NATIONAL TRANSPORTATION SAFETY BOARD

Washington, D.C.

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In the matter of:	:
	:
THE INVESTIGATION OF THE ACCIDENT	:
INVOLVING DELTA AIR LINES, INC.,	: Docket No.
FLIGHT 1288, MD-88, N927DA,	: SA-515
PENSACOLA REGIONAL AIRPORT	: **VOLUME I**
PENSACOLA, FLORIDA, JULY 6, 1996	:
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Atlanta Hilton & Towers Hotel
255 Courtland Street
Atlanta, Georgia 30303

Wednesday, March 26, 1997

The above-entitled matter came on for hearing pursuant to notice, at 8:00 a.m.

Board of Inquiry:

John Goglia, Member NTSB
Chairman

Dr. Bernard S. Loeb, Director
Office of Aviation Safety

Dr. Vernon Ellingstad, Director
Office of Research & Engineering

Thomas Haueter, Chief
Major Investigations Division

Technical Panel:

Thomas Conroy
Jean Bernstein
Dr. Evan Byrne
George Anderson
Frank Gattolin

Staff:

Kevin Peterson
Special Assistant to the Chairman

Linda Jones
Confidential Assistant to Chairman

Shelly Hazle
Government & Public Affairs

Carolyn Dargan
Administrator

National Transportation Safety Board
490 L'Enfant Plaza, S.W.
Washington, D.C. 20594

Parties to the Hearing:

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Pratt & Whitney
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Parties to the Hearing: (continued)

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Lennart Thoren
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Federal Aviation Administration
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Board of Accident Investigation
Henrick Eindler
Stockholm, Sweden

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C O N T E N T S

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I N D E X

I N D E X (continued)

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P R O C E E D I N G S

(Time Noted: 8:00 a.m.)

CHAIRMAN JOHN GOGLIA: On the record. Good morning and welcome. I am John Goglia, member of the National Transportation Safety Board, and Chairman of this Board of Inquiry.

At this hearing, we are considering an accident that occurred on July 6, 1996, at Pensacola Regional Airport, Pensacola, Florida, involving Delta Air Lines, flight 1288.

The hearing is being held for the purpose of supplementing the facts, conditions, and circumstances discovered during the on-scene investigation. This process will assist the Safety Board in determining the probable cause and in making any recommendations to prevent similar accidents.

While airline accidents are rare, they are widely publicized and scrutinized by experts around the globe. When an accident such as this -- where did the lights go?

I'll read this one then. With the last witness having been heard --

(General laughter.)

CHAIRMAN GOGLIA: While airline accidents are rare events, they are widely publicized and scrutinized by experts around the globe. When an accident such as this does occur, it is the responsibility of the National Transportation Safety Board, with the assistance of the FAA and other designated parties from government, industry, and labor, to find out what happened, why it happened, and how we can prevent this unfortunate event from reoccurring.

The purpose of this hearing is two-fold. First, the issues that will be discussed at this hearing, while technical in nature, serve to assist the Safety Board in developing additional factual information that will be analyzed for the purposes of determining the probable cause of this accident. Secondly, this hearing also provides the opportunity not only to the aviation community, but the general public as well, to see a small portion of the total investigative process and the dedicated efforts being put forward by investigators from many different organizations, to find the cause of this accident.

Public hearings such as this are an exercise in accountability. Accountability on the part of the

Safety Board, that is is conducting a thorough and fair investigation. Accountability on the part of the airline, that it is operating safely and within the bounds of the regulations. Accountability on the part of the manufacturers as to the design and performance of their products. And accountability on the part of the working force -- pilots and mechanics, as they perform up to the high standards of professionalism expected of them.

As I have previously stated, these proceedings tend to become highly technical affairs, but they are essential in seeking to reassure the public that everything is being done to ensure the safety of the airline industry.

The purpose of this inquiry is not to determine the rights or liability of the private parties. And matters dealing with such rights or liability will be excluded from these proceedings.

