meetings and invites the FAA to attend. Does anybody in your

office attend these Scaled quarterly meetings?

A. Yes.

Q. Okay. Who is that?

A. Definitely the people located out at Mojave, the AST-500 division, periodically the project team lead from my division attends.

Q. Okay.

DR. WILSON: Okay. I've got just one.

BY DR. WILSON:

Q. Lorenda asked you about your open-door policy and if people can come into your office to voice any concerns that they have, or anyone else's office. My question is, what concerns have been brought to your attention regarding the SpaceShipTwo program?

A. Just, an example, sort of things that we talk about -- and the Scaled, the program is not unique. It's, like in the areas of system safety, is just a typical example. There's always questions on how deep do you go into hazard analysis. Have all the hazards been identified? The likelihood of occurrence of a hazard is always discussed, especially for a new program. How can you assign the likelihood of occurrence if you don't really have a lot of data? Those are just --

Q. Right.

A. -- some of the examples.

Q. Have the concerns that have been brought to your attention, have they been satisfactorily mitigated or are the

people who brought those concerns are they satisfied with the process that's been taken or are there still outstanding concerns that people --

A. I can't speak for specific individuals, all I can say is when issues are brought up, I mean, it's brought up and we have a process to vet them, okay. At the end, when a determination is made, it's based on our process. I can't say -- speak for everyone, that everyone is in agreement. No one is, on any issue, is totally always in agreement, but they are vetted and we do listen to the concerns.

Q. What is that vetting process that you mentioned?

A. We have certain avenues, whether it's a technical review board or whether it's a meeting that we have with a chief engineer is an example. A lot of times if there's like technical issues, we would bring the chief engineer or we might bring the entire management team and then we'll also have some of the staff members there to present whatever issues they may have.

Q. The person who raised the concern are they a part of that process or is there a method that you go about reporting back to that person to let them know what your office has -- the determination that your office has made regarding the concern that they had?

A. In general we want them to be part of the process. If -- the way I like it, if a certain individual has an issue, I want that specific individual to explain or describe what their

concern is.

Q. Okay. Since the accident, have there been concerns brought to your attention? Have people come to your office with concerns?

A. In terms of -- no specific ones, but as follow-up, once the NTSB investigation is completed, yes, definitely we'll be looking into certain things.

Q. What certain things?

A. Well, none specific at this time. We're waiting until the NTSB investigation is complete first.

Q. Okay. That's all I had. Thank you.

MR. LAWRENCE: Anybody else in the room have a follow-up question?

MR. ROBERTSON: I have one more follow up.

MR. LAWRENCE: This will be Will. Okay.

BY MR. ROBERTSON:

Q. So with all of the discussion around human and software error and mitigations, is it okay for an applicant to identify error, whether it's human software or systems based and accept that risk without mitigation under a permit?

A. There's a requirement under the experimental permit regulations that says the likelihood of occurrence and the consequence of a hazard that could affect public safety should be -- needs to be extremely remote, okay. So that's what I was trying to get at earlier, okay.

So the regulatory requirement is you have to demonstrate like the likelihood of occurrence of a hazard that could affect public safety is extremely remote, but part of the debate sometimes is, is agreeing what is that likelihood of occurrence, the probability of that hazard occurring, especially when you don't have a lot of data and it's a new vehicle. So it's not clear-cut is what I'm trying to say, and it gets into debate sometimes. So the applicant can propose a certain probability of that hazard occurring and then that can get into debate.

Q. And so if it's in agreement that that error, again, whether it's human, software, systems based, does not meet that extremely remote criteria, is it then required that a mitigation must be in place?

A. Yes. According to the regulations, it says you have to show that it's extremely remote, yes.

Q. Okay. And then I guess my last question is, if it does not, if that error does not meet that extremely remote so you have to have a mitigation, does the mitigation have to be specific to each identified error or can it be a general mitigation like similar to incremental approach, which I think was identified as a mitigation? Can incremental approach to a flight program be a mitigation across multiple hazards?

A. I would have to think a little bit more about it before answering. It might be different for different situations. I mean, it sort of gets into -- some factors is where are you

launching? How remote, how sparsely populated, how big is that operating area? If the area is large, then human error and other stuff may not be as important on a software error. So there's different factors.

Q. Sir, I apologize, I said I only had one more, but I think, based on something you just said -- so the criteria -- there are methods to determine likelihood of occurrence, but my understanding is that's not actually required under a permit. So the process by which it is determined what likelihood of occurrence is, how does that work? Is that based on engineering judgment?

A. Some of it comes from if you don't have -- unlike aviation where you have a lot of data, sometimes it comes down to engineering judgment, sometimes some MIL standards, the documents.

One thing I do want to say is, and associated when we're talking about human error, software error, is I mentioned earlier that training was a big part of the remoteness. One thing I do want to emphasize, our authority, the office, is really public safety, okay, the people not involved with the launch. That's our authority, to protect the people not involved. So we only license and regulate to the extent necessary to ensure safety of the people not involved. I think that's very important.

MR. ROBERTSON: Okay, thank you. That's all I have.

MR. LAWRENCE: Thanks, Will. I'm going to go to the phone. I'll do a roll call on the phone, if you have any follow-

up questions. Mike Bauer?

MR. BAUER: None for me.

MR. LAWRENCE: Thank you. Lorenda?

MS. WARD: I have two.

BY MS. WARD:

Q. Ken, you just talked about your authority, you talked about how to protect the public. Isn't your authority, also state you need to encourage and promote commercial space?

A. Yes.

Q. All right. My second question is, for SpaceShipTwo wasn't it -- didn't it also have an experimental permit along with experimental airworthiness certificate?

A. When it was -- it had the experimental airworthiness certificate when it was not doing rocket-powered flights. When it was under the experimental permit, when Scaled was doing a rocket powered SpaceShipTwo flight, the experimental airworthiness certificate was not being exercised at that time. And that's --

Q. So when they're doing a gliding flight and they're using an experimental airworthiness certificate, what is the relationship within the FAA between the Office of Commercial Space and then the aviation side; how does that work?

A. That's part of the pre-application consultation period. So, during the SpaceShipTwo glide flights, our office during the pre-application consultation, you know, back in like the 2010 time frame when Scaled were doing like glide flights/captive carriage,

our office was engaged, even though we were not authorizing -- I mean, AST was not authorizing the glide flights or captive carriage. However, we were informed of what was going on because we knew eventually Scaled was going to apply for a permit application and there was relevancy in terms of those test flights.

MS. WARD: All right, that's all I have. Thank you.

MS. LAWRENCE: Sure. Nikki, any follow up?

MS. DUGUE: No follow-ups for me, thank you.

MS. LAWRENCE: You're welcome. Brett?

MR. VANCE: Negative.

MR. LAWRENCE: Christy?

MS. HELGESON: No follow-ups, thank you.

MR. LAWRENCE: Ken, thank you very much for your time. I really appreciate it.

(Whereupon, at 11:20 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:	CRASH OF VIRGIN GALACTIC SPACESHIPTWO MOJAVE, CALIFORNIA OCTOBER 31, 2014 Interview of Kenneth Wong
DOCKET NUMBER:	DCA-15-MA-019
PLACE:	Washington, D.C.
DATE:	January 14, 2015

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.

_____

Stephen Grider
Official Reporter

UNITED STATES OF AMERICA

NATIONAL TRANSPORTATION SAFETY BOARD

Investigation of:	*	
	*	
CRASH OF VIRGIN GALACTIC	*	
SPACESHIP TWO	*	Docket No.: DCA-15-MA-019
MOJAVE, CALIFORNIA	*	
OCTOBER 31, 2014	*	
	*	

Interview of: HENRY LAMPAZZI

National Transportation Safety Board
6th Floor Conference Room
490 L'Enfant Plaza East, S.W.
Washington, D.C.

Wednesday,
January 14, 2014

The above-captioned matter convened, pursuant to notice.

BEFORE: DAVID LAWRENCE
Operations Group Chairman

APPEARANCES:

DAVID LAWRENCE, Operations Group Chairman
National Transportation Safety Board

MICHAEL HAUF, System Safety Group Chairman
National Transportation Safety Board

LORENDA WARD, Investigator-in-Charge
National Transportation Safety Board

KATHERINE WILSON, Ph.D., Human Performance Group Chairman
National Transportation Safety Board

DANIEL MURRAY
Federal Aviation Administration

CHRISTINE HELGESON
Representative to the Human Performance Group
Federal Aviation Administration

BRETT VANCE, Test Pilot
Los Angeles Aircraft Certification Office
Federal Aviation Administration

BOB WITHROW
Scaled Composites

NICOLETTE DUGUE
Scaled Composites

WILL ROBERTSON
The Spaceship Company

BRADLEY PREAMBLE, Office of the Chief Counsel
Federal Aviation Administration
(Representative on behalf of Mr. Lampazzi)

I N D E X

I N T E R V I E W

(12:33 p.m.)

MR. LAWRENCE: Okay. We're on record. First off, welcome, good afternoon.

MR. LAMPAZZI: Good afternoon.

MR. LAWRENCE: My name is David Lawrence. I'm with the NTSB. I'm the Operations Group Chairman for this phase of the investigation. The NTSB is an independent federal agency charged with determining the probable cause of transportation accidents and promoting transportation safety. The NTSB is not part of the DOT or the FAA. It has no regulatory enforcement powers.

I'd like to start by introducing everybody that's in the room, and then we'll go around the -- make sure you're introduced to the people that are on the phone.

DR. WILSON: Katherine Wilson. I am the Human Performance Group Chairman with the NTSB.

MR. MURRAY: Dan Murray. I am AST's representative to the System Safety Workgroup.

MR. HAUF: Mike Hauf, NTSB, System Safety Group Chairman.

MR. WITHROW: Bob Withrow, Scaled Composites on the Systems Safety Group.

MR. ROBERTSON: Will Robertson, Virgin Galactic systems safety analyst and representative.

MR. PREAMBLE: Brad Preamble from the FAA Office of

Chief Counsel here for Henry Lampazzi as his representative.

MR. LAWRENCE: Great. On the phone for -- with the NTSB? Lorenda?

MS. WARD: I'm Lorenda Ward, who is a senior investigator-in-charge. I'm the investigator-in-charge for this accident investigation.

MR. LAWRENCE: Great. With the FAA, Brett?

MR. VANCE: Brett Vance, test pilot, Los Angeles Aircraft Certification Office.

MR. LAWRENCE: And Christy?

MS. HELGESON: Christy Helgeson, FAA representative for Human Performance. I am a flight test engineer and human factor specialist for the Seattle Aircraft Certification Office.

MR. LAWRENCE: Excellent.

Did I miss anybody on the phone?

(No response.)

MR. LAWRENCE: Very good. Today we will be using services of a court reporter who will record and transcribe this interview. The transcript, but not the audio recording, will be made part of the public docket.

The purpose of the investigation is safety, to determine probable cause and prevent reoccurrence. Our role is not to assign blame, fault or liability. This interview is a part of the fact-finding phase of this investigation. We are here to ask questions about your involvement in the permit and waiver for the

SpaceShipTwo program. We cannot, however, offer any guarantee of confidentiality or immunity.

Each of the group members will have a chance to ask questions. We will ask questions one at a time, and everyone has been instructed to not interrupt the person who is asking questions at the time. There will be the opportunity for each group member to ask any follow-up questions after each person has had a turn. If you would, please answer all questions to the best of your recollection. If you do not understand a question, ask to have it repeated or explained. If you realize you misstated or need to modify a previous answer, please do so.

You're entitled to have one representative of your choosing. Is there someone you would like to have as your representative?

MR. LAMPAZZI: Yes. Mr. Preamble.

MR. LAWRENCE: Great.

Mr. Preamble, you may direct Henry -- do you mind if I call you Henry?

MR. LAMPAZZI: Henry is fine.

MR. LAWRENCE: Okay.

You may direct Henry to not answer a question or to request a short break to confer with him.

MR. PREAMBLE: Okay.

MR. LAWRENCE: Okay. The FAA will have the ability to review the transcript prior to inclusion in the docket. Do you

have any questions, Henry?

MR. LAMPAZZI: No questions.

MR. LAWRENCE: Great.

INTERVIEW OF HENRY LAMPAZZI

BY MR. LAWRENCE:

Q. Let's get started. And if you would, just for the record, can I get your full name and job title?

A. Henry Anthony Lampazzi.

Q. Do you mind spelling it?

A. L-a-m-p-a-z-z-i. I'm an aerospace engineer with the FAA.

Q. What office in the FAA are you with?

A. AST, Commercial Space Transportation.

Q. Okay. Which AST division?

A. 200, which is Evaluation and Licensing.

Q. Okay. And if you can, just give me a brief description of your background, what led you to the FAA?

A. The short answer would be that I was at Johnson Space Center as an aerospace engineer for 26 years. I was a test and procedures specialist there. I designed and briefed and taught aborts, contingency aborts, you know, that sort of thing, and then became a training director there, better known -- or the call sign Sim Sup.

Q. Sim?

A. Sim Sup was the call sign, which is short for simulation

supervisor. But essentially, it's training director in layman terms.

Q. Okay. And from that position, you came to the FAA?

A. I did a 1-year stint at British Petroleum.

Q. And when did you come to the FAA?

A. August 27th of 2012. I was here as a contractor, and I was a contractor until the day of the SpaceShipTwo accident.

Q. You were a contractor?

A. Up until that day, yes.

Q. Um-hum.

A. And then my first day on the job as a federal employee doing the same job I did as a contractor was November 2nd. My first day on the job was at Mojave.

Q. Who were you a contractor for?

A. Arctic Slope Regional Corporation.

Q. Within the AST-200 Division, who is your immediate supervisor?

A. Ken Wong.

Q. Okay. You came on in August 27th, 2012 as a contractor working with the FAA. What was your role? What did you do?

A. Essentially, or as you might imagine, day one, I was nothing but a OJT and feeling my way. And as duties arose in Ken's group, I was assigned those duties first as an OJT, and then as a backup, and then, eventually, a lead on some.

Q. Okay. What duties were you --

A. The duties are to evaluate launch systems, whether they be training programs or launch systems, space ports, the like, and evaluate them as a -- the veracity and safety, and then to license or not license, permit or not permit.

Q. And let me ask you a little bit about your evaluation of the training programs at Scaled?

A. No.

Q. What training programs are you talking about that you did evaluations on?

A. We have had multiple applications to FAA, AST, some for courses, some for essentially what you would call a flight school or a space flight school, and they wanted -- they applied for safety approvals to run courses in the spaceflight community.

Q. Did you take a look at any of the training programs at Scaled as part of your duties?

A. I did not.

Q. Did you have any knowledge of the -- maybe not in a capacity, an official capacity, looking at it from an evaluator's standpoint, but did you have any knowledge of their training there?

A. I was not asked to evaluate any of the training. However, given my background, anytime I heard something of training in nature, it, you know, caught my ear.

Q. Sure. Okay.

A. Um-hum.

Q. Is there anybody at the FAA that is looking at the pilot training on the evaluation side?

A. I don't believe so.

Q. Okay. Nobody in AST is looking at pilot training?

A. I can't answer that.

Q. Okay.

A. I can't answer that.

Q. Did you have -- and I know that you started in -- you weren't with the FAA until the 2nd of November, but did you have any work on the permit or the renewal of the permit?

A. The original permit was issued prior to my arrival.

Q. Okay.

A. I came -- I was assigned to this project during the permit renewal process midstream.

Q. Okay. What did you do as far as the renewal?

A. Essentially, I was a backup for Ray Jenkins, who was lead on the evaluation and licensing -- well, licensing is a bad word -- but evaluation of the permit.

Q. Okay. Did Ray have overall responsibility for the permit or were there any specific targeted areas that Ray was responsible for the permit?

A. The job, whether it be his or mine, was to collect all information or input from all parties, package it in such a way that it was clear and understandable, and then present it to management with a recommendation and together with pros and cons.

Q. So you were working as a backup to Ray Jenkins at the FAA, but you were a contractor at the time?

A. Correct.

Q. Okay. Is that typical for the FAA to contract out some of that work?

A. No, it is not.

Q. How many contractors does FAA have within AST?

A. Right now?

Q. Yeah.

A. One.

Q. Do you know who it is?

A. Well, I have to qualify that answer.

Q. Okay.

A. There is one that does IT. There is one that still works for Arctic Slope.

Q. Um-hum.

A. And then there is a third that I saw on the roster for the first time today. I have not met him. I don't know what his duties are.

Q. Okay. Is it a staffing issue or is there just a workload issue that -- the reason why they contracted you for AST?

A. It was a staffing issue at the time. I got a call from Pam Melroy, who was the Dash-2 at the time. And they were looking for folks and were having trouble locating them, and asked me to apply.

Q. They were looking for folks within the FAA?

A. They were looking for folks -- I was at BP at the time. She knew me from NASA.

Q. Okay.

A. And they were looking for folks with my skills.

Q. Were you involved with the waiver process with Scaled?

A. I had knowledge of the waiver process. I knew it was taking place, but I had no input to it.

Q. Were you familiar with some of the mitigations that were defined in the waiver?

A. I was in those conversations, yes.

Q. Okay. Do you recall which mitigations there were for human error and software error that Scaled used to satisfy some concerns with the FAA?

A. Well, that Scaled used?

Q. Um-hum.

A. Are you talking the waiver?

Q. Right, the waiver.

A. And as far as I recall, Scaled did not write or have input to the waiver.

Q. Okay. Did Scaled -- to your knowledge, did Scaled ask for the waiver?

A. There was a conversation about where a gap may exist in the application.

Q. Right.

A. And --
Q. In the permit, because it would have been in the permit.
A. In the permit, the application, that's correct. I say application because it wasn't a permit at the time. Sorry. And we were discussing mitigations to those gaps.
Q. Right.
A. And after having long conversations with many people, the answer that came out was waiver.
Q. Did that conversation originate at the FAA or did that -- let me ask it this way. Scaled did not ask for the waiver. Who within the FAA came up with the concept of developing a waiver on behalf of Scaled?
A. Really it didn't come to fruition in that manner.
Q. Okay.
A. There was a conversation about where the gaps may be.
Q. Um-hum.
A. And I say in the application.
Q. Um-hum.
A. If that's okay. And of the mitigations that were discussed at the time, the waiver was the answer that we landed at.
Q. Okay. Do you know who drafted or wrote the waiver?
A. No one person would have written the waiver. It would have come out in a draft form and it would have been vetted through several people. And did it go outside AST? I don't know.

Q. Okay. That partially answers my next question. The origin of the waiver came from within the FAA, the language of that. That wasn't something that Scaled, correct, that Scaled didn't provide to the FAA; said here's the language in the waiver we suggest?

A. Yeah. I said I don't know -- I'm going to go back. I don't recall --

Q. Okay.

A. -- if that waiver went out to Scaled in the draft process.

Q. Okay. Did you liaison with anybody or talk to anybody at Scaled during the course of performing your duties?

A. Mr. Withrow.

Q. Okay. How often did you all meet?

A. We met weekly at times and biweekly at times.

Q. Okay. Did you communicate or liaison with any of the safety inspectors that were out in Mojave, FAA side?

A. They were -- I don't want to say every time, but they were invited to each meeting and were there at least most of the time on our weekly and biweekly meetings.

Q. Okay. Did they provide any input on some of the safety inspection plans and some of the results? Did they share those with you in your office?

A. They shared that, you know, they did inspections, but the inspection reports, I was not privy to that.

Q. Okay. I'm curious if there was anybody in AST or who in AST would be responsible for ensuring that Scaled complied with some of the provisions of the waiver that were identified as risk mitigations?

A. You're asking if -- who at AST --

Q. Correct.

A. -- would ensure that Scaled was complying with the waiver?

Q. Exactly.

A. Okay. It would be -- really maybe not even my question to answer, but it would be, as I see it, Scaled's responsibility to ensure that they're keeping up with that or operating within that waiver, much like any pilot would be expected to operate within his license.

Q. But the FAA wrote the waiver, correct?

A. The FAA issued the waiver.

Q. Okay. And they issued the waiver. Isn't there anybody in the FAA -- I understand it's Scaled's responsibility to comply with the provisions --

A. Yes.

Q. -- that are in the waiver, but is there anybody that's verifying from the FAA side that Scaled had actually done what is listed in the waiver?

A. I want to say yes.

Q. Okay. You want to say yes?

A. I want to say yes. There -- well, we have the system safety folks. We have flight safety folks. We have people in the field known as 500. And they are always line of sight to the spaceship vehicle and to the Scaled operation and the SpaceShipOne operation. If anything were to be amiss, it would, I would think, be noted. Whether or not something was missed or something they didn't see, I really couldn't say.

Q. How many times --

A. So the answer, I think, would be yes.

Q. So the answer would be yes. All right.

Let me shift gears a little bit. How often have you been out to Mojave to look at the Scaled facilities and --

A. Twice.

Q. Twice? Do you recall when those times were?

A. Yes. The first week in November.

Q. This past November?

A. Yes. And the first week in December.

Q. As far assisting AST as a contractor role, you've never been out to look at Scaled or tour their facilities or anything like that prior to the accident?

A. No.

Q. Did you ask to go?

A. No.

Q. Why not?

A. Travel budget, in a short phrase, short answer.

Q. Is that FAA travel budget or the contractor travel budget?

A. That would be -- well, in my case, the contractor would have paid for it, but then they would have billed FAA for it. So I have to say, in the end, it was FAA travel budget.

Q. Okay. Anybody else that you work with on your team, on the evaluation team that -- I know you were a contractor. Anybody else go out there and take a look during the waiver process, let's say?

A. Well, the waiver process was parallel to the rest of the process.

Q. Okay.

A. Okay. So employees on the ground are at the site. We had employees that are stationed there, and we have had some others visit there.

Q. Okay. I'm just going to list a couple operational aspects of the waiver. And I know your role with the process, but I just want to get your impression as a pilot -- you're a pilot, correct?

A. Yes.

Q. Okay. What type of licenses, FAA licenses do you have?

A. Airline transport pilot.

Q. Great.

A. And I'm a Gold Seal flight instructor.

Q. Excellent. Congratulations. Couple of things. Were

you made aware that Scaled was operating their sim at 1.4 times? Had you ever heard that before?

A. I have recently heard 1.4.

Q. Okay. Do you know if they were actually doing that?

A. No, I did not have -- no, I did not have line of sight to that operation.

Q. Okay. Did you know if Scaled operation involved two chase airplanes during boost flights?

A. I was aware that they did use chase planes. I am not aware of any requirement to use one or two or any.

Q. Okay. Did you know the pilots at all?

A. No, not until after the accident did I meet them.

Q. Did you ever have an opportunity to speak with any of their pilots, any of the test pilots at any point in time during your work with Scaled, either as a contractor or FAA employee?

A. There may have been pilots on our telecons. If they -- if there were, I was not aware of that at the time.

Q. Okay.

A. And I do know one of the Virgin Galactic pilots. And, of course, the Virgin Galactic pilots often fly chase.

Q. Right.

A. So with exception to the Virgin Galactic pilot, I had not met any of them.

Q. Your supervisor, when he brought you in as a contractor to assist in AST, was he aware of your background?

A. Yes.
Q. With NASA?
A. Yes.
Q. And training?
A. Yes.
Q. In simulation?
A. Yes.
Q. Did he ever tap into that knowledge?
A. Yes.
Q. How?
A. Yes. Anything that came his way that was of a training nature or an abort nature, he sent it my way, and he assigned me to that task. Well, let me -- I have to back up again. Everything that I know of that came his way, he brought me into the loop.
Q. I understand. Give me some examples of some of the training elements that he brought to you to take a look at.
A. Yes. One was -- well, the companies or the project?
Q. At Scaled.
A. Oh, Scaled? None. I'm sorry. None with Scaled.
Q. Well, can you give me some general examples of some of the other, outside of Scaled, that he came to you with training related that you dealt with?
A. Yes. We've had several what we call safety approvals that dealt with training. There were some operators that were

looking to stand up flight schools or single courses for the spaceflight community. He brought me in on those.

Q. You have significant operational background. Is there anybody else within AST currently that -- or at the time of the accident that had operational background?

A. Yes.

Q. Who would that be?

A. There are several in the group -- you know, I'll fall short of saying all --

Q. Right.

A. -- in the group have some sort of in-field or operational experience, of the non-IT, financial, accounting-type folks.

Q. Any of the others pilots or have flown?

A. Yes.

Q. Okay.

A. Yes.

Q. Any other with operational background related to NASA like you do?

A. Yes.

Q. Who is that?

A. Dan Murray.

Q. Okay.

A. Ray Jenkins. David Gerlach was with us for some time. Tom Martin, Tom Braun, Jen Bailey.

Q. Um-hum.

A. The list goes on.

Q. And then just one general question to follow-up on this topic, at any point in time did anybody from either -- anyone dealing with the Tier 1b program at Scaled approach you or did you hear of any concerns with the Tier 1b program?

A. No, no. From Scaled?

Q. From Scaled.

A. No.

Q. Okay. Let me qualify that and say from anyone?

A. Well, I'd have to qualify my answer at the start. We like to turn over every rock and look under everything. And before we turn over that rock, we're looking for a particular thing that's not right. So everything we look at is done with that in mind.

Q. Okay. Well, tell me what rocks you turned over and what did you find?

A. Oh, we -- there's flight safety analysis. There's a hazard analysis. When they -- as they changed their propulsion system, we of course, you know, took a look at that. And every -- to be inclusive, every portion of the application, you know, we gave an eye to, you know, assuming everything was right, but looking for, you know, where the hazards might be.

Q. Okay. What was wrong with the flight safety analysis and hazard analysis?

A. Oh, I didn't say anything was wrong with it.
Q. Oh, okay.
A. Um-hum.
Q. That was just one of the -- you just turned that over to look at?
A. No. Let me rephrase that.
Q. Sure.
A. We would use a flight safety analysis or a hazard analysis to find such issues.
Q. Were you aware of any third-party analysis that was done by the FAA or a system safety analysis at Scaled?
A. Yes.
Q. And who was that?
A. His name will be at the tip of my tongue forever and always, but in this forum, for some reason, I don't recall his name.
Q. Okay.
A. But he was --
Q. Do you recall the company?
A. He was on contract and he had a company name, and I'm sorry, I don't recall it right now.
Q. Okay. Are you familiar with any of the findings out of that evaluation of Scaled's permit?
A. There was, as with every other aspect, a lot of conversation that came up with every -- a lot of conversation came

up with every evaluation, every aspect of the evaluation, yes.

Q. Okay. That didn't really answer my question. Were there any concerns that were identified within the evaluation regarding Scaled's permit?

A. And the way you asked the question previously, it was in conjunction with hazard analysis. Is it still?

Q. Yeah, hazard analysis, fault tree analysis, any of those issues identified within that third-party evaluation that was made aware of to the FAA?

A. From the third-party?

Q. Right.

A. Okay. That was -- another question. I'm sorry. The third-party evaluator worked directly with our system safety person and his voice was heard through our guy.

Q. Okay.

A. And they worked often offline and together, and our system safety engineer would give us the results.

Q. Okay. Just one last question on that topic. Was there any changes that Scaled made to their system safety, hazard analysis, fault tree analysis, any of those, as a result of that third-party evaluation with the FAA contractor?

A. I don't believe that they changed their hazard analysis as a function of those conversations. What did occur, though, is there were instances of our system safety engineer conversing with their system safety engineer to come up with an answer of, well,

in FAA think and in Scaled think, put them together, this is the answer, and that would be okay.

Q. Okay. Let me change gears for a second. I want to tap into your knowledge, your previous experience roles as regard to training or your training role at NASA.

A. Um-hum. The Sim Sup job?

Q. Right. Generally, how are NASA pilots trained? And I'm talking about simulation, actual flight. What training devices do they have available to them for boost flight?

A. Simple answer?

Q. Yeah.

A. They have a simulator.

Q. Okay.

A. Multiple simulators.

Q. Multiple simulators?

A. Um-hum.

Q. Full-motion simulators?

A. Yes.

Q. Okay.

A. They have exactly one -- had exactly one.

Q. Is there any way in that simulation to replicate the boost environment for g-loading during boost?

A. To replicate the physics of g-load, yes. To replicate the sensation of g's, not really.

Q. Right. I'm curious of the procedural, the procedures

the pilots would use during the boost. Did they have checklists that they would read and respond to with items that they would have to manipulate during the boost?

A. In the space shuttle?

Q. Right.

A. Yes.

Q. Okay. So during boost and during g-loading, they would actually be manipulating switches and such? This wasn't something that mission control was controlling on its own? It was -- the pilots were actually physically manipulating switches based --

A. Um-hum.

Q. -- on a checklist item?

A. Yes. And I have to qualify the answer.

Q. Sure.

A. All right. Every launch we did -- I'm sorry, I should be talking to the room. Every launch we did was automated. Every landing we did was manual. However, we taught -- actually, it was my job for a long time to teach manual flight techniques, whether it be nominal ascent or abort. I taught those off-nominal and emergency or abort procedures.

Q. Okay.

A. And in those procedures there were actions to complete, as you might imagine. As far as in a nominal launch or a nominal ascent, there was a very minimum -- a minimal number of switches they had to move during a nominal ascent.

Q. Right. For an off-nominal ascent, when they are probably having to handle some type of system malfunction, they were using a checklist, correct?

A. Correct.

Q. Okay. Was the checklist designed so that it was, like, challenge and response, or was it a checklist that one person simply read the checklist and did the action also?

A. One of my jobs was to write those procedures or edit them or improve them. So I can, I think, answer that question pretty thoroughly. The way that the checklists were managed, you had books velcroed in front of the pilot and the commander, in a flipbook fashion that's on hard cardboard so they can grab a tab and bring it over in an easy fashion, and they would keep those pages up as they were flying. But really, it was the job of the MS2 or the flight engineer that sat aft in center to read procedures and ensure that the front-seaters were keeping up with their tasks.

Q. Were the procedures verified by like the pilot monitoring before action was taken?

A. Always.

Q. Always? Was there any procedures during, let's say -- like, the example I gave earlier was a non-nominal ascent systems malfunction.

A. Um-hum.

Q. Was there any procedure where the pilot or the pilot

monitoring would run the checklist solo without verification from the pilot monitoring?

A. Yes. Yes. I just said always --

Q. Yeah.

A. -- and now I'm saying yes.

Q. Okay.

A. All right. In a nominal ascent with a problem, the pilot might be over there looking at the APU switches, and he's the only one that can see them. So he would be verifying his switch movements as the flight engineer verified them. Our simulations did get frenetic enough that these guys were off working by themselves without verification. All right, so I have to qualify that. But -- I said always, but I'm going to say now by and large. And the intent is, the intent is to always have every switch movement, every action verified.

Q. So both pilots would be in the loop on the manipulation of any switch? You said --

A. Well, either both pilots, or more often, a pilot and a flight engineer or a commander and a flight engineer.

Q. Two individuals?

A. Two individuals.

Q. Separate individuals.

A. Yes.

Q. Okay. You said that you were -- I believe you said you were involved in the production of some of these procedures --

A. Yes.

Q. -- in the shuttle and such? What guidance did you use developing that? Was it just experience, tribal knowledge, or was there any kind of advisory circulars from the FAA, industry knowledge? What did you --

A. We used our own paradigm for it. And the method was ones that a need was cited for a procedure or an improvement or a rewrite. That rewrite would be assembled and then put out on a Form 482. Sound familiar? Which is a procedural change.

Q. Um-hum.

A. And you write up, you know, why and then the rationale. And on one side of the page it would say "is current" and -- or "is" and then "proposed," and then explain the benefits. And then once that 482 process is mature enough, it then goes to the simulator for procedure verification. And then once the procedure is verified and there are enough signatures on it, then it goes through the final process to get management approval and publication.

Q. Okay. Were there human performance considerations in the developing of these procedures at NASA?

A. Yes.

Q. What were those sources?

A. Those sources were astronauts, crewmembers and instructors, and often, mission control center controllers, engineers.

Q. Do you -- I think I asked you earlier, but I wanted to be clear. Was there any outside source or reference material that was used that you referenced in the development of procedures at NASA?

A. Can you clarify?

Q. As I mentioned earlier, like advisory circulars? Was there any industry guidance on checklists or procedures development that you used?

A. No. It's possible that that process grew out of an industry standard. But in the heart of the space shuttle program, Johnson Space Center had their own standard for that.

Q. Okay.

A. And that was discussed several times as we moved along.

Q. Okay. I'm going to take you back away from NASA and bring you back to AST work --

A. Okay.

Q. -- and kind of close out my questioning with this. With your knowledge base, your experience base in procedures and training, did anybody from AST-500 or any other AST division seek guidance from you as far as the procedures Scaled was using for their pilots?

A. No. No. We -- I would say no and then qualify it, if I may.

Q. Um-hum.

A. We have a copy as part of their application of the POH,

their Pilot Operating Handbook. Some questions did come up that maneuvered their way through that checklist, but in the vein that I believe you're speaking, no.

Q. Do you recall what the questions were that came out relative to what you just referenced, the Pilot Operating Handbook?

A. No, I don't recall. We were crisscrossed all through that application so many times that to come up with a specific example, I couldn't say and then be 100 percent accurate.

Q. Maybe not specific, but even generalized --

A. In general, we talked about -- one of the things I believe we maneuvered through was how does that powerplant start, how would you shut it down, what would be in the indications if it required being shut down, how long would it take, do they practice that, can we verify that if there is a problem with the powerplant that we could shut it down on time, you know, that sort of thing. And of course, if it's an operation of any sort, we would go to the POH, or the Pilot Operating Handbook, and take a look at what they needed to do, and then have a sense of them being under a load and operating the switches.

Q. That led me to another question. I apologize --

A. That's okay.

Q. Do the NASA pilots do centrifuge training?

A. Perhaps not. Early in the program, they did.

Q. Right.

A. That was in Building 29, and Building 29 was decommissioned and that centrifuge was as well. So I don't recall any of the later astronauts having centrifuge training.

Q. They do any type of g-tolerance training at all?

A. In their T-38.

Q. Okay.

A. And they also operate something called a VMS, a vertical motion simulator, which is in California -- I forgot which facility; I don't recall which facility -- where it's a full-motion simulator where they can practice approaches on their 17-degree glide slope.

Q. And experience requirements, like a recency of experience for astronaut pilots, part of this or part of the mission?

A. Yes, yes.

Q. All of those were?

A. Basically, yes. We would be required to have an ascent sim that was full crew, full motion, together with the mission control center, so an integrated sim, no more than 4 days prior to launch. If they -- and they would generally go from that sim to rest and then their T-38 and head out to Florida, or they would often even leave that simulation and go to Florida if they can get it in within their duty day.

Q. Um-hum.

A. And then there was a requirement that they have an entry

sim in the same manner. It's an integrated sim with full motion and full mission control center 5 days prior to launch. And then if they were out at the cape and slipped, we would have to have a discussion on whether or not they were current enough.

Q. What about actual flight time? Not the simulation, but actual flight time?

A. There was a -- now you're talking flight time?

Q. Um-hum.

A. Are you including their T-38?

Q. Um-hum.

A. There was a requirement for that. And the requirement varied dependent on whether they were assigned or not assigned at the time.

Q. Assigned a mission?

A. Assigned to a mission, a space shuttle mission, or whether they were not assigned to a mission.

Q. Do you recall what the -- how many hours they were supposed to have, like, in a month, 90 days, a year, or anything?

A. I do not.

Q. Okay.

A. I do not recall.

Q. Okay. And this is related to our situation. Were NASA astronauts, when they're going through this training, were their responsibilities primarily the training for the mission or did they have other duties at NASA like engineering or project work

outside of the mission?

A. Another good question. When they were first assigned, they were assigned -- at the time they were assigned, they were usually operating another task. They may be chief of safety or be a branch chief somewhere, that sort of thing. And the moment they were assigned, they transitioned away from their office duties into their mission duties. And at some early date, their job was to train for that mission.

Q. Okay.

MR. LAWRENCE: Okay. Do you have any --

BY DR. WILSON:

Q. You doing okay?

A. Yeah.

Q. Okay. I apologize, because I got a little bit confused on some of the answers that you gave. So if you've already explained this, I'd appreciate it if you could explain it again: your role specifically in the Scaled permit and waiver?

A. And I'll admit that is confusing. I arrived, as I mentioned, in 2012, and then from that date on, I kind of ramped into my responsibilities. And along the way, I went from observing a few things to observing a lot of things, to handling a few things to handling more. So, really, it's a varying scale of things I did with safety approvals and with the Scaled permit, and everything else I've done. Does that help?

Q. Okay. So you said you had knowledge of the waiver

process but no input to it; is that correct?

A. That is true.

Q. Okay. And you were a backup for Ray Jenkins --

A. Yes.

Q. -- in the department? So in terms of a permit renewal, did you do anything with that, specifically, from Scaled?

A. With the renewal, when the application came in, the Scaled project -- you know, of course everybody in the group knows there's a Scaled project out there, you know, all 80 some of us know that's going on. But I didn't become aware of the details until I was assigned to it, and it was underway, the renewal process was underway before I was assigned to it.

Q. Did you have any input to the re-renewal process?

A. The re-renewal process, the modification?

Q. Right.

A. Yes.

Q. Okay. What specifically? I apologize if you said this. I just --

A. No, it's okay. I really didn't say it in this manner, so it's --

Q. Okay.

A. -- a good question. Before the modification, I was further along, obviously, and my duties, and as well as Ray's duties, were to take all input from all parties and put it in an evaluation that was easy to understand, and then once that

evaluation was complete, to come up with a recommendation along with pros and cons, and then present it to management.

Q. Okay. So you did that for the Scaled renewal -- or the modification?

A. I was in on the process for the modification, yes --

Q. Okay.

A. -- along with --

Q. Okay.

A. Um-hum.

Q. And you said -- when David asked you about what input you had on training and simulation-type things, you said you were brought in to consult on that type of stuff, but not for Scaled?

A. Correct.

Q. Okay.

A. And -- with good reason. I don't know.

Q. Okay. Do you have any sort of human factors background?

A. I would say I'm a student, but -- and at Johnson Space Center, there were no, or very few, quote/unquote, "human factors" trained people, although they would have been quite useful. And the human factors experience we had was engineers and instructors that had -- I don't want to say interest, but constant observance of human factors issues and would try to attempt to highlight them as often as possible.

Q. Okay. Are you aware of anyone else in your division that has any sort of human factors background?

A. Well, you say any sort of --

Q. Whether it be a formal training or there's a degree or maybe they took a course?

A. Informally, because as a pilot and as an instructor, you can't help but bump your head on human factors. Whether you do a good job of it or not is another thing, but I feel like I covered those in my career and got advice as needed, as well as Ray Jenkins, who was also an instructor out at Johnson Space Center and is a pilot.

Q. Okay.

A. Yeah.

Q. David had asked you if you were aware of any concerns either from Scaled or from others regarding the permit and waiver. You said not from Scaled. Then you said about all the stones that you had turned over and things like that. Did you have any concerns?

A. Did I have any concerns?

Q. Um-hum.

A. As with every operation like this, you're taking a small vehicle, putting a rocket on it, and then -- and taking it to a near orbit on a suborbital trajectory with test pilots on board. And the very fact that you need test pilots, if you're not concerned about something, you're just not aware. Every time a shuttle launches, are there concerns? We looked at everything for every mission, but if you don't have a concern, you don't really

have a sense of what the operation is about.

Q. Did any of the concerns rise to a level of talking to a supervisor about it?

A. Everything that came our way -- in fact, that was the crux of my job or Ray's job, was to take input from the team on what their evaluations are in their discipline and then bring it to management.

Q. Were there any concerns that you're aware of related to the human side of things, human error, or potential for human error?

A. Yes.

Q. Can you explain what those were?

A. Well, there were, as in any operation, human factors aspects, okay? And we would talk about those human aspects and then give that to a regulation that would cover them, and we would more times than not have no legal reason to require that they do this or that. So it was a non-starter as soon as the conversation came up.

Q. Was anyone aware of the possibility of the single-point failure if the locks -- the feather unlocked, were unlocked too early?

A. Yes. Yes. I don't think that was broadly known, I don't think, but we did know that the feather system was to be activated at apogee.

Q. I know you didn't have input to the waiver, but was

there any discussions about how Scaled was going to mitigate that risk?

A. Well, there was no, that I know of, no legal requirement that they need to mitigate that risk. And I hope you don't think I'm avoiding your questions.

Q. Well, I understand that there was nothing, but was there a discussion?

A. Was there a discussion? Oh. Rephrase the question please?

Q. Now we need the transcript. I was -- regarding the possibility of a single-point failure if the locks were unlocked too early, I'm interested in knowing if there was any discussion within your department about how Scaled might mitigate that.

A. Can I approach it generically first?

Q. Sure.

A. We have not been tasked, in fact, asked to not write regulations for occupant safety until October 1 of '16. However, of course, we have to get, you know, things in motion for that, get those muscles flexed in order for that -- to be ready for that time, and we've been writing something called recommended practices for occupant safety. And in there, it says, and you probably already know, no single action can create a catastrophic event. Well, there's one, right? But we had no legal means to look at Scaled and say, hey, you need to fix that or you need to mitigate that. Certainly, we couldn't hold a launch or deny a

permit based on that because there was really no legal right to do so. Am I going down -- am I answering your question?

Q. Right. Well, I think you might be dancing around it a little bit.

A. Okay. I don't mean to be.

Q. I understand that there was nothing requiring -- or that you could have done to stop Scaled, but I'm interested in what discussion may have been had regarding that system and that single-point failure, and if there was a concern about moving forward with the operation because of that. I understand that you couldn't stop it, but what was the discussion within your group?

A. I want to say we had none.

Q. Okay.

A. And management had -- and that concern was not taken to management.

Q. Okay. I understand that you didn't have input into the Scaled waiver, so I'll ask in a general sense. One of the reasons that Scaled needed the waiver was because they didn't have the human error analysis, but they could take these processes to mitigate those things: training, simulator, redundant systems. So if no human error analysis is done, how would you know that the mitigation strategies are adequate for human error?

A. Great question. And I would have to say again that in order to be within the waiver, it would be Scaled's responsibility to operate within that waiver. Now, the degree to which they

operate and the verification of whether or not they've met the waiver, the verification was not written.

Q. Let me rephrase a little bit, because I'm not necessarily so interested in Scaled and what they --

A. Okay.

Q. -- to make sure that they were operating within that. But if you were to, say, in generic terms, you get a permit application, there's no human error analysis in that, so now we need to issue a waiver. The company says, we do X, Y, Z. How does the FAA evaluate that to say, okay, training, simulation, redundant systems, that's adequate, that's an adequate -- sorry, now I'm drawing a blank --

A. Mitigation?

Q. -- mitigation for human error, if you don't know -- if there's been no human error analysis done to know what the possible human errors that could be made are?

A. How would you know unless you had that verification or if you did that -- I guess I would have to say that you wouldn't.

Q. Okay.

A. I don't know if that's a good answer.

Q. Well --

A. It's true.

Q. That's all that I have for now.

A. Okay. Thanks for your patience.

MR. ROBERTSON: David, I had a quick question for you.

MR. LAWRENCE: Um-hum.

DR. WILSON: I was going to say we're at the 1-hour mark.

MR. PREAMBLE: Yeah. Do you want to go off the record to --

DR. WILSON: Do you want to take a break?

MR. LAWRENCE: Yeah, I think we should stretch our legs. Everybody is getting all droopy-eyed.

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

(On the record at 1:45 p.m.)

MR. LAWRENCE: And we're back. Mike Hauf?

MR. HAUF: Okay.

BY MR. HAUF:

Q. How you doing? I just had a quick question. I was wondering if you could, in general, provide just an overall description of what the evaluation process entails, what all groups usually participate in?

A. Sure. Certainly. The evaluation process is led by AST-200, which is Ken Wong's group. And they write -- to work backwards, they write an evaluation for management, like I said, with recommendations with pros and cons. All right. The input, though, from -- for that evaluation comes from the rest of the AST team. And some of them are flight safety analysis, some are hazard analysis, some are out in the field with line of sight to the vehicle and the operation, some are propulsion folks, some

hazard analysis, like I said, flight safety. And all those groups give a individual report to AST-200, which is then put in a single report, the evaluation, and then it's presented to management.

Q. So do the other teams come up with recommendations and then you forward those on, or does management come up with recommendations based on the input for the other groups?

A. The other individuals within AST have their recommendations that they would give to 200 -- my position. Their recommendation would go into the overall evaluation, and it would be our group or my position that would give an overall recommendation to management that would, by line item, talk about everyone's concerns.

Q. Does management ever disagree with any of the recommendations that the other groups provide forward?

A. Disagree? No. In a word, no. They don't disagree. They wouldn't say, no, I don't think you think that. No.

Q. Okay. That's all the questions I have.

MR. LAWRENCE: Cleaning up the NTSB, on the phone, Lorenda?

MS. WARD: Can you hear me?

MR. LAWRENCE: Yes, we can now.

MR. LAMPAZZI: Hello, Lorenda Ward.

BY MS. WARD:

Q. Hi, Henry. I just have a few questions. One is that you referred to the document, the Recommended Practices for Human

Spaceflight Occupant Safety. Are you one of the contributing authors for that document?

A. Yes, I am.

Q. Do you recall which sections you worked on?

A. Well, we all worked on all of them.

Q. Are there any sections that you worked on more so?

A. Yes, yes, there were, yes. We were tasked with getting the ball rolling on a piece of it and then bringing it back to the group. And my main piece was training, and everything to do with training was mine, and then I had some other topics to handle as well.

Q. Okay. One thing I kind of wanted to go back to was you had mentioned that there was no regulations regarding to single-point failure, single-point catastrophic failure. And I know that there's a requirement, 437.55. Are you familiar with that?

A. I'm familiar.

Q. Okay. Are you able to loosely state what 437.55 is?

A. No.

Q. Okay. I will -- it says basically that it requires an applicant to perform a hazard analysis to identify, mitigate, and validate and verify mitigation measures for each hazard. Does that sound familiar?

A. Yes, it does, very.

Q. Okay, good. So the FAA chose to waive that requirement, and I think there has been discussion on who generated the waiver.

Can you remind me? Were you part of the waiver generation?

A. Minimally. As part of AST-200, we write the evaluation and the orders and often things like the waiver in draft form, and then it makes the rounds to everyone in the group and to management. Whether or not we did that exact process with the waiver, I don't recall.

Q. Okay. Going along with the waiver process -- comment, are waivers issued on a license for like a launch or reentry applicant?

A. They can be, yes.

Q. Okay. Just going back to -- as a full-time employee for the FAA. So that was November 2nd something?

A. Yeah. In fact, it was the exact day that we first met. That was my first day on the job.

Q. Welcome aboard to FAA.

A. Thank you.

Q. Let's see. You have a lot of experience at NASA, and so what I would like to ask is how does NASA's role in human spaceflight compare to the FAA's role in commercial space human spaceflight?

A. There is definitely a lot of correlation and there is a definite difference at the same time. Given that NASA has 50 years of spaceflight that is usable experience, you know, we'd like to take that body of knowledge and experience and move it -- plug it right into the commercial space industry. But it turns

out, we really can't. If by some odd stroke we were to restart the automotive industry, for example, and require that they put in seatbelts and airbags, we'd get a lot of head scratching. There is -- and why? Well, one is that in order for the commercial space industry to get off the ground, it has to develop. And to expect it is developed to the level of a NASA rocket or a space shuttle or even an Apollo rocket may be too much to ask. Then you say, well, to what degree? And the degree we have is to the degree that our regulations are written. Does that help?

Q. A little bit. You did refer to the -- is it October of this year or next year, where they're looking at the regulations for the human -- occupant human spaceflight side of it?

A. It is October 1st, 2015 or the 1st of fiscal year '16.

Q. Okay. That's all I have for you, Henry. Thank you.

A. Um-hum. Thank you.

MR. LAWRENCE: Thanks, Lorenda.

The Scaled -- Bob?

BY MR. WITHROW:

Q. Hi, Henry.

A. Hi, Bob.

Q. Just a couple things. I'd like to get clear on some timeline with you.

A. Okay.

Q. So the original permit was issued, I believe, in May 2012?

A. May of 2012, okay.
Q. And were you on board at that time?
A. I was at British Petroleum at that time.
Q. Okay. And then the first renewal was May of 2013. And were you on board at that time?
A. I was on board at that time.
Q. And were you involved in that renewal?
A. I was ramping up at that time.
Q. Okay. You were asked some questions about the re-renewal or the modification?
A. The -- yes.
Q. When was that?
A. The modification, I don't remember the exact date, but I think it was mid '13.
Q. Mid '13? And you were involved in that?
A. I was involved in that to a degree, yes.
Q. Okay. Okay, thank you. From your -- so in general terms, from your experience, is a hazard analysis the only way to understand and mitigate human error? Only way?
A. No.
Q. Would flight test experience in other vehicles be one way to understand and learn how to mitigate human error?
A. That would be one tool.
Q. Okay. Thank you. And then I have a couple of questions about the waiver. Are you familiar with the contents of the

waiver?

A. As with something as a waiver or a procedure or regulation, I'll never say that I'm familiar with it unless it's in front of me, just by the way I operate.

Q. Okay.

MR. WITHROW: Do we have a copy of the waiver he could look at?

UNIDENTIFIED SPEAKER: There's one right here.

MR. LAMPAZZI: Okay.

BY MR. WITHROW:

Q. So I don't know if you want to -- let me ask what I want to ask, and then --

A. Okay.

Q. -- you can say whether or not you think you need to read it. So --

A. Okay.

Q. There are mitigations that are discussed in the waiver. Do you know the source of the information about those mitigations, where they came from?

A. To a degree, yes, I do.

Q. Where did they come from?

A. There was considerable conversation in our shop about -- and I have to back up a little bit. As is with every application and the evaluation with every application, whether it be a safety approval for one small horse with no consequence all the way up to

the likes of the SpaceShipTwo, there is going to be an evaluation. And we would then talk about every concern within that evaluation, whether it be viable or not; we just talk about everything. And we probably never say the word gap, but we discuss the gaps and what may be issues within that evaluation, and talk about how they would be mitigated or if they are safe -- if this safety approval, permit or license would be -- would affect public safety. And those conversations develop. And once those conversations are developed, it's a conversation that culminated within AST, so you can't really point to one person and say he said it or she wrote it sort of thing. So sort of the short answer to your question was that waiver was written at 800 Independence Avenue within AST office space.

Q. So I guess what I was specifically asking, though, was the actual mitigations that are discussed in the waiver, the ones that we've talked about, crew training and operating area and all those kinds of things, where did the concept of those mitigations originate?

A. Like I said, there was a long conversation, and bits and pieces came from everywhere before it culminated into the waiver as it was written.

Q. Okay. Did any of that material come from Scaled Composite's application for a permit?

A. Not that I know of. However, we had many conversations with Scaled, and a lot of those conversations could have given

birth to a thought of mitigation that would work for you --

Q. Okay.

A. -- for Scaled.

Q. And then you are familiar in general terms with the contents of Scaled's application for a permit?

A. In general, yes.

Q. And are there discussions of mitigations for things like this? Are there -- for example, is there a discussion about the operating area in the permit?

A. Yes. Yes.

Q. Is there a discussion about training in the application for a permit?

A. Yes.

Q. Is there a discussion about the use of a simulator in the application for a permit?

A. Yes.

Q. Okay. So and then -- and one other question, then. So Scaled -- and this is a process question -- Scaled writes an application, and we deliver the material to the FAA along with other stuff, as requested.

A. Um-hum.

Q. And then you evaluate it, and you decide whether or not to issue a permit, and eventually you issue the permit. That's sort of the general process, isn't it?

A. That's the general process, but -- and you kind of said

this. But in that process there's a lot of conversation --

Q. A lot of conversation.

A. -- between FAA and Scaled.

Q. Does this permit text itself have requirements of the nature of using a simulator, doing specific pilot training? Is that part of the text of the permit?

A. Of the permit? The permit is essentially a letter with orders, and the letter with orders, I don't recall having language in it concerning simulators or training.

Q. Okay. Then how is Scaled required by the FAA to do those things, to use the simulator, to do that training?

A. How are they required? By regulation.

Q. The regulations, then, state that you have to use the simulator?

A. The regulation would require that you not affect public safety.

Q. Okay. That's --

A. That Scaled -- I keep saying you, but -- I'm sorry -- it's not really you. That Scaled or SpaceShipTwo not affect public safety.

Q. Okay.

A. Okay. And where there are concerns about public safety and how SpaceShipTwo could have affected public safety and how they were mitigated, training was one.

Q. Thank you.

A. Um-hum.

MR. LAWRENCE: Thanks, Bob.

Will?

BY MR. ROBERTSON:

Q. I just have a few questions specific to the feather system itself, and around the point of single-point failure that was talked about earlier. I think it was Katherine's question that was asked, were you aware of single-point failures, and your answer was yes, broadly, it was known within AST that deployment of the feather was a single-point failure.

A. Early deployment.

Q. Early deployment. So my question has to do with can you explain to me what the term deployment of the feather means to you?

A. Well, to -- the word deploy, if you deploy the feather, whether it is 1-degree deployed or 100 percent deployed, would you call it deployed? I don't know. We didn't split those hairs.

Q. Okay. I guess more or less what maybe I'm getting at is not the gray area as to whether 1 degree is deployed or 99 degrees is deployed. I'm trying to make sure that I understand what the term deployed means, because there is multiple steps from a pilot's perspective that have to be taken in order to deploy a feather.

A. Well --

Q. And so I'm just trying to understand the relationship

between single-point failure that was discussed earlier and the term deployment that was used in that same context.

A. Sure. So no single action can create a catastrophic situation.

Q. Okay.

A. All right. Are you discussing that aspect?

Q. I'm just trying to make sure I understand what you meant by deployment. Is deployment -- so there's multiple steps a pilot has to take. Do you know what those are?

A. There are multiple steps that the pilot would take in a nominal situation to deploy --

Q. The feather.

A. -- the feather.

Q. Yeah, do you know what those are?

A. However, in this off-nominal situation, it would be single-step.

Q. Okay.

A. So in some cases, one step.

Q. Okay. Okay. I think that clarifies it.

A. Um-hum. Yeah.

Q. Thank you.

MR. LAWRENCE: That it, Will?

MR. ROBERTSON: Yes.

MR. LAWRENCE: And then one FAA guy here, so Dan?

BY MR. MURRAY:

Q. So in your 2 years with the FAA in different capacities, how many different evaluations have you worked on?

A. Oh, have to sit here and count them, but I participated in the Scaled modification, the Scaled renewal, safety approvals for [redacted (b) (5)], three or four of them, one for [redacted (b) (5)], and then multiple [redacted (b) (5)]. And currently I'm also working on a project [redacted], [redacted (b) (5)] [redacted].

Q. So Scaled's permit was the only permit evaluation?

A. Yes.

Q. Okay.

A. Yes.

Q. Okay. Relative to your experience working other evaluations, would you say that Scaled's evaluation was typical or are they not similar enough to -- because they're for different purposes, so --

A. It was more clear-cut than the safety approval process. I would say it's looking like less clear-cut than the spaceport process so far.

Q. Okay.

A. But that's a nebulous, unverifiable, I would say, kind of thing. But in general, I would say that's true.

Q. Okay. Last question. So your role as a backup to Ray

was a backup, really, in the sense that you filled in when he wasn't there or was a backup more as an assistant or both or --

A. Yeah. Thanks for asking that question. In the early going, it was -- Ken never said the word, but I felt more or less in an OJT capacity, whereas I was there for just about every meeting, led very few of them. Most of the time we were there together and doing the evaluation together and having the conversation together. And it was, I think, better to have two people there because it's better -- it's clearer to have a conversation with yourself, if I may say it that way, if it's more of a live conversation rather than sitting by yourself and wondering which way to point and which way to write and who to look to next.

Q. That's all the questions I have.

A. Okay.

MR. LAWRENCE: Thanks, Dan.

Going to the phone, Brett?

BY MR. VANCE:

Q. Yeah, hey, Henry. How can you hear?

A. Great, Brett.

Q. Okay, good. I want to go back to that discussion on gaps again. Were those gaps that you guys had those discussions on, was that noticed in the pre-application process or was that just part of the application evaluation itself?

A. It was part of the application itself. We have a

checkpoint addressed as "complete enough." The application is delivered to our 500 group, where the 500 group would have conversations with the applicant and get that application mature enough that we'd feel as though it could be evaluated and give us the ability to come to a conclusion on an application within 180 days. And to put it another way, it's complete enough, but we expect to have some conversation in the interim.

Q. Are you familiar enough with it, then, to say that once you determined it was complete enough to actually do an evaluation on it, that all those, the gaps that were used to come up with the waiver, were done just here in Washington with you guys talking about it and everybody taking a look at the application itself?

A. I don't know when the waiver conversation started, but I would say that the waiver conversation started sometime after "complete enough." And then, talking about whether it happened in Washington or elsewhere, it did happen -- the conversation did originate from Washington, but the 500 group was in on that conversation, and I don't recall when Scaled was brought into the conversation.

Q. Okay. That's actually good enough on that one. I've got several other questions, and these are all just general process questions here for headquarters participation.

Do you guys in AST have like a day of go/no-go checklist for launch? Because you know all the companies that are out there that are going to be doing commercial space are going to have, you

know, their go/no-go cards here, just like you had at NASA. So does AST run one as well?

A. We have inspectors on site for many of our operations, and they do have procedures, and I am not at all familiar with their procedures.

Q. And, you know, along those lines, can you characterize that prelaunch inspection that the AST-400 does?

A. Characterize it in --

Q. Yeah. Do they have a group of things that they look at or do they tailor their prelaunch inspection to the company that they're looking at? What -- how does that work, or do you know?

A. They have a procedure that they use to do that inspection, and they have, of course, meetings prior to going on site. And I have to apologize up front. I don't know what that process -- I am not privy to that process. I just know that they have one and I know it works well.

Q. All righty. A couple more here. Back to the, you know, kind of application process again. I have some more questions about that. So when a company would come to the FAA, what guidance do you give them in the pre-application process? This is regarding Rule 460. Are you familiar just real quick with Rule 460?

A. Yeah, I'm familiar, yes.

Q. Okay. Section 460.5 talks about crew qualifications and training. And I'm wondering if you guys, do you have any guidance

in that pre-application process specifically addressing that part of the rule?

A. For a permit, no.

Q. How about just specific guidance that you've given regarding training programs?

A. You would have to ask 500 that question. I'm sorry.

Q. Okay. And have you had a chance, you know, in any of the applications that you've seen since Scaled Composites, have you had a chance to look at any other training programs that have come your way?

A. Certainly.

Q. Okay. So remembering the ones that you've seen, were those training programs targeted perhaps with any hazard analysis results that companies have presented you with?

A. No. No. Those applications for training were for the delivery of training and did not point toward what they were mitigating except to say that they were answering 460.5.

Q. Okay. All right. I think that's all I've got for now. Thank you.

A. Um-hum.

MR. LAWRENCE: Thank you, Brett.

Christy?

BY MS. HELGESON:

Q. A couple questions. Starting off where Brett -- is there any guidance given in the application process to the

applicant regarding 437.55?

A. And that is -- is that for the permit reg?

Q. The 437.55 is the hazard analysis that does --

A. Oh, of course.

Q. -- include the waiver for both software and human error.

A. Of course. I apologize. That would be a 500 function. And given the conversations we have had revolving around hazard analysis, I'm willing to say that that is part of the conversation.

Q. Okay. You had talked earlier that you felt that you don't have a regulation or a legal means, if you will, to point to to get Scaled Composites to do some of these evaluations. How does 437.55 fall into that statement?

A. Well, there are many ways, at least two ways of completing a hazard analysis. And if the applicant has a method of hazard analysis, we have to accept that as their hazard analysis. And then from there, there's a line of questions about particular hazards to verify that their means of hazard analysis was adequate, or is adequate.

Q. So was their means of hazard analysis adequate?

A. That's a good word. And to verify the word "adequate" is difficult -- not to skirt your question. I apologize in advance. But there are or were a lot of discussions on whether or not the SpaceShipTwo vehicle answered the call for all aspects of the entire system safety analysis. Keep in mind, I am not the

system safety engineer. I did not do or work out a hazard analysis, so that really comes from another individual. But as the evaluator and the input that came to me, I can say that much, but only that much.

Q. Okay. Thank you. Earlier you had mentioned ways to understand and mitigate human error as a fallback to the hazard analysis or flight test. Are there any ways that you can think of to understand and mitigate human error?

A. Yes. Our regulations require that we protect public safety. And any means of keeping that vehicle away from the public mitigates hazards, whether it be training, flying over sparsely populated areas, and systems safety analysis, and all the rest, flight safety analysis.

Q. Okay.

A. And probably a few I'm not thinking of.

Q. Pardon?

A. And probably a few that I haven't mentioned.

Q. Okay. Any others you'd like to mention?

A. I'm just not recalling them right now.

Q. Okay. Earlier you had stated that maybe your office had been asked or you specifically -- I'll ask for clarification -- not to write any new regulations until October 1st, or fiscal '16. Can you expand upon that a little bit more?

A. Certainly. By statute, we have been requested to not write regulations dealing with occupant safety until the 1st of

fiscal year 2016, which would be October 1st, 2015.

Q. And where does that come from? Who is the --

A. Congress.

Q. Who's requesting -- Congress? Okay. Who in the FAA has background on the regulation 437.55? Do you know who wrote it or preamble information?

A. Oh. I don't recall, but that area -- and just to be clear, you're talking about system safety again -- correction -- hazard analysis, true?

Q. Yes.

A. Yes. Tom Martin is right now what I might call our system safety engineer. Of course, he has a supervisor.

Q. Okay. Do you happen to know the intent behind 437.55?

A. To do a hazard analysis?

Q. Yes.

A. Yes. In looking at all hazards or all things that might go wrong, assume that they will go wrong, and then mitigate them to a point that you feel the system is safe. And I shouldn't have said the word feel -- that you can adequately determine that the system is safe and will not harm public safety.

Q. Okay. Switching gears a little bit here, just a couple more questions. Based on your experience working with Scaled Composites, how representative is their simulator of the operating, the flight operating environment?

A. I have never seen their simulator in action. I have

seen their simulator. I have not seen it in action.

Q. Okay. What do you estimate the crew workload to be during boosted flight?

A. Higher than any I've seen.

Q. Any you've seen at Scaled Composites, at NASA? What --

A. Anywhere.

Q. Okay. Do you know what type of training or qualifications are required to fly at Scaled Composites as a pilot, qualifications --

A. I do know that they're all qualified test pilots, some of them military, and if they're military test pilots, they have gone through a very rigorous military test pilot school, if they've been through that course. As far as the civilian pilots, I don't know where they've gotten their training. That was not part of the application.

Q. Thank you. Those are all my questions.

MR. LAWRENCE: Thanks, Christy.

BY MR. LAWRENCE:

Q. Henry, I just have a couple real quick follow-ups. When you were at NASA and you were training the pilots or the astronauts in the simulator, most of those guys had test pilot background?

A. All of them. Well, all of the front-seaters, all those that were commander or pilot were or are military test pilots.

Q. Okay. When you were training in the simulator, have you

ever seen one of these former test pilots/astronauts mistakenly manipulate a wrong switch or button during a nominal ascent?

A. Certainly.

Q. Okay. And then the other thing I want to kind of clarify -- Dr. Wilson was talking about single-point failure, and then there was a discussion about the multiple steps to deploy the feather. And I'll bring it down a little bit more tighter and be very specific on this. Was the FAA ever aware of any hazard associated with the unlocking of the feather during the transonic region?

A. I have not been aware of any written or official conversations that dealt with that hazard.

Q. Going back to NASA. Is there any restriction on vehicle -- or switch manipulation in the cockpit during transonic limit for the space shuttle or the astronauts? Is there any restriction to say don't do anything during that transonic region?

A. It is not based on whether you're supersonic, transonic or hypersonic.

Q. Right.

A. Or even number of g's in a lot of cases. But I don't know of any single action that would lose a crew or vehicle.

Q. In the shuttle?

A. In the shuttle.

Q. Okay. Thank you.

BY DR. WILSON:

Q. I do have one follow-up to that. You mentioned there were very minimal tasks for the crew to do in the space shuttle during an ascent.

A. Yes.

Q. There's a lot of automated, but there were several -- there were some tasks that needed to be done during the ascent, or?

A. Prior to and minimally during, yes.

Q. So then those minimal tasks that needed to be done during the ascent, were those followed based on a checklist or were they memory items or was there a cue from mission control to flip a switch?

A. They were on -- as simple as they were, they were a procedure, and it was written with a timestamp and it was called before it was done, yeah. Um-hum, yeah. And critical tasks were called to MCC.

MR. LAWRENCE: Anyone else in the room with a follow-up?

MR. HAUF: Just one follow-up to a follow-up to another follow-up.

BY MR. HAUF:

Q. This goes back to the unlocking of the feather locks --

A. Yes.

Q. -- in the transonic region. I believe much earlier in a conversation you mentioned that you were aware of the hazard if they were unlocked early.

A. Um-hum.

Q. The question would be how were you made aware of this hazard?

A. Oh, I don't recall. I don't recall. It's one of those things that is learned as you move along, and it's -- yeah.

Q. Okay. And along with that, can you describe what the hazard was that you may have heard about?

A. Oh, that an early deploy would create a -- how would I -- what exactly did I know before versus after? Now, we're talking deploy as opposed to unlock, all right? Was it known that if we unlock the feather, would it be a catastrophic situation? That was likely not as well-known, as opposed to if we deployed the feather. In this case, the feather was unlocked early, and as a result deployed. I don't think it was well-known that an early unlock could cause an early deploy.

Q. Okay. That's all --

A. Does that help?

Q. Yes.

A. And it was a single action to unlock.

MR. LAWRENCE: Anybody else?

MR. ROBERTSON: I have one more question.

MR. LAWRENCE: Go ahead.

BY MR. ROBERTSON:

Q. You said earlier -- I think the question was what was your opinion of the level of crew involvement during the boost

phase, I think it was?

A. Um-hum.

Q. And you said it was high, and I think followed up and said higher than anything you had ever seen?

A. Um-hum.

Q. Do you know what is required of the pilots during the boost phase? Can you give an example of what has to -- what they're doing?

A. Yes.

Q. Okay.

A. The left-side pilot -- the right-side pilot starts the motor while the left-side pilot anticipates the pitch. As soon as the motor ignites, the pilot is using -- is holding pitch while the right side is then operating the feather mechanism or getting ready to.

Q. Okay. Okay, and by pitch you mean?

A. Call it gamma, they call it theta, call it alpha --

Q. The transonic model is --

A. Huh?

Q. The movement through the transonic --

A. I would call it gamma or theta -- I'd call it either theta or alpha.

Q. Okay. And so that, you would still say, is one of the highest workloads you've ever seen?

A. Yeah. To have to use two hands to hold pitch and then

have another critical task going on at the same time, yeah, I would say that's a pretty good work load, especially in a situation where you can't verify each other's critical steps.

MR. LAWRENCE: Okay. From the phone, Lorenda, do you have anything? When she finds the mute button, I'll -- while Lorenda is looking for that, I'll ask Brett Vance, do you have any follow-ups?

MR. VANCE: Nothing else. Thanks.

MR. LAWRENCE: Christy, do you have anything further?

MS. HELGESON: No. Thank you.

MR. LAWRENCE: You're welcome. Lorenda?

MS. WARD: Can you hear me now?

MR. LAWRENCE: Yes, indeed.

MS. WARD: All right. I'm sorry. I'm supervisor -- telephone.

BY MS. WARD:

Q. The one thing I wanted to follow-up with is that, Henry, when you were a contractor with FAA, who did -- did you directly report to Ray Jenkins at the time or someone different?

A. When I was a what? I'm sorry?

Q. When you were a contractor, who did you directly report to at FAA?

A. I did not hear. I'm sorry.

DR. WILSON: When you were a contract, who was your direct report at the FAA?

MR. LAMPAZZI: Oh, when I was a contractor, I -- thank you -- when I was a contractor, I reported directly to Ken Wong.

BY MS. WARD:

Q. Oh, Ken Wong? Okay. And then when you became a full-time FAA employee, are you reporting still to Ken Wong?

A. Yes. The job did not change, the supervision nor the duties changed.

Q. All right. Do you feel like if you had a concern or a safety issue that you could approach Ken and have a discussion with him about it?

A. Yes, yes. I would have been comfortable discussing any situation with anyone there.

Q. That's all I have. Thank you, Henry.

A. Yes.

MR. LAWRENCE: Thank you, Henry.

MR. LAMPAZZI: Thank you.

MR. LAWRENCE: We really appreciate, you know, all the information.

(Off the record at 2:32 p.m.)

(On the record at 2:33 p.m.)

MR. LAWRENCE: Anything you want to add that might assist us in the investigation that maybe we didn't ask about?

MR. LAMPAZZI: No. I have been -- but no.

MR. LAWRENCE: Okay.

(Whereupon, at 2:33 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:	CRASH OF VIRGIN GALACTIC SPACESHIPTWO MOJAVE, CALIFORNIA OCTOBER 31, 2014 Interview of Henry Lampazzi
DOCKET NUMBER:	DCA-15-MA-019
PLACE:	Washington, D.C.
DATE:	January 14, 2014

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.

_____

Stephen Grider
Official Reporter

UNITED STATES OF AMERICA

NATIONAL TRANSPORTATION SAFETY BOARD

Investigation of:	*	
	*	
CRASH OF VIRGIN GALACTIC	*	
SPACESHIPTWO	*	Docket No.: DCA-15-MA-019
MOJAVE, CALIFORNIA	*	
OCTOBER 31, 2014	*	
	*	

Interview of: RANDY REPCHECK

National Transportation Safety Board
6th Floor Conference Room
490 L'Enfant Plaza East, S.W.
Washington, D.C.

Wednesday,
January 14, 2015

The above-captioned matter convened, pursuant to notice.

BEFORE: DAVID LAWRENCE
Operations Group Chairman

APPEARANCES:

DAVID LAWRENCE, Operations Group Chairman
National Transportation Safety Board

MICHAEL HAUF, System Safety Group Chairman
National Transportation Safety Board

LORENDA WARD, Investigator-in-Charge
National Transportation Safety Board

MICHAEL BAUER, Systems Group Chairman
National Transportation Safety Board

KATHERINE WILSON, Ph.D., Human Performance Group Chairman
National Transportation Safety Board

DANIEL MURRAY
Federal Aviation Administration

CHRISTINE HELGESON
Representative to the Human Performance Group
Federal Aviation Administration

BRETT VANCE, Test Pilot
Los Angeles Aircraft Certification Office
Federal Aviation Administration

BOB WITHROW
Scaled Composites

NICOLETTE DUGUE
Scaled Composites

WILL ROBERTSON
The Spaceship Company

BRADLEY PREAMBLE, Office of the Chief Counsel
Federal Aviation Administration
(Representative on behalf of Mr. Repcheck)

I N D E X

I N T E R V I E W

(3:03 p.m.)

MR. LAWRENCE: All right, good afternoon. My name is David Lawrence. I'm a NTSB operations investigator here at headquarters. I'm also the Operations Group Chairman for the SpaceShipTwo accident investigation.

The NTSB is an independent federal agency charged with determining the probable causes of transportation accidents and promoting transportation safety. The NTSB is not part of the DOT or FAA. It has no regulatory or enforcement powers.

Right now we're going to go around the room here, and do introductions for the record. So, let's start --

MR. ROBERTSON: Hi, I'm Will Robertson, Virgin Galactic, System Safety.

MR. WITHROW: Bob Withrow from Scaled Composites. I'm a member of the System Safety Group.

MR. HAUF: Mike Hauf. I'm with the NTSB. I'm the System Safety Group Chairman.

MR. MURRAY: Dan Murray, AST representative to the Systems Safety Workgroup.

DR. WILSON: Katherine Wilson. I'm the Human Performance Group Chairman with the NTSB.

MR. LAWRENCE: On the phone we have -- Nikki, if you'll introduce yourself?

MS. DUGUE: My name is Nicolette Dugue. I'm with Scaled

Composites in the Systems Safety Group.

MR. LAWRENCE: Great. With the FAA, Brett?

MR. VANCE: Brett Vance. I am a test pilot, Los Angeles Aircraft Certification Office.

MR. LAWRENCE: Christy?

MS. HELGESON: Christy Helgeson, FAA representative on the Human Performance Group. I'm a flight test engineer and human factors specialist out of the Seattle Aircraft Certification Office.

MR. LAWRENCE: With the NTSB, Mike Bauer?

MR. BAUER: Mike Bauer, NTSB, Systems Group Chairman.

MR. LAWRENCE: And finally, Lorenda Ward?

MS. WARD: Yes, I'm Lorenda Ward with the NTSB. I'm the Senior Investigator-in-Charge, and Investigator-in-Charge for this accident investigation.

MR. LAWRENCE: Thank you, and anybody I forget on the phone? Excellent. Thank you. Everybody on the phone, if you would do me a favor and put your phones on mute, I would appreciate that.

Today we will be using the services of a court reporter who will record and then transcribe the interview. The transcript, not the audio recording, will be made part of the public docket. The purpose of the investigation is safety, to determine probable cause and prevent recurrence. Our role is not to assign, fault, blame, or liability. This interview is a part

of the fact-finding phase of this investigation. We are here to ask questions about your involvement in the permit and waiver for SpaceShipTwo program. We cannot, however, offer any guarantee of confidentiality or immunity.

Each of the group members will have a chance to ask questions. We will ask questions one at a time, and everyone has been instructed to not interrupt the person who is asking questions at that time. There will be the opportunity for each group member to ask follow-up questions after each person has had a turn.

Please answer all questions to the best of your recollection. If you do not understand a question, ask to have it repeated or explained. If you realize you misstated or need to modify a previous answer, please do so.

You're entitled to have one representative of your choice. Is there someone here you would like to have as your representative?

MR. REPCHECK: Yes.

MR. LAWRENCE: Okay, Mr. Preamble, you may direct Randy to not answer a question or request a short break to confer with him.

MR. PREAMBLE: Okay. Thanks.

MR. LAWRENCE: FAA will have the ability to review this transcript prior to the inclusion in the docket.

Do you have any questions, Randy?

MR. REPCHECK: No.

MR. LAWRENCE: Can I call you Randy; is that okay?

MR. REPCHECK: Yes.

MR. LAWRENCE: Okay, let's just get started, if we could.

INTERVIEW OF RANDY REPCHECK

BY MR. LAWRENCE:

Q. Can I get your full name and your job title, please?

A. Okay, my full name is James Randall Repcheck.

Q. Can you spell that please, your last name?

A. Yes, R-e-p-c-h-e-c-k.

Q. Thank you. And what is your title?

A. I'm the deputy manager of the Regulations and Analysis Division.

Q. Of the FAA?

A. Of the Office of Commercial Space Transportation, FAA.

Q. Okay. And which AST division is that?

A. It's AST-300.

Q. And can you give me just a brief history or background that led you to the FAA? What did you do prior to the FAA?

A. So, I graduated from Penn State University in 1983 with an aerospace engineering degree. Then I worked for NASA at Kennedy Space Center for 3 years. And then I went to law school in 1986, and graduated in 1989. And then from 1989 to today, I've been with the Office. So I was with the Office of Commercial

Space Transportation when they were part of the Department of Transportation.

Q. Who's your immediate supervisor in AST-300?

A. Stewart Jackson. He's the manager; I'm his deputy.

Q. Okay. And can you briefly describe your roles and responsibilities as the -- in your deputy manager position?

A. Sure. And so our division is responsible for a number of things. One is system safety analysis for licenses and permits. The other is flight safety analysis for licenses and permits. We also do all the rulemakings for the office as well as the guidance documents. And my role as manager is to, you know, manage those programs that we do.

Q. Will the upcoming human space flight regulations be originating from your office? Or will you be having input in that?

A. Well, we're not currently doing human space flight regulations.

Q. Right. When you do get to that point will that -- will your office be a part of that?

A. Yes.

Q. Okay.

A. Yes.

MR. PREAMBLE: Just remember to wait until he finishes before you do answer.

MR. REPCHECK: Okay. Sure.

MR. PREAMBLE: Just a reminder there.

BY MR. LAWRENCE:

Q. What previous experience do you have in commercial space permits and waivers?

A. Well, I've been there since 1989, so I've done a number things in the office since then. I've been, you know, I've led licensing teams. I've done a number of inspections. And because of my legal background, done a number of the regulations, including the experimental permit regulation, which is part 437, which is what Scaled Composites was -- fell under in their permit. So I worked on that regulation.

Q. Did you work on any regulations regarding 460, any of that work?

A. No.

Q. Specific to the Scaled's permit application, describe your role; what did you do with their specific permit application?

A. Okay. So our primary role under an experimental permit is to evaluate the applicant's compliance with the hazard analysis requirement of part 437. And so as a manager, my role is to -- and I'm a deputy, but our role as managers is to assign people to the job and, you know, oversee it when we need to.

Q. How many people to have working for you to handle this role?

A. System safety, we have approximately two full-time people.

Q. Any others? That's it?

A. No.

Q. Okay. Just general background for these system safety people that are assisting you?

A. So the program lead for system safety is Tom Martin. He has a number of years' experience, primarily at NASA, on system engineering as well as system safety. And the other full-time person we have is a person named Renee Ray, who's relatively new to it. He has a number of years' experience in space systems, but he's relatively new in system safety.

Q. Okay. If he's new to system safety, what was his background as far as 437 and 460 knowledge, the commercial spaceflight regulations?

A. Renee's been in the office for many years, so he has supported other permit applications.

Q. Okay. And so you were involved -- or were you involved in the initial Scaled permit application and the multiple renewals?

A. Yes, as a manager.

Q. Right.

A. We at the time, we had one person named Jay Naphas that was really our only person in the division that was recording system safety. And so we, you know, Stewart and I assigned him the role of evaluating Scaled Composites' application.

Q. During the initial permit application was there any

tolling that was done to take a look at the issues identified during that initial application process?

A. I don't recall.

Q. Okay. Do you recall if any human error or software error issues were identified in the initial permit application?

A. I don't recall in the initial application.

Q. At any point in time did the FAA contract a third party to review Scaled's permit application?

A. Yes, we have a contractor through -- we have a primary contract with a company called ACTA, and they sub the company called, I guess, Great Circle Analytics. But it's essentially a person named Terry Hardy who we contract with.

Q. Okay. What services do they provide to the FAA?

A. Terry supported our system safety analysts in evaluating permit and license applications.

Q. Why did the FAA go out and subcontract with a third party and do that analysis?

A. Two reasons. One is we only have, you know, one or two people working this full-time so we need the help. The second reason is that we know Terry Hardy. He used to work for me, actually, and Stewart. And he's a very capable system safety analyst, and so we -- since we could get his services, we thought it would be a good idea.

Q. Okay. Did they identify any issues with the hazard analysis from the application?

A. We learned after the issuance of the permit, the first permit, from Terry that -- he had stated in a conference call we had that he had written some memos to us, to AST, and he didn't think that, you know, we, you know, acted on those.

Q. What was the substance of those memos?

A. If I recall it was -- he had some -- he did not believe that Scaled Composites complied with Section 437.55 completely.

Q. Okay. I'll ask a little bit more about that in a second, but I just want to get the timing on this right. Terry said -- Terry apparently -- the evaluation Great Circle did was prior to the initial application?

A. Correct.

Q. Okay. And then did I understand you correct that he had written some type of summary that was provided to you about 437.55 prior to the application that wasn't acted on by the FAA? I just want to make sure I'm clear.

A. Okay. So, yes, he wrote that as part of a contract deliverable to us.

Q. Right.

A. And me personally, I did not see those memos. The person that was working the application did.

Q. So was that information ever shared to you prior to the permit application?

A. No.

Q. Okay.

A. Not that I recall.

Q. Then after you had learned about Great Circle's evaluation and their hazard analysis, what actions did you take?

A. Well, from that initial permit application, we looked at our processes internally and wanted to make sure that those sorts of -- that kind of information got addressed more fully. And so, we looked those issues during the permit renewal a year later.

Q. Okay. And were they incorporated in the permit renewal?

A. Yes. We addressed the issues in the permit renewal.

Q. How did you address those?

A. We had a -- there's a memo that we provided to AST-200 outlining each section in part 437.55. Some of our findings from the application and the memo itself discussed why we were okay with the way Scaled did the system safety process.

Q. Okay. So that sounds like a waiver?

A. No, it was not the waiver.

Q. Okay.

A. It was an internal memo between our division and AST-200. Because the way we work between divisions is through, you know, products. And usually between us and AST-200 we do memos.

Q. Okay.

A. And that's how we formally provide our products to that division.

Q. Okay. The first permit -- or the application for permit was May of 2012, correct?

A. I believe --
Q. Okay.
A. I believe so.
Q. Okay. Well, you were in the evaluation part of that, I mean, correct? You were here at -- you were at AST at the time?
A. Yes.
Q. Okay. And then the first renewal was the following year. But you're saying that you addressed 437.55 hazard analysis issues with the first renewal?
A. Correct.
Q. Okay. Then the waiver came in May of 2013. Why have the waiver, because the waiver was on 435.55 [sic] issues, correct?
A. Yeah, the major issue there was not safety, per se. It was more of a legal argument about whether we needed to do a waiver for the way Scaled Composites did hazard analysis.
Q. So it wasn't safety related, it was more of a legal definition or a legal compliance?
A. Yeah. I think we didn't have -- the driver for the waiver was a safety concern, but we realized after the first permit that we should have -- you know, to do it correctly, we didn't believe Scaled Composites met the 437.55(a)(1), I believe. And so as we relooked at what we did during the original permit application, we thought we should have waived that, and that's what we did.

Q. Okay. What was your role -- and I might have asked this and I apologize if it's a repeat. What was your role in the waiver application process?

A. Okay. So our division does not do waivers. That's AST-200. We provided our input through that memo to AST-200 and then we -- we did not write the waiver.

Q. We did not write the waiver?

A. I'm sorry. AST-300 did not write the waiver.

Q. Okay. Who did write the waiver?

A. I believe there was a number of authors, like any product that we have in the office. So I don't know who the primary author was, but I know it was a number of people that put input into it.

Q. Okay. So just to be correct, you did not have any input into drafting of the waiver?

A. I don't recall if I actually provided comments to that waiver. I don't believe I did.

Q. Did Scaled Composites ask for the waiver?

A. My understanding is that they did not apply for a waiver.

Q. Is it typical for the FAA to draft and pass waivers for applicants that don't ask for them?

A. It's not unusual, because we've had other applicants do the same thing where they've applied for a license or permit, they think they met a requirement, we disagreed. And so the way we

handle that is we consider that submittal that doesn't meet the requirement as tantamount to applying for a waiver.

Q. Okay. There were several -- I have a copy, by the way, for the *Federal Register* for the waiver, if you want to reference it. There were multiple mitigations that were identified in the waiver. How does the FAA verify that those mitigations are actually being complied with by Scaled?

A. So in AST we have an inspection division in AST-400. So once a permit or license is issued the, you know, compliance monitoring is done by that division.

Q. Do you have any -- do you guys talk with the inspectors? Is there any input, do you guys crosstalk within AST?

A. There are -- I believe there are pre-inspection meetings that we could attend if we want to. We generally don't -- I generally don't have time to go to those meetings, so --

Q. That just leads me to another question. Do you ever participate in any of the quarterly meetings or any meetings with Scaled?

A. I generally do not participate in the quarterly meetings. I believe I've been to one or two of them.

Q. You've been out to Mojave?

A. Years ago.

Q. In this capacity?

A. No.

Q. Have you seen the Scaled facilities, or --

A. No.

Q. Okay. Getting back to the specific waiver, do you remember which renewal that was -- that waiver was applied to?

A. I believe it was the first renewal.

Q. Okay. Are you familiar with some of the aspects, the mitigation aspects of the waiver itself? Like training and --

A. Yes.

Q. Okay. Let me ask some specifics and see if you're knowledgeable of the -- your knowledge of these particulars. In the waiver there is several training mitigations, and one of which is operating the sim at 1.4 times speed. Are you familiar with that?

A. I've read that in the waiver.

Q. Okay. Do you know if that was being done by Scaled?

A. I don't have personal knowledge.

Q. Okay. Who would?

A. It would have to be the permit team that reviewed the application, know that better than I would.

Q. Okay. This is for the waiver?

A. Yes.

Q. Okay. So you talk to those people and they tell you about if some of these components in the waiver are actually being complied with?

A. Do I?

Q. Yeah. I mean --

A. To clarify, me personally or AST?
Q. No, you personally.
A. Talk to who?
Q. Like the inspectors out there that are out there maybe taking a look at Scaled and -- take a look and see if the sims actually even run at 1.4?
A. No, I do not talk to the inspectors about that.
Q. Okay. Are you aware if Scaled was actually using two chase airplanes on their test flights?
A. In my position I wouldn't be knowing that.
Q. Okay.
A. I don't --
Q. And are you familiar with any of the training that the pilots do?
A. I mean, we did not in AST-300 -- let me rephrase. I did not have personal knowledge of their training program. But I do know that, in general, we were very confident that Scaled did have a very good training program, and that gave us some confidence in some of the things that we waived.
Q. Based on what?
A. I don't understand the question.
Q. The confidence. You said we were confident of the training program.
A. Well, from my understanding from what we've learned in the application and from the folks that did go out there and see

things, it was a pretty robust training program for the pilots as well as the ground personnel.

Q. But the people that are going out there are not from your office?

A. Generally, no. I don't believe -- I think Jay Naphas, who used to work in my division, he actually lives out there now. But I don't recall if during the Scaled application he went out there.

Q. Are you familiar with any of the safety inspection plans that are done by the inspectors out there?

A. I've not seen them.

Q. You haven't seen the plans, but have you been shared any of the results of the state inspection plans that the inspectors performed on Scaled?

A. No.

Q. Are you aware of any post-accident review of Scaled operations since the accident, from your office?

A. From my office?

Q. Right.

A. I mean, as far as -- let me clarify. Reviewing the accident, I mean, having our office review the accident?

Q. No, your office reviewing the permit, the waivers, the areas of responsibility for your office, have you taken a look back?

A. We've not done a formal review of what we did, no.

BY DR. WILSON:

Q. I have a few follow-ups.

A. Okay.

Q. An easy one, how long have you been in the deputy position?

A. Since 2005.

Q. What did you do before that?

A. I was a staff member in AST-200.

Q. Okay. You mentioned that -- David asked you if you saw the memos from Terry. You said the person working on the application would have seem them, but you personally did not. Who was that person that was working on the application?

A. That was Jay Naphas.

Q. Okay. And you said he's no longer in your department, or --

A. So he -- I forgot, like 3 or 4 years ago, we got a new position in the office, and so he's out -- he's with AST-500.

Q. Okay. And then you mentioned a memo that AST-300, I believe -- I guess here's what I want to clarify. I have that AST-300 wrote a memo to AST-200 regarding 437.55 which discussed why you, your department, was okay what Scaled did to comply with --on the permit application with the hazard analysis. Is that correct, or --

A. Correct.

Q. Okay. And so, and as a follow-up to that, was AST-200

not comfortable -- or did AST-200 not feel that Scaled complied with that?

A. Okay, let me clarify. The memo doesn't state that Scaled met the requirement. It talked about why we were comfortable with what they did in general.

Q. Okay.

A. And so we left it up to AST-200 what they would waive.

Q. Okay. And this memo came with the renewal or after the first permit application?

A. It was -- I believe it was during the first renewal.

Q. First renewal, okay. You said that your division didn't do waivers, AST-300 doesn't do waivers, but you all have the expertise in system safety?

A. Correct.

Q. Correct? Okay. Regarding the waiver for Scaled that focused on the fact that Scaled didn't have the human error and software error analysis done, did they rely on you, your department, for your system safety expertise and input into the waiver, or who would they have relied on for that?

A. Yes, generally we provide input for system safety, all -- for system safety matters for licenses and permits.

Q. So I understand, you all didn't write the waiver, but did you provide input to AST-200 on the waiver?

A. Yeah, my recollection is -- well, we had the memo. And there may have been other evaluation documents, emails. I don't

know.

Q. Okay. Were there any concerns from either you or anyone in AST-300 that were brought to your attention regarding Scaled's permit?

A. Yes, and probably from the first renewal on -- certainly during the first renewal is when I personally got involved more than other times. I think what's interesting about part -- you know, 437.55 is a process-based requirement. Most of our requirements are performance based. And it's very -- and one thing we've learned, particularly since we issued the permit rule, is that it's very hard to evaluate process. There's lots of opinions about whether an applicant meets the requirement or not. And so there's a full spectrum of opinions, they've fully met it verse they didn't meet any of it. And so, yes, there's been lots of discussion within the office about Scaled's permit.

Q. Since the accident or before the accident?

A. Before the accident.

Q. What were some of the concerns that were discussed about the permit?

A. Once again it comes to -- if I recall, there's five subparts to 437.55, and I think -- and we talked -- in the waiver, of course, it talks about the fact that Scaled did not have hazards that were caused by human error or software error. But I think the, if I recall, the main issue brought up was how Scaled defined a mitigation measure. And if I recall, it was if it was

inherent in the design, it wasn't a mitigation measure. If they analyzed the design and found a need to apply additional mitigation, that would be a mitigation measure. Now that's my understanding.

Q. Okay. Were you aware of the single-point failure if there was an early unlock of the feathers?

A. I was not personally -- did not know that.

Q. Okay. After the accident did you become aware that other people in your division were aware of that?

A. I guess, yes. I'm trying to think what I've heard since the accident, but -- I'm going to rephrase. I don't know if anybody actually knew that if the feather was unlocked early there would a structural breakup. I don't know if anybody knew that.

Q. Okay. Were there any discussions in your department of other single-point failures?

A. Not that I recall.

Q. Now, in terms of this, you can either answer in specific -- if your familiar enough with the waiver to answer specific to Scaled or in the general sense. If there hasn't been a human error analysis done and then an operator comes to you with mitigation strategies, training, simulation, how do you -- how would you know that those mitigation strategies are adequate to address human error if you don't know the human error that you should be focusing on because no analysis has been done?

A. I'll say we believed at the time that because of the

robust training program, that human error would not be an issue.

DR. WILSON: I think that's all that I have right now. Thank you.

MR. LAWRENCE: Okay. Mike?

BY MR. HAUF:

Q. Just a, kind of a follow-up on a few things. You talked about the way Scaled kind of defined mitigation. Can you describe what the FAA's interpretation or definition of what mitigation is?

A. Well, I mean, that's still -- we're still having discussions about. Since probably the first Scaled permit application and some other permits, we in the office realized we need to kind of rethink how we -- what we think applicants should do to be safe as well as what our role should be in evaluating that. And so we have a team right now looking at that very question. So I think it's still an open question in the office about how we plan on doing this in the future.

Q. Okay. Were there discussions with Scaled or documented discussions with Scaled talking about the differences in interpretation of mitigation?

A. I'm assuming there were, yes.

Q. You mentioned that you were part of, I guess, developing the part 437.55 regulations. In that, what was the FAA's intent on how an applicant could address human error in their hazard analysis? Like, what would be expected that they would submit to the FAA?

A. I think when we did the permit rule, you know, we crafted the entire rulemaking and there was a lot of things we talked about. I don't know if we really focused on, you know, at that level specific about human error. We had much broader issues to address to kind of craft the experimental permit. So I don't recall any discussions specifically about human errors.

Q. Okay. And were you involved in any of the pre-experimental permit discussions with Scaled?

A. You mean prior to the first permit issuance?

Q. Yes.

A. No. I don't believe so.

Q. Okay. And briefly, could you describe the differences between the experimental permit and a license with respect to the hazard analysis?

A. First of all, I want to go back to the question you just asked. I don't recall whether I was in conversation with Scaled Composites before the permit. I might have been, but I don't recall it.

Q. Okay.

A. As far as the differences between a license and a permit with respect to system safety?

Q. System safety, correct.

A. Okay. so our license regulation, part 431, for reusable launch vehicles, was done back in the late '90s and it has a very general top level requirement for doing system safety. The

experimental permit regulation came much later, you know, a few years later when we had more experience with system safety and hazard analysis, and so we laid out a more detailed requirement in part 437. But, in general, a permit is supposed to be, you know, less burdensome, much easier to obtain than a license. So we expect under a license to see a more robust system safety process than we would expect under an experimental permit.

Q. Okay. I guess, we go back to a little bit about Jay. Can you describe what -- when you gave him the job, can you describe what his responsibilities with working on this project would be?

A. So anybody that's assigned an application project, they're responsible for reviewing the application that we get from the applicant, you know, either asking clarifying questions of the applicant or asking for additional information, and then, you know, recommending whether to -- whether the applicant complies with the regulation or not.

Q. And during that process does Jay -- do you interact with Jay quite a bit assisting him with this or providing advice and guidance?

A. Sure. I mean, so as a manager we would expect him to come to us if there was concerns, if there's some things he needs our help. But -- yeah.

Q. Okay. Did you know if Jay had any concerns during that process?

A. You know, I don't recall. We were -- at the time we had recently reorganized. We were -- you know, he was definitely -- had a lot on his plate, and so did Stewart and I. And so, you know, I don't recall whether we talked specifically about -- I'm sure we talked about Scaled, but I don't recall any specifics.

MR. HAUF: Okay. Dave, I'm good.

MR. LAWRENCE: All right, we're going to do a phone -- stay with the NTSB. Mike Bauer?

MR. BAUER: I don't have any questions right now.

MR. LAWRENCE: Thanks, Mike. Lorenda?

MS. WARD: Yes.

BY MS. WARD:

Q. Hi, Randy. I just wanted to get some clarification on some of the things that you had stated. You said that at AST-300 you have like one or two who are doing system safety analysis full-time; is that correct?

A. Correct.

Q. Now, is there any intention for your division to hire any additional system safety analysis?

A. Sure. So we recently have two new hires. And so, one of those individuals we started training him in system safety, but we're just starting. And so, I wouldn't -- we don't consider him proficient enough to start doing applications at this point.

Q. Do you feel like your division is fully staffed?

A. I think nobody in AST thinks their division is fully

staffed. So --

Q. Fair comment. You said that you worked closely with Terry Hardy and that he had left FAA. What year did he leave FAA?

A. I don't recall. Mid 2000s, 2007-ish. I don't know. I forgot.

Q. Okay. Is he still under your contract with your division?

A. We have a contract with ACTA, and ACTA has a subcontractor to do the work, and I believe that the subcontract is still in place.

Q. Can you spell that company's name, please?

A. It's A-C-T-A.

Q. That's the way I had it, thanks.

You said you've been with the commercial space side since it was under the Department of Transportation and then it moved under the FAA. Do see any differences coming -- you know, going from the DOT to the FAA?

A. Yes, it's -- yes, there's differences, but probably mainly because we're bigger than we were. I mean, back in those days we were a much smaller organization and since we've moved to the FAA, throughout the years we've steadily grown. And so we're a much more capable organization than we were when we were DOT.

Q. And you may have already said this, how long have you been a deputy?

A. Since 2005.

Q. 2005. All right. Thank you, Randy, that's all I had.

MR. LAWRENCE: Thanks, Lorenda. And then Bob?

BY MR. WITHROW:

Q. Yeah, Randy, the Inspection Division does inspections, and you said that the basic way that you guys communicate is through work products; is that correct?

A. In general, just in general, between divisions we would tend to work by memo. Yeah, written communication.

Q. So the Inspection Division, are you aware if they did produce reports about the previous launches of SpaceShipTwo's powered flight 1, 2, and 3?

A. I know the division does produce inspection reports.

Q. And were you aware of any of the contents of those reports?

A. No, and in my job I don't generally read those.

Q. Okay. In the waiver there is a discussion about operating the sim at 1.4 time. Do you know how the concept of operating the sim at 1.4 time got to be mentioned in the waiver?

A. I don't.

MR. WITHROW: That's all.

MR. LAWRENCE: Thanks, Bob. Going to the phone, Nikki, do you have any questions?

MS. DUGUE: No, I have no questions at this time.

MR. LAWRENCE: Thank you. We'll go to the FAA, Dan?

MR. MURRAY: Yep.

BY MR. MURRAY:

Q. The memo between 300 and 200, could you tell us a little bit about what it said?

A. So it went through each section or subsection in 437.55, discussed what Scaled did to comply, where we thought that was deficient, and then we talked about in the end of the day -- at the end, why we were okay with the approach and why we were okay with issuing a permit. We didn't believe it would be a major impact to public health and safety.

Q. Are there any specific elements that you can recall?

A. You know, in this setting, no.

Q. Okay. okay. Let's see, so Scaled is a -- or SpaceShipTwo is a manned vehicle. How many licenses or permits have we granted for manned vehicles? Or even evaluated? Well, let me start with how many licenses or permits have we granted for manned vehicles?

A. I believe for permits, Scaled would be the first manned vehicle.

Q. So this could be the first instance of an evaluation of human error in that context?

A. That's correct.

Q. All right, going back to the permit rule and specifically the hazard analysis section, is there anything you can recall from that rulemaking process that describes how -- the rational for why it's written the way it's written?

A. Well, first of all, once again, it was meant to be easier to obtain than a license. So it was meant to be less of a system safety burden than under a license. We laid out, you know, what we thought at the time was a very basic hazard analysis approach. And I guess we realized later that it was probably more prescriptive than we had thought.

MR. MURRAY: That's all the questions I had, thanks.

MR. LAWRENCE: Thanks, Dan. Going on the phone, Brett?

MR. VANCE: Yeah, I've got a few.

BY MR. VANCE:

Q. Randy, this is Brett Vance out in Los Angeles, FAA test pilot. A lot of these are just process questions. And just to clarify, you mentioned earlier that of course you guys don't write the waivers, but what in regard to the application evaluation process is AST-300's role? What exactly do you guys actually do for the evaluation process?

A. So we would write the evaluation for the, in this case, the system safety regulations. So our input to AST-200 would be the evaluation of the system safety requirements.

Q. So you're taking the application that the applicant gives you and evaluating according to what you just said?

A. Yes.

Q. All right. Do you guys have any role during the pre-application process?

A. Yeah, so -- and we've had -- once again, I mentioned, we

had a reorganization back -- I believe it was 2011, and then a division called AST-500 was created. And some -- a couple years ago they were given the role of the pre-application consultation. And what they do, they work with any new applicant before they've applied for a license or permit, and they bring the people they need to bring in to have the early discussions. And so what AST-500 does is, if they're having a meeting with a potential applicant and they need someone from either system safety or flight safety analysis, we will supply those folks for them.

Q. Okay. And in that case, then, would anybody in AST-500 or in your group, 300, give advice during that pre-application process to any training or crew operation?

A. I don't think it would be our role to give advice on how to train. What would we do in pre-application consultation is try to explain what our requirements are, and trying to help them comply with the requirements.

Q. Okay, that makes sense. So along those lines, a little later in the process then, do you guys have some sort of a checklist or can you walk me through how when you do get the application, how do you analyze the training program content and any record-keeping requirements regarding training?

A. I don't know of any checklist specifically for training. And so -- yeah, I don't know if we have any specific either internal procedure or guidance material on training.

Q. Yeah, I guess Rule 460 talks a little bit about training

a crew out there. Is there anything in particular that look for with respect to training programs just for the flight crews themselves? I'm not talking necessarily for, you know, any control room duties or anything like that, but just for the flight crews.

A. Yeah, that's outside anything that I would do or my division.

Q. Okay. And I'm going to go one more deep on that one just to see if it's relevant in your case. So would the absence of any kind of a training program be discussed as maybe part of the waiver?

A. So if you're talking about 460, the requirement of training of flight crew, sure. If they didn't meet the requirement for training, we'd have two options. One is to issue a waiver or deny the license or permit.

Q. Yeah, okay. Let's see. A little bit more on the applications. You mentioned -- in fact, we've discussed a couple of times already that Scaled Composites was the first and probably the only that's been given a permit for manned operations. Are there other companies in the queue that are applications for manned operations?

MR. PREAMBLE: I don't know if we -- I just want to jump in because we've got, you know, potential competitors to people. I don't how public that information that is.

MR. VANCE: Yeah, I'm not interested in the names. I'm

just interested in the fact that some exist or not.

MR. REPCHECK: I mean, we're talking to lots of companies planning to do lots of things, so -- but, you know, I can answer that there's no other active permit or license for a manned vehicle.

BY MR. VANCE:

Q. I think the question was specifically are there applications in the queue?

A. We really don't talk about other people that apply.

Q. Okay. And finally this one, you talked about this earlier and I wanted to go one more deep on that. You talked about compliance monitoring. So I don't know if you're familiar with this or not, but does AST-400, those guys do any compliance monitoring on launch day?

A. Yes. It's our policy that we have inspectors at each licensed or permitted launch or reentry.

Q. Do you have an idea for what that compliance monitoring on launch date might look like?

A. You know, I do, but, no, it's not my division's responsibility, and I'd probably describe wrong. So I think it's best for someone else to --

Q. Okay. Thanks, Randy.

MR. VANCE: Dave, that's all I've got.

MR. LAWRENCE: Thanks, Brett. Christy?

BY MS. HELGESON:

Q. Yeah, a couple of questions regarding the intent behind 437.55. You had mentioned part of the intent was for that rule to -- for it to be easier to obtain the permit than a license. Why was that part of the intent?

A. Okay, so my understanding was after the SpaceShipOne license activities, Congress in 2004 passed the Commercial Space Launch Amendments Act, and within that law they created the experimental permit. So that's not something that was our idea. It was Congress's idea through statute. And so in the *Congressional Record* it talks about the purpose of an experimental permit, and the idea is to make it easier for companies doing these types of activities to have a reduced regulatory process and reduced burden.

Q. Okay. Do you know why 437.55 was more process based and not performance based if performance based is what is typical?

A. So with -- we use them with launch vehicles in general because we have less experience with them and, you know, the launch concepts vary so greatly that it was very hard to write performance based. A lot -- we have some in 437, but by and large the primary focus of safety for reusable launch vehicles is to have the company go through the system safety process to derive the safety requirements. Because we simply can't -- we don't know enough about what we're going to see to be able to write more detailed requirements. So we rely on, you know, the system safety process to derive those requirements.

Q. Okay. You had mentioned earlier that the rule specifically 437.55 was more prescriptive than originally intended. How was it more prescriptive?

A. So I think we thought that we were being very general, but I think one thing we found with, as an example, Scaled, it took a different approach to hazard analysis, more of an approach used in aviation, and because of the way we wrote the requirement, you know, we had to -- so it didn't fit exactly the way we wrote the requirement, and that's one reason we had to do the waiver.

Q. So that actually leads right into where I was going. I think you stated earlier that Scaled Composites felt that they did meet the requirement of 437.55, but the FAA did not, thus they issued for the waiver. Did Scaled Composites substantiate how they felt they met the requirements of 437.55?

A. I don't recall what they said. I don't recall at this point what they did.

Q. Do you know if there are any specific errors in terms of software error or human error that the mitigations in the waiver were intending to mitigate?

A. Can you repeat the question?

Q. I'm not sure I can remember exactly the same way. The mitigations stated in the waiver, in terms of human error or software error, do you know if any of those mitigations were mitigating something specific or not?

A. I think the -- as I read the waiver, it was -- I don't

-- well, I'm going to say I don't know. I don't recall.

Q. Okay. And where I was going with that is, Kat had asked earlier about having mitigations in a waiver, but there wasn't the human error analysis or the software analysis conducted to identify specifically what the errors were. So I'm just wondering if there were any more general mitigations -- or, excuse me, any more general errors that these mitigations were put in place for. That's a better way to state it.

A. Yeah, I don't recall.

MS. HELGESON: Okay, those are my questions. Thank you.

MR. LAWRENCE: Thanks, Christy. I just have a brief follow-up.

BY MR. LAWRENCE:

Q. You mentioned the term robust training a couple of times in context with Scaled, and at one point in time, following Dr. Wilson's inquiry, you were -- you said robust training, and I'm paraphrasing, because of Scaled's robust training human performance was not considered an issue. And I just wanted to make sure I had that right, and if you wanted to clarify that, because I'm curious what you mean by that.

A. Yeah, that's okay. I think the general thought in the office was that Scaled Composites took training very seriously. They had, you know, they had a simulator. They, you know, they had, once again, what we thought was a pretty robust training for their pilots. And, you know, various -- and they also, my

understanding was they, you know, had a control room and they did a lot of simulations, both, you know, integrated simulations and just pilots in the simulator. And so, the thought was that, you know, they took this very seriously. They trained quite a bit. And they also had a very step-by-step envelope expansion program. And so, you know, we thought in general it was pretty solid.

Q. Okay. Compared to what? What other human space flight, or commercial space flight ventures with pilots right now that are manned were you comparing their training to?

A. We weren't comparing them to other things we had seen because this was, like I had mentioned, this was our first permit with a manned vehicle.

Q. Okay. Well, to characterize it as robust, is there any other comparative program that you were looking at that may have not been a commercial space?

A. No, not that I recall.

Q. Okay. And what went into the evaluation of their training program or looking at their training program?

A. Can you clarify the question?

Q. Sure. What was it that AST did as far evaluating the training program at Scaled?

A. First of all, you start with the written application. So I didn't personally read that part of the application, but it starts with that. And I'm assuming -- well, to really, I mean, to put -- we have to make decisions on the record, right, so it has

to be in the application where we're making the decision. Well, I mean we make our licensing and permit decisions on the written record. You know, our decisions are based on the application.

Q. Okay. So it's what Scaled's telling you that the training program is?

A. Correct.

Q. Okay. That's kind of where I'm leading to. Is there any kind of on-site evaluation of their training? Do you go in -- is anybody looking at these simulators, anybody looking at the training of the aerobatic, anything like that? Or is it just what is being told to AST?

A. I mean, I know we had people out there looking at these things, but at the end of the day we make our licensing and permit decisions based on the written record.

MR. LAWRENCE: Anybody else in the room have a follow-up?

MR. ROBERTSON: I do have questions, I never got to ask.

MR. LAWRENCE: I apologize.

MR. ROBERTSON: That's okay.

MR. LAWRENCE: I apologize.

BY MR. ROBERTSON:

Q. So you mentioned earlier that you believe that the permit was written in such a way to make it easier. Could you help us understand on a very high level the difference between a license and a permit in terms of the requirements on system

safety?

A. Well, so if you look at the words in part 431, which is the license, part 437 which is the permit, there's more written under part 437. Part 431 only states basically that an applicant has to, you know, conduct a system safety process and a couple other -- it's very broad.

Q. Yeah.

A. Okay, so the regulation leaves a lot to interpret. And so, but the idea would be we would expect a more robust system safety process as far as, you know, a safety organization, system safety program plan. You know, we probably look at, you know, some of the things that go with system safety like quality assurance and configuration management, that sort of thing. But, I mean, you know, we haven't done a lot of that. We haven't done a lot of work with that particular section.

Q. Okay. You said broad because, you know, I think that the terminology uses a process that evaluates for reasonably foreseeable failures, is I think what it says. In 437, it specifically says a hazard analysis and goes on to account for human error and software error. So in your opinion, does 431 require analysis for human error and software error?

A. No, it does not require it. But what we would normally do when a requirement's that broad, we have an advisory circular which would describe the kind of things we wanted to see, and you would probably see that in the advisory circular.

Q. Okay.

A. One other change -- one other difference between, a major difference between a license and permit is we require a quantitative risk analysis under a license, and we don't under a permit.

Q. Okay. that's all I have.

MR. LAWRENCE: Okay. Can I get a poll on the phone? First off, Mike Bauer, do you have any follow-up?

MR. BAUER: No follow-ups.

MR. LAWRENCE: Thanks. Lorenda?

MS. WARD: Just one.

BY MS. WARD:

Q. Randy, you may have already covered this. What I wanted to find out was, if the two system safety people that you have in your division, do they have direct contact with the applicant?

A. So, no, we're trying -- in AST we have -- we're trying to reduce the burden on an applicant to not have to talk to three or four or five different people for different things, and so we try to have one point of contact with an applicant. And so we -- I believe for Scaled it was somebody with AST-500, Michelle Murray.

And so what would happen is, you know, as we have questions or concerns with the applicant, we would communicate with AST-200, and we would work those concerns through the team lead for AST-200, who would work with the point of contact with

the applicant.

Q. All right. So then, if I got this right, then AST-300 would work with 200 who would then go to 500, talk to the applicant. Applicant provides information. That would go to 500 and back to 200 and back to 300?

A. It could go that way, sure.

Q. Well, can you give me a typical way, then?

A. That's typical, I mean. But yes, we would originally get the information -- the main point of contact for a company would be Michelle Murray for this particular permit. And of course, Michelle would talk to either me or Stewart Jackson or Ken Wong, or would speak directly to the individual analyst. So it's not an exact strict process every time, but once again, we're trying to ensure that, you know, five different people aren't calling the applicant with questions.

Q. Okay. That was my question. Thank you.

MR. LAWRENCE: All right. Let's see. Brett, on the phone?

MR. VANCE: No further questions.

MR. LAWRENCE: Great. Nikki?

MS. DUGUE: I have one clarification question.

MR. PREAMBLE: I don't know how much further we're going to go, so I -- it's like an hour and 10, so --

MR. LAWRENCE: We're finishing now. Yeah, because --

MR. PREAMBLE: Okay. I didn't know if we keep going

around.

MR. LAWRENCE: No, only go one time.

MR. WITHROW: So, I can't -- based on Lorenda's question, can I do one quick follow-up?

MR. LAWRENCE: Quick follow-up, but I'm talking to Nikki right now. Nikki, your question?

BY MS. DUGUE:

Q. Okay. You said that for the permit process that you write an evaluation to AST-200 regarding how the applicant has complied or not complied with the regulation. Is that the same thing as the memo between you at AST-300 and AST-200?

A. No, that was -- that particular memo was a little different than usual. It addressed that specific issue as opposed to the actual evaluation.

And one thing I should clarify as far as -- particularly for the evaluation input. You know, ideally it would come from a memo from Stewart Jackson or myself. You know, sometimes our analyst would input directly into the evaluation package without it being a memo necessarily from us to -- but ideally we would do it through memo.

MS. DUGUE: Okay. That was my only question.

MR. LAWRENCE: Thanks, Nikki.

BY MR. WITHROW:

Q. With respect to Scaled's application, were you aware of technical interchange meetings between your staff or other staff

evaluating the permit and Scaled engineers conducted either telephone or even face to face?

A. Yeah, I know during any application process there's a number of technical interchange meetings. So I don't know -- I'm not aware of a specific one, but absolutely, there are many technical interchange meetings between us and Scaled, which would include the entire team. And so, we would have -- I guess your point is we would have more direct contact between the analysts and our applicant that way.

Q. And it wouldn't necessarily follow the small intestine that was described before?

A. That's a very good point, thanks.

Q. Okay.

A. Yes.

Q. Thank you.

MR. WITHROW: That's it. Dave?

MR. LAWRENCE: Mike?

BY MR. HAUF:

Q. Yeah, one quick question. Did the system safety -- or your two system safety engineers voice any concerns with the communication process between them through AST-200, through Michelle to Scaled, and back and forth, as to it was taking too long or the questions weren't being answered correctly?

A. Yes. There has been, I would say, growing pains with the way we restructured a few years ago. You know, it's a new way

of doing business within AST. And so how communication flows between divisions and between divisions and applicants I think is something that, you know, we continually try to improve.

Q. Okay.

MR. LAWRENCE: Christy, I don't think I've asked you, one last chance -- you'd be the last one -- do you have any follow-up?

MS. HELGESON: I have one quick follow-up.

BY MS. HELGESON:

Q. Are you familiar with any associated AC's for part 431 or 437?

A. Yes. I believe we have one AC for part 431 on system safety. And we also have, I believe, two AC's for part 437. And we have a couple guidance documents that cover verification and I believe reliability and maybe one other.

Q. Okay. That was it. Thank you.

MR. LAWRENCE: Thanks, Christy.

Randy, thanks, I appreciate your time. Is there anything else that maybe you wanted to add that we didn't ask about to assist us in the investigation?

MR. REPCHECK: No, I think that's it.

MR. LAWRENCE: Thank you, I appreciate your time.

MR. REPCHECK: Thank you.

(Whereupon, at 4:15 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:	CRASH OF VIRGIN GALACTIC SPACESHIPTWO MOJAVE, CALIFORNIA OCTOBER 31, 2014 Interview of Randy Repcheck
DOCKET NUMBER:	DCA-15-MA-019
PLACE:	Washington, D.C.
DATE:	January 14, 2015

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.

_____

Stephen Grider
Official Reporter

UNITED STATES OF AMERICA

NATIONAL TRANSPORTATION SAFETY BOARD

Investigation of:	*	
	*	
CRASH OF VIRGIN GALACTIC	*	
SPACESHIPTWO	*	Docket No.: DCA-15-MA-019
MOJAVE, CALIFORNIA	*	
OCTOBER 31, 2014	*	
	*	

Telephonic Interview of: THOMAS MARTIN

National Transportation Safety Board
6th Floor Conference Room
490 L'Enfant Plaza East, S.W.
Washington, D.C.

Thursday,
January 15, 2015

The above-captioned matter convened, pursuant to notice.