Over the course of this hearing, we will collect information that will assist the Safety Board in its examination of safety issues arising from this accident. Specifically, we will concentrate on the following issues:

Issue number one, drilling and inspecting of titanium alloy rotating parts manufactured by Volvo Aero Corporation. Issue number two, Federal Aviation Administration and Pratt & Whitney oversight of the drilling and inspection of titanium alloy rotating parts. Issue number three, Delta Air Lines fluorescent penetrant inspection process. Issue number four is the issues in non-destructive inspection techniques. And issue number five is FAA oversight and Pratt & Whitney review of Delta Air Lines fluorescent penetrant inspection process.

At this point, I would like to introduce the other members of the Board of Inquiry. They are on my left, Dr. Bernard Loeb, Director of Aviation Safety. On my right, Dr. Vernon Ellingstad, Director of Office Research & Engineering, and on my left, Mr. Tom Haueter, Chief, Major Investigations Division.

The Board of Inquiry will be assisted by a Technical Panel. These persons are Mr. Thomas Conroy, the Investigator-in-Charge and Hearing Officer; Ms. Jean Bernstein, Metallurgist; Dr. Evan Byrne, Human Performance Group Chairman; Mr. George Anderson, Powerplant Group Chairman; Mr. Frank Gattolin, Maintenance Records Group Chairman.

Mr. Kevin Peterson, my Special Assistant, and

Ms. Linda Jones, my Confidential Assistant are here to assist me. Ms. Carolyn Dargan has handled the administrative matters dealing with this hearing up to this point. She is also present to provide administrative support as needed. You may contact any of them for assistance regarding copies of exhibits or other items.

Neither I nor other Safety Board personnel will attempt, during this hearing, to analyze the testimony received nor will any attempt be made at this time to determine the probable cause of this accident. Such analyses and cause determinations will be made by the full Safety Board after consideration of all the evidence gathered during our investigation.

The report of the aircraft accident involving flight 1288, reflecting the Safety Board's analysis and probable cause determinations, will be considered for adoption by the full Board at a later public hearing, which will be held at the Safety Board's headquarters in Washington, D.C.

The Safety Board's rules provide for the designation of parties to a public hearing. In accordance with these rules, those persons, governmental agencies, companies, and associations whose participation in the hearing is deemed necessary in the public's interest and whose special knowledge will contribute to the development of pertinent evidence are designated as parties. The parties assisting the Safety Board in this hearing have been designated in accordance with these rules.

As I call the name of the party, will the designated spokesperson please give his or her name, title, and affiliation for the record? Department of Transportation, Federal Aviation Administration?

MR. DONNER: Mr. Chairman, my name is Bud Donner. I'm the Manager of the Accident Investigation Division, FAA in Washington.

CHAIRMAN GOGLIA: Thank you. McDonnell Douglas Corporation?

MR. STEELHAMMER: Mr. Chairman, my name is William C. Steelhammer, and I'm the Accident Investigation Coordinator for Douglas Aircraft Company.

CHAIRMAN GOGLIA: Pratt & Whitney?

MR. YOUNG: Mr. Chairman, my name is Michael L. Young. I am the Accident Investigation Coordinator for Pratt & Whitney.

CHAIRMAN GOGLIA: Volvo Aero Corporation?

MR. THOREN: My name is Lennart Thoren. I'm

Quality Manager for Aero Engine Services Division.

CHAIRMAN GOGLIA: Thank you. And the Air Line Pilots Association?

CAPTAIN MCCARTHY: Mr. Chairman, Captain Paul McCarthy, Chairman, Accident Investigation Board, Air Line Pilots Association, Washington.

CHAIRMAN GOGLIA: Thank you. I want to publicly thank all the parties for the assistance and -- oh, we lost -- oh, I skipped it. My fault. I can't even blame anybody. Delta Air Lines?