BEFORE: MICHAEL HAUF
System Safety Group Chairman

APPEARANCES:

MICHAEL HAUF, System Safety Group Chairman
National Transportation Safety Board

DAVID LAWRENCE, Operations Group Chairman
National Transportation Safety Board

LORENDA WARD, Investigator-in-Charge
National Transportation Safety Board

MICHAEL BAUER, Systems Group Chairman
National Transportation Safety Board

KATHERINE WILSON, Ph.D., Human Performance Group Chairman
National Transportation Safety Board

DANIEL MURRAY
Federal Aviation Administration

CHRISTINE HELGESON
Representative to the Human Performance Group
Federal Aviation Administration

BRETT VANCE, Test Pilot
Los Angeles Aircraft Certification Office
Federal Aviation Administration

BOB WITHROW
Scaled Composites

NICOLETTE DUGUE
Scaled Composites

WILL ROBERTSON
The Spaceship Company

BRADLEY PREAMBLE, Office of the Chief Counsel
Federal Aviation Administration
(Representative on behalf of Mr. Martin)

I N D E X

I N T E R V I E W

(9:35 a.m.)

MR. HAUF: All right. So real fast, just want to go around on the phone. Could we get a roll call who's out there? Go ahead. I think Nikki's out there?

MS. DUGUE: Nikki's here.

MR. HAUF: Okay. And Brett?

MR. VANCE: Brett's here.

MR. HAUF: And Tom. And I think that's it. Is that correct?

(No response.)

MR. HAUF: Okay. So Tom, let's see. What we do is go over a statement and -- just a statement or a preamble. And then from there, we'll go around the room and introduce everybody, and then after that, we'll start questions.

So my name is Mike Hauf. I'm an investigator with the NTSB, and I am the System Safety Group Chairman for this investigation. The NTSB is an independent federal agency charged with determining the probable causes on transportation accidents and promoting transportation safety. The NTSB is not part of DOT or FAA. It has no regulatory or enforcement powers.

At this point I'd like to introduce all the group member -- or individuals taking part in the interview. And we'll start with everybody in the room here in Washington, D.C. Lorenda?

MS. WARD: Good morning. My name is Lorenda Ward. I'm

the Senior Investigator-in-Charge. I'm the IIC for this accident investigation.

MR. HAUF: Brad?

MR. PREAMBLE: Oh, sorry. Brad Preamble here from the Office of the Chief Counsel, FAA.

MR. MURRAY: Dan Murray, AST representative to the System Safety Working Group.

MR. ROBERTSON: Will Robertson, system safety engineer with Virgin Galactic.

MR. WITHROW: Bob Withrow, Scaled Composites and a member of the System Safety Group.

DR. WILSON: Katherine Wilson, Human Performance Group Chairman with the NTSB.

MR. LAWRENCE: David Lawrence, NTSB, Operations Group Chairman.

MR. BAUER: Mike Bauer, NTSB, Systems Group Chairman.

MR. HAUF: All right. And on the line, can we -- let's see, we'll start with Scaled.

MS. DUGUE: Nicolette Dugue, Scaled Composites System Safety Group.

MR. HAUF: All right. And FAA?

MR. VANCE: Okay. Brett Vance, test pilot with the FAA out of the Long Beach Aircraft Certification Office.

MR. HAUF: Okay. And I believe that's everyone.

Tom, let's see. Do you have any objection to anyone

other than NTSB taking part in the interview?

MR. MARTIN: No. Everything I've got to tell you, I've documented in an email, so I'd be glad to answer any questions from anybody.

MR. HAUF: All right. Today we will be using the services of a court reporter who will record and then transcribe the interview. The transcript, not the audio recording, will be made a part of the public docket.

The purpose of this investigation is safety, to determine probable cause and prevent reoccurrence. Our role is not to assign fault, blame or liability. This interview is part of the fact-finding phase of the investigation. We are here to ask questions about your involvement in the permit and waiver for the SpaceShipTwo program. We cannot, however, offer any guarantee of confidentiality or immunity.

Each of the group members will have a chance to ask questions. We will ask questions one at a time, and everyone has been instructed not to interrupt the person who is asking questions at that time. There will be an opportunity for each group member to ask follow-up questions after each person has had a turn.

Please answer all questions to the best of your recollection. If you do not understand a question, ask to have it repeated or explained. If you realize you misstated or need to modify a previous answer, please do so.

You are entitled to have one representative of your choosing. Is there someone you would like to have as your representative?

MR. MARTIN: I can't think of anyone.

MR. PREAMBLE: Tom, this is Brad Preamble. I'm here as your representative, as we previously discussed.

MR. MARTIN: All right. Then I stand corrected.

MR. PREAMBLE: Okay. All right.

MR. MARTIN: Brad. Sorry about that, Brad.

MR. PREAMBLE: That's all right. I am not offended.

MR. HAUF: Mr. Preamble, you may direct to answer a question -- or to not answer a question or to request a short break to confer with him or her.

The FAA will have the ability to review the transcript prior to the inclusion in the docket.

Do you have any questions, Tom?

MR. MARTIN: No. Excuse me. No, I do not.

MR. HAUF: Okay, great. We will now begin the interview.

INTERVIEW OF THOMAS MARTIN

BY MR. HAUF:

Q. For the record, could you please state your name and job title?

A. Yeah. My name is Thomas Martin. I go by Tom. My job title is the lead technical system safety engineer for AST.

Q. All right. And what AST division do you currently work in?

A. I work in AST-300, Regulations and Analysis Division.

Q. All right. And how long have you been in that position?

A. I joined the FAA in March 2012.

Q. And did you go right into that position in the AST?

A. No. I was hired to do system safety, and about, I think, 5 months later, they asked me to be the technical lead because of my background at NASA and experiences.

Q. All right. And who is your immediate supervisor?

A. Immediate supervisor is Stewart Jackson.

Q. Okay. And specific to Scaled Composites' experimental permit, could you describe your roles and responsibilities with what you worked on there?

A. Oh, yeah. That's kind of a long answer. When I got there in March 2012, the Scaled Composites permit was in its final throes of being signed off by AST, and it was actually evaluated by two engineers. One was Jay Naphas, who is a young engineer that has a very strong background in software, and then one of our contractors by the name of Terry Hardy, who is kind of a system safety expert, nationally known, primarily in software but has a strong background in every aspect. So when I got there, they were issuing the permit.

My involvement didn't come until later on. So I'm not sure how much you want me to answer the question or how you want

me to walk you through that. But my initial involvement was just I reviewed the report that Jay had done based on Terry and his findings and made a few comments, and then they put the technical rationale together and submitted it.

Q. Okay. Now if you wouldn't mind, walk through kind of what you did with the evaluations in the permitting process.

A. Okay. I don't have everything in front of me, so this is going to be on memory, but I can -- you know, I've got -- like I said, I do document all my work and any issues.

So after the permit was issued, there was a -- after the permit was issued, I didn't get involved until later on in the process, but -- with the resubmit, with the extension of the permit a year later. But in between, there was a lot of discussion about how we could add a lot more discipline to the program. The reports that came out from Terry Hardy and Jay showed that we had issued a permit knowing that there were some deficiencies in the applicant's data package with respect to meeting all the regulations contained in 437. Part 55 is what covers system safety.

As we got into the next evaluation, between those periods, Terry, myself, Jay, and several other people in my group, we started looking at trying to figure out how we could focus the process and try to get more discipline and -- so that we didn't have this problem in waiting until the last -- getting data. Between that, the time they issued the permit and the next time

that they had to issue it, most of my time was trying to improve the process. So I didn't spend a lot of time looking at the application or the data from Scaled Composites.

When the next application review came in from Scaled, again, I didn't have the background knowledge, and they wanted me to participate in that review. And I said, look, if you're looking to get this out quickly, which is what was conveyed to me, I said it's going to take me a couple months to understand their system and their processes and their analysis, so I'm not sure that I'm going to be able to do that in 2 months because I won't sign anything that I'm not comfortable with.

So they turn around and ask Jay to look at it because he had the resident knowledge. So Jay went ahead and did the work and issued the recommendation and technical evaluation that supported the reissuance of the permit. To my knowledge, and having reviewed some of the technical data as he was doing it, they still had not provided any information that showed that they met every regulation with respect to system safety.

But following that, and this is where it gets a little fuzzy, we were asked by the team to do a meets or exceeds type of evaluation. I think it was for the next cycle of trying to get that permit extended. And what they meant by that is that in the application, the application stated that they were doing a more stringent approach to try and -- for safety for their system as opposed to just what was called out in the regulations. The

regulations were just looking at conducting a hazard analysis. So they were decreeing that they had a system safety program that was a little bit more penetrating and gave them a better sense of safety, so they asked -- my management asked me to go up with my team to go look at a meets or exceeds.

When we did that meets or exceeds, we came back and told them that their approach didn't really meet or exceed what was stated in 435. And the primary rationale was because when you look at system safety, you've got two parts, right? You've got the system -- the management part of it, and then you've got the engineering part of it. And the engineering part that I'm used to is based on industry standards from 882 and the NASA documents, and it's the detailed approach of trying to identify and evaluate the systems as you go through the design and development, manufacturing, basically through the lifecycle. And that's what 437.55 is intended to do, is to give us that insight. So when I looked at their system safety program, they still didn't address that engineering stuff. So my report back to my management was, you know, to me and Terry and Jay and my other team members, we didn't feel that they exceeded or even met the minimum content of what was in 437.55.

Then following that discussion, they asked me to look at -- they had a change, and they asked me to look at the -- just the change. They didn't want me to go back and look at the entire document, entire application. And I noted, said guys, you know,

I've had about a year now, a little over a year, to get familiar with parts of how we've done business. And I reported to my management we do not have enough information that shows that they are compliant with the regulations; we should have never issued that permit. Either they need to write a waiver, or we need to make them issue -- you know, develop some more information and show us how they've met the requirements.

After giving that to management, there was some pushback within our own organization because before I got there, they didn't have a real disciplined documented approach. And the concern was we were changing how we were evaluating this organization midstream. And several people in management felt like that was unfair.

Now to credit, George Zamka, who was the deputy at the time, he stood up and said, you know, guys, we got Tom; he's our system safety expert; we brought him on for a reason; it sounds like maybe we haven't been doing it completely enough, so from this point on, this is how we're going to start evaluating it. And it sounds like we need -- they didn't meet the regulations, so we have to address that.

But at the time, the management team decided that they -- the waiver was the right path to go. I said I'd be glad to evaluate any waiver that Scaled Composites or Virgin Galactic submitted. Management decided that they were going to write the waiver. I offered my assistance. They said, you know, we don't

need it. I said, let me get this straight. I'm telling you they didn't meet the regulations; they're deficient. That means the residual risk is going up. We don't have enough verification. We don't -- they don't document all the mitigation, so, you know, that makes me uncomfortable. You don't want me involved in the waiver process? And they said that's correct. I said, okay, I'll watch how they document it. The next time I saw the waiver was when it was published.

So fast forward to December, I think, 2013, after they issued a waiver and the permit again, 2013, they had Powered Flight 3. And part of my process is to look at the vehicle data, if it comes to us, or any type of film that's available so that I can make -- you know, I do a kind of a closed-loop thing. Did the vehicle fly like it was supposed to because it's an experimental system? Did we see any type of anomalies that we want to address with them with respect to, okay, you guys didn't -- you got this hazard, but this anomaly seems to be stressing that. Are we sure we got the right mitigations in place? And we saw some flutter on the aft tail wing from a YouTube video that was published. It was raw data.

Right after that, we found out that they had made some changes to the wing because they were anticipating putting in helium tanks to try to compensate for some motor instability. They had limited their thrust, the powered flight to under 30 seconds. And when I saw that, I got concerned because my

experience back at NASA has been, when I was in the Columbia accident investigation, when we had the piece of foam that come off that hit the leading edge of the shuttle, during the re-entry, the aerodynamics and analysis that we did during our investigation of that showed that that breach ended up tripping the flow differently than what it was designed for and actually impeded the leeward side of the shuttle cargo bay. And more importantly, it produced a shock -- a supersonic shockwave on the vertical tail, and we saw loads pretty much near their limit. And the only reason the tail didn't fall off is because the wing ended up falling off and it disintegrated. So I used that as an analogy to my management and said, look, you know, I'm concerned with this.

And they had flown this without notifying the FAA. My management got comfortable with it because Scaled Composites came back and said they had done a lot of C and D and drop testing with it, and they had a lot of information to correlate the data. So the next round in the experimental permit, we didn't see any updates to their hazard analysis. So I did not get involved other than to say no hazard analysis was seen or provided; therefore, you know, I didn't have any evaluation or comments to the regulation, and the permit was issued or reissued.

Right after that, Scaled Composites came back and said that they felt that they needed to put (b) (4) the system and so they were resubmitting and updating their application. And at that time, we had kind of talked internally, and I said if they're

putting (b) (4) there, then we ought to at least see some changes in their hazard analysis. And at this point I started saying, well, we ought to also see the changes in their structural analysis.

Now, when I went and looked at the changes that they implemented, I had a chance now to look at the entire application. And I noted to my management that they did not identify structures as safety critical, and they didn't provide us with any type of hazard analysis associated with that. My management's technical response was that they didn't believe structures was safety critical at the time. So I wrote up a whole email response, kind of white paper, back to them and stated, well, you know, we're missing -- you know, we're kind of skipping along this. When we first looked at the structures, our structures guy, who has since moved on, did identify this as a failure in the report and said this should have been identified as safety critical and they should have had a hazard analysis. Their approach was found invalid. They followed a lot what NASA did, but they didn't put that in the documentation with respect to the regulations that says identify the safety critical systems and provide hazard analysis, controls, et cetera.

So I put that back at those guys and saying, you know, structures is one of the biggest things we're always concerned with. And so we were trying to get back to the line in the sand where you guys, and you guys meaning the management, were

comfortable with the risk that was posed by this system. You know, they've made some major modifications. They've shortened the engine. They've changed the fuel, the shape, and they've added (b) (4) -- (b) (4) plumbing and tanks, (b) (4) psi tanks in the wings and changed the structure of that. You know, we at least ought to get them to update the structures. And to their credit, you know, we had the discussions -- you know, Scaled was willing to do that, but my management didn't feel it was necessary.

So when it came to renewing the license last year, I'm thinking, you know, we keep shaving off and allowing -- letting this line drift. And at the MRB, I stood up and I told them, I said they didn't meet the regulations to begin with, we keep relying on an assumption that they can't get out of the controlled area. I pointed out that Scaled had provided a number of hazards that says yes, they can get out of the controlled area. We didn't ask for that information per the regulations, so the residual risk rose. We didn't ask them to do a hazard analysis for structures, but we accepted their structural analysis report. They modified their structure, and I'm all -- I'm asking, saying guys, we need to step back and say, okay, make sure that they've gone back and looked at not only the structural analysis for margins and compare it to what they had before, but also do the flutter analysis because I was concerned about what we saw in Powered Flight 3, and the flow tripping and causing that problem.

Before we got to that point -- let me back up. One of the things we did ask about, because we were concerned about the vibration environment, was the qualification of the motor. And Don Sargent and I sat down and talked with them, and it was -- it's really productive when you get the technical teams, be able to talk to the technical team. Because what we were told was it was all flight configuration, but what we found out during the meeting was, asking the gentlemen -- flight configuration to me means when you've got the propulsion system all set up, the oxidizer, et cetera, that it's sitting in the test stand like it's going to be sitting in the vehicle, meaning the attach points are the same, because they were planning on using that data, that qual data, to confirm that the vibration environment in the cockpit and on the crew was going to be low. And that was one of the limiting factors why they kept it under 30 seconds before.

And when we found out that it wasn't in the right flight configuration, I said you can't use that data to predict that, so we're going to have to rely more on your software to be able to terminate this thrust if we see the vibration environment that you guys were concerned about. And we were assured that they've done all that testing, but we never got inside during the whole process starting -- you know, talking with Terry and Jay, we never got inside into how they develop their software and how they do their quality assurance, like you would find in DO-178-Bravo or any of the industry practices for ensuring software safety. So we were

relying on their testing program that we didn't get to see. And we didn't get the -- we being the technical team -- the verification evidence.

So they issued a permit over my objections. In fact, we started implementing a process where when we have a decision, they put out a record. Well, the record that came out just said Tom disagreed. So I ended up writing back to them. I said, look, that makes me sound like, you know, I'm holding my slide rule and my breath and going home. So I wrote back to the chief of staff and said we need to document this clearly my why objections were. So I wrote him back, and I don't know if he updated his document. But I did update it and send it back to him.

So from that point on, they issued a permit, and then the accident occurred on the 31st. So that's been my involvement in SpaceShipTwo.

Q. Okay. Thanks. Okay, if we go back a little bit to the -- I guess what Jay and Terry were working on, can you talk a little bit about how Terry got involved? Was it a contract from the FAA?

A. Yeah. Well, so Terry and I kind of go back, and I think that's rather important. I think Terry Hardy was originally an FAA employee. In fact, I know he was an FAA employee. And he was one of the primary authors of the 437.55 experimental permit system safety approach. And after a number of years, and you'll have to ask him why he left, but my interpretation was that he was

very frustrated with the lack of progress and the approach that we were taking with the applicant and trying to get information. And it appeared to him, through conversations to me, that the launch date seemed to be more important.

He left and went to Goddard, NASA Goddard, and that's where I first met him. And him and I worked together on Constellation and a number of projects. And then he left Goddard and moved out to Colorado to become a consultant with Special Aerospace Services. In fact, I left NASA and went to work with him at Special Aerospace Services for a couple years. And in that time frame, he decided that he wanted to be his own independent contractor consultant, so he went out on his own and got a contract with the FAA. Now the details of that, I don't know.

But when I got there, the contract was always specific, you will evaluate this license or this license. And he was put on SpaceShipTwo, Scaled Composites, on contract to help Jay review the application.

Q. Do you know what his evaluation of the permit was or -- and information provided to Jay?

A. Yeah. Well, he wrote a report, so that was my first introduction. As soon as I got there, you know, I dropped in at the end of this. And one of the big concerns from the team was, they had been trying to get the questions out to Scaled, and there seemed to be a lot of resistance within our own organization to provide that information. I think a lot of it had -- well,

maybe -- I'm not going to speak why they didn't do it. But the fact was we would submit -- they would submit questions, and it would go up to our management, and management would ascertain whether or not they should ask the question or if it was too detailed, and either it would get changed or it would get combined or it would be interpreted by one of our organizations -- what we called AST-500, and then they would have the conversation.

So I can only imagine that there was a lot of confusion by the applicant themselves on what we were looking for because there was a lot of confusion within our own organization. But NASA -- but Terry had provided -- as his contract, he was very disciplined, and he wrote a report back to FAA detailing all the deficiencies and makes recommendations. And that's the first thing I read. And our conversations with Mike, me and management was, you guys, you know, this is pretty damning here. If this is the process, this is not right, we need to change that. I mean, that's where he and I and Jay set off to change the process.

But he's got a report I can send you that pretty much details all the deficiencies. And it's not contained in the technical evaluation, but it's summarized -- the one report that Jay did show me, he asked me to kind of consult on it before he submitted it formally. I told him, I said, if you guys didn't see any evidence of meeting the regulations, you need to put that in the document. And if you feel like they're going to be safe because of, you know, the data that you did get, then that's

different and I can't, you know, I can't affect that. But I can tell you that this is a fact that you ought to document, and he did. I'm not sure if it got into the final report, but I know the initial report that I had showed that he documented it, that Scaled did not meet all the regulations and they were deficient. So I have a report that Terry gave me. That's how I know.

Q. All right. Do you know the time frame of that report with respect to the renewals that were going in?

A. This was for the first license sub they issued. So I got there -- let's see, I got there in March 2012. In June, we had a -- and this is interesting. In June, we had a hotwash where, you know, the team got together to say, okay, how do we improve our performance? And I just came across that the other day. And it documents a lot of the concerns I've talked to you in the last 20 minutes about. So he would have submitted that right there about May, because I think that's when we issued -- April-May time frame -- that's when we issued the permit to begin with.

And he was very upset, I got to be honest with you, when -- so I just got there. One of the reasons I came there is because I worked for Jim Van Laak when he was at NASA, and Jim had identified that they needed some help in trying to add more discipline and -- to the process for system safety. And Terry was the other reason I felt, wow, this is a good opportunity to work with Terry again because we really worked well in Constellation.

So he would have submitted it in May. And then right

after that, he got upset that they issued this permit over his report and had a detailed discussion with my immediate management. I don't know if it went any further than that. But it went with Stewart and Randy almost, I think, right there in April. And he says if we don't change our culture and we don't change our approach to evaluating these guys, he wasn't going to continue to subcontract to us because that's his technical reputation on the line. And I agree with him. I think that it's important, so --

Q. All right. Do you know if Jay communicated any of the deficiencies in the report to Scaled?

A. I do not know.

Q. Okay. You mentioned that the -- when the waiver was released, you didn't see it until it was publicly released. When you saw it, did you have any concerns with what was in it?

A. Well, so the way the waiver was written is that my deputy, the deputy to our group, Randy Repcheck, wrote -- I originally thought he wrote the waiver, but, you know, looking back in my notes, he wrote a memo, and I asked him if he wanted any help, and he said no, I got this. And so his memo went to, I think, Mike Kelly, who is our chief engineer and a strong advocate of it's in the middle of nowhere so they didn't really need to meet the regulations, wrote the waiver, I think. So I didn't get to see it, and I only got to see it because Terry kind of sent it to me.

And when I read the waiver, I immediately went to my

boss and I said, you know this is wrong, right? And he goes, what do you mean? I said they only addressed two aspects of it, and that was human error and software. I said they didn't meet hardly anything in 437.55. And, you know, the reason you do that, trying to explain to him my experience, is that, you know, if you've got a brand-new system that has no flights history on the components, and their approach to showing that their risk was low for their hazards was based on a reliability database on aviation parts, and then they adjusted it by a factor of 10 to make it a little bit more severe. And my argument to Mike, you know, when we -- this would come up during the discussion with Mike Kelly was, Mike, you can't use those numbers. Unless you understand the physics of how these things fail, and that's dependent on the environment, you can't use these numbers as a way to demonstrate that the thing is compliant. In fact, my technical write-up on the last one went in, pulled an example -- the paragraph out of the NPRM that states the same thing. You use the reliability database for design and development. You don't use it as a value to demonstrate safety because you haven't flown this thing. You don't know how these components are going to react in the environment.

So I told him that the reason that the regulations, if you read the NPRM, are written the way they are is because of the fact that it's a brand-new system, you want them to do the right engineering. You want them to look at the system from the outset, starting from the design table, get engaged, find -- do your

hazard analysis, the top level. You say, wow, this could cause us a problem, let's put in a safe design or design it out, or if you can't do that, let's make sure we have some redundancy, et cetera. And I think Scaled, on the most part, did a fairly good job when I look at the after-the-fact that they had redundant systems and kind of made it simple. But push come to shove, they were using numbers that I couldn't believe. So I was looking for more of, you know, quality type mitigations, you know, procedures and evidence of that.

So I went through this explanation, and then after that, the last line in the sand is, okay, we've done the best engineering, let's make sure that they fly it in a way that it keeps it away from the public. It's those two things that we have in our regulations that's supposed to protect the general public.

And in fact, I had to write an email once to these guys saying look, you guys are asking me to -- you're not allowing me to talk to the technical team. Every time I bring up an issue, you guys are isolating me, and you don't invite me to meetings.

And so I pulled out the Columbia Challenger report and a paper that Dr. Nancy Leveson wrote, and I pointed out that these are the same things that NASA did, and we're following the same thing. If we don't change our approach, it's just not a matter -- it's not if; it's a matter of when something's going to happen. And, you know, they may shoot the applicant, but they're going to shoot them through us. So we've got to change our approach. And

you guys keep making this a OR gate and not an AND gate. You keep ignoring the engineering in light of they're in the middle of nowhere. And I keep telling you guys they -- you may think they're in the middle of nowhere, but Scaled Composites has identified a number of hazards that says they can get out of that controlled area, so it's not in the middle of nowhere. So we've got to resolve that, and this waiver doesn't do that.

So that was the extent of my conversation with my deputy and my manager. And I disagreed with the waiver.

Q. All right. And who was the deputy and the manager for this?

A. Manager is Stewart Jackson, and the deputy is Randy Repcheck.

Q. Okay, thanks. Just a couple questions about some waivers. There was a waiver, I believe, was released in May -- July of 2013. And then it appears there was another or maybe the same waiver released about a year later. Was that the same waiver, and is it for the same issue or is it -- are there different issues and different waivers?

A. The only waiver that I'm aware of is the original one that they kept re-renewing. And it relieved them of 437.55, just parts of it, which was the software hazard analysis and the human error aspect of it. And we, after every permit renew, we renewed it until this last one. This was really interesting. I'd like to think it was a mistake. But the last permit that we issued the

license -- the letter that Ken Long signed stated that they were relieved from all 437.55. So I don't know what that's about.

Q. Okay. Could you briefly describe the permit evaluation process, what it entails, and how do you -- do you look at fault trees and to what level of detail?

A. Well, so the process has been variable because with the -- because I think we're a growing organization. That's a personal opinion. When we get an applicant in, when I -- the first problem that I saw when I got here, in trying to add some discipline and some rigor to the process, was we were accepting applications based on kind of an administrative checklist. They came to us and said, okay, you need a system safety program planner or you need hazard analysis. And they would give us a document and would title it system safety program or hazard analysis. But there was no quality check.

And so we would take this application, when we first got there, and we would get into the statutory regulation of either 120 days for an experimental permit evaluation or 180 days. And we relied -- when I kind of touched back on these guys, said you know, that's not going to be enough time because when we get in these things, you know, we're not really evaluating whether the application documentation is sufficient to do our detailed analysis or not. We're just accepting it based on this administrative check. And then when I'm trying to ask for

information, you guys -- you know, the management and people on the team saying that's too detailed, and we have an internal argument, and we would basically end up not getting information until pretty much near the end of the evaluation time frame.

And then there would be a lot of pressure, political pressure, saying guys, you know, we got to get this technical eval done by next week. We got to get it up to ADC because they're launching next week. And, you know, maybe I was raised different, in a different culture, but you know, my response always was that, hey, guys, they're not launching until we're confident that they've done the right engineering and that the trajectory analysis is complete to ensure that the public is safe. You know, I don't care when they think they're launching, you know, our responsibility is to the public.

And while everybody would nod their head, actually, the launch date of the applicant -- and this is not just a problem with Scaled. This is throughout the, you know, my 2½ years there. So we set out to try to fix that, and we identified this as a problem. And I set up a process and said, look, the majority of the work that I have to do is associated with a process that the applicant is supposed to be implementing from the outset. And when you have a process and you're trying to validate or verify that they followed the process, you got to sample it.

So what we did is we established, look, most of the work that I had to do to get to a point where I'm comfortable accepting

an application is in the pre-application phase. When somebody comes to our organization and says, hey, I'm thinking about flying this type of vehicle and this type of mission from this launch site, the first people they should engage, not only are remote site people, but the technical team needs to get involved because that's when we start understanding the system. Safety is about knowledge. I mean, it's become like -- I should have it tattooed across my chest and I should have a sign above my desk. Those -- "Safety is about knowledge," and the other one is "In God we trust, all others bring data," because that's what I need in order to sign this off.

So what we're supposed to do is we're supposed to evaluate the application before we accept it, and then help them clean it up. Well, what I was finding was that people were coming in, applicants were coming in, and saying I need this complete and, you know, we need to get the license process going. But the vehicle design or the documentation was not, to me, at a point where I could do my evaluation. And that would put us into the statutory time frame, and that put a lot of pressure not only on me but on the whole team because I couldn't do an evaluation until I got enough data to understand the system.

And my task or my team's task is to evaluate the overall risk to the general public, and that's to look at the mitigations. Are the mitigations and controls that they have in place for the hazards they've identified sufficient to protect to the general

public? Well, I can't do that until I understand how the hazard manifests itself. And if I don't understand how the system works, I can't tell you how the hazard's going to manifest itself. I can infer it. Once I start inferring, I start adding risk because I'm using my own knowledge and my own experience to fill in the gap. And that's not what I want to do. I want to be able to document this is how their system works, this is how they identify the hazards, here's how the hazard manifests itself. Now I understand that. How do they propose on controlling the causes or mitigating the risk? Now I can go look at that one statement against their hazard and how it manifests, and say, yeah, that's sufficient.

And the last part is providing verification evidence. Now, I'm not looking to go and look over their shoulder and check the data. I'm looking do they have a documented verification statement that says that they did what they said they were supposed to do? That's how I check the process.

So up until we started -- it was after Scaled. Up until that point, it was we'd wait for the application to come in. Part of our group would collect it, then they would get a collective team together, and then say, okay, here's all the documents. We got 2 weeks to determine whether it's complete enough.

Now, that's kind of an important statement because when you get reams and reams of data, even though, you know, Scaled did, I think, a very good job of trying to minimize the interaction of all these systems. They still have volumes of

data, documents that they provided us to try to show compliance with the regulations. And you got to go through all those volumes in 2 weeks and try to understand it. So my pushback to the team and the management at the time was that's not enough time. And the response was that's -- we have to do it that way, that's our policy. And but we don't regulate to policy. We regulate to the regulations, and the regulations, as I pointed out, said it's supposed to be an iterative process.

So from that point on, when I started pointing this stuff out and anchoring my process on the regulation, we were able to move the process back to the left. So now we have applicants coming in, and we're starting to engage them. So we're seeing some movement on it, but we still have the same problem that we're getting filtered. We're not allowed to talk to the technical teams.

So and for Scaled perspective, when it first came in, I can tell you that the hotwash that was done, that same complaint was documented and presented to management. Management doesn't trust the technical team, and we were waiting for the last moment to get the data, and then the launch schedule became more important and so we would accept it. And that's the philosophy I've been trying to change.

Q. All right. And who is the management that was pushing back on that?

A. So the process would go, we would submit our questions

-- we'd have our internal discussion, we'd submit our questions. It would go through my management, and you know, sometimes it would sit on their desk, Stewart Jackson's desk, for a number of weeks. I would stop by his office. Eventually, it would go to Mike Kelly, and Mike Kelly, I think -- it's not documented. That's one of the other issues I have. But Mike Kelly would be the primary -- as a chief engineer, determine whether the questions were too detailed, too penetrating, we didn't need to ask that. And so we'd either get a yes or no or a rewrite, and then it would be sent out.

And I've had this happen on one occasion where I got the questions out, and the answer came back, and it was an answer to a different question. And when I looked at the question, somebody had changed my question. So then we were right near the end of the evaluation time frame and they said you guys need to write a technical eval.

I can tell you I've only approved two licenses since I've been there, and that is Blue Origin and EFT-1, you know, which is Orion. And I've only accepted one application that's completed on it since I've been there. So they tend to bypass me and accept it anyways.

Q. So when you would submit a question up to -- or when it gets up to Mike Kelly, which -- and if he wanted to revise it, would he come talk to you about it, or would he revise it and --

A. No. It's rare. We rarely had -- the conversations were

usually initiated within the team, or I would go talk to Mike directly. And occasionally, we would have these discussions in front of the entire management team and -- yeah, that's where he said structures wasn't safety critical. You know, he had told me several times that Scaled had done a number of tests to demonstrate the vehicle is safe. They had dropped it 57 times. And so I pointed out that it had flown 57 times like an airplane, but it had never flown through the powered flight.

And that's the real important aspect of this, right. You've got a system that is trying to make -- is trying to be as light as possible and expend a great deal, enormous amount of energy in a short period of time to achieve orbital altitude and then come back down through the atmosphere. And that environment, you know, is unique for each vehicle because of the way you mount your systems, the way you design your systems, the way you fly your vehicle, the atmosphere that you're flying through during the day, et cetera. And so until you get that information, you really can't use statistics.

So I was pointing out that, yeah, I understand how it's going to fly as an airplane. What I don't understand is how are we going to know that it's going to survive the environment going uphill? And that was one of the concerns I had, the vibration. We had acoustic in the whole atmosphere, but vibration was probably my biggest one, and it turned out to be one because of the way solid motors work, the motor instability.

So typically, we would -- I would sit there and either go to Mike, and we would have the discussion, or he would come in, and he would either say no, I agree or disagree. But there were occasions when he agreed with me, and then there were occasions where it would just kind of die on the vine. And the questions wouldn't either get out to AST-500, they wouldn't be presented to Scaled, or they would sit in the management realm and then, all of a sudden, we were there ready to try to issue a permit.

And so my MRBs would always be I don't have enough information to ascertain whether the vehicle is safe or not. I didn't get this information. They didn't meet this regulation. They didn't provide me this data and these questions. You know, we didn't have these technical interface meetings I requested, so --

Q. All right. And did you have any direct contact with Scaled?

A. Only time I -- and this really became a problem -- not with Scaled, no. With Virgin Galactic, yes, because I was pointing out all the problems we were having and that, you know, you guys kept putting on pressure on me to -- management kept putting on pressure to try to get this thing resolved. So I established a communication with Will -- not Will Upton, Chris Moyer for VG. And he and I started to work.

So a lot of the knowledge I got on the vehicle came from my VG work. I had very little interaction with Scaled until near

the end when we started looking at the terms and conditions, where we asked them to show us the qualification data and how they're conducting the experiment, how they're mounting their motor, because we wanted to get more information on specifically how the dynamic response of that motor was being transmitted to the other safety critical components.

Q. All right. Okay, backing up a little bit here. Could you define what MRB is?

A. MRB is the Management Review Board.

Q. Okay, great. Thanks.

MR. HAUF: I'm going to pass the questioning on to Dave. It is getting close to the hour mark.

MR. LAWRENCE: Right.

MR. HAUF: Do we want to take a break now or continue on?

MR. PREAMBLE: It's up to you guys.

MS. WARD: Let Dave go and --

BY MR. LAWRENCE:

Q. I only have one question. Tom, we didn't --

A. Can you identify who's talking for me, please?

Q. Yeah. This is David Lawrence. I'm with the NTSB. Just a quick question. I'm not sure we got the background, your background prior to coming to the FAA?

A. I've got extensive background in systems engineering. I started with NASA as a -- working as a contractor doing shuttle

ascent trajectory analysis, where I evaluated statistical variation on some of the ascent propulsion systems and structures to look at trying to calculate what we call flight performance reserve to make sure we had enough fuel and oxidizer on board to complete the mission, and we look at atmosphere. And then part of that mission was to design the trajectory. So I have about 5 or 6 years of doing trajectory analysis and launch vehicle evaluation.

I moved over to NASA and went to the space station. At the time it was Space Station Freedom. And I was the mission operation director at -- which is -- everybody sees the flight control room as E&I representative to the program office. I moved over from there to the ISS program lead for design analysis cycle, where we evaluated design concepts against the requirements to try to refine those and make sure we had the right performance. From there, I moved over to the SE&I team, test and verification, where I spent a number of years interacting with the contractor to conduct the environmental qual test programs, and then on the back end showing the -- reviewing the analysis with the appropriate technical expertise to show that they met the regulation and then signing off on the regulation, that they had provided sufficient verification of it, and I ran that team.

I was after that point nominated by my management to participate in a NASA program called Professional Development Program, where I spent a year at NASA Headquarters learning various aspects of how NASA works and the management. When I got

back, we had just launched our first -- we were just launching our first component or had just launched our first component of the station and we started -- we geared up a room called the mission evaluation room. It's called the MER. And a brief explanation about that.

When you look at TV and you see NASA, you see the flight control center, and it's populated by the operations team that monitor the vehicle. And when an anomaly occurs, their responsibility is to react to or save the vehicle and crew based on flight rules that are developed from the engineering team and the operations team. The person in charge is the flight director, and he talks to the main counsel people, and then they have backroom people that support them and follow the mission, et cetera.

There's an exact identical room like that beneath them, and it's populated with all the engineers that designed, developed, tested and integrated the systems, and that's called the MER, the mission evaluation room, and we have exact same counsel. And I was the MER manager, and I managed that entire room and interfaced with the flight director. So my counterpart was the flight director. So when an anomaly occurred, he typically would call down to me and ask me and my team what we thought, and we would give them our recommendation. So I managed that room for a number of years.

After that, I moved on to the chief engineer's office at

JSC, where I conducted a number of reviews and investigation on behalf of the JSC center. And then I was asked to be the first independent technical authority which eventually became the NESC. So my responsibility there was I was independent of the organization, and I would come in and sit next to Mike Suffredini, the program manager, and we would review these technical briefings. And he would look to me for my technical evaluation, and say, yeah, I believe that they've done enough and the risk is low enough, and then he can make a decision based on whether -- the schedule or cost. So it tried to separate the technical and the cost. So I was the first ITA, independent technical authority.

After that, I went to -- Constellation geared up, and I went over to the SE&I team and became the deputy for the SE&I process in analytical tools group, and worked there for about a year and a half until it was reorg'd, and eventually it went away. So I was asked to go and -- actually, I went and talked to my management, said look, you know, with this system safety board getting geared up, I asked to be the chief engineer on that. So I went to the chief of staff office and represented the program on the system safety review panel. And we went to each of the projects, because we had a number of projects for Constellation, and we would review their approach on system safety and their analytical data, and we documented the process that they should follow. And so we were that check, that integrated program check.

I left NASA after about almost 19 years and went to work for a small company consulting because we were downsizing and there wasn't a lot of work and just, you know, needed something to do, more of a challenge. I went to a company called Special Aerospace Services, and Wayne Hale, you may or may not know, but Wayne Hale and I were at that organization and we spent -- I spent about -- a little over 2 years as their chief systems engineer.

And then during that time frame, I ran into Jim Van Laak, and he was a deputy program manager -- deputy administrator at the time. And I told him I'd, you know, I'd like to get back in, but I didn't want to -- I'm not sure I want to go back to NASA. And he kind of talked to me about this position. And then I talked to Terry Hardy and -- who had, you know, at that time left, and decided I was going to come over. So I joined the FAA 2012.

Q. Thanks, Tom. Appreciate it.

MR. HAUF: Thanks, Dave. Mike?

BY MR. BAUER:

Q. Okay. This is Mike Bauer with the Systems Group. Just, hopefully, two brief questions. But for the -- you mentioned how much time you would be allowed to do for reviewing of an application. You mentioned 120 days and 180 days. And what was the difference?

A. Correct.

Q. It was 128 days for the application and --

A. Yeah. So the statutory regulations, when we accept an application for an experimental permit, we have 120 days to provide the applicant back with a response from the FAA, whether we issue a permit or we deny it; if we deny it, these are the reasons. If we deny it, then they have the opportunity to go and protest that up through another chain to Dr. Nield.

So the process is when we get through evaluating, which is about 120 days after the accept the application, we're supposed to make our technical presentations to the gentleman that's ultimately responsible for issuing these permits and license, and that's Ken Wong. Ken Wong is supposed to be this independent person because I think he's an L-Band, which is pretty high in the FAA. He is the one taking responsibility, and he authorizes the license and the experiment.

And if we denied it, and he would deny it, then they had the option to go the other route. That's when the administrator is supposed to not be involved. They go to Dr. Nield, and Dr. Nield can make a determination whether he's going to issue the permit.

Does that make sense?

Q. Yes. The one that would take 180 days, that was --

A. For a license.

Q. For a license. Okay.

A. Process is --

Q. Go ahead.

A. I said the process is the same. I'm sorry. I stepped on you.

Q. Oh, no problem. When you receive the application, are you -- is that your first initial -- is the information you receive on the system based on what's in the application, or do you have interactions with the applicant before that about the system?

A. So we've moved the bar. So I'll start at the beginning. At the beginning, we didn't get to talk to the applicant until the application was submitted. And then even then, we were kind of not engaged unless they decided -- unless, you know, there was a request by them to come in and make a presentation to us to get our team going.

So the experience I've had has been we got this application and start looking at the data, and then later on, within the 2 weeks, occasionally, we would have the applicant come in and make a presentation to the entire team. And at that point they were looking, within that 2 weeks, to make a determination for each of the teams that had to provide technical evaluations, whether the application was complete enough.

Since then, because I've had -- you know, because we pointed out all the deficiencies and how our team was struggling -- and I mean that; it's not just me; I mean, it's our whole team -- we've now since moved that bar to the left. We're getting applicants coming in, in just the conceptual phase and

giving us information on how they're doing it at the broad level. And that allows us to do a lot of things, but it gets us engaged early. And that's the first time that we have talked to the applicant.

Now, I'm still not allowed to talk to their technical team. They want us to go through our management, you know, through Stewart Jackson over to Glenn Rizner and through Mike Kelly and then, you know, after we get those questions all vetted, then it would go out to them, even at the early stages. But we have moved the bar, so I'm excited about that.

Q. Okay. Thank you. Those are the only questions I have right now.

MR. HAUF: Katherine?

DR. WILSON: Did you want to do the break?

MR. HAUF: Oh, yeah.

DR. WILSON: I have four. I don't have a lot.

MR. LAWRENCE: I think a break would be good.

MR. HAUF: Tom, if it's all right with you, we're going to take about, probably about a 5 to 10-minute break here.

DR. WILSON: Five.

MR. HAUF: Five-minute break.

MR. MARTIN: That'll work.

DR. WILSON: I think we're going --

MR. MARTIN: Can I make a request?

MR. HAUF: Sure.

MR. MARTIN: That young lady that's speaking, I can barely hear her. If she wouldn't mind moving closer to a mike, it might help me.

DR. WILSON: Yep. When it's my turn to ask questions, I definitely will.

MR. MARTIN: Thank you.

MR. HAUF: Okay. Everyone on the phone, we'll be back in about 5 minutes.

(Off the record at 10:30 a.m.)

(On the record at 10:43 a.m.)

MR. HAUF: Let's go back on record.

Okay. Katherine?

DR. WILSON: Thanks.

BY DR. WILSON:

Q. Tom, this is Katherine Wilson, the Human Performance Group Chairman. I have just a handful of questions for you. Can you hear me better now?

A. Absolutely. Thank you.

Q. Okay. You mentioned that you had wanted to do a more thorough review of the permit application and were told that, you know, they were going to move forward with the approval process. Do you know what the motivation from AST would have been to approve the permit without doing further analysis? Did anybody --

A. Well, let me correct that statement just a moment.

Q. Okay.

A. I was never told they were going to move forward without, you know, without my input. They just did it. So they would just never address my concerns.

Why they did it, you'd have to ask them. I mean, I can speculate and tell you that, you know, in order for me to sign something, I have to be comfortable. So somehow, somewhere, someplace, after the management -- after the technical team made our presentations and recommendations, even in the, what they call the after-review, the hotwash, they got -- the management team would get together and make this decision. So they got comfortable somehow, someplace, but that was never information that was given to me. So you'd have to ask them.

Q. Okay. Were you aware of any single-point failures in the design of the system, the SpaceShipTwo?

A. From the Scaled perspective, no, because I didn't get to review their application in its completeness. From Virgin Galactic, I did ask -- I did have the conversation about the specifics of releasing the feathering mechanism. The feathering mechanism is what we call tolerant functionally, when you look at the locking system that they've implemented. But my questions to Chris Moyer at the time -- and I'm going on recollection, but -- I can't find my notes because I moved from VG to Houston, but from my -- I recall Chris and I had this conversation, and he said that if they released the mechanism, they would be able to survive the gravity turn but they would ruin all the hydraulic systems and

stress the mechanical structure to the point where they have to go and replace it. So that's my recollection, but -- and I usually write that stuff down. I just can't find it. And that was from VG's perspective. That was not from Scaled.

Q. Okay. And this was before the accident, correct, these discussions?

A. That's correct. This is well before the accident.

Q. Okay. Were you aware of any other concern -- or let me start over. Was anyone else in your department concerned about approving the permit for Scaled?

A. I think everybody had a little apprehension, but you know, there's this internal perceived -- it's hard -- when you don't -- when people don't write things down, and you go into meetings, you know, you get a feel for how things are going. And in discussions at the technical meeting, you know, everybody would say, yeah, we know there's a lot of risk but management wants -- and this is common statement -- management wants us to issue the permit.

In fact, when I brought up the waiver, this is really interesting because I had some experience at NASA with this. When I brought up the waiver, I was pulled in by one of the managers, a guy by the name of Glenn Rizner, and he told me specifically that Dr. Nield does not want you to raise that issue about the waiver.

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. So I can't tell you what other people were thinking. I can tell you that my mood and some of the discussions we had in the technical team, that I think everybody kind of agreed we weren't doing a complete job.

The only other documentation that I saw was a structural analysis done by our structures team and two gentlemen that have left. And I'm going to really pull on memory strings here because I'm old. Mahamay (ph.), I think I'm saying it right, and the other guy's name was John, and I couldn't tell you the last name. I went and found their report, and in their report, their first paragraph states, yeah, structures are safety critical, and Scaled did not address this in their application; the approach they took was sufficient, but they should have done it.

Q. Okay.

A. To me, that was the technical rationale for a waiver if

they weren't going to document it, and I pointed that out to my management when I found that, so --

Q. Have you worked on other permit applications?

A. Yeah. I have worked on quite a few, and that's -- the process that I explained with Scaled is exactly what's happening in other applications for permits and licenses. The two instances where we signed off on -- my team signed off and said, yeah, we recommend a license or a permit, were with organizations that have a very strong engineering team and understand what a system safety program -- not to say that Scaled didn't. It was more of we were able somehow -- they had provided us a very good description of how they were going to do it, and we had very few questions to ask them and we were able to get those questions through and get confident in their approach and verification data. So those two instances, we were able to say it.

But other instances, and I'm not sure I'm allowed to name other applications, but the data has pointed to a number of issues that have manifested themselves, and I stood up in front of my management and told them that. I said the data is pointing here, we shouldn't issue these other pieces of paper. So yes, we're having the same problem.

Q. Okay. Thank you, Tom. That was all my questions.

MR. HAUF: Okay. So let's go to the FAA. Dan?

MR. WARD: Do you ignore me?

MR. HAUF: Oh. Sorry. Lorenda?

BY MS. WARD:

Q. Hi, Tom. I'm Lorenda Ward. I'm the IIC for this investigation. I just wanted to continue --

A. Good morning.

Q. Good morning. I just want to continue that line of thought. Kat had asked you about the number of permits and licenses that you've had the opportunity to review. Can you give us an estimate?

A. Give me a second.

Q. Sure.

A. Yeah. If you give me a second, I can -- do you care if I pull it up on my screen?

Q. Yeah, because I can't see it.

MR. PREAMBLE: Tom, this is Brad Preamble. I just want to add that just for sake of the fact that we have some industry representatives in the room, not to disclose who is making those applications by name. I just want to remind you that we'd prefer you not to do that, but you could talk in general about the number you've worked on.

MR. MARTIN: Thanks, Brad. That was a good comment. Okay, just give me a second and I get a number for you.

So while talking about it, the number -- when we talk about working on applications, let me get a clarification. On actual, where we got into accepting the application and were working on it, or number of applications I'm working on now, even

though they may be in pre-ap? So let me clarify that question.

BY MS. WARD:

Q. I'm trying to get a sense, one, of your workload, and then I was trying to bracket your comment where you said that your team has only approved, I think, two permits and one license. So I was trying to scope that.

A. Okay. So number of licenses I have worked on and permits that I am working on is probably -- this is a rough guess because I don't have the data in front of me; I thought I did -- but I'm going to say, I think roughly six over the last 2 years.

Q. Okay.

A. Most of my work has been working with these trying to get the information and doing process improvement and procedure improvement. The pre-applications, though, which take some time as well, that can get up to 10 pre-apps. And I think the application quantity I probably am usually working on at a time, maybe two to three at a time. Does that help?

Q. A little bit. So are you saying that you've looked or reviewed at least six licenses?

A. Six -- let's see. I have one -- well, okay. So I include -- it's not individual companies, right. It could be companies that have submitted something, and we provided our response back, and then they update it, so I have to go back and look at that. And companies that have reissue of a license or a permit or have other experimental systems going on at the same

time that they have a license evaluation going on. So yeah, this -- I would say roughly five or six.

Q. Okay. Once again, just trying to scope out the numbers, because then when you say your group approved three, that's half. So half of the permits that you've seen or license, you've approved? Would that be --

A. Oh, no, no, no. I was -- okay, so maybe I didn't understand your question. Really the question is how many have we issued since I've been there, right?

Q. Yes.

A. And then how -- I approved. So that's a good question. The only two that I approved were the two that I mentioned, and the ones that I did not have enough information on were about four or five.

Q. Okay. So then we're back to six, six or seven.

A. Somewhere -- yeah, but that's really a rough estimate.

Q. Okay.

A. You know, the challenge here, and you guys probably -- you know, anybody that's got any experience, the challenge is that you've got to be able to, from my perspective, understand a system that is unique. And people write differently and they document what their system is doing. I've got to be able to go in and read that and then -- you know, I try to do that in little chunks. I read it and I say, okay, great, now I can go look at this, and I evaluate it. My process is I go and look at the system, and if

they don't have a system briefing for me, I develop a system briefing and I give it to the team. It's not just me.

So my job is an integration one. I also look at bringing everybody in with their collective experience, say this is how this system works and here's the hazard. I didn't get to do that for Scaled, but that's what we did for Virgin Galactic on the two that we approved for the license. The other ones, we didn't have that information and I couldn't follow through that process. So, when the technical eval came up, my response was I don't have sufficient information to ascertain what their true safety is because I did not get enough information; therefore, I cannot make a recommendation on the license.

And that's just my way of saying, you know, officially guys, you ought -- we're not doing the right thing. You know, when we're not putting in the document -- I'm having hallway conversations with the management team and specifically Ken. I've told him a number of times I didn't understand how he signed these things because we weren't giving him any data. So he's getting something that I'm not getting, and he's making a determination where he's comfortable. And from my perspective, I didn't get it. But you know, they never send it back to me because I'm buried in an organization and I have to go through my management, and they make a determination whether they want to elevate it or not. And then it gets overtaken by management so it gets lost.

So my workload is challenging because, you know, I

started out as a single person and I've got -- I had Terry, and I've got two other folks with me, but one left the organization, and now we're back down to just me and this other guy, so --

Q. Do you still have only 2 weeks to review your portion of the application?

A. It seems to have been relieved a bit, because we've moved the -- the approach we made to our management, management has an offsite once a year, and we put together -- Terry and I and Jay put together a presentation and documented our issue and saying, guys, we can't continue this way. So we've moved that pre-application to the far left. We haven't gone through a complete pre-application with that process yet to accept an application. So I can't tell you if it's going to work or not. But it seems to be working because we are getting engaged with the applicants at least on a monthly basis. And they're sending documents for us to review, little bit pieces, so we can help them achieve that complete enough stature.

Q. Tom, you also referred to technical teams a couple times. I think you referred to it, I think, internally within the FAA, then also externally with the applicant. How many technical teams does the FAA have that reviews an application?

A. Well, we have -- AST-300 is comprised of various parts, but the two technical teams, and they are system safety team and the flight safety analysis team. I can't answer how they divvy up the regulations and who's going to go off and provide evidence if

they've met it or not. But we do have subject matter experts that are scattered through the organization that I count on. Like Don Sargent, he worked for me at the MER back at the ISS, when I was working with the mission evaluation room, as my propulsion guy. So I know he's got a very strong background. So anything propulsion he tends to look at anyway. When I go and talk to him about the hazards, he looks at it independently, and him and I together, you know, evaluate that.

We had two structures guys. They left so I had to do structures. We don't have an electrical guy. We have an engineer -- a chief engineer's office, where we have one Ph.D. and some other folks in there. I'm not sure -- I understand their background enough to be able to tell you what they do, but I know that they haven't participated in any of our reviews.

And then I read Mike Kelly's background. There seems to be a lot of management, you know, experience with high-level people like Ann Golden. But I didn't see a lot of experience with him, you know, doing the stuff like we're doing, doing the analysis. Now, he may have it, but it wasn't on his resume.

So it's scattered throughout the organization. The big problem, I think, it comes back to is that, you know, we would get our information or get our questions together and then we would get pushback from our management. I mean, at one point, to be honest with you, I joked with one of the guys -- I think it was Sherman, who is in AST-500, and I said, I told -- I promise I

won't ask any question I don't need the answer to. What I need is questions asked. And that didn't really help.

Q. How would you characterize the structure of FAA within AST then?

A. Distributive, I think is the best word. See, that's really a question for Dr. Nield. Because, you know, I've managed teams before and I've managed groups before, and I know how I would organize this team, and I would understand the end-to-end flow. I've looked at our organization, and there seems to be put up -- they seem to put up a lot of barriers, you know, within our own organization.

For instance, my management, you know, to me, when I write an email, that's official. It's an electronic document that you can retrieve and you can say, okay, this is what Tom was thinking. I may not be the best writer, but you could at least question me on it, right? My management, since I've been there, have been insistent upon writing memos. And so I have to spend a day or two writing memos, going back and forth to him, and then it's issued to the other managers. So there's like swimlanes. And that makes it very difficult to try to get a unified, integrated answer.

So I tend to, you know, write a memo when they ask me, but I usually go and I sit down, or I call the person, and we talk within our organization. And I go and talk with pretty much everybody and try to figure out what their background is, and can

I leverage off them. So it's a little selfish. Because I want to get a large perspective on these unique approaches that we're getting asked to evaluate. So distributive is my best guess. But why it's distributed that way, I can't answer that question.

Q. You just mentioned that you talked to everybody within AST. So how is your communication within AST-400 and 500?

A. 400, okay, that's interesting; 400 is the inspection, right?

Q. Right.

A. I always lose these numbers. Yeah, the safety inspection team. One of the things I did was -- thank God I have a Dave Gerlach. Dave and I, when I first got there -- I worked with his dad at NASA, and I knew Dave a little bit when he was there. So I got there, Dave and I were talking, and I said, look, you know, here's the process I want to put in place. I want to be able to evaluate the system, have a system briefing and everybody evaluate the hazard as a team, and then look at the mitigations and go in. And then, you know, at the end, they should be -- before they launch, provide us with verification statements or evidence that they've done what they are supposed to, because up to that point, we've agreed with everything. We understand the hazard. We've identified potential hazards they didn't, but you know, we gave them relative risk because it's a brand-new system, right.

But my report, what it does, is that as we go through it

as a team, we identify terms and conditions. An example would be, you know, Scaled -- and I don't know if Scaled did this, but Virgin put this in there, that they would only fly their minimum time. So to me, that's a terms and condition, and that needed to be documented because I didn't want it to start drifting. So when I'm writing up my report, I have a report that I generate that is part of it -- it's usually pretty thick -- we have an appendix of these are the terms and conditions, and those are the things that we're -- assumptions or recommendations that we're making to the licensing team and to the management that they should implement, put in their application -- I mean, on their license -- what do you call it -- approval.

The other thing is is that you tend to get, with a system like this, you get a lot of things that can't be verified until right near day of launch. And that might be, for instance, and this is -- I'm just pulling something out of a hat. They had to remove this pin from this mechanism that's used for ground loads before they fly. If they don't, then bad things happen, let's say. And the control is they have a ground procedure that says they've done it, and they check it off and they sign it. The verification evidence would be, you know, a report at the end of the day.

Well, there's some inspection items similar to that, that says that I need these checked because they're directly linked to, or I envision them being linked to a hazard analysis.

And that's my experience from NASA. So I would have another appendix in my report that is the licensing items that I need checked off. And I worked with Dave Gerlach to develop that format.

So when we get through the entire process, you will get a report that says, okay, here's an executive summary what's going on, here's all the regulations we evaluated, here's the functional tolerance of all their safety critical system. That's in the executive thing. Then you would have a detailed section of their system description that I took excerpts out of the application they gave me and conversations that, if I had with them, I would pull out to put in there. Then you would have a section of hazard analysis, so we would summarize their hazard analysis, how it manifests itself, what's the risk associated with it, what's the likelihood of occurrence, what are their controls in place, what's their verification that they want to do, and did they provide us verification evidence. And that would be an appendix as well.

So my report is complete. So at the end of the day, when we issue a license, I sign it, and I have my boss sign it. I was trying to get the chief engineer to sign it, but he wouldn't sign it because it's a pretty thick document. So I signed anything -- so anybody that works with me or for me that is doing system safety is generating one of those reports, and we would have weekly meetings to make sure that they're on track and, you know, my job is to help educate and train as well. But at the end

of the day, I would sign it, and then Stewart Jackson would sign it.

Q. All right. Tom, I just have one more question for you. Because you had stated that your title, that you are the lead system safety engineer for AST-300. Do you feel like you're --

A. For AST.

Q. Yes?

A. I'm sorry. For AST. I'm not just for 300.

Q. Okay. For --

A. I'm in 300, but I'm the lead for the entire division.

Q. Okay. So my question to you is, do you feel effective, or do you feel like you're being listened to?

A. No, and I've brought that up several times,

Q. All right. That's all my questions.

MR. HAUF: Okay. FAA, Dan?

MR. MURRAY: I don't have any questions at this time.

MR. HAUF: No questions. Okay. Brett?

BY MR. VANCE:

Q. Yeah. A question for me, Tom. This is Brett Vance. I'm out of Los Angeles FAA cert office. This has a little bit to do with the waiver itself. If you're familiar enough with it, maybe you can answer this one. There were a lot of mitigating strategies that were actually put into that waiver. Do you know if there was actually an analyzed hazard to go with every one of the mitigating strategies that was put in the waiver?

A. No. I did not look at the waiver detailed enough to be able to answer that question. So, I'm sorry, I can't say. I wish I could respond to that, but I was not part of that process and I did not -- I just read it, and my first feel when talking with Terry was this is wrong, you guys didn't -- this doesn't make any sense. So, I'm sorry, I can't answer that.

Q. Okay. Next one is did you get any specific indications, and what were they, if any, that a firm launch date might trump a thorough analysis of an evaluation?

A. Ask that question one more time for me.

Q. Yes. Did you have any indications that a firm launch date might trump a thorough evaluation?

A. The common -- nothing written down. I mean, nobody would ever write that down. So this is all going on memory and -- but, you know, when it occurs a bunch of times, it's pretty easy to recall the memory. There are a number of cases, not only just with Scaled, but with a number of other applications, we've got to get this technical evaluation out, they're launching next week statement. And my response, I already told you, was, guys, we should never, ever let a launch date trump the work. They should not launch until we're confident. And it would kind of die on the vine and we'd go on, and then they would issue the permit anyway, so --

Q. Okay. And last thing had to do with AST-400. I'm glad we finally got to that because that's got a lot of interest for me

as an operator. Would you happen to know if as part of their inspection process that -- whether or not AST-400 might have some kind of a launch day kind of go/no-go checklist that they might evaluate against some things you might require or that the waiver might require?

A. I do know when I was talking with Dave before he moved on to another opportunity, Dave Gerlach, Dave and I sat down and he kind of explained to me that they develop a launch inspection type book that they follow and their responsibilities, but I don't -- you know, I only got introduced that a couple times.

My process, because I touch everybody -- I mean, if something happens, I look at it. For instance, you know, the Dragon's on orbit right now, and they had an ammonia leak on the station. So my responsibility, even though it's not clearly stated anywhere, that's basically my responsibility, say, okay, how does that affect a license that we issued.

So I would go and say look, guys, this system was designed, you know, for this. If they can't get to it, the longer they're in orbit, the more they're exposed to the environment that they may have not designed for. You know, their life -- I'm throwing this out. I don't know this for a fact. This is just showing you an example. So if they only expect to be on orbit 2 weeks, so they design it to survive 3 weeks. Well, if they really do have an ammonia leak and they can't get into the lab, that thing's going to be on orbit maybe a month or two. And if those

components get exposed to those environments, that's going to impact the reentry because of the fact that, you know, we need these systems and functions that -- safety critical functions to operate to protect the general public. So I document that because, you know, if there were an anomaly, that can impact our current license, and I would send it up.

How the inspection team implements and reviews things, I don't know. But my job is to look at the entire system, document these are the things I need, and I give to Dave and Dave was going to, you know, work on a process to implement it into their document. So that's the extent that I had with respect to interfacing the 400.

Q. Okay, good. Tom, I think that's all the questions I've got. Thanks.

A. Thank you.

MR. HAUF: Okay. Bob, with Scaled?

BY MR. WITHROW:

Q. Hi, Tom. Bob Withrow, Scaled Composites. Tom --

A. Bob, can I ask you to move closer to the mike? I'm sorry.

Q. Maybe we'll move the mike closer to me.

A. Okay. Fair enough. Good solution.

Q. Tom, can you hear me now?

A. I can. Thank you, Bob.

Q. Can you tell me when Scaled began pre-application

consultation?

A. No, because I was not a part of the FAA.

Q. Okay --

A. I came in, again, March 2012, and at that time Scaled was in the final throes of getting their permit issued.

Q. So from your opinion, if Scaled began pre-application consultation in early 2010 and submitted a draft application and supporting materials, would that be enough time to make an adequate evaluation?

A. Well, there's an underlying assumption there, Bob. Yeah, 2 years would be sufficient. But, you know, what you're assuming there is that we had some people that were -- had enough experience to be able to step through a system safety process and know what to ask. I mean, I got 29 years of doing systems engineering, so a lot of my questions are based on experience and mistakes we made or caught at NASA. I can't speak to who was there in 2010, and would they have been able to -- had enough information at the time.

But when you're talking theoretically, absolutely. That's why we've moved it up, because typically these systems start development really early before they're going to launch, 2 to 3 years. And that's when we want to get engaged because we want to assist. We want to become like a partner in safety and ask them how they're doing things so that when they get to a license, they have thought all the stuff from the collective

experience of not only your team but maybe our team.

So I can't answer would it have been enough time, but theoretically, that's how we've established our process. And because I do have a lot of experience and I have people on our team that have a lot of experience, you know, we're finding a lot of these issues frontally in other applications.

Q. Okay. Is it your opinion that at the time of Scaled's pre-application consultation through the evaluation of our application, that the FAA had enough experience to be able to effectively evaluate our application?

A. I can't answer that because I wasn't part of the review until the latter stages, and then I had to go back to look at the application data that was provided. So I can't answer did they have enough because I don't know who was here and who had left. I mean, they've had some rollover, so I can't answer that.

Q. That's all the questions I have.

MR. HAUF: Okay. Nikki, do you have any questions?

BY MS. DUGUE:

Q. I have just one question. Back when you were explaining the process that you go through when you're evaluating an application, you made a statement about -- you said that management doesn't trust the technical team. What technical team does management not trust?

A. So that statement was anchored on what we call -- we have what we call a hotwash. And what the hotwash stands for is a

post-licensing review of how the process worked. And, I mean, it's not an acronym it stands for, but that's what that means. It's like, okay, let's go and look at how we did this license, and were we comfortable with what we did and the outcome, and then document it in a report. And that hotwash report at the time documented these same issues. And that was there is a perception down at the technical team, the team that's doing the evaluation -- that's what I mean by technical team -- of the application, they don't believe that management is demonstrating sufficient confidence in our judgment because we kept getting overruled on questions. We kept getting overruled on how we did our analysis, that it was too detailed.

And I get that. I mean, I don't want to leave you guys with the sense that I don't, you know, I don't see the big picture. An experimental system is there to test the boundaries. It's to fly the envelope, and I get that, right? But our job is to protect the general public. And when we get information that points to a potential risk, and understanding how that risk is manifesting itself and how these guys, the applicants, you know, go through their process to manage that risk or, not only identify it, but manage it and how they're making sure that it doesn't happen, is extremely important.

So a lot of the questions are, okay, well, how are you doing this, how are you doing that? How does the system really work? You know, who's doing the development of the software?

What do you in your software control -- how do you do your software control plan? And because, you know, the person -- well, I can't speak to that. For some reason, the management team felt that that was too detailed to ask the question. They felt that the controlled area -- and this is what they stated, so I don't have any problem stating this, I mean, a number of times -- the controlled area was sufficient to contain any type of accident. And that's how they would get comfortable, I believe, in not following on with the questions that we asked.

Q. Okay. That was my only question.

MR. HAUF: All right. Thanks, Nikki. Will?

BY MR. ROBERTSON:

Q. Hi, Tom. It's Will Robertson here. I have a couple of questions more on the technical side since, like yourself, I'm an analyst. So I just wanted to clarify a couple points on some things you stated. First of all, I guess I'd like to ask as far as 437.55, could you just briefly explain to me what you think the major requirements are of that on an applicant for a permit?

A. Well, 437.55 is, you know, when you have the specifics, you have to really go back to the NPRM, but -- which would be the preamble that kind of explains why they were written. But the primary reason we have 437.55 is to engage -- is to make sure that the applicant is engaging in a systems engineering process that looks at the design, operation and flight profile to identify hazards that potentially impact the general public.

Now, obviously, you guys are going to be looking -- Scaled is going to be looking at more than that. But their filter to us would be the general public --

Q. I'm kind of just looking for -- I'm just kind of looking for keywords that, you know, talk to me like I'm a systems safety guy. Like what are some of the analysis techniques that are required under that?

A. Oh. Well, we don't specify any hazard analysis technique. Typically, most people will do a functional hazard analysis. Some will do a modal analysis. Some will do FEMAs. There's --

Q. What's required --

A. -- and try to find these hazards. They all have their limitations and, like you know, they all have their advantages, and you -- you know, a lot of them will find 90 percent of them. The regulations don't specify which ones that you want to do, which ones that you want to do.

Q. Okay. So I'm just going to --

A. What you want to do is evaluate which ones you selected. And then the conversation, what I'd like to do is get into like, okay, you guys used this, but this is its limitation; are you guys addressing this at all? And it's not to say you have to, but if you don't, then that becomes part of my write-up because that's part of the residual risk because of the limitations of the way you approached it.

Q. I guess maybe I could answer -- ask a question --
A. The other part of the regulations, though, is, you know, we wanted to -- we want to see that you're actually implementing a process that's being documented. That's why we ask for the hazard -- the risk before mitigations. Because as the process, right, we're going to do a systems and safety, start the design by identifying hazards either from a hazard list or a functional hazard assessment or whatever. And you try to design them out, or you try to add redundancy or, you know --
Q. So would you agree that --
A. -- the risk that --
DR. WILSON: Tom?
MR. ROBERTSON: Tom?
DR. WILSON: Hold on, guys.
MR. ROBERTSON: Tom --
DR. WILSON: You're both talking over each other, so let's just start again.
Tom, I think Will wants to ask you -- clarify his question to maybe --
MR. ROBERTSON: Yeah.
DR. WILSON: -- get you more directed.
BY MR. ROBERTSON:
Q. Yeah. So I, you know, I just really want to know -- let me ask you this. Would you agree that some type of hazard analysis that included human error and software error is a

requirement of 437.55? Yes or no?

A. You can't really answer yes or no. The regulation requires you to consider it.

Q. Okay.

A. So in that respect, I would ask you if I didn't see one, that, you know, how did you guys assess human error or software error?

Q. Okay.

A. And if you came back and said, well, we didn't, then that would go into my report.

Q. Okay. So how was Scaled's, in your mind, permit deficient on 437.55? What did you raise specifically? What was the deficiency or deficiencies?

A. Well, they never provided us -- I know this for a fact -- they didn't provide us the risk before mitigation. They did not address human error or software because we kept asking about safety critical software, and we kept getting a response that the software wasn't safety critical. And our response back to, at least, internally to my management, and I don't know if it ever got back to you, so I got to be fair because of our process breaks, but when you have a pilot that's reading a full functional display and it's using software to interpret sensor data, that software becomes safety critical, and you have a number of safety critical software like on the RFC and the breach detection system. You know, those were -- VMFD may have been off the shelf, but the

other stuff was in-house developed. So we were trying to get -- ascertain how you guys -- did you do a hazard analysis on that, how was the quality control, and we never got a response on that. And I don't think it was -- I don't know why, but we asked the questions and we never got that response.

Q. Okay. And so do you guys have a standard that you use to evaluate compliance against?

A. I'm not sure I understand the question.

Q. Is there an industry standard that you're evaluating the permit, the safety requirements of the permit; is there an industry standard that you follow to evaluate that permit against?

A. What I use and my experience is from is I am familiar with MIL-STD-882 and the NASA system safety approach. So that experience is within me. And the process that I've established and written down is supposed to engage the applicant early and look at just general process of what they're doing, and are they actually instituting or meeting the regulations in this case? Okay, guys, if we would have got there in 2010, my first question in my process would have been, has this document --

Q. Okay.

A. -- include list of hazards and how did you get them?

Q. Okay, so 882 in NASA. So later on, you talked about Scaled's approach using a database of numbers that was then changed by a factor of 10. Just to clarify, do you know where those numbers were coming from that were --

A. I remember reading it someplace in the document. It came from the NPRM with standards for the non-electronic parts reliability database.

Q. Right. Okay.

A. That's the database that's maintained by the Department of Defense, and it contains components and systems in there that other users of that component have reported cellular numbers to, so it's a reliability database.

Q. Right, right. I'm familiar with it. Okay.

A. I'm explaining it for the rest of the team.

Q. Oh, yeah. Sure.

A. The NPRM, and we were told -- and I don't recall when I was told this, but it may have been written down -- they took those numbers and, let's say for failure rate of 1 in 1,000, they made it 1 in 100 --

Q. And so how would those numbers be used? What analysis technique would those numbers be used in?

A. Analysis technique?

Q. Yeah, like of the system safety techniques that are out there, where do reliability numbers show up?

A. Those reliability numbers are supposed to be used in the design performance. Say, okay, we're going to use the system and again, you know, from my experience, right, I'm going to use this number as an estimate on how my system's going to work so that I can say, yeah, I think we got a reliable system. It's not

intended to be used as a means to demonstrate compliance with the regulation that says you have to be extremely remote. In MIL-STD-882, NASA, and even in our own AC, we go through them, we kind of document that, and we say, okay, the numbers, the reliability numbers that they're associated with catastrophic, critical, severe, et cetera, are 1 and 10^{-6} for catastrophic. But in there also it states you're only supposed to use that for design.

Q. Did --

A. Because we don't have enough experience on the system, we look for the applicant to give us mitigations and controls, the qualitative assessment critical --

Q. Do you know if Scaled did --

A. -- quantitative.

Q. Oh, sorry. I thought you were finished. Do you know if Scaled did a probabilistic risk assessment, and if so, were those numbers used in that probabilistic risk assessment?

A. I do not know if they used a probabilistic risk assessment, but I do know that they used the numbers from the NPRM.

Q. Okay, I'm almost finished. So in the context later on, you talked a little bit about motors and instability and -- well, no, I'm sorry, let me back up.

Could you please explain to me -- it sounds like you have a fairly large workload and you evaluate multiple permits. Within your office, are there rules with how you evaluate a

permit, given that you have multiple companies submitting permits all at once and you're working on multiple projects? Are you allowed to, I guess, use one permit to better inform yourself about a license or anything like that?

A. I'm not sure I understand the question. So let me repeat the question to you, see if this is where you're going. Are you concerned that I used another applicant's experience to evaluate another application?

Q. I'm asking if are there rules within the AST-300 department that allow -- that do not allow you to use an application or a permit to evaluate another application or permit against?

A. I'm supposed to -- I'll answer it this way. My evaluation has to stand on the application documentation that's provided and any --

Q. By a specific permittee or licensee?

A. -- communication I had with the applicant.

Q. Okay. And so I guess my last question is you mentioned a gentleman named Chris Moyer. Can you --

A. Yes.

Q. -- can you tell us who Chris Moyer is?

A. Chris Moyer was the VG safety guy, I guess your counterpart. He worked for --

Q. Right.

A. And so he was primarily developing the application for

the Virgin Galactic.

Q. And so what is Chris's role within the context of this exercise we're doing here?

A. Chris Moyer was -- represented VG, and VG had a vested interest in Scaled. But I would never -- you know, our rule, as you say, I can only talk to Scaled about Scaled's information. I can talk to VG about VG information. VG's application -- well, I shouldn't even go there. I can only talk to VG about what they had in their application. So I could not discuss to him --

Q. Okay.

A. -- questions that I had -- if I found a deficiency in your application, I would not go to Chris and say Chris, what the hell are these guys doing? You know, blah blah blah blah, that's not what we want. I would look at Chris and say, Chris, you know, you got a -- and this was -- because I didn't have the detailed evaluation. I didn't do any -- hardly anything on Scaled. I was just looking at the aftermath afterwards it was issued. I was looking at Virgin Galactic's program and procedures, and one of the questions I kind of centered in on was, you know, their release mechanism and what's used -- the pilots use and --

Q. Yeah. I was just trying to clarify because your statement involving Chris had to do with solid motor instability, and I guess I just wasn't drawing, I wasn't exactly drawing --

A. Well, actually -- I'm sorry if I did that. Well --

Q. Yeah.

A. -- my biggest concern with Chris, as I said, Chris Moyer and I had the conversation about the release mechanism. And most of my knowledge about the vehicle came through VG because I was doing the detailed evaluation of them. I did not look at how you guys were -- what procedures you were implementing with respect to ensuring that the release mechanism wasn't occurring until after -- you know, when it was supposed to because I didn't participate in that evaluation. All I would have to do is look at the updates to the application, and I was limited to just looking at those updates. I wasn't allowed to go back and look at the entire application because that would have taken me a couple months to figure out how you approached it versus how they approached it.

DR. WILSON: Okay.

MR. MARTIN: Like I evaluated basically on your application, not on theirs.

MR. ROBERTSON: Fair enough. Okay, thanks. That's all the questions I have.

MR. HAUF: Okay. I have no further questions. Does anybody else? And we're pretty much running at our -- to our limit here.

MR. WITHROW: I actually do have one follow-up question.

BY MR. WITHROW:

Q. Tom, can you hear? We were just -- some microphones got kicked over. Can you still hear me?

A. I can.

Q. Okay. You mentioned being unable to obtain information about the software development processes for the RFC. Are you aware that Scaled delivered to the FAA a document describing the software development processes for the RFC?

A. No.

Q. Thank you. That's all.

MR. HAUF: Okay. No further questions here.

DR. WILSON: Have to ask Brett and Nikki.

MR. HAUF: Oh.

MR. MARTIN: Can I clarify that though?

MR. HAUF: Absolutely.

MR. MARTIN: If they did deliver that to us, because I was not involved in Scaled's development, it probably would have been evaluated by Jay. So it wouldn't have come to me.

BY MR. HAUF:

Q. Let's see. Tom, one last thing here. I was curious if you had any comments or other additional information that you would like to provide that would help our investigation?

A. I think that the process break was evident since I got there, and in -- you learn when you're, you know, through experience the culture is extremely difficult to change. But we are making some headway and, you know, it's unfortunate, but, you know, you make more headway when an event like this occurs, and we are doing that, so --

But the people that I think that were here that could

tell you why we are in the -- why the processes and procedures were where they were would have been the people that were instrumental in developing the regulations, and that's Terry Hardy and Jim Van Laak. I think those two people could give you a lot of information.

I inherited this mess, and I continue to try to fight it and, you know, I don't want to get personal. I do work with the chief engineer quite a bit because he and I disagree on a lot of perspectives. He makes some assumptions that I tend not to. I try to back it up with data. But you know, I think all in all the team is moving forward. It's just it's been very difficult. We don't have any documented roles and responsibility in our -- no charge within our group. So it's difficult to understand who's in charge.

And, you know, once you get past that, and we start, you know, getting documented processes, I think, you know, the regulations are sufficient to protect the general public. We just need to make sure that everybody understands why we're asking the questions we're asking and why that data is important. And we're getting there. It's just been a slow track.

Q. All right. Thank you.

MR. HAUF: If there's no further questions, I think we're good here.

MS. DUGUE: Hang on. This is Nikki. I do have one follow-up question.

MR. HAUF: Okay.

BY MS. DUGUE:

Q. You mentioned that Scaled uses the NTRB and then adds a factor of 10 onto their reliability numbers. Do you have documentation that says that?

A. I believe that's in their application. I remember reading it. I can't absolutely, 100 percent say that. But I remember reading that, and if it wasn't in there, then it was during a conversation. But they told me that they took these values from the database and, not increased it -- well, increased the failure rate, so I guess that would be right. So they would adjust it by a factor of 10 to be conservative. And the problem is is that you don't know what's conservative because you don't know how these things fail in that environment, and that's the biggest issue that I have.

MR. HAUF: Okay. Now I think we're good here. Tom, I would like to thank you for all the information you've provided us and I'll say we're good with the call. So --

MR. MARTIN: Okay. Feel free to call me if you need any other documentation or questions, whatever. Okay?

MR. HAUF: Thanks a lot, Tom.

And everyone else, I'm going to go off line here. Then we'll reconvene at, what is it, 12:30 Eastern Time?

(Whereupon, the interview was concluded.)

CERTIFICATE

This is to certify that the attached proceeding before the

NATIONAL TRANSPORTATION SAFETY BOARD

IN THE MATTER OF:	CRASH OF VIRGIN GALACTIC SPACESHIPTWO MOJAVE, CALIFORNIA OCTOBER 31, 2014 Interview of Thomas Martin
DOCKET NUMBER:	DCA-15-MA-019
PLACE:	Washington, D.C.
DATE:	January 15, 2015

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.

_____

Stephen Grider
Official Reporter

UNITED STATES OF AMERICA

NATIONAL TRANSPORTATION SAFETY BOARD

Investigation of:	*	
	*	
CRASH OF VIRGIN GALACTIC	*	
SPACESHIPTWO	*	Docket No.: DCA-15-MA-019
MOJAVE, CALIFORNIA	*	
OCTOBER 31, 2014	*	
	*	

Telephonic Interview of: THOMAS MARTIN

National Transportation Safety Board
6th Floor Conference Room
490 L'Enfant Plaza East, S.W.
Washington, D.C.

Friday,
January 16, 2015

The above-captioned matter convened, pursuant to notice.

BEFORE: MICHAEL HAUF
System Safety Group Chairman

APPEARANCES:

MICHAEL HAUF, System Safety Group Chairman
National Transportation Safety Board

LORENDA WARD, Investigator-in-Charge
National Transportation Safety Board

MICHAEL BAUER, Systems Group Chairman
National Transportation Safety Board

KATHERINE WILSON, Ph.D., Human Performance Group Chairman
National Transportation Safety Board

DANIEL MURRAY
Federal Aviation Administration

BRETT VANCE, Test Pilot
Los Angeles Aircraft Certification Office
Federal Aviation Administration

BOB WITHROW
Scaled Composites

NICOLETTE DUGUE
Scaled Composites

WILL ROBERTSON
The Spaceship Company

BRADLEY PREAMBLE, Office of the Chief Counsel
Federal Aviation Administration
(Representative on behalf of Mr. Martin)

I N D E X

I N T E R V I E W

(3:31 p.m.)

MR. HAUF: Tom, once again, my name is Mike Hauf and I am the Systems Safety Group Chairman. And going around the room --

MS. WARD: I'm Lorenda Ward. I am the Investigator-in-Charge for this accident investigation and a senior IIC for the NTSB.

MR. MURRAY: Dan Murray, FAA AST representative to the Systems Safety Working Group.

MR. PREAMBLE: Brad Preamble, FAA Office of the Chief Counsel.

MR. WITHROW: Bob Withrow, Scaled Composites and a representative on the Systems Safety Group.

MR. ROBERTSON: Will Robertson, Virgin Galactic, representative for Systems Safety Group.

DR. WILSON: Katherine Wilson, NTSB, Human Performance Group Chairman.

MR. BAUER: Mike Bauer, NTSB, Systems Group Chairman.

MR. HAUF: And on the phone we have Scaled?

MS. DUGUE: Nicolette Dugue, Scaled Composites, Systems Safety Group.

MR. HAUF: And FAA?

MR. VANCE: This is Brett Vance, FAA test pilot, Los Angeles Aircraft Certification Office.

MR. HAUF: All right.

MR. MARTIN: As long as there's not a test for this, guys, I'll be good. So --

DR. WILSON: What?

MR. HAUF: I'm sorry. Could you repeat that?

MR. MARTIN: I said I'm -- as long as there's not a test at the end of this, I'll be good. I'm not sure I can repeat hardly anybody's name. I know Dan Murray from --

MR. HAUF: Yeah, no test today, sorry.

MR. VANCE: Okay, great.

MR. HAUF: All righty. So if we can start questioning.

MS. WARD: Mike, just state what it is --

MR. HAUF: What's that?

MS. WARD: Just state what this since we're going back on the record.

MR. HAUF: What the purpose of it is?

MS. WARD: Right.

MR. HAUF: The purpose of this is to continue our questions from yesterday's interview.

MS. WARD: Thank you.

MR. HAUF: All right, go around the room. I think -- Bob, do you want to start the questions?

MR. WITHROW: Hi, Tom. It's Friday afternoon. I just wanted to clear up briefly a couple of things that I heard in your answers to questions a little bit earlier.

INTERVIEW OF TOM MARTIN

BY MR. WITHROW:

Q. So the first one is, in your evaluation of Scaled's system safety analysis, did you become familiar with the hydraulic systems on SpaceShipTwo?

A. Not through the Scaled application.

Q. How did you become familiar with those systems?

A. Because Virgin Galactic was going to be taking possession of this vehicle, they had a responsibility and requirement to document their systems and their safety-critical systems. And so they provided us an application that contained a lot of data that really drew on Scaled Composite's documentation. So I had an opportunity to look at their hydraulic systems for their -- the flutter control and the rotation of the wing. So that's how I became familiar with it.

Q. All right. So just from a top level, can you enumerate the hydraulic systems on SpaceShipTwo, please?

A. Well, the hydraulic system -- this is all memory. If you want, I can pull it up. It would be easier. But the -- they've got two hydraulic systems on there, and both of them rely on an electrical signal to either bypass the fluid or to allow the fluid to be contained in the piston, and depending on where they are at in the flight mode, that would ascertain where the hydraulic system would be implemented.

And I couldn't tell you when they implemented it. It's

been a while since I've looked at it. So if you want a detailed presentation, I do have one; I can get it. Because one of my tasks in my process that I set up for when I go through a systems safety program, is I try to document the system description, typically in Word, and I put it in a presentation to give to the team, and that's one of the aspects I look at it.

And then when we get it from that perspective we go and look at any hazards they may have listed and we start going around the room and say, okay, here's their system, how it works. Here's their hazard. Did we miss anything? Did they miss anything? Is there something we can help them with, or are the mitigations sufficient to control the hazards they've identified? So I do have those detailed briefings but I don't have them in front of me right now.

Q. That's fine. That's sufficient. So which -- so the pistons, the cylinders that you're talking about that were -- which control surface are they associated with, if any?

A. I think they have two. They have one that's associated with the aileron. The ailerons, they control the flutter of the vehicle, the flutter that might occur. And then they have one, I believe, that's associated with the feather mechanism.

Q. Okay, and is the brake system hydraulic?

A. I don't know. I believe so.

Q. All right, so you stated -- and correct me if I get this wrong. But you stated that you were aware that unlocking the

feather before it was supposed to be unlocked would lead to destruction of the hydraulic systems; is that correct?

A. No, I didn't state that. What I said was, is I brought this up with Chris Moyer. Because when I looked at the system and they told me that they go through the gravity turn and they have two locks to hold the feather mechanism in place -- one of the things that I try to generate to try to show the team and the management is what the functional tolerances are. And they -- Chris was claiming that the system was one-fault tolerant because they only used one lock to go through the gravity turn. And I asked him, well, what happens if that lock wasn't in place, if those locks weren't in place. Because they're mechanically linked, so I find it hard to believe that one lock would be maintained.

And we went through a different number of scenarios with them, and one of them is that they unlock it and they went through the gravity turn -- this is going on memory because I've been looking for my notes since I said it and even before that. But the conversation that I recall was that they thought that they could still get through the gravity turn and that the hydraulic system would be able to take the load, but you would stress it -- you would stress it beyond what it was designed to do and they would have to replace a lot of those components. So that's what I remember.

Q. Okay. And specifically in that case you were talking

about the hydraulic system that you've described for the feather mechanism; is that correct?

A. That's correct.

Q. Okay. That's all in that area.

Can you tell me what the definition is of orbital altitude?

A. Orbital altitude?

Q. Yes.

A. Well, they're not going orbital. They're going suborbital, so is the question still valid?

Q. Well, I believe you stated that the trajectory of SpaceShipTwo went to orbital altitude.

A. I don't think I would -- you might have crossed me up with somebody else, so -- they're going suborbital. Their, you know, orbit -- I think they're trying to design, if you're asking me that question, they were planning to get to a minimum altitude that I believe the government or NASA says they are now at an altitude that would claim to be an astronaut type of situation. I believe that's 300,000 feet, but don't hold me to that. I think it's in their -- I know it's in their application, Virgin's. I don’t know about Scaled. But Virgin states that they'll go somewhere between 300- and 350,000 feet, is what their target altitude was.

Q. That's fine. Your recollection then is that you did not say that SpaceShipTwo from Scaled's permit goes to orbital

altitude; is that right?

A. I don't remember saying that yesterday.

Q. Okay, that's fine. Can you briefly give me a technical definition of flutter?

A. Flutter, a technical definition -- I can't give you -- all I -- I can't give you the textbook discussion of flutter. What I can say is my expectation is when I look at a vehicle, especially when I see multiple films of it, if I see something that's different, then I go and I talk to the experts.

So in this case, I saw the aft tail wing on Powered Flight 3 going into like a harmonic type of response, back and forth. And so I went and talked to Dave Gerlach and I said this looks like flutter to me, but I'm not a pilot. And that's when Dave and I talked, you know, just going off memory again, he said, yeah, it does look like it's flutter. So I couldn't give you the technical definition. What I saw was something that concerned me so I went and talked to people that do have the background.

Q. Is flutter a synonym for vibration?

A. I think that's different in my book. I think flutter is a, almost a -- induced by the aerodynamic load. Vibration is something which is induced -- the way I look at it, would be induced by the system itself, the propulsion system.

Q. And so --

A. You know, the --

Q. So you stated, then, that you -- by observation of the

YouTube video you determined that there was flutter in SpaceShipTwo; is that correct?

A. No. What I stated was that I saw this -- the aft tail wing start to basically what I thought was flutter, going back and forth, because -- you know, going back to my aerodynamic days in school, which is a number of years ago. But my best quality is I recognize what I don't know, and that's why I seek out experts.

So I went and talked to pilots that fly the stuff all the time and have aerodynamic background or structural background. We didn't have a structural person with us, so my first take was let me go talk to somebody that's got thousands of hours and commercially rated in aviation, et cetera, has flown jets, and I went and talked to Dave. I said Dave, this looks like flutter to me. What I'm worried about is when you're getting that response, you know, I know a little bit about it having talked to some structural guys that, you know, if you get into a natural frequency, it could eventually break things, and I was curious why that was happening. So that's how it started.

Q. Did you examine any other data other than the YouTube video?

A. No. And eventually the YouTube video was taken down. So we couldn't -- later on when I brought this back up and my concerns, especially when they changed the outer mold line, that maybe the tripping of the air flow through transonic to supersonic might induce that because of my experience -- an example I gave

you with the shuttle, I went back and looked for that YouTube video and the only one we had of Powered Flight 3 was more of a marketing one that had been provided, you know, to market their systems. So the original raw data was gone. I couldn't show that to my management. But Dave Gerlach stood up and supported what I saw and what he saw, so --

Q. So is it your opinion then that a YouTube video is sufficient information to diagnose flutter?

A. No, absolutely, not. But it is sufficient insight so I can start asking questions, because I want to know, okay, guys, did you expect that? I didn't see it on the first two powered flights; why do you think it happened?

Q. Fair enough.

A. And that's where I was going with that question, and then we found out that they had changed the outer mold line of the wing.

Q. Fair enough. And did Dave Gerlach express an opinion that a YouTube video was sufficient to diagnose flutter?

A. Oh, no. No, no, no. But he thought we ought to at least investigate it and ask the question.

Q. Okay. Did you investigate it?

A. Say that again?

Q. Did you investigate it?

A. I investigated it -- I sent an email out and said, hey, look, it looked like -- the aft vertical tails looked like they

were, you know, in some kind of phugoid or flutter or some kind of oscillation and then the power went out; I think it's something we need to ask about. And then right after that we got word that they had -- that they were going to modify their design to put helium tanks in the wings.

And then Ray Jenkins came back with some pictures, and I think he even Dave Gerlach came back with some ground pictures before the flight, and I said, what are these things? And so we approached Scaled on that and found out that they were facsimiles that were attached to the wing to simulate where these new tanks were going to go. And then that's when I started having a problem with if these things were -- the way it was described to us, and this is just verbal, that they were taped on. I said, guys, you just introduced a whole new set of potential hazards if that's just taped on. How do you even know they're going to survive transonic and supersonic and not fly off into the tail and, you know, cause structural damage?

Well, found out that it was more than that, that they had integrated it into the design with their composite and fiberglass, et cetera, so it was, you know, structurally sound. But it started raising the questions about how do you guys know it didn't trip the flow and cause that problem we saw in Powered Flight 3. And by that time the video was down, so --

Q. So just focusing on what you saw in Powered Flight 3 with respect to flutter, just focusing on that, you stated that

you investigated that, and I'm trying to understand what steps that investigation took, what data was analyzed, and what the results of that investigation were.

A. So what I mean investigate, is when I see that there's a problem or if I see an anomaly or if I get a report from some of the data that they give us after they fly, that they reported an anomaly, my task is I go back and I look at the hazard and I look at the system to see, okay, did we miss something or are the mitigations sufficient.

In this case, when we saw that movement of the tail, my investigation was, first, can I confirm that that was a problem. So I went to the only local expert I had, Dave Gerlach, and I said, Dave, this is what I'm seeing, and he goes, yeah, I saw the same thing. I said I got an issue with that, do you think we ought to be concerned? And he goes, yeah, we need to know where it's coming from. But, you know, we didn't have enough information and I said let's go take a look at it. I brought it up to my management saying I saw this on the tail but we don't know where it's going. Then a couple of weeks later we found out that they had changed the outer mold line, and I put two and two together, and so I'm like, guys, maybe this is the source of that problem that we saw. And that's why I started investigating -- you know, when I say investigating, I started proceeding down that line of questioning.

Q. So --

A. I did never get any data from those guys until after we had gotten through my management, and my management thought it was okay, but they allowed us -- they did ask the question and I think Scaled came back and said they did a CFP and they did a number of drop tests with this that -- so sonically they correlated the CFP model and that they were comfortable that those outer mold line changes would not induce what we saw. And so I said, well, if you guys -- I disagree, but Mike Kelly and Dr. Romanowski thought that we could put this thing to bed. And I said okay, let's move on, they're adding tanks, now I'm worried about the structural part of this stuff, and that came up later during the MRB.

So that's -- that's as far as I went. I never got any data. I wasn't allowed to pursue it. I raised the issue. My management heard what I had to say. By this time the data was gone and they ascertained that they had provided sufficient response to it, that it wasn't a major change, and I was told to drop it, so I did.

Q. So just to summarize what I understand, then. The data that you examined were two things: The first was the YouTube video and the second was a discussion with Dave Gerlach, and that's the extent of the data; is that correct?

A. And the photos of the outer mold line changes from the powered flight; that's correct.

Q. Okay. That's it. Thank you very much.

MR. HAUF: All right. Anybody else have any questions?

Mike?

BY MR. BAUER:

Q. Tom, this is Mike Bauer with the Systems Group. Just a follow-up to Bob's first question, just to be clear. Your discussion of hydraulic systems with relation to the aileron system and possibly the feather system is related to Virgin Galactic and their permit for SpaceShipTwo --

A. That's right.

Q. -- not the Scaled Composites' permit application for the --

A. I didn't get involved with the Scaled Composite application until the second renewal. And then at that point I was only allowed to look at the changes, the ones that they submitted -- to their application. And then from that perspective it was did they have -- you know, what hazard was impacted by this change and are the mitigations sufficient? So that's -- I never got to look at the whole package that Scaled provided us.

Q. Okay. Thank you.

MR. HAUF: Okay. Katherine?

DR. WILSON: No.

MR. HAUF: Will?

MR. ROBERTSON: No.

MR. HAUF: Okay, Lorenda?

MS. WARD: No, nothing.

MR. HAUF: Anybody on the phone? Nikki, do you have any

questions?

MS. DUGUE: No questions.

MR. HAUF: Okay. And Brett, any last follow-up questions?

MR. VANCE: Yeah, I have a follow-up to the flutter discussion, just real quick.

BY MR. VANCE:

Q. One again, Tom, Brett Vance, FAA test pilot. When you guys were discussing the flutter episode that you saw on the video tape, was there any discussion along with that of limit cycle oscillation?

A. No. I didn't have that background to do that. You know, I've got a very strong background in systems engineering, which means I know enough about, well, I've got to get some experts to explain this to me and bring them together to have that discussion, but we never got to that level of detail.

Q. And just to finalize that a little bit, did you ever get a chance to see any telemetry data, like strip chart data, from --

A. No, I did not.

Q. I'm sorry. I stepped on you. What was that again?

A. Oh, that's okay. I stepped on you, so -- no, I did not get to see any data.

Q. Okay. That's all the questions I've got. Thanks.

MR. WITHROW: I need to follow up then.

MR. HAUF: Okay. One last question here with Bob.

BY MR. WITHROW:

Q. So just to reiterate what I believe you said just a few minutes earlier, so a question was just asked and the question was with respect to the flutter incident. I asked if viewing a YouTube video is sufficient to determine flutter and your answer was no, it's sufficient to start investigating a flutter. So in your opinion, is it a fair characterization to say that there was a flutter incident in Powered Flight 3?

A. No, that's -- see, you're crossing answers here. What I saw on the vehicle was different than what I saw in the first two powered flights. Because I'm not an expert in aerodynamics, any flutter, I went to Dave Gerlach and said, hey, does this look like we ought to be worried? This looks like flutter to me. And he goes, yeah, there's something going on.

So I didn't say that it was -- that there was flutter and we had to go. What I saw was the tail start to oscillate back and forth as they went to transonic. So that to me was sufficient because it was different than the first two powered flights that I had seen. And that going to transonic is pretty rough, right? I mean, I remember that in school. So I started looking at -- talking to Dave, should we investigate that, and he goes, yeah, we should keep an eye on that and we can ask the question.

Well, a couple of weeks later goes by and we hear that Scaled was coming back to tell us that they were going to resubmit their application because changes -- not do any more powered

flights because they had seen some vibration on the vehicle. And then right after that, Ray Jenkins came and showed me a picture of the outer mold line changes, and then I already made the connection on why it was a concern because of my experience with the Columbia accident investigation, and if you guys went through -- Scaled went through transonic and supersonic, then I was -- the question I was asking, could that have been tripping the flow and causing that problem that we saw, and if so, should I be worried about the structural components of it? That's the question that was in my mind that I was pursuing.

Q. I understand. So just a simple yes/no question: Did you determine that there was flutter?

A. No, I can't answer that question yes or no because I don't know if that is the correct technical term to say that it was flutter. That's why I went and talked to Dave Gerlach.

Q. All right. That's all. Thank you very much.

MS. WARD: Mike --

MR. HAUF: Go ahead, Lorenda.

BY MS. WARD:

Q. So, Tom, you've mentioned Dave Gerlach a couple times. So when you went to Gerlach, what role was Gerlach in at that time?

A. He was our primary -- investigator -- our primary inspection team person out there.

Q. So it would have been Gerlach who would have to further

pursue the issue?

A. Probably, yeah. You know, it's difficult to say because, you know, one of the issues I have in the team is that we have no charge for each of the groups. So though we have titles and we try to -- you know, people have their own kind of territorial stuff, there's no definition that says your responsibility is to do this and my responsibility is to do that. You know, I just assume by my job title my responsibility is to try and help everybody. But Dave would say, look, if there's a problem, it's our responsibility to write that up and take it further.

So we met as a team after we saw the aerodynamic changes in the outer mold line changes, and I think to a man we thought it was a major configuration change. And then I brought up the issue where I was concerned about the potential impact of that change on the structure of the system because of catching a flow not on the leading edge, but maybe catching it back on the bubble. So I don’t know that for a fact, but I would suspect that's who I would go to is Mark Wright's team, and say, hey, look, can you investigate this?

Q. Could you say that name again, please?

A. Mark Wright is the team lead -- he's the commander of that division.

Q. For AST 400?

A. I think so. I mean, it's -- 400, that is correct. And

his last name is W-r-i-g-h-t. I wouldn't go to Mark, but I would do it -- I would go to Dave and have the conversation, and then once I'm comfortable that I understood enough, I would write it down in an email. That's typically how I operate.

Q. Okay. Thank you.

MR. HAUF: All right. I believe there are no further questions here. So, Tom, we're good to go. Thank you very much.

MR. MARTIN: Okay. Hope I got an A.

MR. HAUF: We'll get back to you on that.

Have a good day.

MR. MARTIN: Thank you, guys.

(Whereupon, at 3:58 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:	CRASH OF VIRGIN GALACTIC SPACESHIPTWO MOJAVE, CALIFORNIA OCTOBER 31, 2014 Interview of Thomas Martin
DOCKET NUMBER:	DCA-15-MA-019
PLACE:	Washington, D.C.
DATE:	January 16, 2015

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 proceeding.

_____

Susan Pilsch
Transcriber

UNITED STATES OF AMERICA

NATIONAL TRANSPORTATION SAFETY BOARD

Investigation of:	*	
	*	
CRASH OF VIRGIN GALACTIC	*	
SPACESHIP TWO	*	Docket No.: DCA-15-MA-019
MOJAVE, CALIFORNIA	*	
OCTOBER 31, 2014	*	
	*	

Interview of: RAY JENKINS

National Transportation Safety Board
6th Floor Conference Room
490 L'Enfant Plaza East, S.W.
Washington, D.C.

Thursday,
January 15, 2015

The above-captioned matter convened, pursuant to notice.

BEFORE: MICHAEL HAUF
Safety Group Chairman

APPEARANCES:

MICHAEL HAUF, System Safety Group Chairman
National Transportation Safety Board

DAVID LAWRENCE, Operations Group Chairman
National Transportation Safety Board

LORENDA WARD, Investigator-in-Charge
National Transportation Safety Board

MICHAEL BAUER, Systems Group Chairman
National Transportation Safety Board

KATHERINE WILSON, Ph.D., Human Performance Group Chairman
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DANIEL MURRAY
Federal Aviation Administration

CHRISTINE HELGESON
Representative to the Human Performance Group
Federal Aviation Administration

BRETT VANCE, Test Pilot
Los Angeles Aircraft Certification Office
Federal Aviation Administration

BOB WITHROW
Scaled Composites

NICOLETTE DUGUE
Scaled Composites

WILL ROBERTSON
The Spaceship Company

BRADLEY PREAMBLE, Office of the Chief Counsel
Federal Aviation Administration
(Representative on behalf of Mr. Jenkins)

I N D E X

I N T E R V I E W

(12:30 p.m.)

MR. HAUF: Good afternoon. I'm going to start with just kind of a general format. What I'm going to end up doing is reading through a statement here. We're going to do a round of introductions and who's on the phones, and then from there, we'll start asking questions.

Okay, so my name is Mike Hauf. I'm with the NTSB, and I'm the Safety Group Chairman for this investigation. And let's see here. I'll run through my briefing here.

Okay. The NTSB is an independent federal agency charged with determining the probable cause of transportation accidents and promoting transportation safety. The NTSB is not part of DOT or FAA. It has no regulatory or enforcement powers.

So now I'd like to go around the room and have everyone introduce themselves. Let's start with Lorenda, please.

MS. WARD: Everyone, folks on the phone, Lorenda Ward, with the NTSB. I'm a Senior Investigator-in-Charge. I'm also the IIC for this accident investigation.

MR. HAUF: Dan?

MR. MURRAY: Dan Murray, FAA AST, the AST representative to the System Safety Working Group.

MR. PREAMBLE: Bradley Preamble with the FAA, Office of the Chief Counsel.

MR. ROBERTSON: Will Robertson, Virgin Galactic

representative, System Safety.

MR. WITHROW: Bob Withrow, Scaled Composites, representative on the System Safety Group.

MR. LAWRENCE: Good afternoon. David Lawrence, the NTSB Operations Group Chairman.

DR. WILSON: Katherine Wilson, Human Performance Group Chairman.

MR. BAUER: Michael Bauer, NTSB, Systems Group Chairman.

MR. HAUF: And then on the phone, we'll start with Scaled and then we'll go to the FAA.

MS. DUGUE: Nicolette Dugue, Scaled Composites representative on the Systems Safety Group.

MR. VANCE: Brett Vance, FAA test pilot, Los Angeles Aircraft Certification Office.

MS. HELGESON: Christy Helgeson, FAA representative on human performance, flight test engineer, human factors specialist, Seattle Aircraft Cert Office.

MR. HAUF: Okay. Let's see. Do you have an objection to anyone other than an NTSB employee taking part in the interview?

MR. JENKINS: No.

MR. HAUF: Okay. So today, we'll be using the services of a court reporter, Steve, who will record and then transcribe the interview. The transcript, not the audio recording, will be made a part of the public docket.

The purpose of the investigation is safety, to determine probable cause and prevent reoccurrence. Our role is not to assign fault, blame or liability. This interview is a part of the fact-finding phase of the investigation. We're here to ask questions about your involvement in the permit and waiver for the SpaceShipTwo program. We cannot, however, offer any guarantee of confidentiality or immunity.

Each of the group members will have a chance to ask questions. We will ask questions one at a time and everyone has been instructed not to interrupt the person who is asking questions at that time. There will be an opportunity for each group member to ask follow-up questions after each person has had a turn.

Please answer all questions to the best of your recollection. If you do not understand a question, ask to have it repeated or explained. If you realize you misstated or need to modify a previous answer, please do so.

You are entitled to have one representative of your choosing. Is there someone you would like to have as your representative?

MR. JENKINS: Brad.

MR. HAUF: Brad. Great, thank you.

And, Mr. Preamble, you may direct Ray to not answer a question or to request a short break to confer with him or her.

The FAA will have the ability to review the transcript

prior to inclusion in the docket.

Do you have any questions?

MR. JENKINS: No.

MR. HAUF: Okay. So we will start the interview.

INTERVIEW OF RAY JENKINS

BY MR. HAUF:

Q. For the record, could you please state your name and your current job title?

A. Sure. Raymond R. Jenkins. I'm with AST-200, Licensing and Evaluation Division.

Q. Okay. And how long have you been in this position?

A. About 4½ years now.

Q. Okay. And how long have you worked at the FAA?

A. I started on November 8, 2010.

Q. 2010. Okay. And what did you go before the FAA?

A. I worked in the space shuttle program for 13 years. I was a technical instructor. I instructed astronauts, engineers, technicians, from every end of the space shuttle, including external tank and solid rocket boosters, ground support equipment, fork and launch control center, as a safety engineer.

Q. And what led you to go to the FAA?

A. They closed down the shuttle program.

Q. Okay. And so who's your immediate supervisor?

A. That would be Ken Wong.

Q. Ken Wong. Okay. And specific to Scaled Composites, to

start off, can you go over, briefly describe your roles and responsibilities?

A. Sure. I was the team lead and I organized meetings. I organized the appropriate individuals to take a look at the application materials that was forwarded over by Scaled Composites to the group.

Q. Okay. And do you have any -- let me back up here. Do you have any interaction directly with Scaled?

A. Oh, yes.

Q. Okay. Can you describe that interaction?

A. That would be minimal. It would be minimal conversation, whether it be with Scaled myself, certain team members on various issues. Many of the other issues were filtered through AST management and the engineering staff.

Q. Okay. And let's see. Did you -- do you have any knowledge of the waiver or can you describe -- did you work on the waiver?

A. I know about the waiver. I was informed of the waiver. I read the waiver, but my input to the waiver was minimal.

Q. Do you have any thoughts on the waiver, about the waiver?

A. Yes, I do. I believe that there could have been better things done. I think it could have been done a little differently. I believe that there was a more efficient route that could have been taken.

Q. Can you describe the differences or the different routes?

A. Essentially what those in AST management and others within AST recognized that Scaled didn't meet the regulations word for word. That was true. However, I do believe and -- I believe working with Scaled a little more, we could have met the regs directly without going the direction we went.

Q. Was there -- was upper management influencing any of these decisions or why couldn't -- why didn't they interact with Scaled to develop these?

A. Once there was upper level interference, it was -- there was definitely an active push, if you will, because the permit was coming up on time, and there needed to be something done in order to meet the 120-day deadline.

Q. Was there a way to stop the time clock?

A. There is.

Q. Can describe what --

A. That's called tolling.

Q. Tolling. Okay.

A. Which we could have initiated or Scaled could have asked for, either party. Once AST initiates the tolling process, only AST can start that clock again.

Q. Was tolling considered for the this process?

A. It was discussed.

Q. Okay.

A. Yes.

Q. And I'm guessing it was -- you decided not to do it. Can you describe to me why, the decision why?

A. Well, I cannot really answer that directly of why.

Q. Okay. And do you know where the waiver was -- do you know if the waiver was originated within the FAA? Was it in AST or other groups?

A. It was within AST.

Q. And the specific AST or the specific part of AST, what groups?

A. Okay. It would be been between AST-200 and 300 primarily.

Q. Okay. And as you -- could you -- were you involved in the original permit application?

A. I've done all the applications, whether it be the first permit, the renewals and modification.

Q. What about the pre-consultation discussions?

A. I have attended, but that was almost my first few months in here. So everything's still a little fuzzy, the FAA, government world. So --

Q. I understand. Okay. And can you describe, what is it that you or your team would look at in a permit to help make decisions?

A. Certainly. So we would take a look at your application materials, and we would basically go over everything that applied

to part 437 because that would be the permits. And again, we'd take a look at those regulations. In the case also that this was going to be human space flight, part 460 would apply as well. So we really take a look at those parts and make sure, again, the application material met those regulations.

Q. Okay. Is there any instructions, any rules that say how much of or how much information an applicant would have to have on certain sections or descriptions of what they put in there?

A. Well, we use part 437 as guidance.

Q. Okay.

A. So -- and also part 460 again, and they must meet the minimum requirements. So as long as their application met those minimum requirements, we considered that complete enough to evaluate.

Q. Okay. And how about the hazard analysis section? So 437.55?

A. Um-hum.

Q. What areas do you look at in there?

A. Okay. That's really part of AST-300's operation.

Q. Okay.

A. And I would advised by 300 of the outcome of their analysis of that.

Q. For this project, who from that group was working on it, that you'd interact with?

A. For the original application, that would have been Jay

Naphas. For the two renewals and the modification, that would have been Tom Martin.

Q. Okay. And were there any others that worked on that?

A. Rene Ray would have been backup to Tom Martin, but he was kind of later in the process. There could have been others helping Jay and Tom, but they are the primary folks, those two.

Q. Okay.

MR. HAUF: So I'm going to pass the questions off to Dave at this time.

BY MR. LAWRENCE:

Q. Okay. Just a few questions, Ray. You said you did evaluations on the 460 side of the regs.

A. Yes.

Q. Does that include 460.5 and .7?

A. Yes, sir.

Q. The training and recordkeeping?

A. Yes.

Q. Tell me about the evaluation. How did you do that?

A. Again with 460.5 and 460.7, all the 460s for that matter, they're very minimal when it comes to human space flight. And not to ramble on too much, but using my background from human space flight experience, in looking at 460, it's very little. So again, as long as they met -- their application material met what was in the regulations, we would go, okay, it's good enough to evaluate. There was minimal explanation about training.

Q. Um-hum.

A. Minimal explanation, whether it be about environmental control life support system, et cetera. Again, meeting the regulations.

Q. Well, did you go out to Scaled? Have you ever visited Scaled?

A. I have been.

Q. Okay. When was the last time you went there?

A. Oh, golly. It'll be a year this February 13th.

Q. Okay. What was the nature of the visit?

A. Scaled quarterly meeting. Well, the Virgin Galactic quarterly meeting.

Q. Okay. Was there any evaluation process being done or was it just attendance of that meeting?

A. That's more of an informational meeting that Scaled and VG would provide quarterly.

Q. Okay. In 460, there are some provisions for recordkeeping, let's say. They have -- specific to 460, that area. How did you know that they were maintaining records for the test pilots in the program? Did you just accept what Scaled provided as an answer to -- in the application or did you actually go out there and take a look at these records?

A. I did not. It was another team member.

Q. Okay.

A. I really don't have a good background on that.

Q. Okay. So there was somebody that had eyes on some of the training records and pilot records; is that --

A. Yes, that's correct.

Q. Okay. Who would that have been?

A. If I recall, that would have been AST-400.

Q. Okay. So I'm leaping here a little bit, but that means that you were liaisoning with or communicating with the 400 inspectors that were out there?

A. Oh, yes.

Q. Okay. So the 400 inspectors were kind of -- would you consider them an arm, an at-site branch of the evaluation process?

A. Oh, yes.

Q. Okay.

A. Yes.

Q. Have you seen any of the safety inspection reports that were developed by the inspectors that were out there?

A. I have.

Q. Okay. Any issues that you identified or any issues that came up in any of the inspection reports?

A. None that I saw before the accident.

Q. How many reports did you see?

A. Oh, boy. For the -- all the powered flights?

Q. Um-hum.

A. So I'd seen at least four for the powered flights.

Q. Okay. So there's just one report and that's got quite a

checklist of items that need to be completed by the inspector?

A. Essentially.

Q. All right. Your background, are you a pilot?

A. I am a commercial airplane, single-engine land, multi-engine land, single-engine sea, flight instructor --

Q. Um-hum.

A. -- ground instructor, CFII.

Q. Okay. You mentioned at NASA you did training, astronaut --

A. I did.

Q. -- and talked about training.

A. I did.

Q. But it wasn't -- we're not talking about training like simulation and such. This was like ground systems-based type of training for the instructors or what?

A. I have thousands of hours of simulator time spatial.

Q. In the shuttle?

A. Yes, sir.

Q. Okay. As training?

A. Training.

Q. Training, that --

A. That I provided to the astronauts, that was provided to me, or I trained all the instructors.

Q. Okay. Let me ask you a little bit about that, too. What about the simulator that they used?

A. Well, we had the best of the best. We had single system trainers.

Q. Um-hum.

A. We had what they call fixed base and we have motion based.

Q. Okay. I'll talk to you about the motion based. What did the simulation -- how was it modeled?

A. The beautiful thing about the motion based was we would take a pre-load, generic load --

Q. Um-hum.

A. -- for ascent orbit, come back downhill, breakthrough landing. We could -- we had a generic load, but we could take a flight load from a previous flight, put that software load in and go ahead and train off of that as well. And keep in mind, some flights were a little different because some flights we have a Hubble mission that wouldn't be at the same inclination or we'd have an ISS mission that was at 51.6.

Q. Right.

A. So depending on what the operations required, then --

Q. Was there any kind of g-loading simulation or or pilots trained in that type of sensation?

A. Shuttle days, I don't think we -- and I can't really speak with authority on this, but in the shuttle days we didn't really use a lot of centrifuge, and if we did, it would surprise me. We did that only really through Mercury through Apollo. But

I don't recall, and again I can't speak with authority. I can't recall any centrifuge training being done.

Q. Was there any type of g-training in flight? G-training?

A. Well, we had the shuttle training aircraft, which had descents of 17 to 19 degrees. So perhaps you may involve g-loading. Of course, they have the T-38 trainer, so proficiency training with that. But I'm speaking out of my realm now because I was totally ground flight trained, if you will.

Q. Right. I'm interested, too, because earlier you made a comment about 460 as being minimal is the word you used. You know, what -- define minimal.

A. Well, I'll go to my expertise. My expertise is environmental life support system. I'm subject matter expert for the shuttle program. That regulation, in my opinion, just doesn't meet the bill when it comes to human space flight.

Q. Why?

A. It is very shallow. It's very short. It just doesn't -- it says you must provide a breathable atmosphere. Well, yes, but what kind? How much? What's acceptable? What's an acceptable leak rate to have?

Q. Um-hum.

A. What if you happen to see a leak, et cetera, on and on and on. And it really doesn't go into carbon dioxide removal or carbon monoxide removal, for that matter, et cetera. The list is just --

Q. What about the training side of it, the requirements?

A. The training side of it, that is up to -- whether it be individual companies like Scaled or VG or whomever, again, as long as they meet the spacecraft requirements and they meet the regulation, that's when we have to determine if it's good enough look at and evaluate.

Q. Well, I'm curious, too. Have you had -- for the balance of the permit and application process for Scaled, have you worked on other applications or licenses?

A. I'm currently working on [redacted (b) (5)].

Q. Okay. I don't want -- I don't need to know any other, but that's -- not names, but is that the only other one that you're doing other than what --

A. No.

Q. -- you've worked on in Scaled? Okay.

A. No.

Q. Just how many generally?

A. I'm working on three different projects right now, not including VG and Scaled.

Q. Okay. Without naming, you know, the party or the entity, are all the training similar? Would it be -- you know, are they similar, each applicant have a similar training --

A. No.

Q. -- that they're planning on?

A. To be straightforward with you, develop in support of

the International Space Station and capsule for that project is significantly more dense, more developed, more robust than what you find with VG and Scaled.

Q. Okay. Do you know that -- do you know if anybody at Scaled in the operational side reached out to NASA to take a look at best practices in their training?

A. I don't know that for sure, but I would think that's most likely what Scaled would have done, yes.

Q. Okay.

A. I can't say for sure though.

Q. Right. Has anybody -- how many people are in your office as far as --

A. Within AST --

Q. Yeah, evaluators.

A. I think there's like 87 of us.

Q. Well, I meant within your specific --

MR. PREAMBLE: Wait. Sorry. Just to remind both of you all not to step on each other for the benefit of the court reporter and the transcript. Thank you.

MR. JENKINS: Okay. Sorry.

BY MR. LAWRENCE:

Q. Within your division of AST, how many evaluators are there?

A. 200? I'm going to say maybe 10 of us, 12 of us.

Q. How many have operational experience?

A. I'm going to say four of us.

Q. Beyond the evaluation side of your roles and responsibilities in your office, did you see anything that rose to the level of concern that you brought to management based on your past experience at NASA?

A. Yes.

Q. Can you elaborate?

A. The team at times, my team that I led and still do, we have a group, no question, people on the team who are excellent at their craft who were respected engineers in the shuttle program or had other manned space flight experience. There were times when we would ask technical questions. These questions would be scrubbed by AST-500 and then further scrubbed by AST engineering, the chief engineer, to the point that they were meaningless. Additionally, when we would want to directly communicate with Scaled, there were numerous times that I was told, both verbally and in email, not to contact Scaled directly because they were concerned about relationships. I am concerned about human space flight, not relationships.

Q. What was the eventual outcome of that? Was there any -- this pushback that came from management, was --

A. Yes. My teammates and I were told very vigorously many times to the point that there were times that I would actually make calls anyway to Scaled or VG, for that matter, even now, and would have to deal with the outcome later.

Q. Is there any kind of fear that you have of retribution for some of the actions you've taken?

A. Again, I am a true spirit space caring individual and -- do I fear that later down the road? Yeah, I did not then nor do I now.

Q. Okay. In the process of -- specifically to the Scaled and your work on the Scaled application, permit, has that been a consistent theme throughout the process that you've seen as far as your -- the filtering --

A. Oh, yes.

Q. Consistent?

A. Consistent.

Q. I think Mike asked you a little bit about the waiver and your impressions of the waiver. In your opinion, do you think the waiver was sufficient?

A. No.

Q. Can you explain why?

A. I really wish the team and myself would have more opportunity to work with Scaled.

Q. Is that a time constraint that was placed on you?

A. There was a time pressure, yes.

Q. Can you elaborate?

A. So in a cycle, in the case for a permit, you have 120 days to process the permit, and time was coming up. And if I recall, that permit was for the renewal, the first renewal on May

23, 2013, and time was of the essence to meet that 120-day timeframe.

Q. Okay. But I think you mentioned earlier, there is a process to stop the clock.

A. There is.

Q. And you had discussions about tolling --

A. Yes.

Q. -- the application process.

A. Yes.

MR. PREAMBLE: You just got to wait until he finishes and then answer.

MR. JENKINS: Oh, I'm sorry.

BY MR. LAWRENCE:

Q. Who made the decision in AST not to toll the application?

A. It would say that was a collective decision of all management. I wouldn't say it was one specific person.

Q. Management?

A. Yes.

Q. Were the technical evaluators, their opinion considered?

A. Considered, yeah.

Q. What was the general consensus of the evaluators as far as tolling?

A. I would say that my team and I would have had no trouble tolling.

Q. Okay. Are you aware of the third-party evaluation of the permit that was done by Great Circle?

A. You mean by Terry Hardy? Yes.

Q. Are you aware of that?

A. I am.

Q. Okay. Do you know what was in that evaluation?

A. Honestly, I am fuzzy on that. So --

Q. Were you briefed on it?

A. I was briefed on it. It was quite some time ago. I know Terry basically did not believe that they had met the regulations. That's my recollection.

Q. And that evaluation was pre-application?

A. That I don't remember.

Q. Okay. You're familiar with it, but were you presented that at any point in time? I know it's been a while, but --

A. I'm sure my system safety analysis team would have come to me and briefed me on it. I do remember talking to Jay and Tom about it, so -- yes, I was briefed on it.

Q. What were -- what was the outcome of that conversation you had with the others?

A. I know speaking with Tom, specifically, concern about Terry's comments. But for the details of that, you'd have to go straight to Tom.

Q. Okay. Let me ask you from your base experience at NASA, the pilots of Scaled, the test pilots of Scaled used the three-

prong approach for their training. Are you aware of how they conduct their training?

A. I'm aware they trained the three prongs.

Q. Simulator, extra aircraft --

A. Yeah, sure. Absolutely.

Q. -- g-loading.

A. Yeah.

Q. And the White Knight Two?

A. Right.

Q. Okay. In your experience, in your base experience, are those sufficient training tools to simulate or prepare a test pilot for boost operations?

A. Well, I can tell you truthfully, I agree with their approach. I think the simulator was an ongoing development. As time went on, I believe that they enhanced it. The g-loading and extra, I mean, that's a great idea. That has basically a 30-day expiration. You've got to continuously do this g-loading before you go fly, otherwise, physiology kind of doesn't address that later. White Knight Two, I mean, brilliant idea of having the same configuration, cockpit configuration, enabled to switch into SpaceShipTwo. For their type of flight operation, yeah, I thought it was a good way to start.

Q. You probably talked in debrief to the astronauts post-mission --

A. Sure.

Q. -- when you were there. In their conversations, is there anything that can simulate the boost phase?

A. Well, I did tell you the SMS, the shuttle motion or mission simulator, some call it, did an excellent job of simulating the rocking, the lighting of the SSME space shuttle main engines and the SRBs, solid rocket boosters, and even the release off the pad. It'll really give you a kick in the pants. You could feel it. Was like the real thing? No. So much vibration coming from the solids once they light that -- you could simulate it to a point.

Q. But the scale of the simulator is non-motion?

A. That is correct.

Q. Is that a limitation in training in your opinion?

A. In my opinion, it is a limitation.

Q. Okay. During your experience training the astronauts, were the test pilots or the astronauts required to manipulate any controls or any switches or do any type of tasking?

A. Oh, certainly.

Q. During the ascent?

A. Certainly. And I must emphasize it depended if it was a nominal ascent or an off-nominal ascent. Generally, in nominal ascent, you pretty much want to be hands off unless there's an issue or a significant switch throw needs to be done going uphill.

Q. Were they using checklists to accomplish those tasks?

A. Certainly. Absolutely.

Q. Tell me about the process of how they would run checklists during a nominal ascent?

A. Well, upfront, left seat you've got a commander, or CDR; right seat you have a PLT, or pilot. Off center, just behind the CDR and PLT was MS2. The MS2 you can think of as the flight engineer. The flight engineer would basically direct the CDR or the PLT to -- if there was a reason to troubleshoot issues, that person would direct them to the appropriate checklist or they would confer with each other, for example. So if they have a switch that would do ICAPS, which one is it? It's on -- 015, for example, pull circuit breaker, which circuit breaker you pull, et cetera. But they had it down to such a sync, it's a total flow of team operation.

So the way I explained it, it was -- by the time I explained it, it was double oriented.

Q. Let me clarify, as far as running the checklist, was it a challenge/response? Do you understand what I'm asking? A challenge/response type of checklist where the person reading, reads the checklist item and waits for a response from --

A. Oh, certainly.

Q. Okay.

A. Certainly, especially with MS2. You take, for example, on CDR left-hand side of the shuttle, there's panel L1, which is the environmental control life support system. This is my training. It was the commander's responsibility if anything went

wrong going uphill that not only would he or she report their checklist, but the MS2 in back would be verifying as well. So there would be a challenge/response going on, and there would be indications on the checklist. It would say CDR do this switch throw and then MS2 would back that up.

Q. Were there any procedures during the ascent, and we'll stay with the nominal ascent, that required one of the pilots or astronauts to manipulate something without running a checklist? In other words, simply announce I'm flipping this switch without a response.

A. Great question, actually. There was a time where we had a problem with the solid rocket boosters separating because, if I recall, because of cable issues. And there are a set of buttons on Panel C3 between the commander and the PLT, which would actually fire off the SRBs. If they didn't fire off within, say, a nominal 2 minutes, 10 seconds, if they didn't fire off, then, I recall, 5 to 7 seconds later, they would manually push the two buttons and fire those off.

Q. Um-hum. That was just -- but there's not a checklist for that?

A. No, it's just a trained item.

Q. Yeah. Was there a verification prior to --

A. I'm not going to say -- excuse me. I'm not going to say it wasn't in the checklist, but I'm going to say it was not, because that time is so critical, those 2 seconds with that extra

weight, you've got to get rid of them.

Q. Was there a verification though from the pilot that was going to, you know, act --

A. Oh, sure. And the way we do it is, again -- I'll give you a great example. They had something called cabin vent valves, and these two valves were to check the pre-pressure, the cabin pressure preflight. And going uphill, it's really important that the circuit breakers were actually pulled out once you got on board it, and the reason they were pulled out once you got on board was so you didn't accidentally hit one of those switches and dump your entire atmosphere over board. So there was challenge/response for that. It would be again the CDR's responsibility for that, but he would say -- he or she would say, do you see on Panel 015, pulling circuit breaker blank? And they would say yes, I confirm it, or yes, I agree.

Q. So both pilots are in the loop --

A. Certainly.

Q. -- for the procedures that --

A. Certainly.

Q. -- are developed for the shuttle program?

Do you feel in your role in AST that you had adequate support from management to perform your duties?

A. I will say that my immediate manager has been outstanding. I will say that, yes.

Q. Any other management personnel that --

A. I believe that others probably don't see things the way 200 does, and perhaps -- I can't say what other people think, but maybe I don't think they truly understand the essence of human space flight and I think maybe some appreciation should be recognized to the dangers of human space flight.

Q. Would you characterize that as a lack of experience?

A. You know what, partially, but that experience can be gained, an appreciation of human space flight. One of my other functions, and I probably should have mentioned this in the beginning, I'm on the Embry-Riddle Commercial Space Operations Degree Program Advisory Committee, but I also teach their space flight operations class for teaching astronauts and cosmonauts. This stuff can be learned if you want to learn it. The problem is, I really feel that maybe there was more of a political driven attitude instead of an essence of worrying about human space flight.

Q. What political attitude?

A. Again going back to the filtering of questions, I would rather like to see my team and myself work directly with Scaled or VG or whomever, and have a more robust interaction to get the questions and work with them and not have multiple intermediaries to the point. The technical information or the data is so washed out, it's not even what we asked for in the beginning, and the efficiency, I believe, would just escalate if that were allowed to happen.

Q. Based on your experience -- and that's a great answer; I want to expand upon that. Any other suggestions other than opening lines of communications directly to an applicant, any other suggestions that you could make to make the process safer?

A. Oh, boy, I'm not going to become -- again, going back to the question you asked a few minutes ago about experience.

Q. Um-hum.

A. Experience can be gained, but human space flight, what I lived for 18 years of my life now, human space flight has got to be recognized as a true hazard and not something in which somebody has a relationship with a company or they're afraid they're going to hurt their feelings. Again, I would rather see my team and other companies work together on their licensing or permitting process directly for efficiency's sake, so there's nothing being washed out. So I really believe those who don't have experience, if they want experience, come join my team, glad to have you, but don't try to run interference for things you really don't technically understand about. Those are my concerns.

Q. Thanks, Ray.

A. Sure.

Q. Appreciate it.

MR. LAWRENCE: Those are my questions.

MR. HAUF: Katherine.

DR. WILSON: Yeah, thanks.

BY DR. WILSON:

Q. I'm going to jump around a little bit because some of these are follow-ups. So I apologize.

A. That's fine.

Q. You talked about the discussion for tolling. What was the reason for the discussion? I'll leave it broad and then --

A. Sure.

Q. -- narrow it.

A. The team and I thought at that time, with the given data we had in front of us, that we needed more time to work with Scaled.

Q. Were there any specific issues or it was a broader, more time to review, that you were looking for?

A. I think when it came down to the software issue and the human factors issue, I think having direct technical interchange meetings with Scaled more, I should say, and without those being filtered, would have worked very well.

Q. Okay. On any of the other permits, permit applications that you've worked on, has tolling ever been used?

A. Well, we do have a licensing process, and I'm working on a license right now for the Virgin Galactic which is in the tolling process.

Q. Okay. Did the tolling process start because of the accident or --

A. No.

Q. -- is it separate from the accident?

A. Separate issue altogether, and VG has been very good in communicating with us.

Q. Okay. What exactly is your goal as the project lead?

A. So basically what I do is I gather a group of our experts together, whether it be from AST-100, 200, 300, 400, 500, and I combine all their expertise, and what we will do is we will get application material. We will go ahead and divvy that out to the appropriate place. For example, the system safety analysis 300, flight safety analysis, would go to 100 and so on. 400, of course, is inspectors. Excuse me, flight safety analysis would be 300.

Q. Um-hum.

A. So I get the people together. I direct meetings. I push them in the right direction and keep them motivated, to get the project -- to get an answer for that project.

Q. Okay. You said that you had minimal interaction with Scaled. Who specifically at Scaled did you interact with?

A. Currently that would be Bob Withrow.

Q. Bob Withrow, okay. You talked about minimal explanation, for example, on training that was in the Scaled permit application.

A. Um-hum.

Q. Did you think that more information was needed?

A. I'm going to say based on the three-prong approach, that I believe they met the reg.

Q. Okay. Did you attempt to request any more information or request any more information, or because they met the reg, did it stop there?

A. I would have no doubt that we asked them for more information, whether it be on that and many other subjects. So, we requested it.

Q. Do you have any human factors background?

A. At a master's level, but I don't have a master's degree in human factors. I was trained, you know, introductory class. In fact, I probably had two or three human factors classes. I was also taught human factors, cockpit, for crew resource with United States Alliance and NASA for the shuttle.

Q. What is your master's in?

A. I have two essentially. I've got a master of aeronautical science, one's in space studies and the other one's in aviation/aerospace safety systems.

Q. Okay. Anyone on your team or specifically within your AST-200 or AST have a human factors background?

A. The only person I think would have, and I may be wrong about this, but the only person I think right now that would have a human factors background in our group would probably be -- well, I should say people -- probably Jay Naphas. I would think Tom Martin would have some, maybe Rene Ray a little bit. Anna Cushman does, I do know that, and she's with Bob on the --

Q. Okay.

A. And there could be others. I don't know.

Q. When you were at NASA, was there any specific human factors person that worked with you?

A. There was a group. Probably Johnson Space Center for sure.

Q. Right.

A. Yeah, there was an entire group.

Q. Okay. Were you aware of any single-point failures in the SpaceShipTwo?

A. Can you elaborate for me? In a particular system, or --

Q. In any system. I mean, specifically we're interested in the feather system, but any other? So let me start with, were you aware of the single-point failure if these feathers were unlocked early in the transonic region, that there could be a catastrophic event?

A. Yes, I was. I was aware of that.

Q. Prior to the accident?

A. Yes.

Q. Okay. Was there any discussion within AST about that?

A. Not that specific issue, no. It had shown in the pilot's operating handbook. The team might have discussed it, but it wasn't one of those items, because of the limitations we have on the permit, that we really looked at that particular issue.

Q. How did you become made aware of that failure or the potential for that failure?

A. Oh, it's right in the pilot's operating handbook.
Q. All right.
A. You can tell, it wouldn't -- so basically with a Mach 1.4 --
Q. Um-hum.
A. -- and I don't recall the phraseology or exact words, but it pointed out to us basically, hey, don't deploy before that point, at least before that point.
Q. Were you aware of any other single-point failures within the spaceship?
A. If I recall, there was a -- it's not a big one, but there was a problem with window heaters. But before this past powered flight, I believe that was resolved satisfactorily.
Q. The concerns that you had regarding the permit, who did you go to with your concerns?
A. I would go to Ken Wong, my immediate boss.
Q. Okay. Any discussion -- you mentioned that the 460, you raised, that they were not very specific?
A. Oh, certainly. And that goes on to this day, whether it be Scaled or whomever.
Q. Right. Has there been any discussion about proposing more specific regulations?
A. Certainly.
Q. Um-hum.
A. Certainly. We've had a great workout on that.

MR. PREAMBLE: Yeah, I don't know how much we want to go into that with some folks present.

BY DR. WILSON:

Q. I don't need to know specifics, but just that it is a process that's being worked on?

A. Absolutely.

Q. Okay.

DR. WILSON: I think that's all the questions I have right now. Thanks.

MR. HAUF: Thanks, Katherine. Mike?

BY MR. BAUER:

Q. Just a follow-up, actually two follow-ups from -- earlier you mentioned about the minimal interaction with Scaled through AST management and staff. In other permit evaluations, is that a similar way that you interact with the applicant?

A. I will say I'm also involved with safety approvals, and to answer your question directly, I have a significant amount more communication when we're doing a safety approval with a company, than I would with a permit or a license.

Q. So permit or license, this -- the way you described it, it's very similar -- it's not applicant dependent?

A. No. It's not applicant dependent for permit application.

Q. Right.

A. This is just the hierarchy. This is how things go.

Q. Okay. And then just a follow-up to Dave's. Dave had a question and you described a couple of procedures from the space shuttle, one about SRB release that that was a time-critical --

A. Yes.

Q. -- function for the crew. And then you also described a cabin pressure procedure. Was that cabin pressure procedure under any crucial time --

A. Oh, wow.

Q. -- compared to, compared to the SRB procedure?

A. It depended when it happened in flight. If it was going uphill, it was a big leak, and you were less than 3 minutes and 40 seconds off the pad, you're coming back home. You're doing what they call a return to launch site, a RTLS. If you're beyond 3-40 minute point, you're going to do what they call a transoceanic abort landing. You're either going to end up landing in Africa or even Istres, France. If you're on orbit, depending how big the hole is, you either feed the leak or you decide you want to come home. And there are all kinds of different tradeoffs. Where are you going to land? Is your primary landing site available to you? So it really depends on the phase of the flight.

Q. I guess maybe I misunderstood the procedure, because you mentioned a procedure where circuit breakers would be opened up to avoid a crew mistakenly hitting a valve and basically venting the cab.

A. Sure.

Q. And that was -- I guess that was the procedure I was referring to. I mean, is that a similar answer?

A. No, actually that particular procedure you're referring to is one that is done right after the main engines are cut off. So you're looking at roughly 9 minutes into the flight. The CDR would reach overhead and pull the two circuit breakers. That would eliminate the power to the solenoid to the switches.

Q. But from a time schedule, whereas like with the SRB release, that was 5 to 7 seconds after the -- if the boosters did not separate --

A. Yeah.

Q. -- they had to react quicker than after main engine cutoff?

A. So the booster issue is super time critical where you can wait on the circuit breakers.

Q. Okay.

A. But in the checklist, though, it says right with the timeline, boom, boom, boom, do it here.

Q. Okay.

MR. BAUER: That's all I have.

MR. HAUF: Okay. Lorenda?

BY MS. WARD:

Q. Hey, Ray. Are you aware of any other waivers that have been given for a permit or license?

A. No, ma'am.

Q. No. You said you've got three other projects that you're working on?

A. Yes.

Q. Of those three projects, are any of the applicants attempting human space flight?

MR. PREAMBLE: You know, if you want an answer to that, I don't even know if we want to answer that with some party representatives in the room. I would have him answer it but not with folks in the room.

MS. WARD: Okay.

MR. PREAMBLE: So -- only because I don't -- I think the people who are entitled to -- that are pursuing that are entitled to not have that -- their competitors know that.

MS. WARD: It's a yes or no question.

MR. PREAMBLE: Okay. Without naming --

MS. WARD: Yeah, without naming.

MR. PREAMBLE: -- who might be interested in that.

MR. JENKINS: I will say all my projects are human space flight.

BY MS. WARD:

Q. All of them? Okay. Great. That leads to my next question. You mentioned efficiency within FAA to help make human space flight safer. Are there any other suggestions you might have to make human space flight, commercial human space flight safer?

A. There has to be a hardcore look and reality check of what we're involved with. Human space flights can't be taken for granted. This is not flying from LAX back to IAD, not yet. Will it happen? Yeah, it'll happen. But right now we need to have more appreciation as an entire group that truly, as corny as this sounds, there is a demon in that sky and you need to recognize that fact. Human space flight is nothing to mess around with, and trust me when I say, there's nothing worse than telling a group of students or adults, for that matter, to have to explain *Apollo 1*, *Soyuz 1*, *Soyuz 11*, *Challenger*, *Columbia*. *Columbia*, I had five friends out of the seven I lost on that bird. So I have a true appreciation for what's happening. I'm afraid, and this is just in my opinion, that perhaps others don't share that opinion.

Q. You mentioned your team, you referred to your team as far as those who were working on Scaled. How many people within FAA are working on the Scaled project?

A. Directly on my team, there are probably about 10 of us. We've had a little turnover in the last 3 years. A couple of people have gone different directions, left to do other things for whatever reasons, but there's been like 10 of us consistently.

Q. Are you able to give me numbers like for who's in like 200, 300, 400 and 500?

A. So three of us right off the top are in 200. That would be myself -- can I mention names? Is that okay?

Q. I don't need --

MR. PREAMBLE: Yeah.

BY MS. WARD:

Q. Okay. Go ahead.

A. Henry Lampazzi, Don Sargent. 100, I'm going to do this off the top of my list -- my head here. We should have Julie Price. Then for 300, sorry for bouncing around here, we have Jen Bailey, Tom Braun, Tom Martin. For Scaled, however, I must emphasize it's more with Jen Bailey and Tom Martin than it is Tom Braun. 400, at one time, Dave Gerlach was my inspector and I believe -- I don't know who is assigned to the team right now since the accident, to be honest with you. 500, you've got Michelle Murray, you've got Jay Naphas and you have Sherman Council. And I hope that totals up correctly.

Q. Close. It's in the ballpark. So then 400, no one's been identified to replace Gerlach?

A. I will take that back. Marcus Ward has replaced Dave Gerlach. Yes, you're right. Yes, there was a replacement.

Q. Earlier you mentioned that for AST-200, that there's also 10 people. Is that correct?

A. Roughly, yeah.

Q. Now, are all those team leads?

A. No.

Q. How many of those people are team leads?

A. Wow. I'm going to say probably six of us.

Q. About 60 percent.

A. Yeah.

Q. Okay. How would you describe your workload?

A. Before the accident, it was very consistent but workable. A lot of interaction with my teammates and Ken Wong, my immediate supervisor, and other supervisors as well. But it was fine.

Q. I just want to come back to you mentioned that you had little input to the waiver on projects that you're the team lead for.

A. Yes, ma'am.

Q. Do you feel like you're effective being a team leader?

A. Well, I will constantly lead my team in the right direction based on my background and my love and passion for human space flight, regardless of what decisions I agree with or don't agree with. And I have made my effectiveness known to others.

Q. Okay. I just wanted to point out, because you mentioned that you -- that management had limited your ability to reach out to Scaled. Is that just for you to reach out or could Scaled contact you freely?

A. I would have preferred that Scaled contact me in many cases directly, but they, too, knew that there was a filter.

Q. Can you elaborate a little bit on that?

A. Sure. AST-500, because they were out in the field, would filter our communications, schedule our technical interchange meetings, in some cases scrub our engineering

questions, and that's pretty much how it shook out.

Q. Did you participate in any of the hotwashes that the FAA --

A. In fact, I delivered one myself, along with Dan, on June 20th of 2012.

Q. Is that the only one you participated in or did you participate in others?

A. Oh, no, I've participated in all of them, but that's one that was specifically delivered because of the first permit being issued to Scaled.

Q. We have a letter from your supervisor to the president of Scaled. It's referring to modifications that occurred, and this is right before the accident.

A. Okay.

Q. And for the point of contact they listed actually you --

A. Right.

Q. -- for them to contact and not Michelle. So had things started swinging the other way, maybe, or --

A. No. In fact, every piece of documentation from the first permit right through that modification, whether it be the permit, the first renewal, the second renewal, the modification had a standard letterhead, if you will, my name, phone number. But the truth is, I have to check first what communications I am allowed to have directly, and normally that was filtered through 500.

Q. So after one of those letters was issued, you were never contacted by Scaled?

A. I cannot say that Scaled never contacted me directly, but if there was an issue, it was a minor issue. It was a very insignificant issue.

Q. All right. That's all the questions I have. Thank you.

DR. WILSON: Do you want to take a break?

MR. HAUF: Yeah, that's a good point. We're an hour into this. Would you like to take a 5-minute break?

MR. JENKINS: I'll use the restroom and we'll get back to it. Absolutely.

(Off the record at 1:30 p.m.)

(On the record at 1:40 p.m.)

DR. WILSON: Can we just verify that everybody can hear better on the phone?

MR. HAUF: Sure. Can everybody out there hear us a little better now?

MS. DUGUE: Yes. It's better for me, thank you.

MR. VANCE: And for me.

MS. HELGESON: And for me.

MR. HAUF: Okay. So let's go to Scaled. Bob, would you like to start with some questions?

BY MR. WITHROW:

Q. Hi, Ray. I wish we were in a more pleasant time.

A. I agree.

Q. I have a few questions for you.

A. Sure.

Q. So I believe you stated that you disagreed with the waiver because you felt that there was a more efficient way of approaching things and that that way would have been to work with Scaled.

A. Right.

Q. If you had been permitted to work that way, can you describe what you would have done and what you would have expected the outcomes to have been?

A. I think the first thing, Bob, that we should have done as a team is gone out and had seen quality of Scaled, sat down with you and the other engineers and hammer it out to get some good engineering work done instead of having others do the work for us.

Q. Okay. And when you say it, hammer it out, what is the it?

A. Whatever that information we did not have already, whether it be the software or the human factors issues, whatever issues that we could have sat down with you all and just had good engineering conversations and gotten it out of the way in a more efficient and robust manner.

Q. And then what do you think the outcome would have been?

A. I can't predict what my management wanted done. I will say what I believe, Bob, and this is coming from me. I believe in

the end we would not have to issue a waiver.

Q. Okay. Okay, with respect to -- so, in general, from the top level, an experimental permit, there are requirements that a permittee has to follow. Where are those requirements documented? In other words, where do you document what you require of a permitee, other than, say, the rules and regulations?

A. We do have what we call Team 00 documents.

Q. Um-hum.

A. In particular -- oh, gosh, do I want to do it off the top of my head -- in the collection of what we call the P00 documents, there are a generic set of directions, if you will, on how to go about performing a permit, or how -- going about the permit process.

Q. But I mean from the point of view of the permittee, how does he know what's required of him by virtue of having that permit?

A. As you know, what we have out there are minimal documents, minimal guidance documents. Again, we have the regs. There is no firm document out there that says the permittee must do blank.

Q. Is a waiver a way of documenting requirements?

A. I just don't know.

Q. Okay. You described comparing training between a couple of things you're working on, Scaled and other, which I believe is an orbital resupplier, I think that was the term you used. Is

that correct?

A. No, it wasn't.

Q. Okay. There's two different kinds of training. And Scaled is suborbital and the other one, I gathered, was orbital. Is that correct?

A. No.

Q. Okay. I don't mean Orbital, the company. I mean --

A. You mean as a suborbital or orbital.

Q. Yes.

A. There is another company that's suborbital.

Q. Okay. And with respect to training of those two, was there a large difference in the suborbital case?

A. I will tell you the other company right now is just in the developmental stages --

Q. Okay.

A. -- and I don't have their training information.

Q. Okay. So when you were comparing actual training information, were you comparing them between an orbital and suborbital type?

A. Certainly not.

Q. Okay.

A. Certainly not. And, in fact, my background, as well as other members of the team, is well versed in suborbital flight, whether it be from the Alan Shepard days to what Scaled is trying to accomplish.

Q. Okay. So you stated, I think, that sometimes you, rather than going through the filtering process, you would approach Scaled directly; is that correct?

A. I have done that, yes.

Q. And when you approached Scaled directly, did you ask for information?

A. Sometimes.

Q. And when you asked for that information, did you receive the information you asked for?

A. I would say less frequent.

Q. Okay. And then you stated that I think it was AST-500 that arranged for TIMs, technical interchange meetings.

A. Correct.

Q. And were those TIMs generally held between technical people on your staff -- when you were involved in them in other words, were they held between the technical people on your staff and technical people on Scaled staff?

A. Yes.

Q. And in those meetings, were you able to achieve -- get the information you needed when it was direct through TIMs?

A. With the TIMs, yes.

Q. Okay.

A. However, when it came to technical questions that we had as a team, those questions were again filtered.

Q. Okay. With respect to training, you described the

motion simulator on the shuttle project, and you stated that it's a limitation in training to not have a motion simulator. So my question is -- is that correct, first of all?

A. Yes, but it depends on the base, the kind of flight you're doing. But go ahead.

Q. So my question is for an operation like Scaled's proposed operation, is a motion simulator a requirement for safe flight? In other words, can you conduct a safe flight without having a motion simulator as part of your training?

A. I believe that Scaled is going about it the right way in order for suborbital flight.

Q. For suborbital.

A. Would it have been a little more beneficial to see the high pitchup release from White Knight Two and let that motion base swing the way it's supposed to, compared to a shuttle -- even though that's an orbital craft, but just talking about the ascent base, would that have been beneficial? Yeah.

Q. Um-hum. So if I paraphrase your answer, it would have been beneficial, but it wasn't required to --

A. I concur with your statement.

Q. Okay. Thank you. You described an operation in the shuttle during the boost phase, and then you described, I think, it's pretty much keep your hands off. Is that correct?

A. Yes.

Q. Okay. And the reason why you keep your hands off the

shuttle because it's an automated boost; is that not so?

A. As long as the general purpose computers are working. If they weren't, then you'd have to go to manual stick steering.

Q. Nominal, nominals.

A. Nominal uphill is all on the GPC, yes.

Q. So, and obviously you're aware that for the most part, SpaceShipTwo is not an automated --

A. Absolutely.

Q. So the question I have is, is it possible to have safe operations in a non-automated boost? Is it possible to design the system that can work safely in a non-automated-based scenario?

A. Again, I will speak for myself. In the history and everything I know about human space flight, I do believe it's possible, yes.

Q. And even though that would presumably require manipulation of the controls during the boost stage because it's not automated?

A. As you know, it's a trick going uphill when it's not automated and you're flying manually.

Q. Yes.

A. It can be a handful. Again, and in fact, I will tell you, I've only seen two people in my entire life use the shuttle motion simulator and fly that off the pad -- and, again, in a sim vehicle -- fly it off the pad, successfully do a launch without overloading on the g's and having the vehicle come apart.

Q. Right.
A. And I wasn't one of them.
Q. Yeah.
A. So --
Q. But the question still stands. Is it necessary to have an automated, and you answer was no. So that means, I presume, if it's not automated, you have to manipulate some controls.
A. Correct.
Q. And that can be done safely?
A. It is my belief it can, yes.
Q. Thank you.
A. You bet.
Q. And then my last question is in dealing with time-critical items. So, in general, I think it's standard flight practice to have things on checklists and just fly the checklist, right; is that pretty much how you would normally do things? But in time critical cases, you mentioned that there were training items that would essentially happen without the reading of the checklist if there were time pressure?
A. Training or memorization items.
Q. Yes.
A. Yes.
Q. And those are standard practice for certain --
A. For certain phases of flight in the shuttle world, yes.
Q. Okay.

A. But that's always been true from the days of -- Wright until now.

Q. I would believe that, yes. So I guess what I'm asking then is the time criticality of a particular thing that has to be done can dictate how it's done, whether it's done by reading or challenge and response or if it's memorization or training items then, correct?

A. That's correct.

Q. Thank you.

MR. WITHROW: I think those are all the questions I have right now.

MR. HAUF: Nikki?

MS. DUGUE: I have no questions at this time.

MR. HAUF: Okay. Thanks. Will?

MR. ROBERTSON: Yeah.

BY MR. ROBERTSON:

Q. When a permit is issued, it's often issued or can be issued with something called terms and conditions?

A. Yes.

Q. Could you explain what the purpose of terms and conditions are?

A. Terms and conditions can be -- one example would be, you must not fly over a populated airspace, for example. That would be a term and condition. There are limitations on what you can do with that permit, just as well as the licensee can receive terms

and conditions, and as they become more familiar with their flight operations, perhaps those terms and conditions get eliminated or enhanced to help out.

Q. Would you agree with the statement that a term and condition is a requirement on the permittee that they must follow in order to --

A. I would say yes.

Q. Okay. Would a waiver, in your opinion, be the equivalent of terms and conditions?

A. So when we list out these terms and conditions and we give that final certification document, if you will, in this case, the waiver you're referring to was not listed, and I may be recalling this wrong, was not listed as a term and condition. So I don't believe it was the intent to have that listed in the terms and conditions.

Q. Okay. All right. So to change gears, you're familiar with the procedures to fly the spaceship vehicle?

A. I am, but it's at a very generic level.

Q. Okay. What would you characterize as the level of activity during the boost phase of that flight? How would you characterize it?

A. I don't know. I just don't have that experience to sit in SpaceShipTwo. I know about the procedures. I've seen the video. I know what happens. I can only imagine what's happening inside the cockpit. It makes for busy times, I have no doubt,

keeping the stick straight and doing what you've got to do to fly that to profile. So I imagine it makes for busy times, but I can't speak with any authority to that.

Q. All right.

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

MR. HAUF: Thank you. All right, FAA. Dan?

BY MR. MURRAY:

Q. Okay. Ray, I want to ask you a couple of questions, help maybe shed a little light on how the permit evaluation process works. So you're the permit team lead for the Scaled permit. As the lead, that gives you visibility across all of the aspects of the permit evaluation?

A. Yes.

Q. Okay. Would you say that all aspects of the permit evaluation are worked the same, or --

A. No.

Q. Are there some that -- are there any that you as the lead take on the responsibility for evaluating yourself or are all of the pieces evaluated by team members?

A. What will happen is -- for example, let's say I will evaluate the rapid control system. I will have a team member who has also experience in that look at what I've written up for that technical evaluation and confirm or deny what I have written up is true. So I've taken on multiple parts of the SpaceShipTwo, whether it be the landing gear, RCS, environmental control. But

as a team lead, I will certainly put my information out there to be reviewed by others.

Q. And how do the other parts get divvied up?

A. Well, per group, again AST-100, 200, 300, 400, 500, the first three being bigger players ultimately. While the process of that permit's going on, 400, of course, will work the launch operations and other issues. The 500 obviously is pre-consultation.

Q. But in terms of specific evaluation pieces, particular elements of the regulation that are being --

A. Well, 100 would be, as you know, aerospace, and 200 would be the licensing component. And then 300 would be the aerospace issue or, excuse me, the flight -- system safety analysis. 400 again would be inspectors for launch and accidents, God forbid, and, of course, again 500.

Q. So divisional roles, divisions have roles assigned to them and that plays into the makeup of the --

A. That's correct.

Q. -- teams. All right. Are there -- how about subject matter expertise? How does that --

A. Well, I -- myself and the team have been blessed with some great subject matter experts and -- for example, Dan Sargent on my team, a propulsion expert, absolutely a true pro when it comes to human space flight. He's been doing this since the day of the Lunar Module 1964. I have Henry Lampazzi who is my deputy

who has infinitely more hours than I do in the shuttle mission simulator. We have a lot of good people. Jen Bailey, for example, aerospace issues. And then Tom Martin, Tom is a pro when it comes to systems safety.

Q. Is there anything unique or different about the way systems safety is worked relative to the other parts of the evaluation?

A. Yeah, Dan, it appears to be so. It appears that we at AST are very inconsistent on how we handle systems safety. You take, for example, the issuance of the original permit for Scaled, and then we had turnover in AST or at least we had a member go to California and then we had a newer member come in, Tom Martin. And Tom, his background is, of course, from the shuttle days and also Space Station Freedom, when that plan happened, and he is a very meticulous individual and he is truly worried about the safety of, in this case, spacecraft, a very competent individual. I believe he takes a very in-depth look compared to what we did before on the original issuance.

MR. MURRAY: That's all the questions I have. Thank you.

MR. HAUF: Okay. Online, Brett, do you have any questions?

MR. VANCE: You bet.

BY MR. VANCE:

Q. Hey, Ray, Brett Vance, FAA test pilot.

A. Hey, how's it going?

Q. I have a couple of shuttle process questions.

A. Sure.

Q. And also a couple of AST process questions.

A. You bet.

Q. I'll do the shuttle first. Can you give me an idea what type of training the shuttle commander and the pilot had to accomplish once they were assigned to a mission, just general types of training?

A. If I can, let me go ahead and jump ahead even further than that. So when they first come on, they're known as ASCANs or astronaut candidates. They go through 2 years of generic training, followed by 2 more years of even more intense generic training, and then they go, in the case of what you're asking about, a CDR and PLT, it could be anywhere from 2 to 3 years of mission specific training. One flight in mind, for me especially, I was part of that team, was STS-92, flight to the International Space Station. We had multiple vehicle swap-outs, and I think it almost took us 4 years to get that crew up there.

So it's very intense. The CDR and PLT will train in a shuttle training aircraft. They will train motion base. They will train in the fixed base in single system trainers, do hundreds if not thousands of hours behind sim and actual flight time, and that also includes proficiency flights in the T-38s.

Q. Okay. So we've got flying training and simulator

training that are mission specific. Of course, the T-38 is training for high speeds and courses.

A. Right.

Q. What about ground training requirements?

A. Ground training, numerous, numerous classrooms, classroom assignments. That could be anything from how does your general purpose computer work to how do I use my personal computer on the orbiter, how do I go to the bathroom in the orbiter. Every topic that you could ever care to want to know about in human space flight has got to be covered in the ground training session. Photo TV, you never think about that being one of your classes as a crew for -- even a CDR or pilot, but yet they are trained on how to snap pictures, what the sunlights are doing, what type of camera to use, how much power levels you have, et cetera. It gets down to that level, or it did in that program.

Q. And what about things like survival training?

A. Oh, certainly.

Q. Parachute training, things like that?

A. Certainly. So what they would do, especially as their astronaut candidate days begin -- I really should say towards the tail end of it, they would do parachute training, and they're only pulled by a boat, have them over the water, and they would drop them over the water, for example. Survival equipment was a big deal. We had to launch an entry suit. To launch an entry suit took quite a bit of training to get used to. Most of us know it

as a pressure suit. Launch an entry suit, dealt with high g's but it also dealt with having a diaper inside. It dealt with having good circulation. You also had individual transponders for each individual astronaut, on and on and on. This training was intense, just on the survival purview.

As a crew, you would go out together and you would spend a few days out in the wilderness. In many cases this was done, in fact, even during generic training, just to test the ability to see how well people work together as a team or individuals, for that matter, to see what their pros and cons are.

Q. Okay. Yeah, I've been there and done that, and also the towing behind the boat. That was a lot of fun, though.

Okay, so you described some broad, extremely broad training.

A. Yes.

Q. So my next question to finish this line here on the shuttle program, how did you guys document all that?

A. We had an extensive documentation system. So, for example, if I was going to teach something called mechanical operations, and it was the introductory course, if I recall, it was MECOPS 20001. Then there would be a follow-on course in mechanical operations off-nominal, and then we would take that to, oh, a long form now procedures. There's so many different classes.

But what we would do is we would fill out a form, we

would enter it into the database, because each astronaut, as you may know, would have a record of what they need to be trained on. More importantly, if they started to see training that they needed to renew before it came out. I can't tell you how many numerous classes I taught, whether it would be opening up a payload bay door or closing external tank doors, or what have you, for just renewal purposes, so an astronaut could remain qualified. So it's a very broad process but a very detailed, methodical process of paperwork and computer entry.

Q. I'm glad you brought that up about renewal because sometimes during the course of events you go non-current and you had to be reminded to renew a certain level of --

A. Absolutely.

Q. Did I just hear you say that it's computer-documented as well as the paper-based documentation?

A. Oh, yeah, we definitely use that. That's how the astronauts will keep track of what they're doing.

Q. Okay. Were those in training folders that have their names on them, or what?

A. Oh, gosh. Now you got me there. It's been a while. I am sure in the end-all, be-all database of the Astronaut Corps, that's exactly what they have. I was part of the systems group, shuttle systems group when I was at the Johnson Space Center, and my specific issue, or what I would do is teach them a course, whether it's environmental control, life support, caution warning,

or what have you, grade them and that would be submitted into the system, and then would go into their ultimate folder. Where their folder resided, I'm sorry, I don't know.

Q. Okay. I think that will do for, you know, what you do -- what I was after.

Getting back to AST for a second, you guys as a group or you as an individual inside AST-200 or whatever, did you guys have a job aid or any kind of a checklist or anything that you would use to evaluate an application against parts 437 and 460?

A. The only thing we really could go by was, again, for the regs and our internal crew documents, and that's really more of a guidance document than anything else. And I think we need to remember one thing, because Scaled is such a unique vehicle, the fact that not only is it a suborbital flight vehicle, it is a human-rated suborbital flight vehicle. So this is the first time we've really ever evaluated a vehicle like this with the exception of SpaceShipOne. So it was not consistent for all processes.

Q. So at this point, particularly with 460, you had only done that once before with SpaceShipOne, so there was really no other defined process except for reading the reg and then asking pertinent questions?

A. That's correct.

Q. Okay. One more on the AST processes. This one is about the waiver, and there are several mitigations that are listed in the waiver. Was each one of those mitigations based on an

actually submitted hazard analysis that was presented to AST?

A. I'll tell you, could you ask me the question one more time. Let me get my thoughts here.

Q. Yeah, in the waiver process, when you read that document, there's several mitigations that are listed.

A. Right.

Q. And I guess my question here relates directly to kind of a cause and effect. So was there a hazard analysis that was submitted to you for each one of the litigations that were listed in the waiver?

A. There was a hazard analysis but there were multiple documents, would eventually collectively had provided mitigations, zonal analysis and that kind of document.

Q. And you can track all that?

A. We have all that, yes.

Q. Okay. I believe that's all the questions I have. Thanks, Ray.

A. You bet.

MR. HAUF: Okay. Christy?

BY MS. HELGESON:

Q. All right. I'll start where Brett left off. That hazard analysis that was presented to AST, did it address any human error issues?

A. I'll be honest with you, it's been a long time since I've looked at it. I can't say with any certainty. I'm sure that

there were items that would have addressed human factors issues. I can't say --

Q. So in terms of the -- sorry.

A. No, go ahead.

Q. In terms of Rule 437.55 for hazard analysis and human errors, what is AST's expectations from Scaled Composites to identify a characterized human error hazard related to SpaceShipTwo?

A. Specifically, in that case, I think one of the issues would have been with vibration. Additionally, also not just human factors issues but also the software. As we went along as a team, one of our biggest concerns was the vibration. Once the rocket engine was lit, were both pilots able to read the displays appropriately?

I think another concern was seeing video of shaker table experience, if I recall with Brian Binnie. That was a bit concerning as well. And utilizing my experience and other group members' experience with the shuttle world, knowing that once you light a solid, you get that vibration and it's shaking through the vehicle, it can be quite concerning reading instrumentation, whether it be digital or analog.

Q. Any other concerns regarding human errors in an interface other than vibrations?

A. Honestly, off the top of my head right now, I really can't remember. I'm sorry.

Q. So who at the FAA AST would review any human error issues presented by Scaled Composites?

A. That would have been our systems safety analysis personnel. That would be Jay Naphas, Tom Martin, Rene Ray.

Q. Earlier in your interview you stated that you felt Scaled Composites correctly met the regulations. So in your opinion, how do you feel Scaled met the regulation of 437.55 in terms of human error?

A. Well, I felt Scaled met to a point, and they did meet the regs, but again like any other FAA regulation out there, there is a minimum requirement. Do I believe they met that? Yes. However, I do have systems safety experts on my team and if they tell me they don't believe that there's been an issue met in the case of systems safety, I must listen to their expertise and pull that forward. I'm sorry. Do you want to maybe rephrase the question or is there a --

Q. A follow-on is what is the FAA minimum requirements to meet of human errors stated in 437.55?

A. Honestly, I would have to pull out 437.55 and read the reg, and I've recommended -- and I have recommended to all my teammates, when it comes to regulations and reading the verbiage, that they go straight to the document and try not to do it off the top of their heads.

Q. Are you able to speak to how NASA identified and characterized human error associated with any hazards it posed to

the space shuttle program?

A. Oh, wow, that's a pretty big painting right there. That is not my expertise. Have I been involved in that? Yes. And it can be something as simple as a sharp panel in analyzing that. It can be something as simple as a T0 umbilical truck slamming into the side of the orbiter post-landing. There are numerous events, numerous issues. The shuttle program can provide lessons in this case, but it's so broad that I don't know how applicable a lot of it would be.

Q. Do you have a high level process that you could talk us through at NASA that would identify those hazards with human error?

A. Oh, sure. In fact, I was part of the Ares 1X development, and my responsibility as a safety engineer was for the command module and launch abort system as well as the avionics system. I ran a team there working for United States Alliance under NASA, ran a team in which we analyzed every component of the avionics. For example, everything from "Will this shock me?" to "Will this cut me?" to what the effects will be, good and bad. And we ran that through something called a PFEMA, and that's a process failure effects mode analysis, basically right down to the nut and bolt level. So one of my expertise is also being a safety engineer and analyzing issues with ground support equipment and flight hardware. So that's how we did it at KFC, and that's just for the Aries 1X. The shuttle is just a different animal

altogether. It would take days to explain that.

Q. I guess I'll direct you a little differently. The examples that I'm hearing are -- seem to be what the shuttle could do to the pilot, not what the pilot could do to the shuttle. So in terms of human error, such as decision errors or skill-based errors, was there anything specifically done to identify what those hazards were at NASA?

A. Oh, I can give you just a good for instance. Taking it off of an auto mode during ascent and putting it in control stick steering and flying it outside the needles would make the vehicle come apart, and that would be totally pilot induced. And the way that could happen is if you have computer failure and they have to fly it manually.

Q. So are you aware of any single-point failure a pilot could induce at NASA that would cause a catastrophic outcome?

A. As ridiculous as it sounds, anything is possible. I mean, they could have separated the orbiter from the entire stack going uphill in something called a fast sep and it would have been a very bad day. But if it is their only way of getting away from that big orange tank, it possibly could have been done. But that could have been single event catastrophic no doubt.

Q. Would that be considered a nominal or non-nominal event?

A. That's off-nominal, totally. Totally off-nominal.

Q. Any nominal events, single point, that could cause a catastrophic outcome that the pilot could induce?

A. Sure. Fuel cells, for example, power generation, running a fuel cell to the point it gets beyond 253 degrees, the fuel cell comes apart on them because they weren't paying attention to the fact that the fuel cell cooling wasn't appropriate. And also -- I'm sorry.

Q. Go ahead.

A. Also tying a buss to a short. It's very simplistic, but if you do that, you can bring down a whole managing bank. You could bring down two main engines if you lose one AC buss. So multiple situations.

Q. Do you know if NASA identified or completed assigned probability to any human error identified in a hazard analysis?

A. I am going to tell you, I don't know the number for sure, but you can bet on it.

Q. Are you aware of any issue that assigning probability could be human error like is done with typical hazard analysis for mechanical failure?

A. I'm not.

Q. How familiar are you with a Scaled Composites and Virgin Galactic pilot background and experience?

A. I wouldn't say I'm an expert at it but I have a good feel that these people are high-time commercially rated and with an instrument ticket. I would assume that most of them are ATPs, if they're not commercial. I know of a few of their credentials but I don't know all the pilots.

Q. Do you know how pilots are selected to fly SpaceShipTwo at Scaled Composites or Virgin Galactic?

A. Actually, I am not aware of their hiring practices.

Q. Who at AST is involved with how Scaled Composites or Virgin Galactic chooses their pilots based on background and experience?

A. I've got to be honest with you, with the permitting process, we again take a look at 437, especially 460.5, to make sure that they meet the minimum requirements, which again 460 is just woefully inadequate, again this is my opinion, when it's just asking for a private pilot rating and an instrument ticket to go fly spaceships. I don't -- I can't answer to whom those, the specifics about the hour time for the Scaled or VG pilots or who you would ask who would know that. Again, I just don't -- other than myself and probably my lead or my assistant lead, but there's got to be others I'm sure. Probably AST-500 would be the voice to talk to.

Q. So if you had a magic wand and could change the pilot requirements that's stated in 460, what would it look like?

A. Well, what it would look like is, at a minimum an ATP, at a minimum, and that goes with military experience, some kind of missile background, very much the hiring practices of the way we chose our astronauts in 1959, very similar to that, having an engineering background, a minimum of 1500 hours of flight time, et cetera. If they don't have experience in jets, they must have

experience in some kind of missile activities, and be able to contribute something to the process other than just wanting a vehicle, be able to be part of the engineering team as well.

Q. Do you know if the pilots of Scaled Composites and Virgin Galactic have an engineering background?

A. I do not know that.

MS. HELGESON: No further questions. Thank you.

MR. JENKINS: You're welcome.

MR. HAUF: Thank you, Christy.

Okay. Just a couple -- I just have a couple of follow-up questions, and then we'll run around the room really fast.

BY MR. HAUF:

Q. The first one's going back to the waiver. Do you know if Scaled submitted any information to the FAA in regards to a hazard analysis for the waiver?

A. I'm not aware of any.

Q. Okay. That's the question there. And then jumping back to AST-500 and the scrubbing of the questions, actually I have two questions here. The first one was did they give you a reason why they were scrubbing the questions?

A. Absolutely.

Q. Can you --

A. And that reason was they were worried about the relationship with Scaled.

Q. Okay. And then were there any, let's say, system safety

or safety-critical questions that were scrubbed? And, do you have any examples of those?

A. Yes, there were. Not off the top of my head, and I would really suggest that Tom Martin would be the individual to really follow up with on those. He would have a better memory on that than I would.

Q. Okay, great. Thank you.

A. Sure.

MR. HAUF: Okay. Does anybody else in the room have a question?

DR. WILSON: I do. Yes, I'm sorry.

MR. HAUF: I didn't mean to --

DR. WILSON: That's okay.

BY DR. WILSON:

Q. Two quick follow-ups. Lorenda had asked you about your workload in the office.

A. Um-hum.

Q. You mentioned your workload before the accident was, I forget the words you used, tolerable, maybe, or acceptable. I don't remember the exact word, but -- so I'm curious how your workload has changed since the accident?

A. It has lightened up significantly.

Q. Lightened up. Okay. Is there a reason that you can discuss?

A. Oh, it's just because of everything that's happened and

because of the standdown essentially. And VG -- what's going on with Virgin Galactic, we're still working with VG. So -- but, of course, I was working with Scaled also. So it's, you know, the workload has just been cut --

Q. Okay.

A. -- because of that, that's all.

Q. In a perfect world, what guidance would you like to see an operator reference when submitting a permit application?

A. I think, and again my opinion --

Q. And that's what I want.

A. Okay. AST needs to come out with a complete, robust documentation, some form of guidance document that says a permittee must do this, this and this. It's -- and I must emphasize this, forget the intensity, but again being a pilot, it's one thing to meet the minimum regulation. Human space flight, space flight does not recognize these minimums. There is danger above, gang. Above 50,000 feet, the game changes. It just does. We can sit here and say people meet the minimum regulations all you want, but are you really willing to accept that flying humans into space? Minimum doesn't cut it. That's my opinion.

Q. Is there guidance out there that people should be referencing in lieu of this document that you would like to see AST provide? What should operators -- what guidance should they be looking at?

A. Right now I think that what I've seen thus far from

these operators, and not having guidance, has been spectacular. Truthfully. To do what has been done so far, and come that far, without particular guidance -- and I'm not saying the federal Government should be guiding everything. But not to have the appropriate guidance and not come from an operation like NASA who's been blessed for 50 plus years, it's been unbelievable. But we at AST, FAA, the whole group, we've got to develop something that's coherent, people are able to understand, these companies are able to perform, and if they have questions, have the engineers, the people that know the business, be allowed to talk to these companies for better efficiency. Better things will happen. Better things will happen. We need some kind of document out there definitely. Definitely. It can be an AC or what have you, but something.

Q. Are there ACs that people should be referencing now?

A. There is a real good one that we have at AST for environmental control life support. I like that a lot, and it was done, I don't know, 10 years ago -- Dan? I don't even know. But that's a real good one. There are multiple good ones that we have listed. But as far as the permit goes, we need direction, we need guidance. And with the emphasis that if it's going to be 437 and it's human space flight, we're going to have part 460 in there as well. Again, the full guidance.

Q. Thank you.

A. You bet.

MR. HAUF: Mike?

BY MR. BAUER:

Q. Yeah, just -- you were in charge or the team lead for the permit evaluation.

A. Correct.

Q. Which involved AST-100, 300, 500?

A. Yeah.

Q. From a tasking role, did AST-500, let's say, report to you or were they under their own direction during the permit evaluation?

A. Yes. Yes to both.

Q. Yes to both?

A. They had their function. They would report to me. But these were nominal issues and, again, any communication had to be done with the team; I had to go through them.

Q. So any of the filtering decisions for questions to the applicant would be made wholly by AST-500 or with management and --

A. No. Generally what would happen is management within AST-500 would look at these questions, along with our chief engineer and others in management, and scrub these questions. And again, the problem being you have to have people with the appropriate background to truly know what they're looking at and not say I'm afraid of our relationship. It just makes no sense to me, as a space caring individual, why questions would get scrubbed

because we're afraid of relationships.

MR. BAUER: That is all the questions I have. Thank you.

MR. HAUF: Bob, I think you had a question.

BY MR. WITHROW:

Q. I have a couple of follow-ups, but, Ray, just with your last statement, I'm just wondering, you know, the concern about relationships, if AST and Scaled weren't happy with each other, what difference would that make?

A. That's not the issue, Bob.

Q. Okay.

A. It's not that at all. It's -- 500, to be frank with you, is more concerned about the relationship with Scaled. It's all great to have relationships, don't get me wrong.

Q. Yeah.

A. But you know as an engineer, the technical side wins out here.

Q. Oh, absolutely.

A. Right. So I want the technical issues resolved, as I'm sure all of you at Scaled want them resolved, but there are other communications that you're not privy to that I feel we could have better interacted with you at Scaled, again at a more appropriate level, engineer to engineer.

Q. Okay. So now we can go to a technical question. So talking about numerical probabilities, you mentioned that in your

experience in the shuttle that there are single -- what people are calling single-point failures, but at least things where a single human action can lead to a catastrophic outcome. And my question is this, a two-part question: The first part, in 437.55, there's a requirement on the permittee to mitigate things that can cause catastrophic outcomes to a 1-in-a-million probability. Is that correct? Extremely remote?

A. Yes, correct.

Q. And extremely remote is generally determined to be 1 in a million. So if there are single human actions that can lead to a catastrophic outcome, then that would mean that the probability of that action has to be less than 1 in a million. Is that not so?

A. That's so.

Q. Are you aware of human physical actions that are routinely achieved at a 1-in-a-million failure rate?

A. (No audible response.)

Q. So then -- and just to point out, he shook his head no.

MR. PREAMBLE: Yeah, can we just get -- you need to give a verbal answer.

MR. JENKINS: I'm sorry.

BY MR. WITHROW:

Q. So then what's the practical way of complying with that requirement when it comes to human error?

A. I don't --

MR. WITHROW: That's it. Thank you.

MR. HAUF: Will?

BY MR. ROBERTSON:

Q. The only other questions I have had to do with something called "complete enough." Are you familiar with that?

A. Yes.

Q. Okay. Could you maybe explain what the term "complete enough" and how it applies to a permit?

A. Complete enough would be, let's say, an applicant sends information to us that we see within the regs. Again, we'll make be a hypothetical spacecraft, a human vehicle, let's say, and that it meets the particular regulations at basic minimum, and then that gives us an opportunity to go ahead and review that application. Or, let's say, for example, it left out smoke detection and fire suppression and it wasn't there. Would I come back to you and say it's not complete enough? Most likely what we would say is, hey, you're missing this section, let's go ahead and proceed but deliver that information to us.

Q. By proceed, what do you mean by proceed?

A. Oh, we'd start --

Q. You would give the permit with some sort of term and condition, and then the applicant could operate --

A. Complete enough means we're at the very beginning of the process, we just received the documents, and we're just starting to review. Now, if it was totally just void of any appropriate

information, we would go back and say this is just not good enough; you need to go back and do more work before we can even start our application review.

Q. Okay.

MR. ROBERTSON: Okay. I guess that's all the questions I have.

MR. HAUF: All right. Any further questions in the room? Lorenda?

MS. WARD: Yeah, I just have two real quick ones.

MR. HAUF: Sure.

BY MS. WARD:

Q. You keep talking about the relationship. So how would you describe the FAA's relationship with Scaled?

A. I would say it's excellent. But we can't have relationships dictate space flight. That's the issue.

Q. Which is a great segue.

A. You're welcome.

Q. Is AST looking to update or change the processes in regards to human space flight and how they grant the permit or license?

A. I know there's been a recent initiative to better our regulations, as far as part 460 goes. I don't know specifically what they're doing in regards to 431 and 437, whether it be license or permit.

Q. Within your division, such as in AST-200, as you go

forward, is there any plans within your office to change how you evaluate your human space flight applications?

A. I currently have not been made aware of any changes as of yet.

Q. Okay.

A. But I'm sure there will be.

Q. Okay.

MS. WARD: That's all I have.

MR. HAUF: All right. On the phone, does anybody have any questions? Let's start with Nikki.

MS. DUGUE: Yes, I have one follow-up question.

BY MS. DUGUE:

Q. We talked a lot about what NASA does or doesn't do. Do you feel that NASA has a robust program as far as human space flight, flight training, systems safety analysis?

A. I feel at the time the shuttle program was going on, we had the best. As --

Q. Do you see --

A. Go ahead.

Q. All right. Do you see AST adopting a lot of their processes?

A. The thing is, do we need to adopt to the training practices of NASA/United Space Alliance, other contractors, the way we did in the shuttle world? We don't need to do it the way the shuttle did it, but there are multiple practices which need to

be adapted. Yes, we need to do that. It needs to be a streamlined version.

Q. Okay. Thank you.

A. You bet.

MR. HAUF: Okay. Christy?

MS. HELGESON: No follow-up questions from me. Thank you.

MR. HAUF: Okay. And, Brett?

MR. VANCE: No further questions.

MR. HAUF: Okay. Great.

BY MR. HAUF:

Q. Okay. Now one last question for you. Do you have any comments or additional information that you believe may assist us in our investigation?

A. No, I do not.

Q. That works. Very good.

MR. HAUF: Okay. If there's no further questions, I think we're done.

(Whereupon, at 2:35 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:	CRASH OF VIRGIN GALACTIC SPACESHIPTWO MOJAVE, CALIFORNIA OCTOBER 31, 2014 Interview of Ray Jenkins
DOCKET NUMBER:	DCA-15-MA-019
PLACE:	Washington, D.C.
DATE:	January 15, 2015

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.

_____

Stephen Grider
Official Reporter

UNITED STATES OF AMERICA

NATIONAL TRANSPORTATION SAFETY BOARD

Investigation of:	*	
	*	
CRASH OF VIRGIN GALACTIC	*	
SPACESHIP TWO	*	Docket No.: DCA-15-MA-019
MOJAVE, CALIFORNIA	*	
OCTOBER 31, 2014	*	
	*	

Interview of: JENNIFER BAILEY

National Transportation Safety Board
6th Floor Conference Room
490 L'Enfant Plaza East, S.W.
Washington, D.C.

Thursday,
January 15, 2015

The above-captioned matter convened, pursuant to notice.

BEFORE: MICHAEL HAUF
System Safety Group Chairman

APPEARANCES:

MICHAEL HAUF, System Safety Group Chairman
National Transportation Safety Board

DAVID LAWRENCE, Operations Group Chairman
National Transportation Safety Board

LORENDA WARD, Investigator-in-Charge
National Transportation Safety Board

MICHAEL BAUER, Systems Group Chairman
National Transportation Safety Board

KATHERINE WILSON, Ph.D., Human Performance Group Chairman
National Transportation Safety Board

DANIEL MURRAY
Federal Aviation Administration

CHRISTINE HELGESON
Representative to the Human Performance Group
Federal Aviation Administration

BRETT VANCE, Test Pilot
Los Angeles Aircraft Certification Office
Federal Aviation Administration

BOB WITHROW
Scaled Composites

NICOLETTE DUGUE
Scaled Composites

WILL ROBERTSON
The Spaceship Company

BRADLEY PREAMBLE, Office of the Chief Counsel
Federal Aviation Administration
(Representative on behalf of Ms. Bailey)

I N D E X

I N T E R V I E W

MR. HAUF: Okay. My name is Mike Hauf and I work at the NTSB, and I'm the System Safety Group Chairman for this investigation. And I'll be doing the interview here.

The NTSB is an independent federal agency charged with determining the probable cause of transportation accidents and promoting transportation safety. The NTSB is not part of DOT or FAA. It has no regulatory or enforcement powers.

At this point, I'd like to introduce all of the people in this room and on the telephone. We'll start with Lorenda.

MS. WARD: Hi, I'm Lorenda Ward. I am a Senior Investigator-in-Charge, and I am the IIC for this accident investigation.

MR. PREAMBLE: Brad Preamble from the FAA, Office of the Chief Counsel.

MR. ROBERTSON: Will Robertson, Systems Safety for Virgin Galactic.

MR. WITHROW: Rob Withrow, Scaled Composites, representative on the Systems Safety Team.

MR. LAWRENCE: David Lawrence, NTSB. I'm the Operations Group Chairman.

DR. WILSON: Katherine Wilson, NTSB. I am the Human Performance Group Chairman.

MR. BAUER: Michael Bauer, NTSB, Systems Group Chairman.

MR. HAUF: And on the phone, can you introduce

yourselves?

MR. MURRAY: Dan Murray, FAA AST representative, Systems Safety Working Group.

MR. HAUF: And Brett, have you arrived yet? Okay, still waiting for Brett.

Okay. So do you have an objection to anyone other than an NTSB employee taking part in your interview?

MS. BAILEY: No.

MR. HAUF: Okay. Today we'll be using the services of a court reporter who will record and then transcribe the interview. The transcript, not the audio recording, will be made a part of the public docket.

The purpose of the investigation is safety, to determine probable cause and prevent recurrence. Our role is not to assign fault, blame, or liability. This interview is part of the fact-finding phase of the investigation. We are here to ask questions about your involvement in the permit and waiver for the SpaceShipTwo program. We cannot, however, offer any guarantee of confidentiality or immunity.

Each of the group members will have a chance to ask questions. We will ask questions one at a time and everyone has been instructed to not interrupt the person who is asking questions at that time. There will be an opportunity for each group member to ask follow-up questions after each person has had a turn.

Please answer all questions to the best of your recollection. If you do not understand a question, ask to have it repeated or explained. If you realize you misstated or need to modify a previous answer, please do so.

You're entitled to have one representative of your choosing. Is there someone you would like to have as your representative?

MS. BAILEY: Um-um.

MR. HAUF: And, Mr. Preamble, you may direct Jennifer to not answer a question or request a short break to confer with her.

The FAA will have the ability to review the transcript prior to inclusion in the docket. Do you have any questions?

MS. BAILEY: No.

MR. HAUF: Okay. To begin with --

MR. WITHROW: Nikki's on there too. I don't know if you had heard that.

MR. HAUF: Oh, I did not. So, Nikki, could you introduce yourself?

MS. DUGUE: I'm Nicolette Dugue with Scaled Composites, representative on the Systems Safety Group.

MR. HAUF: Okay. And Brett, have you arrived?

MR. VANCE: Brett Vance, FAA Test Pilot, Long Beach Aircraft Certification Office.

MR. HAUF: Okay, great. So we'll start here.

INTERVIEW OF JENNIFER BAILEY

BY MR. HAUF:

Q. Okay, to begin the interview, and for the record, could you please state your name and job title?

A. Jennifer Bailey, Aerospace Engineer.

Q. Okay. And so, which AST division do you work in?

A. I'm in AST 300.

Q. Okay. And how long have you been in that position?

A. I have been there 4 years. At the end of this month it will be 4 years.

Q. Four years. Okay. And who is your immediate supervisor?

A. Stewart Jackson.

Q. Stewart Jackson. Okay. And prior to coming to this job, could you give us some background on your previous experience at the FAA and prior to the FAA?

A. Okay. Yeah, I came to the FAA in 2011. Before that, I was at the 45th Space Wing; I was a civilian for the Air Force. And I did a similar job of -- I was a safety engineer and did debris risk analysis for launches from the Cape. I also was a safety intern for 2 years. I worked -- I started at the Air Force in 2006.

Q. Okay. And do you have a background in safety or systems engineering?

A. I have a degree, a B.S. in engineering physics, and an M.S. in human factors in systems engineering. My concentration

was in systems engineering.

Q. Okay, great. Let's see here. With regards to the experimental permit, could you describe if you had any -- have you worked on it at all, and if so, what have you worked on?

A. I did the operating area containment analysis. I was, as part of the team, working that side. And so, we did the original permit, and then I was involved with the modifications, the following modifications.

Q. On modifications, okay.

A. Also with the operating area containment portion of the analysis.

Q. Okay. Did you have any -- or did you work on any other areas of the permit, like the hazard analysis with respect to systems safety?

A. No, I did not.

Q. Okay. And regarding -- kind of jumping around a little bit, did you work on the waiver or have any input into the waiver for this -- for Scaled?

A. I did, in that for the waiver I was asked to provide data on the population density within the operating area. And I provided those numbers, and those were put into the waiver. But that was my only involvement.

Q. Okay. Who did you supply that information to, or who was working on it?

A. Randy Repcheck asked me for that information. He's my

deputy manager.

Q. Okay. Thanks.

MR. HAUF: I'm going to pass questions over to Katherine at this point, and then I'll probably have some follow-ups.

DR. WILSON: Sorry. I was not expecting to be next.

BY DR. WILSON:

Q. Did you interact with anybody at Scaled Composites regarding either the permit or the waiver?

A. I don't recall specifics. I know I was on telecons with Scaled Composites during the evaluation period.

Q. But you didn't have a specific role where you interacted with one person?

A. No.

Q. Okay. Regarding the permit or waiver, did you have any concerns?

MR. WITHROW: Just one of the people on the phone said that they have a hard time hearing.

BY DR. WILSON:

Q. Regarding the permit or the waiver, did you have any concerns?

A. I was, really was not aware of what the waiver was, why they -- what they were doing in regards to the waiver while it was happening.

Q. How about the permit, the approval of the permit?

A. As far as my portion of the permits, I did not -- at the

end of the permit evaluation period, I did not have concerns with the vehicle. As far as for the operating area containment portion, I did not have any concerns.

Q. For both the permit and the waiver was that all that you -- was that your only role regarding the Scaled permit and waiver was the operating area?

A. Yes.

Q. Okay. If you did have concerns, who would you have brought those concerns to?

A. I would have brought them to my manager, and then also to Ray Jenkins, who's the team lead.

Q. Is that something that you would have felt comfortable doing?

A. Yes.

Q. Were you a part of any discussions regarding tolling of the permit process?

A. I do not recall.

Q. Did anyone ever discuss with you any concerns that they had about either the permit or the waiver?

A. I don't recall any specific instances. The only -- the concern that I remember is the timeline, that I know for systems safety there was a crunch at the end to get the evaluation completed. But I, other than that --

Q. Do you recall what was happening at the end of that timeline, why was there a time crunch?

A. I don't.

Q. Anyone else on your team have a human factors background?

A. Not that I'm aware of.

Q. Okay. What did you do specifically with the Air Force?

A. I was a safety engineer, and I did debris risk analysis. And so what this is, we used a program that we also use at the FAA called the Range Risk Analysis Tool, RRAT. And we looked at the -- at the range, it was risks to the public and to the personnel on site at the Cape from EOV launches.

Q. Okay. Not specifically other permits that you've worked on by who the operator was, but could you estimate about the number of permits that you've worked on?

A. It hasn't -- this was the first -- I think this was the first permit that I worked on. I don't recall any before that.

Q. All right. Since you started working on this permit have you worked on others?

A. I'm working on one now. I don't recall any others at this time.

Q. Okay. On that other permit, again, in generality, have you had any concerns that you've had to bring to your supervisor's attention?

A. I haven't had any concerns that -- I've worked them out with the team lead. I haven't had to bring them to my supervisor.

Q. So working with the team lead, any concerns that you had

were satisfied to your satisfaction and resolved?

A. Yes.

Q. Okay.

DR. WILSON: Okay. I think that's all the questions that I have right now. Thank you.

MR. HAUF: Okay. Dave?

MR. LAWRENCE: Yes, thanks.

BY MR. LAWRENCE:

Q. Good afternoon. I believe you said you did an evaluation of the containment area? Was that in -- did that also include an evaluation of the R-2508 complex?

A. Yes, the operating area was equal to RD-2508.

Q. Okay. Great. Let me ask about your process there. You just -- let's get a high level generalized what you -- what did you do in your work to evaluate that complex and its viability for the launch profile for the SpaceShipTwo? And we'll keep that at a 30,000-foot level, and then I'll ask you some lower level questions later.

A. So we made sure that the vehicle -- the planned trajectory and any dispersions on that strictly would stay within the operating area. And we also looked the populations within the operating area to make sure there weren't any high-density populations or any places like stadiums or where large groups of people would gather inside that area.

Q. Okay. I'll take you down a level instead.

A. Okay.

Q. Now, let me ask you little bit more. Since you've had to, I guess, compare the trajectory of the vehicle when it's in its profile with the complex, did you have to become familiar with the performance of the vehicle?

A. For a permit, it's not so much into the details of the exact performance of the vehicle. We look at the overall operations and what they plan, and will that be able to stay within the operating area.

Q. Okay. Talk to me a little bit about the overall operations that you became familiar with, with the SpaceShipTwo vehicle.

A. What do you -- like, what do you mean?

Q. Well, did you have to become familiar with some of the procedures, some of the characteristics of the launch trajectory of the vehicle? Did you have to learn a little bit about what the vehicle was planned to be doing when it goes up? You know, it's going to go to an altitude and then it's going to be in apex and come back down. Did you have to have a little knowledge about what the vehicle was planning on doing?

A. Yes. We had to know the trajectory profile of the vehicle, where they planned to drop, and -- how high they would go and where the reentry point would be and the transition to glide.

Q. Okay. Was that based on information that Scaled provided to AST?

A. Yes.
Q. And that was part of the permit application?
A. Yes.
Q. Okay. Have you been to Mojave?
A. Yes, I have. Not for work, but yes, I have.
Q. Okay. Is there a reason why as part of your evaluation process you didn't go to Mojave?
A. There was not an opportunity given to me, and I --
Q. Would it have helped to travel to Mojave?
A. I think it's good to meet people that you're working with face-to-face, but other than that, I don't know that it would have especially helped.
Q. Great segue to my next question. Some of the people that you worked with within AST, did you work with any of the AST-500 people that were the inspectors?
A. Inspectors, I don't recall.
Q. Okay. Who did you liaison with or who did you communicate with at Scaled? I'm not sure if that was already asked, so I apologize.
A. I don't recall the names of the people that were on the phone or email.
Q. Okay. And you don't -- do you recall if you communicated with anybody at AST-500 at any point in time during your evaluation?
A. I know that I did. I don't recall at that time who all

was out there.

Q. Okay. Did you ever develop any questions out of the process of your evaluation of the Scaled permit that you needed to provide to AST-500 at any point in time to maybe relay to Scaled?

A. I don't recall any specific questions. It's been a while.

Q. Okay. Let me ask general process as far as, if you had any questions that you wanted to get from Scaled, did you pick up a phone and call the Scaled people, or would you have to contact somebody within AST to handle that?

A. I would go through the team lead, Repcheck.

Q. Okay. Do you know what his process then would be?

A. No.

Q. How to get the answer?

A. I don't know the specifics of his process.

Q. Okay. How many people were working in your office in the 300?

A. For this, I know it was -- for the operating area containment I know it was Dan Murray and me, and Andre Wilde. He's no longer in our office.

Q. Dan Murray, and I'm sorry?

A. Andre Wilde.

Q. Okay. Who's no longer there?

A. Yes.

Q. And then, during the course of your evaluation of the

containment area, did you identify any issues that needed to be resolved on the part of Scaled to comply with the permit application?

A. We did identify that there was -- Scaled did not provide the population areas that they would avoid during the key flight safety events, so we had that as a term and condition on the original permit. But then they did provide that at the first modification a year later.

Q. So they didn't provide that on the initial application?

A. Correct.

Q. And then provided it on the renewal?

A. Yes.

Q. Was it required to be a part of the application?

A. Yes. That's why we had a term and condition that they had to provide it before the powered flight.

Q. Should there have been a waiver on that portion of the application, the initial application, if it didn't meet the requirements?

A. No, because the term and condition covers that. So we would just not allow them to fly -- we would still -- we didn't want to waive the requirement. They were still required to provide that information. We just had to require it before they could do the first powered flight.

Q. Okay. So was there a condition placed on the initial application?

A. Yes.

Q. Okay. How responsive were they to that particular issue?

A. They were very responsive.

Q. Dr. Wilson asked about your ability to be able to raise concerns to your superiors. Do you have any issues with concerns that you may have with the Scaled application or any of the renewals that have not been addressed?

A. No.

MR. LAWRENCE: I think that's all I have.

MR. HAUF: Mike?

BY MR. BAUER:

Q. During your analysis for the permit application, did any of it deal with systems, system operation or vehicle system operations?

A. I don't -- what --

Q. As part of your evaluation process for your portion of the application, did any part of it require you to look at any vehicle system operation of the spaceship?

A. So, you're -- like, the specifics of how the vehicle --

Q. How the vehicle's -- how the systems are operated? How their system landing gear --

A. No. We don't get into the weeds like that.

MR. BAUER: Okay. I have no further questions.

MR. HAUF: Lorenda?

BY MS. WARD:

Q. So how do you validate it? So if the applicant brings to you their variance distribution or instantaneous impact point, how does that -- how is their permit validated?

A. We have a -- we have software programs that we use. We have software called TAOS, Trajectory -- now, the acronym is going to escape me. We used TAOS and PTK and RRAT that I mentioned before to independently verify trajectories and to verify the information that the applicants give us.

Q. Now, for that -- is it a different process for a permit than it is for a license?

A. Yes.

Q. Can you elaborate on those differences?

A. For a permit, we do not require as much of the specific data. We do not always require a specific -- as much trajectory information. And we do not require them to perform an E sub C calculation, an expectation of casualty calculation. For permits they just have to show that they will stay within the operating area. And for a license, we do a quantitative analysis to determine the number -- expected number of casualties from the launch. For that we need much more detailed information about how the vehicle will break up and what the different malfunction trajectories could be.

Q. So you just talked about how they'd stay within the containment area. How large is that containment area?

A. It was very large. I don't remember the -- but it's -- it was the whole RD-2508 airspace was the operating area.

Q. Okay. And just for clarification, for the instantaneous impact point, like, is there a range associated with that so that if a person is doing -- like is it based on like a brackage around, okay, we have a piece of some certain size may land within a circumference, or -- but if it stays in the area are you okay?

A. Yes.

Q. All right. You talked about population density in the very beginning. So for a permit they don't have to take that in consideration?

A. For a permit, they do need to take the population density into consideration. It says in the regulations that it should be a sparsely populated or unpopulated area, and that there should be enough of a sparsely populated area within the operating area that they could -- that, in essence, the risk is low enough to launch in that area without having to do an E sub C calculation.

Q. All right. Does the regulation talk about infrastructure as far as major highways or roads that might cross through that containment area?

A. Yes. We do -- it does say to look at highways through the operating area.

Q. Is sparsely defined?

A. No, there is no written definition.

Q. What would be an acceptable casualty statistic?

A. For a permit?

Q. For a permit.

A. There is no casualty number for a permit.

Q. So the goal is zero?

A. So, I guess that's a fair way to say it. The goal is zero, yes. We don't want any casualties for any of the operations.

Q. You mentioned there were key flight safety events that weren't identified originally by Scaled. Do you recall what those flight safety events were?

A. When the flight safety events were identified, it was -- the regulation says that they must conduct those key flight safety events over -- those definitely have to be over sparsely or unpopulated areas. And so, they hadn't identified what areas they would protect. So there's some areas within the operating area that have higher densities of population, like California City and Mojave. So they needed to put protection areas around those so they wouldn't do events like the drop from White Knight Two or do the boost over those more densely populated areas.

Q. Do you recall if any of the assumptions or calculations that were done mentioned if SpaceShipTwo was to break apart?

A. Yes. We always -- we consider the breakup of the vehicle.

Q. Does the FAA look at -- for a permitted activity that's

going to have multiple launches, do they look at each launch individually or do they just look at the original permit? As far as it pertains to impact point, concern on the wreckage distribution?

A. I don't know that I understand your question.

Q. I don't know how much you can talk about the permit, but I know that in Scaled's permit they had a longer, say, duration of burn identified. So if they were building up to achieve that final goal, did the FAA look at each of the individual powered flights to say, okay, these calculations are still good?

A. We looked at the worst case, the maximum boost trajectory, and made sure that would stay within the operating area. We did not look at each of the smaller boosts individually.

Q. If it was a license activity would the FAA do that?

A. We may. To save -- we do -- a lot of the times we look at the worst-case trajectory to try to contain the problem, see what the worst scenario could be. We don't always look at each individual scenario.

Q. All right. So I'm just trying to scope because I think it's been established one of the FAA's mandates is to protect the general public. That's like a big outlier out there, right? And one of the ways to do this is by having the applicant do the instantaneous impact point and dispersion. So just so that I have it correct, you look at the worst-case scenario, not individual ones, and then base your calculations off of that?

A. Yes.
Q. Is that a correct assessment?
A. Yes.
MS. WARD: All right. That's all I have, thanks.
MR. HAUF: Thanks, Lorenda.
Bob?
BY MR. WITHROW:
Q. Hi. Just to maybe clarify the last point that Lorenda was asking about. So in doing your operating area containment analysis, is it correct that the regulations require that the instantaneous impact point stay within the operating area and outside of the exclusion zones?
A. Correct.
Q. So that's the answer I wanted. I just had another-- actually a couple of questions. So I believe you -- if I heard you right, your background includes some education in human factors. In assigning numerical probabilities to things that humans do, what are the ranges of probabilities for actions in -- like what kinds of conditions would they be? So, you know, do they range from one to a million probability of failure? And how does that -- how do you do that in human factors analysis?
A. Yes, I have that background of a degree in human factors and systems. I have not had any practice in my work with human factors, so I do not know a good range of numbers --
Q. Okay.

A. -- that would be applied.

MR. WITHROW: No more questions. Thank you.

MR. HAUF: And, Will?

MR. ROBERTSON: I don't think I have any questions at this time.

MR. HAUF: Okay. If we go to the phone, I'll start with Nikki. Do you have any questions?

MS. DUGUE: Just one question.

BY MS. DUGUE:

Q. Can you explain what the ultimate goal is for the operation area dispersion analysis that you do?

A. Okay. The goal for the operating area containment analysis is to ensure that the vehicle will be contained in an area that we know has a low population. And so, in essence, it keeps the risk within an acceptable number. Even though we don't calculate an expectation of casualty number, in essence, it will keep that within our criteria that we do have for licenses, which is 30 in a million.

MS. DUGUE: Okay. That's all I have for now.

MR. HAUF: Thanks, Nikki.

Brett, let's go to you next.

MR. VANCE: I've got a couple.

BY MR. VANCE:

Q. Let's see. Jennifer, did you see any hazard analysis documentation coming in during the application process from Scaled

or from anybody else?

A. I do not recall looking at any of that documentation.

Q. Okay. And you mentioned earlier, I think, that you said you had a master's. Was it in human factors and systems engineering?

A. Yes.

Q. How much human factors related work do you do there in AST related to application evaluation?

A. I am not doing any human factors work at AST.

Q. Okay. One more that might actually kind of be related to that -- maybe, maybe not. Do you get to help out at all with AST 400 inspections that they do prior to launch?

A. No, I do not.

MR. VANCE: Okay. Again, thanks. That's all the questions I had.

MR. HAUF: All right. And, Dan, are you still there?

MR. MURRAY: Hi, Jen. I have no questions. Thank you.

MR. HAUF: Okay, great.

Will?

MR. ROBERTSON: I have a follow-up.

BY MR. ROBERTSON:

Q. So, I know you just answered Bob's question that you didn't have a whole lot of practical experience in applying human factors. But from what you do remember from academic, do you recall some of the analysis techniques that you were taught in

dealing with human factors?

A. No, I do not.

Q. Do you ever recall that hazard analysis was a technique that might be applied for human factors, or --

A. Yes.

Q. Yes, you do? Okay.

MR. ROBERTSON: That's all I have.

MR. HAUF: Okay. Thank you.

I guess around the room, does anybody else have any questions? Lorenda?

BY MS. WARD:

Q. I just had one. I just, out of curiosity, is that is there like size or weight in consideration for these calculations?

A. For the -- when we do the E sub C calculations, yes, we take into account the dimensions of the vehicle, the size, that type data.

Q. I'm more curious about the -- once the vehicle has -- separates in many pieces. Has there been determined what the maximum size or weight would be to be contained within the containment area?

A. For the permit, we do not do the breakup analysis. We -- I need you to repeat the question.

Q. Well, as we know that, you know, lighter bits are going to catch the wind and go. So that's why I was just curious if there was any consideration due to size and weight into the IIP,

instantaneous impact point, calculations.

A. There was consideration in that we needed to make sure that those small pieces couldn't be carried outside the operating area. Sometimes for a permit you have a buffer area around the operating area. We want to make sure no populations or aircraft that are outside the operating area could be affected. But the size of this operating area and that Scaled was sufficiently in the middle of the operating area and not towards the edges, that covered that.

MS. WARD: That's all I had, Mike.

MR. HAUF: Okay. Thanks.

MR. WITHROW: We have follow-ups now.

BY MR. WITHROW:

Q. So with respect to instantaneous impact point calculations for an experimental permit, is it the case that it's the vacuum instantaneous impact point that's used in those calculations?

A. Yes.

Q. Can you explain what the vacuum instantaneous impact point is -- calculation?

A. Okay. It's -- at any time you look at, if the vehicle were to fail and come falling down, where that point on the ground would be that the vehicle would impact without any consideration to the aerodynamic -- considering it's a vacuum, there's no drag on it.

Q. Sort of like a tungsten BB would hit the ground, it just goes, right?

A. Yes.

Q. Just where it's going to go without wind effects and things like that?

A. Correct.

Q. Thank you.

MR. ROBERTSON: I have another question.

BY MR. ROBERTSON:

Q. Does your analysis specific to permit consider different outcomes for the vehicle? Meaning do you consider inert breakup, impact crash, explosion, or do you just assume inert breakup or one of those?

A. We look at all of the scenarios and see where those dispersions, where they -- how far they could go from the nominal trajectory, and make sure that stays within the operating area.

Q. And we talked about worst case earlier. And is an inert breakup or an -- or maybe I should phrase it this way. Which of the outcomes would you consider worst case?

A. It actually depends. An explosion is worse for -- it can carry the pieces farther and it can break them into smaller pieces so it can be worse for aircraft. Sometimes for on the ground, an inert breakup can be worse for people that are on the ground. It could -- if a piece hits a building, it could bring down a whole building.

Q. So the answer is it depends. I guess what I'm trying to get at is Lorenda's question about small parts and those possibly going outside the containment area. Now, is your analysis as it applies to the permit really concerned about whether small parts that could injure someone go outside of the containment area? Or is it really looking at parts that could injure people within the containment area? Does that make sense?

A. We look at both of those. So --

Q. So, it is occurring --

MR. PREAMBLE: Sorry --

MR. ROBERTSON: Let her finish.

MR. PREAMBLE: -- yeah, let her finish the answer.

BY MR. ROBERTSON:

Q. Yeah, go ahead.

A. So, the ones that -- so the way we protect for the ones that stay in is to make sure that the population is low inside the operating area. And then, for the smaller pieces, we make sure -- see what the failure scenarios are and make sure that the operating area is big enough to contain that.

Q. Okay. Thank you.

MR. HAUF: Okay. All right, any last questions from the phone call?

Hearing none, the last question for you is, do you have any comments or additional information that you believe may help our investigation?

MS. BAILEY: Not at this time.

MR. HAUF: Okay. Thanks. We're good.

(Whereupon, at 3:35 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:	CRASH OF VIRGIN GALACTIC SPACESHIPTWO MOJAVE, CALIFORNIA OCTOBER 31, 2014 Interview of Jennifer Bailey
DOCKET NUMBER:	DCA-15-MA-019
PLACE:	Washington, D.C.
DATE:	January 15, 2015

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.

_____

Stephen Grider
Official Reporter

UNITED STATES OF AMERICA

NATIONAL TRANSPORTATION SAFETY BOARD

Investigation of:	*	
	*	
CRASH OF VIRGIN GALACTIC SPACESHIPTWO MOJAVE, CALIFORNIA OCTOBER 31, 2014	*	Docket No.: DCA-15-MA-019

Interview of: RENE REY

National Transportation Safety Board
6th Floor Conference Room
490 L'Enfant Plaza East, S.W.
Washington, D.C.

Friday,
January 16, 2015

The above-captioned matter convened, pursuant to notice.

BEFORE: MICHAEL HAUF
System Safety Group Chairman

APPEARANCES:

MICHAEL HAUF, System Safety Group Chairman
National Transportation Safety Board

LORENDA WARD, Investigator-in-Charge
National Transportation Safety Board

DAVID LAWRENCE, Operations Group Chairman
National Transportation Safety Board

MICHAEL BAUER, Systems Group Chairman
National Transportation Safety Board

KATHERINE WILSON, Ph.D., Human Performance Group Chairman
National Transportation Safety Board

DANIEL MURRAY
Federal Aviation Administration

BRETT VANCE, Test Pilot
Los Angeles Aircraft Certification Office
Federal Aviation Administration

BOB WITHROW
Scaled Composites

NICOLETTE DUGUE
Scaled Composites

WILL ROBERTSON
The Spaceship Company

BRADLEY PREAMBLE, Office of the Chief Counsel
Federal Aviation Administration
(Representative on behalf of Mr. Rey)

I N D E X

I N T E R V I E W

(9:32 a.m.)

MR. HAUF: Okay. So, I'm Mike Hauf. I'm with the NTSB and I'm the System Safety Group Chairman for the investigation.

MR. ROBERTSON: Can I stop you real quick? There is no microphone over here so --

MR. HAUF: It's right there.

Okay. So, the NTSB is an independent federal agency charged with determining the probable cause of transportation accidents and promoting transportation safety. The NTSB is not part of DOT or FAA. It has no regulatory or enforcement powers.

At this time I'd like to go around the room and introduce everyone here and then on the phone, starting with Lorenda.

MS. WARD: Hi, Rene. I'm Lorenda Ward with the NTSB. I am a Senior Investigator-in-Charge. I'm the IIC for this accident investigation.

MR. REY: Thank you, Lorenda. Pleased to meet you, Lorenda.

MR. MURRAY: Dan Murray, FAA, AST Representative to the System Safety Work Group.

MR. REY: Pleased to see you.

MR. PREAMBLE: Bradley Preamble from the FAA, Office of the Chief Counsel.

MR. REY: Thank you.

MR. WITHROW: Bob Withrow from Scaled Composites, a representative on the Systems Safety Group.

MR. REY: Pleased to meet you.

MR. ROBERTSON: Will Robertson from Virgin Galactic, representative for System Safety.

MR. REY: Pleased to meet you.

MR. LAWRENCE: Good morning, I'm David Lawrence, NTSB. I'm the Operations Group Chairman.

MR. REY: Pleased to meet you.

MR. BAUER: Michael Bauer, NTSB, Systems Group Chairman.

MR. REY: Pleased to meet you.

MR. HAUF: All right. For those on the phone, I'll start with Scaled.

MS. DUGUE: Nicolette Dugue, Scaled Composites, representative System Safety Group.

MR. HAUF: Thank you. And FAA?

MR. VANCE: Yes. This is Brett Vance, FAA test pilot at the Los Angeles Aircraft Certification Office.

MR. REY: Nice to meet you.

MR. HAUF: Thank you.

MS. WARD: And just for the record, I'd like to acknowledge that Kat Wilson had to step out, and when she comes in -- that way she can just sit down, but she's our Human Performance Group Chairman, and she'll be asking questions related to that.

MR. REY: Great. Thank you.

MR. HAUF: Thanks, Lorenda.

Okay. So, today we'll be using the services of a court reporter who will record and then transcribe the interview. The transcript, not the audio recording, will be made a part of the public docket.

The purpose of this investigation is safety, to determine probable cause and prevent recurrence. Our role is not to assign fault, blame, or liability. This interview is part of the fact-finding phase of the investigation. We are here to ask questions about your involvement in the permit and waiver for the SpaceShipTwo program. We cannot, however, offer any guarantee of confidentiality or immunity.

Each of the group members will have a chance to ask questions. We will ask questions one at a time and everyone has been instructed to not interrupt the person who is asking questions at that time. There will be the opportunity for each group member to ask follow-up questions after each person has had a turn.

Please answer all questions to the best of your recollection. If you do not understand a question, ask to have it repeated or explained. If you realize you misstated or need to modify a previous answer, please do so.

You are entitled to have one representative of your choosing. Is there someone you would like to have as your representative?

MR. REY: I would like to have Brad.

MR. HAUF: All right. And, Mr. Preamble, you may direct Rene to not answer a question or to request a short break to confer with him.

The FAA will have the ability to review the transcript prior to inclusion in the docket.

Do you have any questions?

MR. REY: No, sir.

INTERVIEW OF RENE REY

BY MR. HAUF:

Q. Okay. To begin the interview, and for the record, could you please state your full name and job title?

A. My full name, Rene Joseph Rey, and my job title is Senior Aerospace Engineer.

Q. Okay. And which division in the FAA do you work in?

A. I work in AST-300, the Regulations and Analysis Division.

Q. And how long have you been in this division?

A. Since December 31st of 2001, so that's 13 years.

Q. Okay. And who's your immediate supervisor?

A. Mr. Stewart Jackson.

Q. Okay. And kind of describe your roles and responsibilities for your job.

A. I do two things primarily since I've been assigned to this division. Number one, I primarily develop regulations. For

example, right now I'm working on a public risk rule. That's about 50 percent of my time, and the other 50 percent is spent on system safety analysis.

Q. Okay. And for the specific focus on the -- let me back up here. Could you describe what you worked on, on the Scaled permit application and/or waiver?

A. Okay. The application itself, the original one, which was issued in 2012, I did not work on. However, I was privy to the lessons learned from that because we were all -- we were a pretty small group back then and we did a lot of multiple things. On the waiver itself, I assisted Mr. Tom Martin, who was the lead systems safety engineer, with the analysis and the process involved with that.

Q. Okay. If we jump back to the experimental permit, did you work on any either the renewal or the modifications?

A. I was working on the renewal and/or modifications, yes, to the original one issued in 2012.

Q. So that was the first renewal also?

A. Yes, sir.

Q. When was that?

A. That was -- we began that in 2014. That's when I started working on it, in early 2014.

Q. And what did you -- what was your responsibility for that period?

A. I assisted Tom with the technical report that we put

together after we had reviewed all of the data that's received from the applicant.

Q. Can you describe what this technical report is?

A. The technical report is basically a subset of all the system safety and safety-critical systems data and analysis that the applicant provides, what they did to satisfy the regulations for part 437.

Q. Okay. And could you go over how -- or what is the process for reviewing the application and the criteria you use to make judgments against?

A. Okay. Fundamentally we look -- we don't do -- I'm going to say up front, we do not do hazard analysis, per se. We don't have the information necessary to do something like that. We would have to be working for the company to have access to all the data.

Rather, we take what the applicant provides and we look at have the hazards been identified? How do they manifest themselves? What are the consequences of those hazards? What are the mitigations that the applicant put in place to mitigate or eliminate the hazards? And lastly, how were those mitigations verified? So, we basically look at all that and summarize, based on our assessment, in a report.

Q. Okay. And for the hazards, how -- in general, how would someone at the FAA know if the applicant has identified all of the hazards?

A. That's a good question. And we do our best to not only review what the applicant has provided, but to also, based on our experience, look at other possible hazards that are foreseeable. So we obviously don't go -- since we're not engineers with the company, we don't sit down and we're not involved in the design of the system. So we do the best we can to work with what they provide us and to ask questions related to possibly other hazards that could be related to or that they did not consider.

Q. Okay. Do you have meetings with the applicants at Scaled, or how do -- well, I'll let you --

A. No, sir. How do I interface?

Q. Yeah, to interface with Scaled.

A. Well, that's been a problem, from my perspective. We have an organization within our organization that has been designated as the sole interface with the applicant, and all of my questions and all of our answers are -- that we receive are filtered, mainly filtered on the way out as we submit them. And the answers we usually get back aren't the ones that we were seeking.

Q. And which division would do the filtering, as you said?

A. The organization is AST-500.

Q. Are there specific individuals in that organization who would filter?

A. Well, the process starts with our management, my immediate management. We submit our questions to them, and then

it goes to the chief engineer. And then the questions are submitted to AST-500 and then finally submitted to the applicant.

Q. So if you receive a response to your question and you realize that it's not the response you were looking for, what actions do you take?

A. We immediately go back to the -- in this case, the license manager was Mr. Ray Jenkins. We'd go back and say, look, this isn't answering the mail. We really need to ask -- we need to get this specific information and you need to go back and request it. And then he would go back through AST-500 to get further clarification.

Q. Can you give me an example of a typical or, say, a safety-critical question that you didn't immediately receive?

A. Well, the one that sticks the most in my mind was related to the modifications that were done to SpaceShipTwo with regard to the helium tanks, the addition of helium tanks in the wing structure. And we were immediately told by our management that the structure was not safety critical, and therefore, not to worry about it. You know, of course, we disagreed.

Q. And who is this management?

A. Our chief engineer.

Q. And who is that?

A. Mr. Mike Kelly.

Q. Mike Kelly. Okay. Were there any questions on the feathering system that were asked that were not addressed in your

opinion properly?

A. No, sir. Not -- at least that I did not hear any on that.

Q. Okay. Jumping back to the, I guess the evaluation of the permit application, do you look at the fault trees and go through each and every one of those?

A. Yes, sir, I did. Well, Tom Martin and I worked through each and every one.

Q. Okay. And jumping back a little bit from that, what kind of experience or training do you have in system safety as related to fault tree analysis or system fault tree analysis?

A. Well, actually my training goes way back. When I was an Air Force officer, I was in space. I was assigned to the U.S. Air Force Space Division, and I got my preliminary training there with hazard analysis and fault tree analysis. I did not receive formal training in terms of a classroom. That was all on the job.

Q. Okay. And are you familiar with ARP-4761 and all of the fault tree processes and hazard system processes?

A. Yes, sir, I've read that. I've read through those. But am I an expert in that? No.

Q. Okay. And do you feel that you have enough time to go over all of the fault trees to make a true evaluation of them?

A. Well, that's a good question. We are under -- we have always been since -- and not just this system, not just Scaled, but with every system we have always been under the gun to get

things done as quickly as possible. As you know, we only have 180 days for a license, 120 days for a permit. And what really exacerbates the pressure on us, or the time constraints, is the fact that if the application -- if it's been deemed complete enough, then the technical data that we need to really do the evaluation isn't always there. As a matter of fact, 95 percent of the time it hasn't always been there.

Q. And if you find that it's not there, what actions to you take to try to get that information?

A. Well, if it's not there, we immediately ask questions through the chain of command, and the process has been established from AST for getting those questions answered, as I described earlier.

Q. Okay. And do you feel that you've always received the information needed to make the best judgment you can, or is there information that was lacking, but you still had to press forward?

A. The information was lacking and we had to press forward in the majority of the cases.

Q. And did you voice -- and did you have any concerns about that and did you voice those concerns?

A. Absolutely. And what's interesting is Tom Martin has a very detailed record of everything that has been done since he's been here, and it's all documented on our Q drive within our system safety folder. And a lot of the information is also documented in our licensing and permit directories as well. And

that doesn't even include the emails. He has everything organized.

Q. Okay. Jumping a little bit, in fault tree analysis do you -- in your experience, do you normally see that human error would be a part of the fault tree analysis?

A. I've seen human error as part of fault tree analysis, yes.

Q. And is there typically a probability assigned to human error?

A. Yes, sir. And as well as -- well, yes, sir.

Q. Can you describe how a probability could be assigned to human error?

A. To be honest with you, I've never understood how a number like that -- how someone could come up with a number like that. So I'm just naturally skeptical of anything relating human error with probabilities. Because, really, there are so many factors that go into that probability: the experience of the pilots, the system design. I just -- it boggles my mind to think of all the factors that go into that and how you would even come up with a number. So I was naturally skeptical of that.

Q. Okay. And in the regulations in 437.55, it requires that human error is part of the hazard analysis?

A. That's correct.

Q. Could you describe what the FAA's intent was or how to include human error in the analysis? I can rephrase it a bit.

A. Yes, please.

Q. What would be the acceptable response from an applicant that would demonstrate that they met that requirement?

A. To me, a very extensive training program. I would be focused on -- in this case, since it's driven by two pilots, how crew resource management is -- not only how they train for that, but how they practice it in the simulator. Are all the switches within reach by both pilots? How do they communicate? I would like to see evidence of all that. In other words, in the case of that being the mechanism, when it is activated by the co-pilot.

I don't know what happened, but in my experience, the co-pilot would have announced what he intended to do based on the checklist or whatever procedures he had in place. The pilot would have acknowledged, roger that, execute, and it would have been done. I would have been interested in how all that played out.

Q. Okay. And in Scaled's permit, what would be acceptable to the FAA on how they would document the human error in their hazard analysis?

A. I don't have an answer for that because I didn't evaluate that particular area. I have my opinion on how to do that, but I don't think it would be apropos to the investigation. It would just be my opinion.

Q. And what section of the experimental permit did you review?

A. I did the hazard analysis portion of it exclusively.

And I really focused on the systems themselves. The questions that came up related to human error, really, there was only one question that I was involved with, and that was one that we posed to our management related to were all the switches easily reachable by both pilots, and we were told that that wasn't important. But, of course, I would disagree with that because I can tell you from -- aircraft and the landing gear switch is on the co-pilot's side on the far right. And in really serious instrument conditions, I never understood how a single pilot could handle that. So I thought that was important.

Q. Okay. And in your review of the hazard analysis, did you review the feathering system and the hazards there?

A. Yes, I did.

Q. Do you feel that Scaled addressed all the hazards within that system, specifically within the, I guess, the boost range?

A. As far as I could tell, I felt they had.

Q. Okay. And if you had questions with that, you would go to -- or how would you contact Scaled?

A. Well, once again, I would go through AST-500 if I had had any questions on that feathering system.

Q. Okay. And were you aware of the hazards if a pilot unlocked the feathering system early on within the boost phase that the feathers could, I guess, deploy or tip?

A. It was my impression that -- of course, how it's listed, based on the procedure that I understood, it was supposed to

unlock at a certain time and not before. But I was also assured that regardless of when that locking mechanism was disengaged, the aerodynamic forces on the vehicle, you know, in normal flight, should not have activated the feather mechanism.

Q. Okay. And where did that assurance come from?

A. In telecons that we had had with Scaled.

Q. Okay. Do you know --

A. Because we did ask those questions, you know, what happens if you disengage early? Well, with the aerodynamic forces -- you don't have to worry about that. The only reason why we even unlock it is because we want to make sure that the feathering mechanism will activate when we're at our apogee and we're going to engage that system. We want to make sure the lock doesn't freeze up and hold it there.

Q. Okay. And do you recall who was involved in these meetings?

A. I do not recall.

Q. Okay. Do you remember a time frame of these meetings, roughly?

A. It was all in 2014.

Q. All in 2014?

A. Yes, sir.

Q. Okay. Jumping here, the waiver, could you re-explain what your role in the creating or providing information for the waiver was?

A. Well, the waiver -- the one that I'm referring to was the one that was signed by Mr. Ken Wong in May of 2014. There were a number of modifications that were done to SpaceShipTwo, structurally, with the software; those are the two that really jump out at me -- the trajectory. There were about six or seven different mods that were done to the vehicle. And we wanted, especially in the area of the structure, the structures area -- that's the area that I really focused on primarily -- we wanted to see supplemental hazard analyses on those particular mods. And our management decided to waive the hazard analysis requirement for that in part 437.

Q. Okay. Well, did Scaled ever provide the information that you were looking for at some point in time?

A. I didn't see it.

Q. Okay. And were you aware of the waiver in July of 2013?

A. Not per se. Not specifically.

Q. Okay.

A. What I do know is that there were a lot of waivers in the beginning and we just did basically a continuation of those. So naturally, I extrapolated back to assume that everything that I was looking at now was the same as it was before.

Q. And have you, in other areas that you worked on, reviewed or provided information for other waivers, if not for Scaled, but other applicants?

A. No, sir.

Q. Okay. And that same question for -- how many experimental permits have you reviewed typically?

A. Actually, the Scaled one was the first one.

Q. Okay.

A. Because -- if I could explain that a little bit. When I first came to AST, back in those days, we were -- we weren't so much a matrix organization as we are now, and everyone did everything. I did licensing evaluations. I was a safety inspector. I did rules and regulations, wrote them. I did everything, literally. So the fact that I'm system safety analyst now, that's relatively new compared to my timeline overall at AST.

Q. Going to the writing rules and regulations, did you have a part in writing 437. -- or a part --

A. part 437. No, I didn't, but it wasn't because I didn't want to. I have a flight test background, a pretty extensive one, and I felt that part 437 should have been more flight test planning oriented, because that captures everything. In a good flight test plan you can really capture a lot, so -- and I was voted down. Nope, we don't need you in this; we have a different focus.

Q. And that was all parts, no part in part 437.55?

A. No, sir, I had nothing with that. But Mr. Terry Hardy did. I don't know if you've ever been introduced. He's a consultant and former AST employee. He's a system safety expert and consultant, and he had a big role in that hazard analysis,

what should go into it, and he wrote the AC for that as well.

Q. Okay. And did you have any part in the AC?

A. No, sir, I didn't.

Q. Okay. And speaking of Tom, what company does Tom work for currently?

A. Tom Martin?

Q. Not Tom. Terry Hardy.

A. Terry Hardy. He has his own consultancy group, something Circle, Incorporated. Great Circle, Incorporated.

Q. Okay.

A. And he's based out of Colorado now.

Q. Okay. And you said he had a role in the writing of the regulation?

A. Yes, sir, he did. Yes.

Q. And do you know if he had any part in reviewing Scaled's application?

A. Yes, he did. He was a very big player in that. Tom Martin relied on him a lot, probably to the tune of sometimes up to maybe 40 hours a month.

Q. Okay.

A. Yes.

Q. Okay. Can you describe what Terry was asked to do?

A. Well, basically, when we received the application for the renewal, it was handed off to Terry and he evaluated what was in it, and came back with a report that outlined all the

deficiencies that he saw, and then he made recommendations.

Q. Okay. And did he also provide input for other modifications, renewal modifications?

A. I don't know that.

Q. Okay. And did you have a chance to look at the report that Terry put out?

A. Yes, I did. I read it.

Q. Did you talk about any of the -- do you remember or can you talk about any deficiencies that Terry talked about?

A. He had serious concerns with the fact that Scaled wasn't meeting the regulations as they were written in part 437 across a broad range of issues.

Q. Okay.

A. And he had the same concerns that I had talked about earlier in this conversation.

Q. Were Terry's concerns fed back through FAA management and then back to Scaled?

A. Okay. I know they were fed back to FAA management because Tom Martin, as I said, he's the most serious documenter I've ever met in my life. He should have been a medical doctor, as a matter of fact, the way he writes. But absolutely he did. Whether it got back to Scaled or not, I do not know.

Q. Okay.

MR. HAUF: Okay. I'm going to pass off my questioning to David.

BY MR. LAWRENCE:

Q. Good morning, Rene. Can I call you Rene?

A. Yes, sir, of course.

Q. Great. Perfect. A couple of things that are just follow-up questions. You alluded to your Air Force Base background and --

A. Yes.

Q. -- pilot and such. Can you give me just a very brief background prior to coming to FAA?

A. From my Air Force career?

Q. Well, yeah, what led you up to the FAA, briefly?

A. Okay. I started out as a flight test engineer in the Air Force, C-130 data project for a simulator. And then, I got into space. I was a Titan 34D integrator, and eventually became a branch chief in charge of the operations and the integration, and that was a lot of responsibility. And then I moved over in the space shuttle side of the house, avionics support equipment, development and acquisition, and worked with NASA -- integration plans, developed black boxes that went on the mid-deck.

And then from there, I got out of the Air Force and did mission analysis concept development, did a propulsion system design for a start-up. And then, the real key projects that I had, though, I was a program manager on DC-X for flight test. That was a single stage reusable launch vehicle prototype. I wrote the test plan, flight test plan for that. X-33, I managed

the operations engineering group, and that included range interface, ground and flight testing, ground support system, automation integration, and then reliability, maintainability, supportability and analysis. I covered all of that.

And then, Boeing Corporation, I worked on the certification end of an international reusable launch vehicle project, and back to the FAA.

Q. Great. Thank you. Earlier you had mentioned that you helped develop some of the regulations. You mentioned 437 and 460. Mike asked you a little bit about 437. Let me ask you about 460. Did you have your hand in the development of 460 regulations?

A. 460 is the human space flight regulation, and I didn't participate in that.

Q. Okay.

A. I had different ideas where I thought that should go. And, once again, I was excluded from participating in that.

Q. Okay. Let me ask you a little bit about that. Based on your test pilot background and your extensive background on 460, are you knowledgeable what is included in 460?

A. Absolutely.

Q. Specifically, .5 and .7?

A. Yes.

Q. Okay. Let me ask you about pilot experience that is defined in 460. Are you familiar with what the experience

requirements are?

A. If I recall correctly, it's not an airline transport rating type requirement, which I thought it should be. It's basically a private pilot, if I recall correctly.

Q. It's a private pilot with an instrument rating.

A. With an instrument rating, but still private pilot.

Q. Right. And so, you just -- you sort of answered my question with your response, this next one, but I want to ask it anyway. Do you feel in your view, based on your experience and your background, do you feel that is an adequate experience level for human space flight?

A. Absolutely not. Private pilot with instrument rating, no. To me, I would want -- at least in the initial stages now as we're developing it, I'd want a test pilot in there with, you know, 5,000 hours and a test pilot school graduate, and a person who's flown many different types of high-performance jet aircraft at high altitude.

Q. Do you have any comment on recency of experience as well?

A. And, of course, current.

Q. Okay. You mentioned earlier about your interface with AST-500. Was that also with AST-400 as well? You know, some of the problems -- I'm sorry -- some of the problems --

A. Well, actually AST-400 is the inspection division. And the only thing we did with them -- and our report, of course, also

included -- I know that we look at the hazards and everything, but we also made recommendations for terms and conditions that should go into the license and things that inspectors should be looking at. For example, if -- and this is just a what if. If Scaled said, okay, we use MSG-3 in our maintenance, we would say -- ask the inspector to please look at that documentation and look at the records and see what they did specifically, and did they follow the terms that they stated they would in their application.

Q. Mike had asked you a little bit about the feather unlock system earlier and you said there were discussions?

A. Yes.

Q. Let me expand on that. Were those discussions internal FAA discussions?

A. Predominantly. But we also were in telecons with Scaled on that as well, but the exact dates I don't recall.

Q. I understand. As you developed questions in your role -- and you sent them down to AST-400?

A. No, 500.

Q. I'm sorry, excuse me, 500. Do you recall if the feather unlocking system and some of the concerns that were raised during those telecons about the early unlocking transonic were included in questions that went to AST-400?

A. I don't recall if those were conveyed or not because, once again, my focus was not on that. It was more on the things that I understood really well, structures, and stuff like that.

Q. Okay. Ever been to the Mojave?

A. Oh, gosh, yes.

Q. In what capacity?

A. Well, I attended the FAA's initial flight test standardization course. I spent 6 weeks there flying at the National Test Pilot School. I've also done the UAS flight test course there as well. I've spent some time at the Scaled hangar back in the good old days when I was an inspector. I also made an inspection of the Mojave Space Port itself with Mr. Stuart Witt.

Q. You mentioned that as an inspector you've been at Scaled. In what role were you an inspector?

A. Well, there, it was just -- it wasn't -- I wasn't doing a formal inspection of their system. I was accompanying another inspector just to familiarize myself with what their operation looked like. So I wasn't performing in any official capacity as an inspection, per se.

Q. You were shadowing another inspector?

A. Shadowing. Exactly.

Q. Okay. And what was that inspector inspecting?

A. He was just looking at how far along SpaceShipTwo was in its construction.

Q. Was it a safety inspection plan that he was activating or --

A. He had a plan, but I don't recall exactly. That was many years ago.

Q. Okay. Are you familiar with safety inspection plans that were done on Scaled?

A. I haven't been a safety inspector for a long time, so to answer your question, not really.

Q. Okay. Let me talk to you about, again, with the communication between AST-300 and AST-400. Why couldn't you just pick up a phone and call a Scaled guy if you wanted to get an answer?

A. I wish we could have. I don't know -- I think really -- okay, I'll answer the question this way because I really don't know what's in the minds of my managers, the senior management. But we have a dual mandate at AST. One is to ensure the public safety and the other one is to encourage, facilitate, and promote the industry. In my opinion, we put a lot more emphasis on the encourage, facilitate, and promote.

And the way I interpret that is, we don't want to be -- AST is very reticent, AST management is very reticent to place any unnecessary burdens on the applicants. And asking for extra data, having us interface directly with the engineers at Scaled, or any other company for that matter, we have the potential to increase the burden dramatically because we might be asking for things that are not necessary. So, as a result, there's a filter there to ensure that that doesn't happen, basically to head off the unnecessary burden.

Q. And earlier you had mentioned time constraints.

A. Um-hum.

Q. Okay. Let me ask you this. In your opinion, would you characterize, yes or no, the FAA's evaluation was more concerned about timeliness than quality?

A. No.

Q. Can you explain?

A. They were very concerned with timeliness, but the problem is, we weren't getting a lot of the data. As I explained earlier, if I had been running "complete enough," I would have made sure that everything was there so that we could do an effective evaluation of their, for example, their hazard analysis. But because basically they were checking off boxes and submitting documents that were necessary, but didn't necessarily have the requisite content, we found ourselves going into the 180-day or 120-day period to get all that data, and that shortened our time to do the evaluation.

Furthermore, usually when we finally said it was complete enough, our management would put the clock back to a month before, so we were already starting with a month deficit. You know, that's a big deal when you have only 120 days -- a whole 30 days is a big deal -- to evaluate that. So we were always under the gun. We always -- the applicant would always have a launch date that we were trying to meet. And, by god, we're going to meet that regardless.

Q. Is there process at the FAA to stop the clock, pause,

and play catch up?

A. Yes, there is. There's a -- tolling is allowed. There's a provision for tolling if we can't get the data, and we have exercised that at times.

Q. With Scaled?

A. I don't think so, but I really don't recall if we ever tolled Scaled. I knew they switched over to Virgin Galactic and I know we've done it for them.

Q. Okay. But that's on the licensing side?

A. That's correct. And that has nothing to do with this.

Q. And that's 180 days for that?

A. For a license, 180 days.

Q. Right. I'm going to skip -- and I apologize, Rene -- a little bit. You mentioned something about CRM, which piqued my interest to learn a little bit more about your background. Is CRM discussed or addressed anywhere in 437 or 460?

A. I don't recall. I'm sure some obtuse reference is in there. Whether it's crew source management, per se, I don't recall. I'd have to review the regs.

Q. Okay. For an experimental vehicle that is operated by two pilots, how important is CRM in your opinion?

A. Extremely important.

Q. Can you elaborate?

A. Absolutely. As I stated earlier, coordination is of tantamount importance, especially when all of the controls aren't

necessarily within reach of both pilots. And in terms of reading checklists and initiating important procedures, it's very important that pilots work together to complement each other to confirm what the other is doing, especially in critical operations.

Q. In your test pilot background, do you have CRM training or have you received CRM --

A. Absolutely. When I was -- when I did the FAA standardization course, everything was about crew resource management. And so, yeah, we received a lot of good training in that and we received a lot of credit for that.

Q. I'm going to ask you about CRM being addressed in the regulations. Do you know if CRM, are familiar if it was addressed in the permit application of Scaled?

A. I do not recall. I didn't look at that part. I didn't review that part of the application.

Q. Okay. I'm curious. So you're aware of some of the operational aspects of the waiver -- are you familiar with the waiver?

A. Um-hum.

Q. Can you address some of those operational aspects and talk about that? The training that was addressed, the operations relative to chase airplanes that were identified in the waiver?

A. I'm not familiar with those areas specifically.

Q. Okay. When a waiver is applied to a permit, whose

responsibility is it to make sure that the applicant is, or the permit holder is complying with the provisions that are identified in the waiver?

A. Well, it's a twofold process. The person who signs the license, to me, is -- or the permit, is ultimately responsible for ensuring that all of the proper steps have been taken and all the proper procedures are in place so that it can be enforced. In other words, you write it into the permit -- or into the license, the terms and conditions.

As far as actually ensuring compliance, that is AST-400, the safety inspectors, who are responsible for being knowledgeable and asking the right questions.

Q. And I just want to be clear about a follow-up question on something Mike asked a little bit about Terry Hardy and the Great Circle analysis that was done.

A. Okay.

Q. Who requested that?

A. Tom Martin did.

Q. Okay. And Mike asked you if any of the provisions or suggestions that were provided by Terry Hardy were incorporated by Scaled?

A. See, I don't know if they were.

Q. Okay. I apologize for jumping again.

A. That's okay.

Q. I just thought of another question relative to the

waiver. Who wrote the waiver?

A. Actually, a lot of people are involved and had their hands in that. But the person who is, once again, ultimately responsible would be Mr. Ken Wong, because he signs it and he reviews what his subordinates write for him.

Q. Okay. Did Scaled ask for the waiver?

A. Yes.

Q. Did Scaled have any participation in the drafting of the waiver?

A. Not to my knowledge.

Q. So that was an internal --

A. Yes, sir.

Q. -- an internal FAA created document?

A. Absolutely. Yeah, Scaled did not sit down, as far as I know, and write anything or -- they just basically had their modifications that they presented to us and made that request. They did not craft in any way the waiver itself.

Q. Is that typical for the FAA to write a waiver for an applicant?

A. Well, I guess it is at AST.

Q. Do you want to elaborate on that?

A. I don't know how it's done everywhere else within FAA. But it's -- like I said, we encourage, facilitate, and promote, so whatever we can do to help out.

Q. Are you aware if the FAA has written any other waivers

for applicants?

A. I am not.

Q. You've been to Mojave and you've been to the Scaled facility. Have you talked to any of the test pilots?

A. No, I haven't.

Q. Would you like to in the execution of your duties?

A. If I had my way, I'd be living there.

Q. Why?

A. Because I think what Scaled is doing and Virgin Galactic is doing is really cutting edge exciting stuff, and I would just love to just bask in the knowledge and the learning opportunity that's there.

Q. But in your capacity of your role in the FAA, is it encouraged for you to visit applicants?

A. No, sir, it's not.

Q. Why?

A. Well, we're living under a number of constraints. Number one, I think first and foremost -- okay, I'll retract that. We have extreme budget issues in terms of travel. It's not, probably not the most important factor, though. The most important factor in this interfacing really is, once again, our management does not like the engineers to be, quote, "the face" of FAA or of AST. That's why AST-500 was created, to be the face of AST at these remote locations, and everything is filtered through that organization.

So, ideally, if I was doing -- evaluating hazard analyses, I would love to be there, to answer your question, and sit face to face and ask my questions and ask my follow-up questions, because everything -- until we eventually, we're satisfied.

Q. Is that cultural or is that written some place that you have that restriction of --

A. I'm glad you brought that up, because that is why we are -- this whole setup is so dysfunctional. We do not have written roles and responsibilities of who's supposed to do what to whom and when.

Q. Is that a concern that you have?

A. Absolutely.

Q. Why?

A. Because we all -- we have some very good people at AST, very highly qualified people, and we can't really do our jobs effectively the way the system is set up right now. I take great pride in what I'm doing and having all the information. And it's just extremely frustrating when I'm not allowed to -- when my hands are tied all the time. And I'm always under -- I just feel that, you know, even down to the phraseology of the questions, it has to be politically correct, in a sense. It drives me nuts. I'd just like to ask you, is it blue? You know, why don't you have it green? You know, I'd just love to be able to do that.

Q. Is that -- I want to make sure I got the question

answered. Is that a cultural or is that a policy that's written?

A. Okay. It's not a written policy.

Q. Right.

A. As a matter of fact, a lot of these things are not written. It's really kind of interesting when, sometimes when you -- whenever Tom or I would email somebody in management, we never get a response back, because then it's documented. So, really, it's a policy, and it has become the culture as a result of that.

Q. Have you or Tom or anybody else in AST-300 ever brought that to the attention of senior management, your concerns?

A. We do it ad nauseum. We complain -- I don't mean -- we talk about it all the time. I don't want to use the word complain. We have serious reservations about that, yes.

Q. Any responses from senior management?

A. Usually senior management listens, but no response. I can't tell you how many times I've been in a certain individual's office and have almost screamed with frustration, will you answer my question? And I get -- it's, well, I guess, you know, no one wants to talk to a lawyer, I guess, because it might be incriminating. I don't know.

Q. One last question, and this will be an opinion question based on your experience and your role in the FAA. Do you think these restrictions that you talked about earlier impede safety in any regard?

A. Yes, sir, I do.

Q. And can you explain that?

A. Okay. To me, when I'm doing this, and if I were running the organization, safety would be number one. And I would encourage the development and the evaluation to make sure that the system that we were licensing or permitting was the safest possible system that could be fielded. I'm not saying, now, make it foolproof. Whatever is foreseeable, make it the safest system possible. And make it so that we can verify that indeed it was: All the homework was done, all the hazard analyses, all the verifications were completed to the best of the applicant's ability.

And then, secondly, I would make sure these people were flying over a remote area so that the population is minimally impacted, because you can't foresee everything. In our organization, it should be "and." Safest system possible and remote area. In our -- in AST, it's an "or." Safest system possible or remote. If it's remote, don't worry about this part; because it's a permit, so who cares if they crash and burn? I mean, we're not that cavalier; obviously, we would never state that, but that's in essence what it is.

Q. Thanks, Rene.

MR. LAWRENCE: Mike, that's all I have.

MR. HAUF: Brad and Rene, we're getting close to being here for an hour. Would you like to take a 5-minute break?

MR. REY: A 5-minute break would be nice.

MR. HAUF: Great.

MR. REY: Thank you.

(Off the record at 10:26 a.m.)

(On the record at 10:35 a.m.)

MR. HAUF: All right, to continue -- Katherine, do you have any questions?

DR. WILSON: I do have some questions.

BY DR. WILSON:

Q. I apologize. I'll be jumping around a little bit to fill in some of the blanks that I had.

You said that one of the things that you do when you're reviewing the hazard analysis of an applicant, you use your experience to identify some hazards that the applicant didn't consider in their analysis. If you do identify hazards that the applicant didn't consider, what is your process after that?

A. First, of course, we document it in our report, in preparation for a report. And we immediately raise a question to go back to the applicant to say, hey, did you consider this? Because, you know, obviously the process isn't perfect when people are preparing their hazard analyses and things. I mean, they have a wide range of things that they can include in their application, and if they -- most of the time they'll just say, oh, I don't think that's very important, I'll set it aside, and just send what they think is the most salient.

And most of the time, I mean, if people thought about

these things, then, oh, okay, yeah, I got something on that. Yeah, I'll send it to you right away. Ideally, that's the way it should work.

Q. Did you -- when you went through this process for the Scaled application, did you go back to them requesting additional information about hazards?

A. We went to AST-500 with our questions for further explanations of things that we didn't quite understand or we didn't have enough data for.

Q. Did you get a response from Scaled through AST-500?

A. Sometimes we did.

Q. In those cases where you didn't get a response, what then did you do? How did you go about completing your analysis?

A. Well, the way we did that, we would just -- we would document it, of course, in an email with our concerns with the fact that we didn't have this data. And the key phrase that we used to always use was, well, you know, we can't quite quantify the risk; you're increasing the risk here. If we don't get an answer to this question, the risk has just gone up. And just letting you know, it's your decision, but this is where we stand.

Q. Okay. What changed between the initial application from Scaled and their renewal that required the waiver?

A. There were about six or seven items. They were mainly modifications to either the trajectory or to the system itself. And on the system there were changes to the software for the

propulsion system. There were structural modifications, the addition of helium tanks to the vehicle. There were changes to the thermal protection. As a result of adding booster they put -- they put thermal protection on that. And there were a couple of other mods that I don't recall exactly, but I do remember that there were six or seven modifications.

Q. The waiver covers human error and software error analysis.

A. Correct.

Q. Were the modifications related to human error and software error, or should there have been a human error and software error analysis done on those modifications?

A. Absolutely.

Q. Okay. So the waiver applied to the modifications or to also, in general, things that maybe were not included in the first application?

A. Well, as it turns out -- and I really don't understand this at all, to be honest with you. The modifications -- I can see the letter from -- you know, the modifications were all listed. And then, all the hazard analyses were waived. That's the easiest way to describe it, the best way to describe it, they're just waived.

And I remember talking with Tom Martin saying, does this make sense? He said, well, that's not what we talked about. He said, but you know what, it could be an error, maybe it was just a

mistake. I just said, oh, no, I don't think so. And that's where we left it.

Q. Okay. I believe you said you didn't work on the human error waiver, portion of the waiver?

A. That's correct.

Q. Okay. So then I'll ask you in a general sense, if no human error analysis, hazard analysis was completed, how can -- how do you ensure that the mitigations that are put in the waiver adequately covered the human error?

A. Well, that's just the problem. The risk went up dramatically. And we -- I don't know. I don't know.

Q. What would you have expected to see in terms of human error hazard analysis in an application?

A. Once again, there are a lot of factors that go into human error. It's not just simply about procedures. Because, to me, you have to implement -- ideally, you would design a system so that you would minimize the chance of human error. All the instruments are easily readable, vibration in the cabin is minimized. Because so much goes into interpreting the information that you're receiving, obviously if your vehicle is vibrating excessively, it's very hard to read the instrumentation. And once again, and all the controls are accessible by both pilots. So my analysis would look at all those factors.

Q. If there was a -- if a single pilot action could cause a catastrophic event, would that be of concern to you?

A. Absolutely. It sure would. There should be checks and balances, and that's what crew resource management's all about.

Q. So a procedure that requires one pilot to verify an airspeed and take an action, would that be adequate? Or would you expect to have sort of a crosscheck and verify with the second pilot?

A. I would expect a crosscheck and verification. As I stated earlier, you know, ideally the co-pilot would have called out the next step, and the pilot would have acknowledged, okay, verified that we were at the right airspeed, right Mach number, and then would have said, okay, execute. Then it would happen.

Q. Were you aware of this -- I think we've asked you in sort of a sense, but I'll just ask more pointedly in case we've danced around it some. Were you aware that unlocking the feather early could cause a catastrophic event?

A. No I was not. I was under the assumption -- under the impression that the aerodynamic forces were such that, that wouldn't happen.

Q. What was your understanding of the purpose of the locking mechanism of the feathers?

A. To keep everything together and secure so that if you were pulling g's, like, for example, as you were pulling out to go into your climb, everything would be held in place.

Q. Okay. The process of going through management to contact Scaled with any questions that you had, AST management to

contact Scaled, was that unique to the Scaled permit or was that the same process used for all permits?

A. No, that is the same process for everybody.

Q. I believe you said that the Scaled permit was the first permit that you had worked on?

A. Yes, I did.

Q. Is that still the only permit that you've worked on, or have you worked on others since then?

A. Everything else that I'm working on right now is a license application.

Q. On any of those applications have you had concerns?

A. Yes.

Q. Have you addressed them with your management?

A. Yes. As a matter of fact, we're going through a little exercise right now with complete enough, determining whether an application is complete enough, and we need a lot more data and we're doing battle right now over getting that data. Not with the applicant yet, with our own management.

Q. Okay. I apologize. I think this may have been somewhat discussed, but I'll ask again. The mitigations that are listed in the waiver, training, simulation time, use of two chase airplanes, who is -- whose responsibility is it to ensure that Scaled is keeping those mitigations in place?

A. I would say right off the top of my head the AST-400, the safety inspectors. They're responsible for compliance.

Q. Do you know how often they do their inspections?

A. Well, based on the procedure there are a number of times that they go out. I'm a bit fuzzy because it's been a long time since I've been out there in the field, but there are key milestones where an inspector will go out and, back in the good old days, key reviews that a safety inspector will attend as well, depending on where they are relative to their launch date.

Q. Okay, and one last question for you. So in a perfect world, you get an application, what guidance would you want that applicant to be referencing in order to do as complete of an application --

A. I would highly encourage the use of our advisory circulars, especially in the area of hazard analysis. We have a really excellent one written by Terry Hardy that is a really excellent template. Now, one of the key things with an AC, as you all know, I'm sure, is that right up front there's a caveat that says this is one way, but not the only way, of doing this. So this is the way we recommend, but if you have a better way or a different way and we get the same results, fine, do it.

And really, we're very open to any innovative processes. But the problem with innovation getting really creative is arriving at the same results, or arriving at the results that will say that the system is safe enough or adequate. So there's the problem.

Q. And I thought of one more question. Do you have any

formal human factors background training?

A. I have attended human factors training at our place -- at the FAA's facility in Oklahoma. That was only a week's worth of training. And, of course, that was a long time ago. I've been taught by some really good instructors in other courses along that way, along those lines. I just remember the fundamentals, the Swiss cheese in lining up everything; I'll never forget that.

DR. WILSON: Thank you. That's all that I had. Thanks, Rene.

MR. REY: Thank you.

MR. HAUF: Mike?

MR. BAUER: Yeah, I have a few.

BY MR. BAUER:

Q. Some of them might just be making sure I understand clearly what you stated earlier.

A. All right.

Q. So the first one would be you talked about the process for the communications between an applicant --

A. Yes.

Q. -- and with your work. And just to be clear, that process is not documented?

A. No, sir.

Q. For the communication for you to management to engineering to --

A. If it is, I've never seen it.

Q. Okay. You also discussed that you had -- there were discussions that you had with the applicant, for example, where your understanding of the aerodynamic loads were not great enough to move the feather in an unlock. And it was part of a telecon?

A. Yes. Yes.

Q. When those telecons would occur, was the exchange of information open or was it directed through a similar process?

A. That's really a good question. And I remember one that I was sitting on. You know, back in the old days -- I don't know if this is true -- in the Soviet Union, on a ship you'd have the commander of the ship, and then you have a political commissar who was there right by his side to make sure he didn't do anything that was politically unacceptable. Well, I kind of felt the same way on the telecon because we had AST-500 reps there, and I was always on guard for phraseology, what I should say. You know, it was just there in the background, and that's what I likened it to.

Q. So, it was open yet --

A. Yet restrained.

Q. Yet restrained.

A. Yes. And the other thing I want to add to that, since you're on it. Ideally, I would like to have my question answered now. I'd like to call you and say, hey, what about this; what about that? By the time you have these meetings, they're very structured and they're on a schedule. And by the time you get there, maybe your issue has even become moot or you've forgotten

it. There's always that possibility.

Q. Okay. In that discussion process, do you feel that if Scaled provided a response, that that response would have been filtered prior to going to you?

A. I am not aware of anything that Scaled has ever provided, I'm not aware of it being filtered by AST management. There would be no reason to do that.

Q. Okay. Just --

A. Yeah, no --

Q. I know we're talking about the --

A. -- I understand. It's two-way communications.

MR. PREAMBLE: Yeah, you guys are talking over each other.

MR. BAUER: Sorry.

MR. PREAMBLE: Be careful. This is a transcript, so --

MR. REY: Sorry.

BY MR. BAUER:

Q. No, I just wanted to -- we've been talking a lot of filtering one way. I just wanted --

A. Yes, sir.

Q. -- to get the impression if --

A. A good thorough checking.

Q. Now, going to just a different subject a little bit, in the system safety assessment or the fault hazard assessment, do you consider there to be a difference between an assumption placed

in the FHA, or in the description of an FHA, and the mitigation?

A. Oh, absolutely there's a difference.

Q. Okay. So if there was an assumption for the process, would you expect that assumption to not show up in the system safety assessment, or as a mitigation? Maybe I'm --

A. Well, I'll answer it the best I can. To me, what you're asking for, usually when you do an analysis you have the conditions under which the analysis is made. For example, you know, sunny day, this temperature, et cetera, and based on these initial assumptions, this is what we would come up with.

The mitigations -- to me, what you're talking about, when you make an assumption -- when you give me a reliability number, for example, okay, this can't happen because this is so reliable it's got four 9's. The first question is, okay, is that an assumption? I mean, what is that based on? And, oh, it's based on a database of electronic parts. Okay, now, were the parts aircraft or what kinds of systems were these things on? Were they space systems? Well, no, not exactly. Then how do you know that this system -- you made an assumption that this system still functions in space the same way, and so, therefore, that can't be a mitigation.

Q. Would a limitation in a pilot operating handbook be considered a mitigation to a hazard, in your opinion?

A. It could be, depending on what it is, how critical.

Q. For example, a limitation of gear extension speed, would

that be a mitigation to a hazard of uncommanded gear deployment?

A. Well, the thing is, with hazard analysis we have a hazard and what's the consequence of that hazard? If extending the gear, the worse thing that can happen is the gear will be ripped off and then possibly fall on somebody on the ground. Putting a speed, an airspeed in the handbook, that's nice, but I'd also want to see that in the procedure or the checklist for the pilot as well.

Q. And then just one last question. You were describing, I think in answer to one of Kat's questions, that you determine if the application is complete enough.

A. Um-hum.

Q. And I just want to understand that. With regards to the clock time of 128 days for the applications, does the 128-day timer start when you deem the application complete enough, or not?

A. Okay. The 120-day clock starts the second the application is deemed to be complete enough. But, as I stated earlier, if I may add this, ideally the day that we decide it's complete, that's when the clock should start. But we always start with at least a 30-day clock status because it's backdated from the time they initially submitted the first data.

Q. Okay.

A. So it's extremely frustrating.

MR. BAUER: I don't have any other questions right now.

MR. HAUF: Okay. Lorenda?

BY MS. WARD:

Q. All right. A follow-on to Mike's question of the 120 days. Of that 120 days how much time does your group, say, within AST-300, have carved out for your review?

A. It depends. Of course, the license evaluator always has his own schedule for when he needs -- Ray Jenkins was really good about this. He laid out all the timelines, all the milestones of when certain things were due. And, of course, at AST-300 we'd always push back and say, well, there's no way we're going to meet that date because we don't have the data; we can't give you a response. And if we do, if you force us to, we're going to simply say we don't approve, and that's it.

So in terms of time, to answer your question, it varies how we can handle -- how soon we can get the data.

Q. If you could ballpark it, how many days do you think that you have?

A. If it's a 120-day evaluation period, and we do get the full 120 days, I would say 90.

Q. So you have 90?

A. Ninety days to really get our final response, because we piecemeal it all along.

Q. Within that 90 days, that's also built in the applicant's response to any questions?

A. Exactly. Yes.

Q. How long do they have to answer any questions?

A. We always tell them time is of the essence. As soon as possible, please get us a response. But we never give them you have 2 days to get this to us. We never set a deadline.

Q. So there's not -- who does the follow-up then?

A. AST-500 does all the follow-up.

Q. All right. So you would go to AST-500 and say I still have not heard back --

A. Exactly.

Q. -- I need my answer?

A. Exactly.

MR. PREAMBLE: Just wait until she asks the question and then answer.

MR. REY: Yes, sir.

BY MS. WARD:

Q. You mentioned earlier that you have -- I thought I heard flight test engineer from the Air Force side, and then David talked about flight test pilot. Do you have both types of experience or is it more on the engineering side?

A. More on the engineering side.

Q. Okay. Is there anyone else within AST that you're aware of that has like a test pilot background?

A. I'm really searching very carefully here to know a pilot. Dr. Nield is a graduate of the Air Force Test Pilot School. He's a flight test engineer graduate. That's it.

Q. Okay. You also mentioned that you went to the National

Test Pilot School in Mojave?

A. Yes.

Q. Now, I know they have two tracks associated with the 6-week school. So did you do the engineering track or the pilot track?

A. I did the flight test engineer track.

Q. Okay, good. You referred to the budget and the limited budget that you have within AST for travel. Now, is that throughout all of FAA or is it just within AST?

A. It would appear that that is just within AST.

Q. Okay. When was AST-500 stood up, if you recall?

A. I don't recall exactly, but within the last 3 years.

Q. About 3 years?

A. Yes, ma'am.

Q. Who was the inspector for Scaled?

A. The one that I'm aware of, his name is Marcus Ward. Usually there's more than one. I'm not really sure, but I do recall a conversation where he was talking about the pressurization system that wasn't up before the takeoff and they had to wait. So he had to have been there.

Q. You mentioned earlier about I think the lack of content within some of the hazard analysis and needing more data, and then actually going back and asking for that and not getting it. If you were able to fix that process, what would you recommend?

A. I would recommend that we in AST-300 be allowed to

interface directly with the applicant for all engineering reviews, as well as ad hoc meetings to discuss hazard analyses or specific hazards as well.

Q. Do you feel like AST-500 has the capability to relay on your requests?

A. No, I don't.

Q. Could you elaborate?

A. I think that the people we have out there don't have the requisite background or experience in systems engineering to do that job.

Q. You talked about the good old days. Do you feel like it worked better before you had this new division stood up?

A. Absolutely, I do. It wasn't perfect, but, yes, I do.

Q. Do you know if there's any plan in place to define or to document what people's roles and responsibilities are within AST?

A. I'm not aware of any.

Q. Okay. You stated earlier at the very beginning of the interview that you're a senior aerospace engineer, and you've been with FAA since 2001, so roughly 13 years?

A. Right.

Q. Do you feel like you're effective in your position?

A. No, I don't, and nor do I think that I -- my full capabilities are utilized.

Q. Have you expressed that to management?

A. A myriad of times.

Q. Okay. Thank you, that's all I have. Thank you, Rene.
A. Thank you.
MR. HAUF: Okay. Will, do you have any questions?
MR. ROBERTSON: Sure.
BY MR. ROBERTSON:
Q. So you just stated -- or let me paraphrase on your roles and responsibilities and your time. You said 13 years at the AST -- or FAA. Is that --
A. Correct.
Q. -- correct?
A. No. AST -- FAA I've been there.
Q. Okay. Thirteen years?
A. Yes.
Q. And you stated that you develop regulations 50 percent of the time and 50 percent of the time you would say that you work SSAs?
A. Um-hum.
MR. PREAMBLE: You need to give a verbal --
BY MR. ROBERTSON:
Q. Do you have a --
MR. PREAMBLE: Sorry. You need to give a verbal answer.
MR. REY: Yes. Yes.
BY MR. ROBERTSON:
Q. Okay. Do you have any other background prior to FAA in system safety assessment?

A. No, I do not.

Q. Are you aware of a standard called ARP-4761, called Guidelines and Methods of Conducting System Safety Assessment Process on Civil Airborne Systems?

A. I'm aware of that, yes.

Q. Okay. And I think earlier you stated that you're aware of it, but you're not an expert in it?

A. Correct.

Q. Okay. Are you familiar with MIL-STD-882-DOD, Standard Practice for System Safety?

A. Yes.

Q. Would you consider yourself an expert in that?

A. No, I wouldn't.

Q. Are there any standards that you're aware of for conducting system safety that you would consider yourself an expert in?

A. I'm not an expert in any of those standards.

Q. Okay. You also said that you were skeptical of the values that you see, and I took that to mean -- I don't know if you used the term in fault tree analysis for probabilistic risk assessment?

A. Well, yes, I'm actually skeptical.

Q. Okay. And you also alluded to -- and you may have also mentioned an electronic database, and I think you were talking about something called the non-electronic --

A. Yes, I was.

Q. -- NPRD --

A. I was referring to that.

MR. PREAMBLE: Okay. Yeah, you need to wait until he finishes.

BY MR. ROBERTSON:

Q. I think you were referring to a database called -- there's actually two: electronic database, which is the EPRD, and then there's a non-electronic, NPRD.

A. Both.

Q. Both. Exactly. Are you familiar with the DOD funded group, the Reliability Information Analysis Center and what they do?

A. I have heard of them. I have not dealt with them.

Q. Okay. So my next is, I think, an area that you are aware of. Have you ever actually performed hazard analysis?

A. When I was at Boeing, I used a functional hazard analysis approach to develop standards for our international RLB. It was a new concept that we had developed with our reliability and safety people.

Q. Okay. So that was actually experience you had prior to FAA then?

A. Yes.

Q. So you did have experience in system safety prior to FAA?

A. Well, I wasn't calling it -- the reason I said no was because I -- we didn't -- I didn't do it under the umbrella of system safety, per se.

Q. But it is a system safety analysis; is that true?

A. Yes. Yeah, of course of it is.

Q. Okay. Okay. Are you -- do you know, the ARP-4761, does that prescribe the use of hazard analysis for handling human error or software error?

A. I don't recall.

Q. What about MIL-STD-882?

A. I don't recall.

Q. Does the AC that you alluded to -- I think it's AC 437.55 -- earlier --

A. Yes.

Q. -- does that prescribe the use of hazard analysis for human error and software error?

A. Yes.

Q. It does?

A. Um-hum.

Q. Okay. Earlier you stated that you believed Scaled had addressed all the hazards when you reviewed their analysis. Is that correct?

A. Could you state that question again?

Q. I think earlier I heard that you stated that you believed Scaled had addressed all of the hazards. And it was in

reference to a question about their system safety report.

A. I think Scaled may have, but I'm not aware of everything that Scaled had done.

Q. Okay.

A. Because I know we had a lot of questions on the hazard analysis that we felt had not been done.

Q. Okay. So my next question was regarding Terry Hardy's report. And that he stated that he had concerns with a number of items that he felt that Scaled had not met with regard to their hazard analysis.

A. With regard to the regulations.

Q. The regulations. So he wasn't specific to the hazard analysis?

A. He had a lot of specifics in his report, and I do not recall every single one of them because I haven't reviewed that in a while.

Q. Okay.

A. But he just -- the thing that stands out most in my mind is that Scaled did not meet the regulations.

Q. Okay. And so, I guess my final question with regard to this is that you also stated that you spend about 50 percent of your time developing regulation. And by that did you mean system safety regulation?

A. No. I do not do -- I have not done system safety regulation, per se. However, in the future rulemaking that I'm

initiating right now, system safety will be the heart of that new reg.

Q. So you had no part in developing 437.55?

A. No, I didn't.

Q. Okay. So to move on to a different section, you mentioned that you had a discussion with Scaled about the feather forces. And I was wondering was that discussion within the context of system safety?

A. Yes.

Q. Are you familiar with the ground rules and assumptions of Scaled's system safety -- or hazard analysis, I should say?

A. I don't recall at the moment.

Q. Okay. Let me restate that question because I sort of -- are you familiar with the ground rules and assumptions that the FTA assumes that the analysis occurs with pilot correct operation?

A. Yes.

Q. Okay.

MR. ROBERTSON: Okay. I think that's all I have.

MR. HAUF: Anything, Bob?

BY MR. WITHROW:

Q. Just to make sure I'm clear on some timelines here. So the first Scaled -- the first issuance of the Scaled experimental permit was when? Was it in May of 2012?

A. Yes, it was.

Q. And you stated that you started working, I believe, on

Scaled permit issues in 2014; is that correct?

A. Yes, I did.

Q. Okay. So the second of the Scaled permits would have happened then about a year later, May of 2013?

A. The one that I'm familiar with was the one that we issued in May -- or October 2014.

Q. So then you did not work on the first renewal that happened -- was issued in 2013?

A. That's correct.

Q. And then there was the issuance of the waiver, which also occurred later in '13, and you did not work on that?

A. That's correct.

Q. Okay. Thank you. I just wanted to get the timeline straight.

So a number of times you've stated that your team, you or your team were looking for supplemental information and you weren't able to get it. Do you know if Scaled was asked for that supplemental information that you weren't able to get, or is it the filtering process?

A. You see that's a good question. I don't know if Scaled was ever asked our questions. I really don't know.

Q. Okay. Are you aware of any time that Scaled didn't deliver information that was asked for?

A. There were a number of times when we didn't get the information that we asked for, but whether it was because Scaled

didn't -- I don't have any reason to believe that Scaled refused to provide it. I just don't think they were asked.

Q. Okay. Okay, good. Okay. The waiver -- so, a couple of questions about the waiver. First of all, I think you stated that you understood that there were a number of waivers in relationship to the Scaled permit?

A. Um-hum. Yes.

Q. And so, the waiver that has been discussed here is the waiver of two pieces of 437.55, the human and software error. What other waivers are you aware of for Scaled?

A. Well, actually that was the one that I was referring to because it had multiple mods to it. So, to me, it was one waiver for everything, but it waived a number of --

Q. Okay. So a number of conditions --

A. -- a number of conditions, yes.

MR. WITHROW: I'm sorry, my -- no, that was my fault.

MR. PREAMBLE: Oh, okay.

MR. WITHROW: That was my fault, not his.

BY MR. WITHROW:

Q. Go ahead.

A. Yeah. So, to me, it was -- it waived a number of different conditions or mods.

Q. Okay. So let me just restate it and make sure I got it correctly. So there was one waiver, but it waived multiple things?

A. Exactly.
Q. Okay. You stated that Scaled had asked for the waiver?
A. Yes.
Q. Do you know when Scaled asked for the waiver?
A. I don't recall.
Q. Okay. Do you know who asked for the waiver at Scaled, if there was a person?
A. I definitely don't recall that.
Q. You're familiar, though, with the content of the waiver?
A. Yes, I am. The letter that went out, I am.
Q. And so you're familiar with the structure of the waiver, how it's written?
A. It was written on one page.
Q. Okay. So questions have been asked about complying with conditions in the waiver. So would it be -- is it the case that the waiver is written in such a way that it's sort of like if you comply with this, then the FAA will waive that? Would that be a fair statement of the way that waiver is written?
A. Here's what's so perplexing to me. The waiver just stated, we hereby waive part -- the two parts of 437 for the above. And that was it. There were no terms and conditions on it. I'm surprised it went out like that, to be honest with you, from a legal perspective.
Q. So far as you know, there are no conditions that Scaled needs to comply with in order to have that waiver?

A. No. As far as I know, no. It wasn't stated in the letter.

Q. Okay. You visited Scaled when you were shadowing an inspector who was making inspections, which -- what's the name of the inspector who was inspecting?

A. Golly, you know, I don't recall. It was so long ago. It was when Scaled was very young.

Q. You discussed what you would think would be ideal pilot qualifications.

A. Um-hum.

Q. Can you state what you know about the pilots' qualifications -- the Scaled pilots' qualifications?

A. Okay. I don't know specifically, but I was under the impression that the pilots were not jet pilots. They were -- they had high performance piston or maybe even -- not even turbo prop, but they were propeller pilots with probably a lot of time, but not test pilots or people who had had a lot of experience with high performance jets.

Q. Okay. And we're speaking specifically about for SpaceShipTwo; is that correct?

A. That's correct.

Q. Okay. And are you aware of SpaceShipOne?

A. Oh, yes.

Q. And are you aware that the pilots in SpaceShipTwo are many of the same pilots who were in SpaceShipOne?

A. The one that I'm really familiar with, his name stands out in my mind, but his name was not -- that wasn't the name that I saw in the latest flight.

Q. Okay. Do you know the pilot by the name of Pete Siebold?

A. I know of him.

Q. Okay. Are you aware that he was a pilot in SpaceShipOne?

A. I don't recall.

Q. Okay. But you're aware that he was a pilot in SpaceShipTwo during --

A. Absolutely.

Q. Okay. Would being a pilot of SpaceShipOne be relevant experience for piloting SpaceShipTwo?

A. I would think so.

Q. I think that's all on that topic.

You were talking about the OR gate/AND gate portion of operating area versus operating safety and how it's structured with an experimental permit. And you said that, you know, it really doesn't matter if the ship crashes and burns just as long as it doesn't cause injury on the ground, or something like that. I'm trying to -- I don't have the complete -- but the question I have is that distinction of that OR gate versus AND gate, the source of that, is it in just the regs? Does it come from the statute?

A. You know, actually the source of what I said is what has been pronounced by certain people in AST management, to the effect that, you know, what does it matter? You know, I mean, they're flying over a remote area, nothing can happen. So, who cares?

And my position has always been, well, it does matter because you're working with commercial space transportation here. You're talking about the future of transporting people, and that means making the safest system possible even now. That should always be your goal because that will help make sure that no one on the ground -- because nothing's perfect. I mean, even that remote area had railroad tracks running through it. You never know when a train's going to be going through, or if they had a highway through, you just never know, even if it is random. Stuff happens.

Q. So the operating area then that was in the permit for the Scaled experiment permit, is it a sufficient operating area, according to the analysis that was done? Do you know?

A. Well, that would fall under the auspices of flight safety analysis, and I wasn't involved with that at all.

Q. Okay. And does the statute concern itself -- so the CLSAA, the amendment to the Commercial Space Launch Act, does it require the safest possible system or does it require that one is sufficiently protecting the uninvolved public? And maybe I can disentangle that, if you want. So, first of all, does it require the safest possible system?

A. No.

Q. Does it require one that ensures the safety of the uninvolved public?

A. Yes.

Q. Thank you. You mentioned the issue of tolling versus there's always a launch date in mind. In the case of the spaceship -- the Scaled experimental permit, was that a factor?

A. To be honest with you, it's always a factor, and not just Scaled's application, but something we would do -- pardon me?

MR. PREAMBLE: Oh, no, no, no, that's all right.

MR. WITHROW: That's hard to do.

MR. REY: Well, we're conversing.

BY MR. WITHROW:

Q. Yeah. Yeah. So, that would mean that it was a factor in the Scaled experimental permit?

A. Yes, absolutely.

Q. So then, do you know what the launch date was that was causing that kind of concern?

A. I don't recall the launch date specifically. It's just that management wanted things by a certain date, and that it was predicated on we are an encourage, facilitate, and promote entity.

Q. You stated that you had read all of the fault trees that were submitted by Scaled, and that's quite a task; there's quite a lot of them.

A. It was painstaking. If there's -- if I could bottle it,

I would be a very rich man for --

Q. In those fault trees is there any example of human error being analyzed?

A. There were so many, and to focus this -- I didn't focus on the human error side of that half of the house. I was more interested in the propulsion system and the structures and everything else.

Q. Okay.

A. So I didn't focus on that.

Q. Who would have rendered an opinion about the sufficiency of that, the fault trees with respect to human error?

A. Ultimately, it would have been Tom Martin because he was the lead system safety engineer.

Q. So, I'm sure that you won't remember in detail, but let me just ask, there's fault trees that have to do with hazards relating to ground control, control of the vehicle on the ground. They're numbered 1501, 1502, and 1507. You would have looked at those because you looked at all of the analysis?

A. Um-hum.

Q. But you don't recall whether or not that one included human error?

A. Well, what I did was I read through all of them, and then I focused on certain ones that Tom wanted me to focus on. When I read -- when I say I read through the fault tree analysis, I was familiarizing myself with the structure and various methods

that were used to articulate, you know, the hazards and the way it branched off and everything, and then I focused on certain areas, and that was it. So I don't have a real detailed knowledge of these areas that you're talking about.

Q. Okay. Thank you. You mentioned that you were told by management that structure's not safety critical?

A. Yes, I was.

Q. What do you understand that to mean?

A. Well, when you say it's not safety critical?

Q. Well, I'm asking you. What did management tell you, first of all, about -- what I wrote down was they said structure is not safety critical.

A. Okay. Here's the context in which that was said. When structural mod -- we became aware of the structural mods, we wanted to evaluate those because we said structures are a safety-critical system. And the reply, when we voiced that, we raised that concern, we were -- I was told or we were told, structures are not safety critical, so, no, these questions are not going forward.

Q. Do you know if Scaled expressed that?

A. No, I don't. I cannot -- this is strictly on my side of the house. I am not privy -- I don't -- I'm not privy to anything like that that Scaled would have said.

Q. And just one final little area. You described that your understanding of the purpose of the locks in the feather system

was to keep things together under g-loading conditions, such as whether --

A. Well, leaving a gravity turn. It was for the gravity turn.

Q. And so to keep them together during --

A. Well, to keep the system from activating during the gravity turn. Because, you know, I would imagine there would be g's, g-forces acting on the system and aerodynamic forces that would tend to maybe bend it a bit.

Q. At deployment?

A. Deployment, yes.

Q. Okay. So then -- but you stated that you weren't aware that the unlocking during that period of time could cause a deployment?

A. Well, the reason I said that was because the gravity -- my understanding of what happened was it had already completed gravity turn. It was now accelerating toward whatever Mach it was going to be accelerating to. But the key number was Mach 1.4 before releasing that locking mechanism, and it was done at Mach 1.

Q. Okay. But what I'm specifically asking is your understanding when you were evaluating system safety and the times that you did that. You stated that you were in a teleconference where you were assured by Scaled that the aerodynamic loads would not allow the feather to deploy?

A. And really, what I recall from that telecon is that -- I know Tom Martin was on it too. And he was asking a lot of pointed questions about the locking mechanism and possible failure mechanisms for -- I can't remember the part that he was talking about now. But the reply was, well, you know what, it's really for the gravity turn, and once that's done, aerodynamic forces are going to keep that thing together, so don't worry about it; it's not an issue. And that's what I recall.

Q. Okay. So let me rephrase to make sure I understand. So the discussion that you recall had to do with the period of time that would have been after, say, Mach 1.4 and after the gamma turn was complete, about the aerodynamic forces keeping the feather system closed?

A. Yeah, that is possible, but we didn't discuss airspeed, per se.

Q. But it was after the gamma turn maneuver?

A. It was after the gamma turn maneuver.

MR. WITHROW: Okay. I think that's all. Thank you.

DR. WILSON: Can we go off the record one minute?

MR. HAUF: Sure.

(Off the record at 11:30 a.m.)

(On the record at 11:40 a.m.)

MR. HAUF: Okay. Dan?

MR. MURRAY: Sure.

BY MR. MURRAY:

Q. So, a clarification, Rene. You said that Tom was the lead for system safety. Was that throughout the whole permit, original permit renewals, or was that for just some part of it?

A. Now, when you mean original permit are you talking about the very first one, the one that was issued in 2012?

Q. Yes.

A. He had just been on board 3 months when that was issued, so he was definitely not.

Q. Who was the lead at that time? Do you know?

A. J.D. Hutzinger (ph.).

Q. Okay. Now, you've worked the renewal for Scaled, the second renewal, I think we clarified. But you also worked on original applications, original so to speak, for licenses. Is the renewal process, particularly for system safety, any different than the original application process?

A. Different in terms of do we just take the data that came before and just look at the deltas?

Q. I guess that's what I'm asking, yeah.

A. No. Tom Martin's philosophy is to look at it from the very beginning, holistically. Look at what came before, and then do the deltas from there.

Q. Okay.

A. So it's the same process, though, is that -- yeah, it's the same process.

Q. So you'd say that the scope and the level of depth is

the same?

A. Absolutely the same, yes.

Q. Okay. Okay. Now, Scaled's hazard analysis, did it focus on just public safety or public safety and crew safety?

A. Just public safety.

Q. Just public safety.

A. That's all I was concerned with, yes.

Q. Okay. I want to switch gears back to the discussion you had earlier about some of the concerns that you have. Are there opportunities within AST for people on the staff to raise concerns directly to senior management?

A. I'm thinking about any time. No, not really.

Q. No?

A. No, I don't think so. Now, I have individually gone to AST-1 and closed the door and voiced concern.

Q. Okay.

A. But that was many years ago.

Q. But as part of the license or permit evaluation process from start to finish, are there events along the way that provide the staff with opportunities to express concerns?

A. Yes. Yes, I understand your question now. Yes, there is -- we have what we call management review boards and technical review boards, depending on what the issue is.

Q. Okay.

A. Now, for licenses, for approval, license approval or

permit approval, we go through what's called a management review board.

Q. And so those are formal meetings?

A. Yes.

Q. Okay. Who presides over them or who leads them?

A. The ones that I've been to, Dr. Nield.

Q. Okay. Are there minutes taken or are there notes for a decision document?

A. There is a record of decision document.

Q. Okay.

A. And that's the only documentation that I'm aware of. I would think the -- I'm not aware of any minutes that are taken by like someone sitting down there transcribing.

Q. Okay. Do you attend a lot of the management review boards?

A. When they were first started I did, but after a while I just stopped because I had other things to do that were of higher priority.

Q. Are there management review boards for just the original permit evaluation, or are there also management review boards for renewals and modifications?

A. There are MRBs for renewals and modifications as well.

Q. Okay. Did you attend any of the management review boards for Scaled's permit or modifications or renewals?

A. I did not attend in person. I listened remotely,

listened in remotely.

Q. Okay. Did anyone raise any concerns at that point with regard to issuing a permit determination or issuing a permit renewal or an approval of modifications?

A. Yes. Tom Martin did.

Q. And can you recall what specifically he was saying and who he was saying it to?

A. No, I do not.

Q. Do you recall how his concerns were addressed?

A. Not word for word. My impression, being on the phone, was that he was summarily dismissed, his comments.

Q. By who?

A. By the presiding official. And on that one, I don't know who the presiding official was because sometimes it's not Dr. Nield. It's someone else who's senior management.

Q. Is it just the evaluation team who has the opportunity to raise concerns at those meetings or can anyone do it?

A. Anyone who's in attendance can do it, can raise a concern. That's been my experience.

Q. Did you raise any concerns during that meeting?

A. I did not. I just didn't think it was my duty to do that when I had the lead system safety engineer in there carrying the ball pretty much.

Q. Okay. And that's the case for the original permit evaluation as well as the renewals and the modifications?

A. Now, the original permit, the only one -- the only thing that I did attend on that was the hotwash for the lessons learned for that permit. And I also read the report as well that came out with the lessons learned with that. I was not present for the MRB.

Q. If anyone had raised a concern at one of those meetings would it have been documented?

A. I have never seen anyone's concerns documented. What I have seen in the record of decision was a brief summary of what was discussed, the options that were presented, and the selection of the option that was -- that that suited senior management. That's it. I didn't read -- it wasn't like a legal brief where you present both sides of the story and you talk about the issue, and then arguments against the issue. It wasn't balanced. It's never been balanced.

Q. Is there any mechanism to capture dissenting opinions?

A. Not that I'm aware of. Only in the lessons learned. That's the only place I've ever seen anything that even remotely resembles a dissenting opinion on what went wrong and what can be done better. And actually, the one that I'm referring to is the one that was the lessons learned that were presented in June of 2012 for the original Scaled permit. That was really well documented, the lessons learned. It was impressive.

MR. MURRAY: I don't have any further questions. Thanks.

MR. REY: Thank you.

MR. HAUF: Thanks, Dan.

All right, on to the phone. Nikki, do you have any questions?

MS. DUGUE: Yes, I have a couple questions.

BY MS. DUGUE:

Q. My first question is just a clarification on your answer to one of Dan's questions, which was do you believe that Scaled's hazard analysis was focused on crew safety or public safety? Can you just re-answer that question for me?

A. Yes, it was focused on public safety.

Q. Do you believe that that was Scaled's intent?

A. Well, let's put this in perspective. Part 460 had to be addressed in the permit because you had human crew on board, and the human crew was the flight safety system basically. So from that perspective, keeping the flight safety system operational and intact as possible, there were crew protections that had to be evaluated from that perspective, from a system safety perspective as far as the flight safety system is concerned.

So as far as their intent is concerned, I have no idea what their intent was. I only know what I saw and what my perception was at the time.

Q. Okay. We've talked about how management told you that structure was not flight safety critical. And I believe once you mentioned that structure is a flight safety-critical system. Do

you believe that structure is a system?

A. Absolutely.

Q. Do you believe that structure is a system to be analyzed in a functional hazard system?

A. Absolutely.

MS. DUGUE: Those are all my questions.

MR. HAUF: Thank you. Thank you, Nikki.

And on to Brett.

MR. VANCE: Yeah, a few.

BY MR. VANCE:

Q. And Rene, these are going to be mostly process questions. And this is Brett Vance, FAA test pilot from Los Angeles.

You mentioned earlier that you were working on some new regulations, and I think you said system safety was going to be the focus of one that you're working on now. Can you elaborate on that one, and also any other new regs that you're working on?

MR. PREAMBLE: Well, you know what? Because we're going into prospective regulations, I would prefer to answer that in a government-only session.

MR. VANCE: Okay.

BY MR. VANCE:

Q. Number two, the second one here, in AST is there any kind of a written process, maybe some -- like a job aid or a checklist, to assist you guys in evaluating an application?

A. We have a number of procedures that we use in evaluating a license. Now, the one that I'm familiar with, the licensing team itself, which is led by AST-200, they have their checklists that they go through to make sure that the applicant submits, you know, the required data. But that doesn't in any way address how detailed that data is.

The only thing that comes being close to a procedure is what Tom Martin has put together as part of the system safety program. When he first came on board, that's what he was hired to do. And we have some really good templates that he has developed that guide us through all the things that we should be looking for in an applicant's hazard analysis, for example, or any aspect of the system safety process.

Q. Okay. You almost kind of led into my next question here. Do applicants get any written guidance on how to complete their application during that pre-application process you put them through?

A. My understanding from AST-500, they have a Pre-application process and they have their checklists and everything. And as part of their initial briefing, we do have a system safety portion of that briefing where we state what the regulations are and what we expect to receive from the applicant.

Q. You know, it sounds like that covers Rule 437. Do you give them anything to cover -- I mean, since this is all new, anything to cover Rule 460 for the human addition there?

A. Yes, 460 in this case would have been included in that briefing.

Q. And a couple more here. This is a little bit more process. This is on the mitigation for some of these waivers -- or to the waivers, the most recent one in particular. You mentioned earlier that most of the hazard analyses that you've seen were structural related. Can you tell me if every mitigation in the waiver addressed a specific hazard analysis that was provided by Scaled?

A. It did. It was just a one -- one page that I -- it was only a one-page waiver. It just waived -- what I saw, it waived six modifications that Scaled had done to SpaceShipTwo.

Q. So were you aware of other mitigations like the 1.4 time speed in the simulation, two chase ships, things like that?

A. I was aware of that, but really more from an interest, a pilot's interest than anything else.

Q. Okay. And finally, have you ever seen another circumstance where launch date pressure may have trumped the need for completeness on an application eval?

A. I've been seeing them since the day -- well, since -- at AST for 2 years. We've had a number of applicants' insistence where tremendous pressure has been put on us on the licensing evaluation team to get an application approved for a certain launch date. I can't begin to -- I can't even shake a stick at all of them, there's so many.

Q. Have you had to shortchange your processes because of that?

A. Now, I wouldn't use the word shortchanged. In every instance, our concerns have been brought up, in some cases, most vociferously defended and discussed, and a license or application has been approved anyway.

MR. VANCE: Okay. That's all the questions I have. Thanks.

MR. REY: Thank you.

MR. HAUF: Thanks, Brett.

BY MR. HAUF:

Q. Almost done here. Just three real fast questions. In the telecons with Scaled were there meeting minutes taken there?

A. No, sir. At least not on our side.

Q. Okay. What about the hotwash? You said that one --

A. Oh, excuse me. May I retract that for a second? There were not formal meeting minutes taken, but I can assure you that everything that Tom Martin was on, he's got a written description of everything that happened and all the decisions that were made.

Q. Okay. Hotwash, you mentioned that there were meeting minutes or that was well documented?

A. The hotwash that I referred to, there was a hotwash report that was extremely detailed on all the shortcomings, as well as the good things that happened. It was very well written. It was dated June 2012.

MR. HAUF: Okay. I have no further questions.

Going around the room, Will?

MR. ROBERTSON: I have a question.

BY MR. ROBERTSON:

Q. Okay. So earlier you stated that Scaled's analysis was performed in the context of public safety.

A. Um-hum.

Q. Are you familiar with parts 25 and parts 23, system safety analysis sections? To be specific, 25.1309 and 23.1309.

A. Not as well versed as I should be.

Q. Okay. Are you aware that Scaled's hazard matrix comes from the AC 23.1309?

A. Yes.

Q. Okay. And so, can you state what the severity matrix ranking is for catastrophic from that hazard severity matrix, or you're not familiar enough to --

A. No, I'm not familiar enough to do that.

Q. Okay. Do you know if it is written in terms of public safety or occupant safety?

A. And I don't know that either.

Q. Okay. I think that's all the questions I have.

Actually, let me see. Are you aware that it is written in the context of occupant safety?

A. (No audible response.)

Q. Okay.

MR. HAUF: Thanks, Will.

Yeah, Bob?

BY MR. WITHROW:

Q. Just one little area. So the concept of structure being a system -- so that's the general topic area -- in aviation safety analysis as opposed to space safety analysis, do you feel that it's -- do you know enough about that to know if it's standard or not to consider structure to be a system?

A. No, I do know enough to know because we used that at Boeing. And when I was doing the functional hazard analysis to develop standards for an international RLB, structure was right up there as a system. And in the evaluated standards that would have been necessary so that it would function properly.

Q. Okay. So then in your opinion, it is standard practice in aviation safety analysis --

A. Yes.

Q. -- to consider structure to be a system just like valves and switches and things like that?

A. Yes.

Q. Okay. Thank you.

A. You're welcome.

MR. HAUF: Okay. Anybody else?

MS. WARD: What I'd like to propose is that for Brett's answer to be closed out as far as any regulation, you want it to be government-only, is if we can go ahead and excuse the others

for lunch. And then, if Rey could go ahead and answer -- Rene could answer that question?

MR. PREAMBLE: That's fine with me.

MS. WARD: Yeah, that way we can go ahead and knock it out. What I would like to do is, due to the fact that we went long, instead of starting back at 12:30, to propose 12:45 or 1:00, because I know it gets busy downstairs, sometimes it's slow to get food.

(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:	CRASH OF VIRGIN GALACTIC SPACESHIPTWO MOJAVE, CALIFORNIA OCTOBER 31, 2014 Interview of Rene Rey
DOCKET NUMBER:	DCA-15-MA-019
PLACE:	Washington, D.C.
DATE:	January 16, 2015

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.

_____

Stephen Grider
Official Reporter

UNITED STATES OF AMERICA

NATIONAL TRANSPORTATION SAFETY BOARD

Investigation of:	*	
	*	
CRASH OF VIRGIN GALACTIC	*	
SPACESHIP TWO	*	Docket No.: DCA-15-MA-019
MOJAVE, CALIFORNIA	*	
OCTOBER 31, 2014	*	
	*	

Telephonic Interview of: JAY NAPHAS

National Transportation Safety Board
6th Floor Conference Room
490 L'Enfant Plaza East, S.W.
Washington, D.C.

Friday,
January 16, 2015

The above-captioned matter convened, pursuant to notice.

BEFORE: MICHAEL HAUF
Systems Safety Group Chairman

APPEARANCES:

MICHAEL HAUF, System Safety Group Chairman
National Transportation Safety Board

LORENDA WARD, Investigator-in-Charge
National Transportation Safety Board

DAVID LAWRENCE, Operations Group Chairman
National Transportation Safety Board

MICHAEL BAUER, Systems Group Chairman
National Transportation Safety Board

KATHERINE WILSON, Ph.D., Human Performance Group Chairman
National Transportation Safety Board

DANIEL MURRAY
Federal Aviation Administration

BRETT VANCE, Test Pilot
Los Angeles Aircraft Certification Office
Federal Aviation Administration

BOB WITHROW
Scaled Composites

NICOLETTE DUGUE
Scaled Composites

WILL ROBERTSON
The Spaceship Company

BRADLEY PREAMBLE, Office of the Chief Counsel
Federal Aviation Administration
(Representative on behalf of Mr. Naphas)

I N D E X

I N T E R V I E W

(1:05 p.m.)

MR. HAUF: Okay. So what I'm going to do is introduce myself, and then start reading the statement and then at which point I will go around the room and have everybody introduce themselves in the room in Washington, D.C. and then have people online introduce themselves. Then I'll continue reading the statement, and then start the interview right after that.

So to start off, my name is Mike Hauf. I'm the Systems Safety Group Chairman for this investigation, and I'll be conducting the interview here.

The NTSB is an independent federal agency charged with determining the probable cause of transportation accidents and promoting transportation safety. The NTSB is not part of DOT or FAA. It has no regulatory or enforcement powers.

At this point, I'd like to go around the room and introduce everyone here in Washington, D.C. Lorenda?

MS. WARD: Good morning, afternoon. I'm Lorenda Ward. I'm a Senior Investigator-in-Charge here at the NTSB, and I'm also the Investigator-in-Charge for this accident investigation.

MR. MURRAY: Dan Murray, FAA AST representative to the System Safety Working Group.

MR. PREAMBLE: Bradley Preamble, FAA, Office of the Chief Counsel.

MR. WITHROW: Bob Withrow, Scaled Composites, a member

of the Systems Safety Group.

MR. ROBERTSON: Will Robertson, Systems Safety representative for Virgin Galactic.

DR. WILSON: Katherine Wilson, Human Performance Investigator and the Group Chairman for this investigation with the NTSB.

MR. LAWRENCE: Good afternoon, Jay. David Lawrence, NTSB. I'm the Operations Group Chairman.

MR. BAUER: Michael Bauer, NTSB, Systems Group Chairman.

MR. HAUF: All right. Okay. So everyone online, let's start with Nikki.

MS. DUGUE: Nicolette Dugue, Scaled Composites representative on the Systems Safety Group.

MR. HAUF: All right. And FAA?

MR. VANCE: Brett Vance, test pilot with the FAA, Los Angeles Aircraft Certification Office.

MR. HAUF: Okay. Is there anybody else online?

MR. NAPHAS: Yes, you have Jay Naphas, FAA AST. I'm now in the Operations Integration Division.

MR. HAUF: All right. Okay. So today, we will be using the services of a court reporter who will record and then transcribe the interview. The transcript, not the audio recording, will be made a part of the public docket.

The purpose of the investigation is safety, to determine probable cause and prevent reoccurrence. Our role is not to

assign fault, blame or liability. This interview is part of the fact-finding phase of this investigation. We are here to ask questions about your involvement in the permit and waiver for the SpaceShipTwo program. We cannot, however, offer any guarantee of confidentiality or immunity.

Each of the group members will have a chance to ask questions. We will ask questions one at a time and everybody has been instructed not to interrupt the person who is asking questions at that time. There will be an opportunity for each group member to ask follow-up questions after each person has had a turn.

Please answer all questions to the best of your recollection. If you do not understand a question, ask to have it repeated or explained. If you realize you misstated or need to modify a previous answer, please do so.

You are entitled to have one representative of your choosing. And, Jay, is there someone you would like to have as your representative?

MR. JENKINS: My representative is Brad Preamble.

MR. HAUF: Okay. Excellent.

And, Mr. Preamble, you may direct Jay to not answer a question or to request a short break to confer with him.

The FAA will have the ability to review the transcript prior to inclusion in the docket.

Jay, do you have any questions?

MR. NAPHAS: Not at this time.

MR. HAUF: Okay. Good. So now we'll start the interview.

INTERVIEW OF JAY NAPHAS

BY MR. HAUF:

Q. And for the record, can you please state your name and job title?

A. My name is Jay Thomas Naphas. Job title, Technical Liaison.

Q. Okay. And currently, which AST division are you working in?

A. AST-500, Operations Integration.

Q. Okay. And how long have you been in that position?

A. In this division, since September of 2012.

Q. 2012. And previous to being in this position, what was your prior experience at the FAA?

A. My prior experience with FAA was in AST-300 as an aerospace engineer specialized in systems safety, and I had internships for two summers prior to that with the Houston Flight Standards District Office.

Q. All right. And I understand that you worked on the original permit with Scaled. Can you talk about your roles and responsibility with working on that permit?

A. Let's see. When the permit first came in, I was the system safety person tasked to the team.

Q. Okay. And what were your job duties for that permit?

A. It was to review the incoming application, discuss it with the applicants, if clarification was needed, get revisions, evaluate it against the regulations and against our advisory circular and guidance and U.S. practices in system safety.

Q. All right. Were you involved in any pre-consultation meetings with Scaled to talk about the application process?

A. Please clarify pre-consultation. Pre-application consultation, is that what you mean?

Q. Yes.

A. Okay. Yes, we had several discussions regarding systems safety during the application preparation period with several draft applications going back and forth.

Q. Do you know the time frame for when those discussions were held?

A. Those should have been around 2010, 2011. I'm not exactly certain of the year.

Q. Okay. And in those meetings, what kind of -- were there any discussions on the hazard analysis with respect to, say, the feathering system?

A. Yes, we had several discussions on the feather, on all subsystems really.

Q. Okay.

A. We go subsystem by subsystem through the analysis.

Q. And were -- do you remember if there were any concerns

brought up with that system?

A. There were many.

Q. Do you happen to remember those?

A. Inadvertent feather actuation, failure of the feather mechanisms, the inability to unfeather factored heavily into our analysis.

Q. Do you know if there were any discussions on what the effects would be if the feather system was operated prior to, say, 1.4 mach?

A. I don't recall a discussion of specific mach numbers during that period.

Q. Okay. And in these discussions, were you having direct conversations with Scaled Composites?

A. Yes.

Q. Okay. Do you remember who?

A. We usually had at least Bob Withrow on the phone. Sometimes they'd bring in Nicolette Dugue, and there were some other support specialists used that escape me at the moment.

Q. Okay. And did you work on any of the renewal modification permits?

A. I worked some of them. Up to about 2013, I was still consulting with AST-300 as kind of a follow-on my prior position.

Q. All right. Back to the original application, in reviewing the hazard analysis, could you describe what your review of, say, the fault tree analysis was, how you went about it and

what criteria you used to evaluate it against?

A. Okay. The fault tree specifically or the hazard analysis just in general?

Q. Let's talk about the fault tree right now.

A. Okay. The fault tree, I looked through to see if there were any obvious missing components on any of the diagrams and had a subcontractor, Terry Hardy, do a scan. We checked the numeric values for general engineering sanity or --

Q. In reviewing the fault trees, were any deficiencies noted?

A. We noticed over time a few instances of either omission of an element or a failure we thought was non-conservative, so we'd ask questions about it.

Q. Were the deficiencies resolved in your opinion?

A. I believe they were.

Q. Okay. And could you describe a little bit about what Terry Hardy was -- what his responsibility was?

A. Terry was at that time functioning as a second set of eyes for my work at AST. He took the same hazard analysis inputs, the functional analysis with fault trees and the -- common cause analyses, and compile his own independent look at the consistency and accuracy of those documents.

Q. Okay. And do you know, in Terry's review, do you know what any of his findings were?

A. Terry's view was a bit more pessimistic than mine. He

noted several discrepancies, the names of which escape me at the moment.

Q. Do you remember if you agreed with Terry's assessment of the hazard analysis?

A. I agreed with a great many of his findings, while several of them were beyond FAA's mandate.

Q. Okay.

A. They dealt with crew safety and if there are people on board, there are mandates to the crew and then to the public.

Q. And for the ones -- for the areas that you did agree with, did you provide that feedback to Scaled and work with them to resolve them?

A. I provided that feedback to my management, some of which got to Scaled Composites.

Q. Not all of it?

A. As I recall, there were some things that we were unable to based on management feedback.

Q. Can you maybe talk a little bit about the management feedback on that issue and who the management was?

A. Management would have been AST-300 management and occasionally the chief engineer.

Q. Do you remember who the chief engineer was at that time?

A. I don't remember if it was Mike Kelly or Ben Zafi (ph.) at that time. It changed in the middle of the process.

Q. Okay. Did you have any concerns that some of the

information wasn't provided?

A. The information meaning?

Q. That you were putting forth or the information from Terry's analysis that you were providing to management and hopefully to Scaled.

A. (No audible response.)

Q. We can move on here.

A. I'm sorry. I'm not entirely clear what that question means to FAA.

Q. That's fine. I'm going to change subjects here. Did you have any involvement in the waiver process or the waiver?

A. The waiver, referring to the May 27 or 23-ish of last year waiver, or 2013, sorry?

Q. The waiver, I believe, in July of 2013.

A. Okay. That one, that one came as kind of a surprise to me. I had a couple of renditions of a waiver in about May of 2013 but I didn't think that that one ever got published.

Q. Can you kind of maybe talk about that as why it was a surprise? And did you talk to management about that?

A. I talked extensively with my AST-500 management about the waiver and whether or not I thought it was a good idea or whether I thought the waiver was accurate.

Q. And did you think it was accurate?

A. The waiver, as published, I didn't think reflected exactly the situation that it was representing.

Q. Okay. How would you have or what were some of the things that you maybe didn't agree with there?

A. The biggest thing I had a problem with was that it asserted that Scaled Composites hadn't addressed human error or software error in their hazard analyses. I recall going through the fault trees and finding software error and human errors represented there.

Q. So in your opinion --

A. They both --

Q. I guess in your opinion of the original experimental permit, you feel that Scaled did address human error as described in the regulations?

A. I believe it addressed human error. I'm not certain of how thoroughly it addressed, but that was.

Q. So let me restate this. In their application for experimental permit, was human error addressed as the requirements stated in the hazard analysis?

A. The requirements only state that you have to consider human error and software as elements in the hazard analysis. There's kind of a type mismatch here between the regulations as written and the analyses Scaled presented. The regulations, as you read them, basically specify a preliminary hazard analysis for a failure-by-failure kind of analysis. Scaled's functional analysis doesn't have the same kind of labeling scheme for hazards that the regulations design for.

Q. Okay.

MR. HAUF: Right now I'm going to pass the questions off to Dave.

MR. LAWRENCE: Sure.

BY MR. LAWRENCE:

Q. Good afternoon, Jay. Can you hear me? This is David Lawrence with the NTSB.

A. I can.

Q. Okay. Great. Just a couple of follow-up questions. I want to ask you a little bit about your background prior to coming to the FAA. First off, how long have you been at the FAA?

A. I started with the FAA in June of 2007.

Q. Okay.

A. With AST.

Q. And I believe you said you started in -- I apologize, Jay. Go ahead.

A. Sorry. I had to get a drink of water. I started with AST in June of 2007. Prior to that, in the summers of 2006 and 2005, I did internships with the Houston Flight Standard District Office.

Q. Were you inspector with the FSDO in Houston?

A. I was an intern with the FSDO. I observed inspections, I helped document one aviation accident, and went through the inspections of others back at the office, mostly, you know, with them on their inspections and ramp checks and the like.

Q. Are you a licensed pilot?

A. Yes, I have a private pilot, single-engine land, and --

Q. Okay. And I believe you --

A. -- and --

Q. I'm going to try and pause as long as I can because there's like a little bit of a delay in your response. So I apologize if we walk on top of each other, but you had mentioned that you began at AST-300 and then went to AST-500. Why the move?

A. Let's see. Mainly an extension of scopes. I wanted to be basically our field representative for systems safety to better help the organization by taking -- I had been evaluating hazard analyses in systems safety processes back in D.C., and take that experience out in the field and sort of coach people on what we expect during evaluation.

Q. Okay. And you originally described your role in AST-500 as a technical liaison. Who do you liaison with?

A. The representatives from each of our -- each of the companies that we work with. Typically a company will assign a point of contact for the government affairs or regulatory affairs and we'll work with them and other people on staff as necessary to help them through the, mainly the pre-application process.

Q. Great. And a follow-up to the conversation you had with Mike a moment ago. You said there were conversations about the feather system, and I believe you said you remembered conversations about an inadvertent activation of the feather

system. Was that correct?

A. I believe so, yes.

Q. Do you recall if there was a conversation about an inadvertent activation of the feather unlock during boost flight?

A. I don't recall that discussion.

Q. Okay. Can I ask you, Jay, what job aids do you use to perform your job?

A. In systems safety -- I assume you're referring to my work in 300?

Q. Your current job in 500.

A. Current job in 500, we have an pre-application consultation procedures document that's recently published as well as a -- or construction, I believe it's called, that's still in draft form. We also use our advisory circulars that are published on the website. I can't think of any others --

Q. Okay. Thank you.

A. -- at the moment.

Q. Thank you. In the commercial space transportation division of the FAA, AST-400 on the organizational chart is called the Safety Inspection Division and AST-500 is the Operations Integration Division. Can you just give me a brief description of what each of those division's role is and what the differences are?

A. Sure. AST-400 is primarily tasked with observing operations for regulatory compliance. Those can be anything from

pre-flights, flight termination system checks, tests, dress rehearsals, and then the actual launch. They're looking for any visible violations of the representations in the permit or license application or the regulations. AST-500, by contrast, is a kind of -- sometimes has been called relationship management or partner management or we take more of an executive, top level view of the operation, see how people are responding to things, what the general mood is, you know, in a room, and look for precursors to other potential interactions.

Q. Okay. Are communications from AST-300 technical evaluators filtered through AST-500 to the applicant?

A. At this point, sometimes, though usually it's just take the inputs from 300 and just take a quick look at them for proprietary information from other companies -- sometimes analysts will compare companies just to give our internal people a reference -- and then send those comments out.

Q. Are there other reasons other than ICAR that you would filter comments or questions from AST-300 to the applicant?

A. One good example is if there were comments about Virgin Galactic's hazard analysis in a question sent on to Scaled, then we would filter those out so we don't give out proprietary information from another company to -- the company.

Q. Is there any policy that prevents AST-300 technical evaluators from contacting an applicant directly?

A. In AST-500, they generally like to be part of those

discussions if they're going to, say, call an applicant, just to maintain awareness of what exchanges are going on. But it just might just be low enough so that we can get the right resources potentially from AST-200 or 400 to resolve them.

Q. Okay. And you had mentioned earlier that the AST-400 was essentially -- I think you used the word compliance, checking for compliance with -- for the applicants. Is that correct?

A. Correct, compliance with the regulations and compliance with the representations in the application information which will be --

Q. Would that include adhering to provisions outlined in a waiver?

A. I believe it would.

Q. Okay. Have you ever been to Mojave, Jay?

A. I've been there many times, yes.

Q. Oh, you're in Mojave. That's why you're on the phone.

A. Yeah, I'm in Palmdale technically, but, yes, we're frequently up in Mojave.

Q. Let me be a little bit more specific. Have you visited or do you regularly visit the Scaled facilities?

A. Yes, I've visited there for quarterly meetings for the entire time I've been out here if memory serves, and have once flown the SpaceShipTwo simulator in their lab. I've observed several glide flights, powered flights, cold flow tests and simulations.

Q. What was the reason for you to go fly the simulator? Was that in the capacity as part of your job?

A. That was primarily a familiarization thing really. We had some down time and had time to just run through things with two of our folks D.C. when they were out.

Q. Do you have a chance to talk to any of the test pilots when you're out there?

A. Yes, I've talked with at various times Pete Siebold, Dave Mackay. Those are the primary two, occasionally Mark Stucky.

Q. Do they ever share with you any concerns about the Tier 1b program at Scaled?

A. No, I don't recall any specific concerns about their own safety, other than the rational engineering judgment kind of concerns.

Q. What -- can you elaborate on those concerns?

A. Many of the things like Collins getting the data acquisition systems to stay up and running, the kind of minor technical glitches that any program typically has.

Q. How did you like flying the sim? What were your impressions?

A. My impression was it was a fascinating piece of machinery and looked like the kind of view I'd like to see one day. It actually felt, up until the point of landing -- I had a little trouble with that part, but other than that, it seemed to fly really, really nicely.

Q. Do you know if the sim was run at real time or was it an accelerated run like 1.4 times?

A. I think the -- I don't recall the timescale, no.

Q. Okay. Where were you during the PF04 accident?

A. During the PF04 accident -- during the actual flight itself?

Q. Correct.

A. I was in the observation auxiliary room below the control room.

Q. And what was your role there?

A. My role -- let's see. My role prior to and after the flight is the same partner management, relationship management role that we described a minute ago. During the flight I'm primarily just another set of eyes, another set of ears for the inspectors upstairs. We have a live inter-messaging system with them normally.

Q. Is there at any point in time that the FAA has the authority to intervene during the mission?

A. Let's see. For some operations, we have a delegated authority to stop a launch, but typically it's for a sea launch or for operations at unusual hours, and that rests entirely with AST-400 if that occurs.

Q. Do you know if they have the authority to stop a launch?

A. They will at times. I'm not sure of whether they have ability delegated for SpaceShipTwo operations.

Q. Okay. Let me ask you really briefly about your workload. Do you -- how many other permits or waivers are you -- or applications are you currently working on?

A. Let me see. I haven't taken a count lately. It's probably on the order of 10.

Q. Can you briefly describe your workload?

A. The best way I could characterize it is heavy, sometimes extremely heavy and never less than moderate. We're pretty overloaded here a lot of the time.

Q. What do you attribute that overload to? Is it the total number of applicants or is it support from management? How would you characterize that?

A. Let me see. I think, in my opinion, at least, AST is understaffed. We could definitely use a few more people to share the load. But the difficulty is communicating -- we're trying to get -- work, for example. So that kind of forces us to take our time in talking things through, rather than have them in shared real time.

Q. Do you feel like you have the support of management?

A. In AST-500, I definitely have management support. They do an excellent job of clearing things for me when they need to.

Q. What about in other divisions, to your knowledge?

A. In AST-300, it was more mixed. Most of the time I could see their perspective and understand why I was getting the feedback I was getting, specifically in getting questions out to

applicants, from that prior role. I could usually understand what they were driving at, but sometimes I had concerns that I needed to push a little harder.

Q. Last set of questions. In your capacity at any point in time, did you have anything to do with the development of 460 rules?

A. The 460 rules, I don't recall having much or any input in those rules, no.

Q. Okay. Thanks, Jay.

MR. LAWRENCE: Mike, that's all I got.

MR. HAUF: All right. Thanks, Dave. Katherine?

BY DR. WILSON:

Q. Hi, Jay. This is Katherine Wilson. I could use a little -- can you hear me?

A. I can.

Q. Okay.

A. Good enough for now.

Q. I need a little clarification on a few things you said. I'm not sure if I heard you correctly. Did you or did you not feel that a waiver was needed on the Scaled permit?

A. I didn't think that we really needed a wavier, especially not the waiver that was published.

Q. Okay. And so regarding that, in terms of the human error analysis, what aspects of human error did Scaled address in their permit?

A. I have trouble recalling specifics.

Q. Okay. Would that be -- would you expect to see specific aspects of human error addressed or would -- in general terms, as you're reviewing these permits, would you expect to see specific aspects of human error or human error as a general term?

A. We wouldn't want to see just a block that says generic human error, no.

Q. Um-hum.

A. We want to see some specific action on a fault tree.

Q. Okay. The waiver listed a number of mitigations that Scaled would use to compensate for human error. How would it be determined that those mitigations were appropriate?

A. That's a very expansive question. I'm trying to think of how to start. So the question is the -- determining whether a mitigation for human error in general is sufficient?

Q. Well, the waiver says that Scaled did not provide adequate human error analysis and the waiver was being allowed or the waiver was being written because Scaled had several mitigations in place: training, running the simulation at 1.4 times. So I'm trying to understand how it would be determined that those mitigations are appropriate for a generic human error analysis, using the term that was in the waiver.

A. Okay. So, a bit of background, the sufficiency of mitigations would be driven by public safety only from our perspective. Now, the treatment of public safety in Scaled's

hazard analysis was, if I recall correctly, primarily based on loss of control or inability of the pilot to recover from any particular situation. So the mitigations that we looked for were or would be ways that a pilot could regain control or could get the vehicle to a sufficiently controlled state that they could get everyone out of it while not going too far off course. Course deviation was the primary public safety risk involved with the operation.

Q. Okay. Another clarification. Did you -- you worked the original permit, is that the original permit application? Is that correct?

A. That is.

Q. Did you have any concerns on that permit?

A. My primary concern with the permit was that the eventual license would use the same analysis and continue with it. As we noted pretty extensively in our reports, the assessment we did was good for a specific test program over a specific duration and wouldn't really be expandable beyond that.

Q. Were those concerns discussed in your department?

A. Yes.

Q. Were they -- go ahead.

A. Sorry. Tom Martin and I discussed those at great length.

Q. Was your concern resolved to your satisfaction?

A. The resolution would have come under Virgin Galactic's

license evaluation, which I haven't been very much involved with.

Q. Okay. If you had a concern on another permit that you're working, who would you address those concerns to?

A. In my present capacity or back in AST-300?

Q. No, in your present capacity now.

A. Can you please restate the question?

Q. If you had any concerns about a license or permit, who would you address concerns to now?

A. I would direct them first to my deputy manager and manager, Michelle Murray and Glenn Rizner, respectively, and then physically they'd work at either -- from Palmdale, Michelle's authority, or within D.C. at Glenn's level.

Q. Have you had to do that? Have you brought any concerns to their attention?

A. I have a good few times.

Q. Do you feel that they were resolved adequately?

A. I think they were resolved to the best of my management's ability.

Q. Do you still have outstanding concerns on -- regarding this particular -- a particular permit or license?

A. Is that any particular permit or license?

Q. Well, the ones that you had concerns on that you say that you thought they were resolved to the best of your management's ability, are you still -- do you still have the same concerns or are you satisfied with --

A. Well, in a lot of cases, I'll have the concerns for a fairly long period of time while they get resolved. It typically takes quite a while for some things to resolve.

Q. Do you think in general within AST, given that you've worked in multiple areas, that concerns are resolved adequately?

A. Is that in general or specific to the Scaled permit?

Q. In general.

A. In general, I've seen a big improvement in recent years.

Q. Can you elaborate a little bit more on that? What have you seen improve?

A. Let's see. I think we've got better in recent years in internal communication, which helps greatly in resolving any kind of issue because the people who need to know about it actually know about it. We're getting better at managing our different divisions. We're getting better at a lot of things, especially since George took office, and that's George Nield, sorry.

Q. Okay. Has there been written policies that have helped to improve the process or do you think there's been a culture shift within AST?

A. There's been a lot of things. There's been a lot of things. There are new procedures, new systems, new policies and even new divisions that we organized at least once in that time.

Q. Thanks, Jay. I think that's all the questions I have right now.

A. All right.

MR. HAUF: Okay. Mike, do you have any questions?

BY MR. BAUER: Yeah.

BY MR. BAUER:

Q. Jay, this is Mike Bauer from the Systems Group. Prior to 2005, what did you do prior to 2005?

A. Prior to 2005, or in 2005, I started my graduate program at Embry-Riddle in safety science. Prior to 2005, I worked various jobs, special design for hazards and testing software for a local firm in Prescott.

Q. Actually Prescott, right? Sorry.

With the review of Scaled's application, prior to Scaled's application, how many reviews did you do of safety analysis?

A. There were at least half a dozen, I think, mostly for lunar lander type vehicles supporting the --

Q. Okay. You -- I believe it was either with Mike or Dave, they were -- there was a question about filtering and you mentioned if the question coming from one of the other AST organizations, for example, was -- had a question related to, let's say, Virgin, even though it was a Scaled application, the information would be filtered to not have any proprietary information exchange between companies, correct?

A. Correct.

Q. When a question like that would be filtered, would that information be discussed with the originator of the question?

A. That depends on whether the proprietary data can be filtered out without losing the meaning of the message.

Q. I guess could you expand on that?

A. Well, say the message had to do with, I'll think of an example, the details of a permit hazard analysis, for example, as compared to a license. In comparison, you don't lose a lot for the permit applicant if you take out the license information or vice versa. Where we run into trouble with that potentially is if the comparison was between two licensed applications and the question hinged on why didn't they do this type of analysis because that's what we expect, otherwise, we would have done it, here's an example. You don't run into too much of that these days.

Q. Did that happen early on? Was that -- were there a lot of I guess filtering early on of questions?

A. Well, there was -- let's see. It took us a little bit of time because a lot of same analysts were working Virgin Galactic applications as they do on Scaled applications, primarily because we're staff limited and they want that system understanding of crossover. So it took a little bit of time to get everyone really rigorous about this is Scaled and only Scaled. This is Virgin and only Virgin.

Q. When you were in AST-300, did you feel that any of your requests for information were being filtered in any way from either management or say the liaison, AST-500?

A. AST-500 didn't have the same role when I was in AST-300, and for most of my time in AST-300, AST-500 didn't exist. So there wasn't filtering by 500 because there was no 500 to do the filtering.

Q. So when you were in AST-300, you would directly correspond with an engineer at Scaled regarding questions about the system safety analysis?

A. Yes, usually Bob Withrow.

Q. Okay. During your permit application review, was there -- do you have a sense of any pressures to complete the review by a certain date?

A. There's definite time pressure on our statutory time limit on evaluations, that 120-day clock that you probably heard of.

Q. If you felt like you were not getting the information you needed, was there a procedure or process in place to pause the clock?

A. There is. That's called tolling or the applicant could request that the evaluation clock be stopped while either some concerns on their end were being addressed or while we had outstanding issues without which we couldn't proceed with the evaluation.

Q. Were there any concerns coming from you or your interactions in AST-300 to stop the clock to get more information?

A. I don't recall a specific example.

Q. Now I'm going to apologize if this was asked in Mike's original questions, but whose decision was it to involve Mr. Hardy I believe?

A. Whose decision was it to bring on contractor support for this evaluation?

Q. Correct.

A. I got that support from 300 management.

Q. Was it requested by you or was it requested by management?

A. I was certainly enthusiastic to have him. Terry's an excellent worker.

Q. Had you worked with Mr. Hardy previous to that -- to this application?

A. Not extensively, no.

Q. Okay.

MR. BAUER: I have no further questions.

MR. HAUF: Okay. Thank you, Mike. Lorenda, do you have any questions?

MS. WARD: Yeah. Of course.

BY MS. WARD:

Q. Hi, Jay. This is Lorenda. I'm the IIC for this accident investigation. I just have a few questions to follow up on what Mike was asking about Mr. Hardy's participation as part of the evaluation. I think you talked a little bit with Mike with his questions, how was his comments, his input that he gave on the

original permit, do you have like a percentage of or can you give us a percentage of how much of his comments were implemented?

A. It would be a fairly wild guess. I don't know what value that would have.

Q. Well, how about, can we say majority, none, half?

A. It's somewhere around half. He went through with a much finer toothed comb than AST's mission supports.

Q. Is that going back to the FAA's role to protect the public?

A. Correct.

Q. What about the other piece of, to encourage, facilitate and promote? Do you think that would fall under there at all?

A. Fall under where exactly?

Q. Well, I guess it rises a question, is there a definition for to facilitate?

A. I don't know of a specific definition for that term.

Q. What about encourage?

A. Nor that one.

Q. Promote?

A. Not that one either.

Q. Okay. Do you know why AST-500 was stood up?

A. AST-500's primary role -- let's see. I'm backtracking a bit. We were noticing prior to the formation of AST-500, that information in our organization was kind of getting stove piped or segregated within divisions, and management realized that we

needed a division that would kind of break down those barriers and integrate different operations. That's where our division got its name.

Q. So internally you felt like the information was being stove piped?

A. Yeah, that was a term that floated around quite a bit around 2010.

Q. You mentioned that AST-500 was in the business of relationship management. Can you elaborate on that?

A. Like there were two major types of information that come out of any particular meeting. There's the technical information that is interchanged or that is discussed, and then there's the general, analytical, space level and overall safety culture degree of openness, the session and the -- you could almost say human factors of the meeting. It's the latter that AST-500 focuses upon.

Q. Would that both be internally and externally?

A. Yes.

Q. Do you have any training in human factors?

A. I have some graduate work in human factors at Embry-Riddle.

Q. Was there any training offered to you when you took your new role in to AST-500?

A. When I took my position in AST-500, our role as a division was still being defined. So we didn't have particular

training.

Q. Has your role been defined now?

A. Much more so, yes.

Q. Has any training been offered to you since your role has now been defined?

A. Well, we've had a couple of different training courses offered. With my background in software, I was offered some training in SharePoint which is something we're developing competence in, in AST, but I haven't yet been able to get the budget for it.

Q. We've heard -- budget has been brought up a couple of times in some of our other conversations with interviewees. Do you feel like you have enough resources to do your job?

A. I have enough resources to get by at my job. To really excel would take a bit more.

Q. How much more?

A. In dollar amounts?

Q. Sure. We're in America.

A. Yeah. Well, we could use a good bit more budget for training for conferences, our functions, our function as a relationship management and, for want of a better term, industry relations and be able to go meet with these people -- and we haven't been able to do that so much.

Q. In your opinion, do you feel like the FAA's relationship with their applicants before AST-500 was created was better or

worse?

A. I think it was more chaotic and more sporadic. Before AST-500, we had four or five, at least, points of contact in our organization for each point of contact with an applicant. So they would be getting calls from different divisions, different people on their application and nobody really centralized all the communication, so that we understood what was being asked, what action items we had open with an applicant or even the point of contact with their organization.

Q. You talked about the open action items with an applicant. Is there a clock that's associated with that?

A. I missed the term. What was the process or --

Q. We can talk about process, I guess, but my question was more in the line of you referred to one of the things you monitor is if there was an applicant -- if you're waiting for a response back from an applicant, then I was just curious if there was a clock associated with that.

A. Oh, a clock. Let's see. There's no specific timing mechanism there. We're trying to develop one, so we know how long an action item has been outstanding and how long it's taking us to respond and how long it's taking them to respond.

Q. Do you feel like the 120 days that your statutory authority gives you to review a permit is adequate?

A. That's a complex question. The 120 days is perfectly adequate if the application comes in the door in pristine

condition, through a very good pre-application process. That's another part of AST-500's role, is to mature the application process so that we get applications that are much, much closer to complete when they first get formally submitted.

Q. So -- you mentioned the maturing of their application. Are you guys intimately involved then with them creating their application?

A. We're not at the applicant's shops helping them write the application as such but we do provide -- material, we'll have AST-300 or 200 assist with those when we get them and generally try to provide -- of materials so that by the time it gets formally submitted, it's in a condition for the evaluators to look right through, find everything they need, and be done in short order.

Q. I think you mentioned earlier that you felt like you're in a coaching role. Is that an adequate portrayal?

A. I don't know if coaching is the correct term. It's actually closer to kind of a guide or a local resource on questions on systems safety or questions on operations safety or those types of things so that we don't have to have a meeting with AST-300 every time they have a question on systems safety.

Q. Are you the only one within AST-500 who has contact with Scaled?

A. No.

Q. How many others?

A. Mostly in AST-500, it's Michelle Murray, Sherman Council and myself that will work with Scaled when we need to.

Q. So what is Sherman's role with Scaled?

A. Sherman's kind of our backup when it comes to Scaled. He's our primary point of contact for Virgin Galactic. So that's why he's moved in on all the Scaled communications because it will affect what Virgin eventually does.

Q. How about Michelle? What's her role?

A. Michelle is -- I'm sorry. Are you done?

Q. I was. What's her role?

A. Okay. So Michelle was the primary point of contact in AST-500 for I think three years before I came out. She was the first -- out here in the AST-500 role.

Q. So then when you arrived, did you take over Michelle's role?

A. I started transitioning slowly into taking over that role.

Q. All right. That's all the questions I have. Thank you.

A. Thank you.

MR. PREAMBLE: Can we a 5-minute break?

MR. HAUF: Okay. That's fine. Okay. Jay, and the others on the phone, we're going to take a quick 5-minute break here and then jump on, five, six minutes.

(Off the record at 2:10 p.m.)

(On the record at 2:18 p.m.)

MR. HAUF: Okay. So, Will.

BY MR. ROBERTSON:

Q. Hi, Ray. This is Will Robertson here, Virgin Galactic. How you doing?

A. Good.

Q. Good. I wanted to ask you a little bit about your background with respect to systems safety and bear with me here. I'm going to try to read my notes as I do this which is a little difficult. So you stated that your role and responsibility I guess with AST-300 were first to analyze the SSA. So my question is what sort of formal training do you have in systems safety analysis?

A. Let's see. In systems safety analysis, a good portion of the master in safety science at Embry-Riddle is systems safety evaluation versus safety assessment.

Q. And -- sorry. Are you done?

A. Just a few more things. I've taken a course with Dr. Nancy Leveson out at MIT on control theoretic analysis or they call it STPA nowadays. That's just theoretic analysis of processes. I'm trying to recall. I've been subject to quite a number of conferences, published in a few of them. I think that's it.

Q. Okay. And so most of that's academic based it sounds like.

A. Correct.

Q. So when we talk about systems safety analysis, it's sort of a general term, right? I mean it encompasses a lot of sub-analyses. So could you tell me some of the analyses specific to systems safety analysis that you have experience with?

A. Let's see. I've got a lot of experience with preliminary hazard analyses, fault trees every now and then, and -- analysis and actually very good with software safety analysis. I know it was the subject of a good bit of my research and conferences.

Q. Okay. And again, was that academic in nature or have you ever worked a program? I'm trying to differentiate here. So it -- was that experience academic in nature, all of which you listed?

A. No, a good bit of that is you might call on-the-job training with different assessments that come in our door at AST.

Q. In a review capacity then you mean?

A. Correct.

Q. Okay. Have you ever completed on your own any of those types of assessments?

A. You mean given this for a live project?

Q. Yes. Anywhere. Like have you ever completed a hazard analysis, a fault tree analysis, a zonal, you mentioned -- have you ever actually done one of those in a project capacity?

A. No.

Q. So my next question has to do with standards. What

standards are you most familiar with? And by that, I mean systems safety standards.

A. I'm mostly familiar with MIL-STD-882 through my work on, I think it's now TechAmerica, or it was TechAmerica G-48 Committee.

Q. Okay. And just to be specific on that one, because I know that one's changed over the years quite a bit, do you recall which version of MIL-STD-882?

A. My original training was on version -- on Revision D but I was -- I had some input on some of the comments to the -- of 882E.

Q. Great.

A. And 882E is -- analyses for the Air Force also.

Q. Any other standards?

A. There was the GEIA 0010, or 0-0-1-0, standard that is basically a commercialized version of the MIL-STD-882 -- G-48, and there are various other Air Force instructions and comparable documents there.

Q. Okay. I'm curious. You list common cause analysis and FTA, and I might be wrong about this, but are those analysis techniques listed in MIL-STD-882?

A. I don't know that they're called out specifically.

Q. So then I'm assuming, I'm making the assumption here, you're familiar then with ARP 4761?

A. Somewhat. I got familiar with it during the lead up to

the Scaled permit evaluation.

Q. I'm sorry. I didn't hear that last part. Can you say it again?

A. Sure. I primarily got familiar with the ARP standard during the lead up to the Scaled permit evaluation.

Q. Okay. Now just to clarify, those are standards on systems safety analysis which is a group of analyses per 437.55. What specifically is required in terms of systems safety analysis?

A. 437.55 basically requires a hazard analysis, specifically a preliminary hazard analysis or a form like that or provide comparable information at least.

Q. Does it specify any specific things that you have to consider within that hazard analysis?

A. It does. It says consider design defects, software or human error, and a few other categories in there as well.

Q. Okay. In your opinion, have you ever seen human error analyzed using hazard analysis?

A. I seen it analyzed in various different ways, usually inline with the overall hazard analysis.

Q. What do you mean inline? Oh, sorry. Go ahead, finish.

A. Inline there just means that there's not a separate human error assessment off to the side of the main hazard analysis. It's integrated into the main document.

Q. Okay. Okay. So I want to shift gears here I think. I might come back to this, but earlier you were asked a question

about Terry Hardy's involvement, and I think your statement, and I'll paraphrase generally, was that you felt that Terry's concerns were beyond statute. Could you elaborate on that? What about Terry's findings were beyond statute?

A. Let's see. Well, there were say hazards identified regarding pit crew egress or based on participant egress that doesn't have much of a public safety concern. We had a very hard time encompassing that in our actual statutory mandate. Or some of the feather elements of the rocket motor controllers, for example, where the result is an on trajectory breakup. That's in our assessment -- analyzed. So it doesn't bear as heavily as it would if it were going for say mission success.

Q. And those are all the ones that you would submit?

A. Say again.

Q. That's everything. I'm just trying not to cut you off again. Okay. So moving on.

A. Okay.

Q. Sorry. You later stated I think that you did not, that you did not feel that Scaled had not addressed the systems safety assessment per the statute. Is that correct? I should state that in a positive light. You felt that Scaled did address the safety portion of 437.55.

A. I don't think they adequately covered public safety.

Q. Were you and Terry the only analysts working Scaled's permit?

A. We got assistance towards the end of the process from Tom Martin who had just hired on.

Q. Okay. And did Tom Martin express any concerns with respect to 437.55 safety?

A. Yes --

Q. And --

A. -- if I recall correctly.

Q. And can you tell us what those were?

A. His -- let's see. His concerns were the assessment of hazards prior to mitigation which we found out eventually that Scaled had done. They just didn't submit it because it didn't seem relevant to the permit, and which I had assessed as being met by the presence of unindicated hazards which means there had to have been an assessment prior.

Q. Okay. So do you know where -- I'm sorry. Who writes the waiver within AST? What division?

A. That should be out of AST-200.

Q. So do you know where AST-200 received information that human error and/or software error were not covered within the analysis given that the individuals that you just listed didn't bring those up as issues?

A. I'm not sure. I -- from AST-300 -- records altogether.

Q. Okay. Thank you. I guess the only other thing I have for you is I just wanted to clarify something. Earlier you stated there was somewhat of a mismatch between labeling regarding 437.55

and --

MR. LAWRENCE: Just a second. Can we go off the record for just a minute?

MR. HAUF: Yes.

(Off the record at 2:31 p.m.)

(On the record at 2:32 p.m.)

MR. HAUF: Okay. Guys, sorry about that. We're back on the record here, and Will will continue with his questioning.

BY MR. ROBERTSON:

Q. Yeah. So my last set of questions deal with the statement about the labeling scheme that Scaled produced. Jay, I think you said that it mismatched with -- there was a mismatch between the labeling scheme Scaled used and the statute. Could you elaborate on that? Help me better understand what you meant by that labeling scheme.

A. One clarification in the meanwhile. There were concerns with software analysis in Terry Hardy's reports.

Q. Okay. And did that relate to what you referred to as the failure modes of the RNC on trajectory backup or I'm sorry, trajectory breakup?

A. That among others.

Q. Okay. Okay.

A. And regarding the labeling question at hand, the type mismatch that I'm trying to find a good way to convey, is there are several different ways of identifying and specifying hazards.

One is -- based. Another is function based. And our regulations were written around an outcome based hazard identification system, one that specifies a -- and then breaks it down into the individual sub-systems that would cause it. Scaled's analysis by contrast, function by function to the SpaceShip and the WhiteKnight, and identified what the outcome was associated with that function. So that's why the two don't line up exactly.

Q. Okay. And by that, are you referring to fault tree analysis when you say that?

A. I'm referring to a functional hazard assessment.

Q. Okay. I guess I'm a little confused because 437.55 says that you will do a hazard assessment. You're saying it doesn't specify a functional hazard assessment.

A. Correct, it doesn't specify a functional hazard assessment in 437.55.

Q. I get that. Okay. And then one last thing. Earlier Katherine asked you a question and -- regarding general aspect of human error or error of human in general. So whether you would address a specific human error or just say human error with no specificity to it, and your answer was, we would expect specific instances, not a general block in a fault tree was your answer. And I was wondering, why would you, why would you expect a fault tree at all? It's not part of statute.

A. That was just an example of one way that a human error generic block could show up in a hazard assessment. Another way

could be in a classical preliminary hazard analysis that would show up as human makes a mistake as a top level event, and that doesn't really tell you a lot. You want either deliberate action or inaction or missing cues or those sorts of things to show up there.

Q. Okay. Great. Okay. That's all the questions I have. Thank you very much, Jay.

MR. HAUF: Thanks, Will.

MR. NAPHAS: Thank you.

MR. HAUF: Bob.

BY MR. WITHROW:

Q. Hi, Jay. Bob Withrow.

A. Hi, Bob.

Q. Can we talk a little bit about pre-application consultation? I believe you stated that you were involved in Scaled's pre-application consultation process starting in 2010?

A. That's an approximation.

Q. And that it continued through 2011?

A. I believe so.

Q. And you stated that there were several draft applications involved in that process. Is that correct?

A. --

Q. Would you say that by participating in that pre-application consultation involving draft applications that that improved your understanding of Scaled's systems safety analysis?

A. It definitely did.

Q. And you also stated that you had several meetings with Scaled during that period of time where you would walk through section by section or function by function the systems safety analysis. Is that correct?

A. Yes.

Q. And would you say that that also improved your understanding of Scaled's systems safety analysis?

A. I would say so.

Q. So eventually you decided to transition to AST-500 and I believe, is it correct, that Tom Martin was your replacement?

A. That's correct.

Q. Did Tom Martin take place -- participate in the pre-application consultation we just talked about?

A. By the time Tom Martin hired on, the application had already been submitted and they were already in the evaluation period. So he was not in the pre-application consultation.

Q. So was there a process to try to transition that knowledge that you had obtained to Tom Martin?

A. Yeah. We -- as soon as he started or as soon as he hired on, I started having him attend the meetings when we had them and start reading the documents that -- building his own understanding of the process.

Q. And how long did that transition period take?

A. That lasted roughly -- it was probably finished by the

time I transitioned to 500.

Q. And I'm sorry. How long would that have been in days or weeks or months or years?

A. Roughly a year.

Q. Very good. And do you feel that that knowledge transfer was successful and adequate?

A. I believe so --

Q. Okay.

A. -- of the whole process.

Q. Very good. Excellent. So we have discussed what the mandate is for safety for an experimental permit and can you just clarify for me, is there a mandate for crew safety in an experimental permit, a mandate upon the permittee?

A. The only mandate that there would be for whose safety is in the crew's capacity as a safety system for the general public.

Q. Thank you. When we were discussing the waiver, I think you made a statement that you were surprised by the waiver and you thought it would not be published. I have -- is that correct, first of all?

A. That's my best recollection, yes.

Q. When you say it would not be published, do you mean that there would not be a waiver or that there would be a waiver and it just wouldn't be published?

A. I thought that the waiver efforts might have -- been otherwise canceled.

Q. Okay. You also stated that, I believe, that you -- so you were talking about the enforcement or the monitoring or compliance portions I guess is the best way to put it, within AST and they monitor compliance with the regulations and also with representations made in the application, and then you were asked a question as to whether or not you felt that statements made in a waiver would also be an area where compliance was required. Did I get that right?

A. I believe so.

Q. Can you point to a regulation, a specific regulation that would support that, that belief?

A. Let's see. The -- I don't recall the section offhand, no. Oh, now I recall. There's one specific to systems safety in 437.55 in Section (c). It says they -- it basically says that the parties shall implement the result of their hazard analysis in their system. That's one instance of it, of a regulation.

Q. Are you familiar with 437 -- 14 C.F.R. 437.13. It's entitled Additional Experimental Permit, Terms and Conditions.

A. Yes.

Q. Can you tell me your understanding of that regulation?

A. The -- let's see. It would help if I had the text in front of me.

Q. Can I read it? So I have it. I pulled it up on ECFR.gov. I have it here. It says the FAA may modify an experimental permit at any time by modifying or adding permit

terms and conditions to ensure compliance with 51 U.S.C. Subtitle 5, Chapter 509.

A. Right.

Q. So my -- go ahead. Pardon me.

A. Go ahead.

Q. Well, my question is your understanding of what it means to modify or add permit terms and conditions.

A. Okay. With any permit, there's a section for terms and conditions. Those are things -- they're either special attention items poached from the application material or the evaluation thereof or they're from -- let's see. A specific requirement imposed to maintain compliance of the law. It's mainly an AST-200 function. It's one which I have familiarity but not real practical experience.

Q. Thank you. And so those things are in a document. Is that correct? Of some kind.

A. Yes, those are issued along with permit itself if memory serves.

Q. Okay. And within your knowledge, do you know if the Scaled waiver is included in those terms and conditions?

A. I don't know enough to answer that one.

Q. Okay. Thank you. Also in discussion of the compliance portion of AST's job, you mentioned a number of inspections that are made again to determine whether or not there are violations of regulations or of representations made in the permit. Is there an

end resulting report of some kind that's issued from those inspections?

A. Let me see. That's a better question for AST-400. I know they have a pretty extensive documentation system.

Q. Okay. Have you seen any reports of -- from those inspections?

A. I have seen a few on a few different projects.

Q. Have you seen any for the Scaled experimental permit?

A. I think I've seen one or two but it's been a while.

Q. Would those be for -- so if it's AST, that would be for powered flight then, would it not?

A. It would be for any event for which inspectors come out to the scene or come out to the site.

Q. From your recollection, from the reports that you've seen, were there any areas of noncompliance listed?

A. I don't recall any noncompliances on the ones I saw.

Q. Thank you. Just a little clarification. You mentioned in response to a question that you had a lingering concern about Scaled's systems safety analysis, primarily that it might be misused, continuing onto a license. Did I understand that correctly?

A. I think so.

Q. So my clarification is by license, did you mean Virgin Galactic's license?

A. Correct.

Q. So your concern was that Scaled's systems safety analysis would be used in Virgin Galactic's submission and that would be incorrect?

A. Yeah. That's not how it turned out in reality.

Q. Okay. Thank you. Almost there. So with respect to functional hazard assessments, are you familiar with the Advisory Circular 437.55-1?

A. Yes.

Q. Are you aware that the functional hazard assessment is listed as an acceptable means of compliance in that advisory circular?

A. That I am.

Q. So I'm curious to why then there would be a mismatch if it's listed as one of the acceptable means of compliance, the -- mismatch --

A. Well, the mismatch is more of a -- let's see. I'm trying to think of how to best describe it. It's more of the name of the thing that we're looking for, changes depending on which method you use. So let's see. It's -- at this time. If you're looking at a function assessment, you'll see different hazard categories. You won't see one consolidated list. This is called human error on a ship for example. There is -- if someone is dealing with a more classic analysis, you would see a consolidated list for one outcome --

Q. Okay.

A. -- at best.

Q. Well, let's move on. Last topic area. So you mentioned that -- so first of all, is fault tree analysis part of hazard analysis?

A. It's --

Q. And that would be the case within the scope of 437.55 of the regulations?

A. There's no prohibition -- that's true

Q. Okay. And you mentioned that in your evaluation of Scaled's fault tree analysis, you saw examples of software error and human error being analyzed. Is that correct?

A. No, it was in the fault tree at various levels.

Q. Okay. And then holding aside whether or not the treatment was sufficient, just -- it would be incorrect to say that Scaled did not consider human error or software error because it shows up in the fault tree analysis. Is that a correct statement?

A. That is, in my opinion.

Q. Okay. So there -- so I guess to sum that up, there could be a debate about the sufficiency of the treatment but it is correct that Scaled did treat software and human error in its hazard analysis?

A. Yes.

Q. Okay. That's all I have.

MR. HAUF: Dan.

BY MR. MURRAY:

Q. Hi, Jay. This is Dan Murray.

A. Hi.

Q. I have a few questions for you. Going back to a point that somebody made earlier here, in one of your earlier comments, you said that Terry was, was more pessimistic than you. Is it common in systems safety for multiple evaluators to come to a different conclusion?

A. It's pretty common. Engineering judgment can vary between people.

Q. So you'd say the reason is mostly engineering judgment.

A. I would say so, different experiences bearing in mind.

Q. Okay. Well, when those kind of differences in engineering judgment come up, how do those get resolved or can they be resolved?

A. They can usually be resolved by discussing the assumptions used in each assessment, comparing those and actually going down to -- usually by reference to the overall -- or overall system operation. You can put it in that context, but the -- opinion tends to be --

Q. Okay. Now when you moved to 500, you said that you continued to consult with 300 on hazard analysis?

A. Correct.

Q. Okay. Were there differences of opinion or engineering judgment with those analysts' findings?

A. I'm not sure I follow the question.

Q. Well, when you moved to 500 and you were still working with the folks who were still in 300 working on the hazard, a hazard analysis, did you find that you still had -- that you had differences of engineering judgment or opinion with regard to their conclusions on hazard analysis?

A. We still have an occasional differences of opinion but we would usually resolve them to a final -- decision.

Q. Okay. Following up on Will's question about the mismatch between the regs and Scaled's analysis, so what did, what did Scaled follow if they did not follow the reg?

A. That would be the -- Scaled would have probably been following as discussed in their application I believe the standard hazard analysis and systems safety process they used for typical aircraft applications.

Q. Okay. And so they did follow a standard process?

A. Yeah.

Q. Okay. In your experience in conducting hazard analyses in AST, have you seen that before?

A. At that point, we hadn't seen another aviation style analysis or I hadn't at least.

Q. Is it acceptable when conducting an evaluation if you find somebody working to a different standard? Is it still possible to find that standard acceptable?

A. Yeah, if that would be an equivalent level of safety.

Q. Equivalent. Can you tell us what an equivalent level of safety is?

A. Let's see. As a principle, an equivalent level of safety is a process item or other thing that provides a level of safety that's equivalent to one specified by the regulations.

Q. Okay. When you evaluated Scaled's hazard analysis, did you perform any independent analyses?

A. I used a -- or on my own, I used a control theoretic analysis to try to define any instances where the vehicle's trajectory -- due to interaction of different components of the system.

Q. And you mentioned earlier control theoretic analysis is a technique that Nancy Leveson pioneered. Is that correct?

A. Correct.

Q. How would you say that Scaled's hazard analysis, without mentioning any other companies or vehicles, how would you say that Scaled's hazard analysis compared to other hazard analyses?

A. Compared to the applications I had seen up to that point, Scaled's was the most voluminous of any of the analyses.

Q. Voluminous as in, as in quantity?

A. Yeah.

Q. How about quality?

A. In quality it was at a minimum on line with the other analyses we'd seen.

Q. Okay.

A. And better in quite a few areas than others that we've seen for other parts of the relations.

Q. Any areas in particular?

A. Their treatment of common cause was something that up until that point, I hadn't seen another company do as a standalone analysis.

Q. In the context of a permit or license you mean?

A. Correct.

Q. Okay. When you're evaluating a hazard analysis, how are the assumptions or ground rules evaluated?

A. We'll typically compare the assumptions -- in the systems safety process when one's available. The systems safety process description isn't required under Article 37 but it still submitted one which certainly held to the understanding of the overall process.

Q. And what was that that you said they submitted?

A. Sorry. Again.

Q. I'm sorry. You -- I missed the term you used. You said what they had submitted that wasn't required.

A. Oh, that's a systems safety process description.

Q. And where do those come from?

A. Those being systems safety process descriptions?

Q. Yes. Are they required in any other parts of the 400 regulation?

A. They are under Part 431.

Q. So would you say that what Scaled put in its application for hazard analysis was more inline with Part 431 or more inline with Part 437?

A. I would say it was more a 431 style assessment.

Q. And why would you say that?

A. Mainly because of the several different types of analysis employed and the presentation of the systems safety process description.

Q. Would you say that -- which would you say has the higher standard of rigor to it, a 431 analysis or a 437 analysis?

A. 431 I think.

Q. And again you said that's more inline with what Scaled did?

A. Yes, Scaled's -- the format of Scaled's submission was more the kind of thing I would expect under a 431 application.

Q. Okay. Did you participate or observe in any of the management review boards for Scaled's permit or renewals?

A. Yes.

Q. Were you responsible in any of those for providing any parts of those briefings?

A. I briefed some systems safety sections of at least the original permit. I don't recall the renewal.

Q. Okay. How did you --

A. Probably the first renewal.

Q. I'm sorry. I didn't mean to talk over there. Go ahead.

A. Right. It was probably within the first renewal and not in the second.

Q. Okay. Thank you. How did you characterize your evaluation of Scaled's hazard analysis to the senior management in those reviews?

A. I'm not sure I understand the question. Is that --

Q. When you presented your results of your evaluation on hazard analysis at the MRB to the AST senior managers, what were, what were your results? What was your finding? Did you find them in compliance or not in compliance?

A. I don't recall the specifics of those briefings.

Q. Okay. Do you recall if there were any objections or non-concurrences voiced at those Management Review Boards?

A. At the time of the Management Review Boards, a lot of issues had either been settled by Virgin or had been settled by other means.

Q. Okay.

A. --

Q. Did you -- so the evaluation document is where you gather and document your results from your work on the hazard analysis for an permit and license. Is that correct?

A. That is.

Q. Did you gather any other results or findings in any other document for Scaled's hazard analysis?

A. Let's see. I believe there's a final report from Terry

Hardy's work that's on file and I think the technical evaluations will summarize all that information.

Q. There was mention in the previous interview of a memo that went from AST-300 to AST-200 that discussed the hazard analysis. Do you recall that memo?

A. I recall seeing it.

Q. Okay. Did you provide any of the text or the input to that?

A. I provided some red lines to -- I don't know if it's the memo or the waiver that I'm recalling but I remember having input into some of the waiver or, no, the memo --

Q. Okay. Going back real quickly to --

A. -- at least in the form of red lines.

Q. I'm sorry. Can you repeat that please?

A. Sorry. At least in the form of red lines.

Q. Okay. Thank you.

A. That's what they were accepting.

Q. Okay. Going back very quickly to Terry's memo in response to Will's question about the -- beyond the statute, you listed three things. Those were -- was that a complete list or was that just what you were recalling?

A. That's just --

Q. Okay. I just have a few more questions for you. In response to Lorenda's question, you described relationship or partner management. Is that an aspect of AST-500 that you find

important?

A. It is.

Q. And why would you say it is important?

A. Because in my view, what I've seen in systems safety, you get the most benefit in safety terms and in safety improvements when we have clear and open communication, and a precursor for that is having a decent working relationship with the people who are doing the actual work.

Q. And by those people, you mean the staff of the applicant or the permittee or the licensee?

A. Correct.

Q. Okay. Do you think the rest of the staff in AST understands what relationship and partner management means?

A. I don't have a way to judge their understanding of it. I would expect some do and some probably don't.

Q. Okay. From your experience in both AST-300 and more in AST-500, have you found or is it true that other divisions have to let AST-500 speak for them, to applicants or are they able to speak for themselves?

A. What we try to do is just facilitate the discussion and the people in the other divisions through contract with our points of contact at the company.

Q. And can you elaborate --

A. --

Q. Sorry. Can you elaborate on facilitating the

discussion?

A. Sure, that's -- we'll typically hear of a need for discussion from say Tom Martin in 300 with someone at Scaled or Virgin or whoever, and we'll either set up a meeting or say, hey, give this question to -- and we like to just get a back brief on what was communicated and what the findings were.

Q. So you don't always participate in those meetings or calls?

A. Not always, no.

Q. But when you do, is it AST-500's role to speak during those calls or is it someone else's role or to lead those calls I should say?

A. We try to just give a contact for the discussion upfront, the scope of the discussion and then turn it over to the technical experts for the real content of it.

Q. Earlier there was a question about filtering of questions as a role of AST-500. You mentioned a couple of examples of why that happens. Did you have any experience with that when you -- before you joined -- well, you mentioned -- before you joined AST-500, there wasn't much of an AST-500, but did you have any -- do you have any personal experience of having questions filtered?

A. Yes, with their applicants.

Q. Okay. Did you understand at the time why?

A. I would usually come to understand why the things were

being filtered out. There were some that, that I was still shaky on but --

Q. Has your experience being a member of AST-500 shed any additional light on why the filtering was necessary?

A. It definitely has. It's a shift in perspective with the new role, a broader context for a lot of the very detailed technical questions.

Q. Do you feel that filtering requires engineering judgment?

A. In some cases, yes.

Q. Okay. Do you feel that the staff of AST-500 has the proper engineering judgment to perform that function?

A. Regarding proprietary information, yes.

Q. All right. Anything else?

A. Let's see. Regarding whether or not questions should be asked I believe is the meaning of the question?

Q. Just any other nature for which filtering would occur. I know you specifically cited proprietary and I think ITAR earlier. Are there any others?

A. In my own work at least, those are the only things I look for. Otherwise, it's technical content only.

Q. Okay. All right. I think that is all of my questions. Thank you very much, Jay.

A. Thank you.

MR. HAUF: All right. Going to the phone. Let's start

with Nikki. Do you have any questions?

MS. DUGUE: I don't have any questions at this time.

MR. HAUF: All right. Thank you, Nikki. And, Brett, do you have any questions?

MR. VANCE: Yes, sir.

BY MR. VANCE:

Q. Jay, a lot of these are process questions, and then a couple are operational. So, first of all, are the procedures that you use in AST-500 interfaced with some of your other AST branches? Is that published anywhere? Is that just word of mouth, primal knowledge, any thoughts on that?

A. There's a published procedure now at least on the application consultation.

Q. That's for the application consultation, but about how you relate to AST branches?

A. I don't know that we have a published process for intra-division communication.

Q. Okay. So no policies or anything like that, just things you learn once you show up?

A. As far as I know.

Q. Okay. Well, let's go a little bit further on that. How do you interface with AST-400 during the final inspection prior to launch day?

A. Okay. Typically what we'll do is we'll call the inspectors to -- if they're coming to California especially, we'll

point them to the better hotels in the area -- instance of the -- if the inspectors --

Q. So your role in that integration and that interface is mainly just administrative. You don't do anything operationally oriented on those inspections prior to launch day?

A. Not really. We'll usually use the opportunity for either technical interaction meetings or catching up on other evaluation issues if there are any.

Q. Okay. The next one is still AST-400 focused. Do you know if they have a launch day checklist, like a go, no go checklist that might include waiver compliance as well?

A. They have a safety inspection checklist. I know that much which includes a lot of the inspectable items.

Q. Is that the one that they do on -- a few days prior to launch or is that a launch day checklist?

A. It depends on the inspection. They'll typically have a vehicle or an inspection plan for any inspection they do, depending on the type of inspection.

Q. All right. Earlier we talked about high workload and you mentioned understaffing, just to follow up on that a little bit. Has the shortening maybe of the evaluation time frame contributed in your opinion to your heavy workload?

A. I'm not sure I understand. The shortening of the evaluation period?

Q. You know, we heard that, you know, there's some

significant time crunches on the 120-day time frame. Is that time frame ever shortened by management?

A. I wouldn't say by management. I would say as a result of wrong scheduling and delays in submission. There are quite a few things that affects the timing of both submission and launch.

Q. Would that contribute in your opinion to the high workload?

A. It definitely would.

Q. All right. Next, are you aware of any hazard analysis -- this is talking about the waiver. Are you aware of any hazard analysis in the documentation presented to you by Scaled Composites for the purposes of the waiver?

A. Hazard analysis documentation specific to the waiver?

Q. Yes.

A. I don't recall any specific submission.

Q. Okay. Next on that same topic, do you know if AST grant any waiver provisions without a corresponding hazard analysis?

A. A hazard analysis that corresponds to the waiver provisions?

Q. Yeah, several items in the waiver and I guess was each one was represented by a hazard analysis?

A. I don't know if there's a hazard analysis specific to the waiver. I'm not entirely sure I understand the question.

Q. That should be enough. Finally, we've talked before several times, and I'm just trying to nail down just another

aspect on this one on human and software error analysis. So can you clarify, and you mentioned before, I think, that you said that the human and software error analysis just seems to be considered. Do you know if documentation is actually required on that topic or does it just need to be considered?

A. Well, there used to be, there used to be evidence but it was considered.

Q. Is that written evidence or can it be discussion? Can it be I guess documentation in the form of minutes? What are you saying exactly?

A. It would normally need to be a part of the hazard analysis at some level.

Q. Okay. Thanks a lot. I've got no further questions.

MR. HAUF: All right. Thank you, Brett. Okay. We'll go around for some follow up questions in the room. Dave.

MR. LAWRENCE: Yeah, I just have a quick follow up on some things.

BY MR. LAWRENCE:

Q. Jay, this is David Lawrence, NTSB. Just a quick follow up. Just my understanding of your background, you went from the FSDO Office working intern work straight into AST. Is that correct?

A. With the balance of my private program and training.

Q. Okay. During your academic development or moving through the FSDO intern work, did you have any working knowledge

or practical application of work associated with the space regulations, either 437, 460 or any of them?

A. No, there was no space activity in Houston at that time.

Q. Okay. So would it be fair to say that your knowledge base of space regulations, specifically 437 and 460, were basically OJT while you were in AST-300?

A. Correct.

Q. Okay.

MR. LAWRENCE: I have no other questions. Thanks, Mike.

MR. HAUF: Thank you. Does anybody else have any questions?

MR. MURRAY: I'll throw in one more.

MR. HAUF: Dan.

BY MR. MURRAY:

Q. Jay, do you provide any teaching or instruction on regulations or hazard analysis?

A. Let me see. In the form of -- yeah, some.

Q. And that's within AST?

A. I have at times provided training to staff within AST on systems safety.

Q. How about outside of AST?

A. I teach a course on MIL-STD-882E's software LSS for the Air Force when they get it.

Q. All right. Thank you.

BY MR. HAUF:

Q. Okay. I just have one or a couple of questions for you here, and this is Mike. In the pre-application process, do you provide the draft permit to any other divisions in AST for their input?

A. We typically will, yes.

Q. Okay. And then previously you mentioned that you were enthusiastic that Terry was involved with his assessment. Can you describe again why were you enthused about that?

A. Well, being somewhat junior in the area to host someone with his experience, consulting on a project.

Q. Okay. And last question here was with -- when Tom Martin got involved, did you agree with his assessment or his comments on the application --

A. Which of his comments are you referring to?

Q. The discussion about the safety assessment. I believe you guys had maybe a few differences. I thought that was mentioned earlier.

A. Yeah, and let's see. In some cases, I would come to his understanding or in other cases, I maintained my own.

Q. Okay. No further questions. Okay. I guess the very last question would be for you is, do you have any information or comments that you believe would assist us in our investigation?

A. I don't know what all you've been provided. I'm not sure I do.

Q. All right. Thank you.

MR. HAUF: We're good to go then. Thank you for everything and all the answers you provided us. Off the record.

(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:	CRASH OF VIRGIN GALACTIC SPACESHIPTWO MOJAVE, CALIFORNIA OCTOBER 31, 2014 Interview of Jay Naphas
DOCKET NUMBER:	DCA15MA019
PLACE:	Washington, D.C.
DATE:	January 15, 2015

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.

_____

Stephen Grider
Official Reporter