MR. VALEIKA: Ray Valeika, Senior Vice President, Technical Operations.

CHAIRMAN GOGLIA: I don't know how I did that, Ray.

MR. VALEIKA: I've lost a lot of weight.

(General laughter.)

CHAIRMAN GOGLIA: I found it.

(General laughter.)

CHAIRMAN GOGLIA: I want to publicly thank all the parties for their assistance and cooperation that they have displayed during the course of this investigation.

Furthermore, Mr. Henrick Eindler is here from the Board of Accident Investigation, Stockholm, Sweden.

He is the Swedish accredited representative to this investigation. And I'm sorry for butchering your name.

On March 10, 1997, the Board of Inquiry held a prehearing conference in Washington, D.C. It was attended by the Safety Board's Technical Panel and by representatives of the parties to this hearing. During that conference, the areas of inquiry and the scope of the issues to be explored at this hearing were delineated and the selection of witnesses to testify to these issues was finalized.

While this hearing will only focus on several select safety issues, the Safety Board's final report will address other pertinent safety issues that were developed during the course of the investigation, but are too encumbering to discuss during the time frame of this hearing.

Copies of the witness list developed at the prehearing conference are available at the press table. There are numerous exhibits to be used in this proceeding. Copies of the exhibits are available at the press table for review. And the Safety Board has provided a complete set of exhibits to Kinko's, located at 100 Peachtree Street, Suite 101, Atlanta, Georgia. Copies of the exhibits can be obtained on request and it's at the individual's own expense. And we have one exception to the witness list that I would like to discuss right now.

We have one exhibit that is proprietary in nature, very proprietary. And to that extent, it will be distributed to the parties only and it's uniquely color coded. It will be treated differently in the following manner: It is not to leave the room. It is not to be copied. It is not to be distributed to anyone other than party members. Those portions, if it is used during this hearing, will be included in the record. But if it is not used in questioning or any portion of it is not used, it will not be included in the record. It is that portion that is not used will not be in the record.

At the end of the day, we will collect this document, and it will come back under the control of the Safety Board. It is considered to be very proprietary to the manufacturer, and it's covered by a fairly recent law about disclosing of propriety information, and that requires these unusual steps.

The witnesses testifying at this hearing have been selected because of their ability to provide the best available information on the issues of aviation safety. The first witness will be the Investigator-in-Charge of the accident investigation, who will summarize certain facts about the accident and the investigative activities that have taken place since then.

The remaining witnesses will be questioned, first by the Safety Board's Technical Panel, then by the designated spokesperson for each party to the hearing, followed by the Board of Inquiry.

As Chairman of the Board of Inquiry, I will be responsible for the conduct of this hearing. I will make all rulings on the admissibility of evidence and all such rulings will be final.

The records of the investigation, including the transcript of the hearing and all exhibits entered into the record, will become part of the Safety Board's public docket on this accident and will be available for inspection at the Board's Washington office.

Anyone wanting to purchase the transcript, should conduct -- should contact the Court Reporter directly. None of the parties -- note: The parties also must order their own transcript. The NTSB does not provide copies for your use.

At this time, I would like to acknowledge other officials who are observing this hearing. We have the National Transportation Safety Board's Manager Director General Jordan present in the audience.

Mr. Conroy, have all the exhibits been entered in the public docket?

MR. CONROY: Yes, sir.

CHAIRMAN GOGLIA: Thank you. Then the first witness will the Investigator-in-Charge, Mr. Thomas Conroy.

MR. HAUETER: Mr. Conroy, for the record, could you provide your full name and place of employment?

MR. CONROY: My name is Thomas R. Conroy. I am the Investigator-In-Charge of this accident and a Senior Air Safety Investigator for the National Transportation Safety Board in Washington, D.C.

MR. HAUETER: And could you provide briefly your background in aviation and accident investigation?

MR. CONROY: I'm a designated Naval Aviation Safety Officer in the United States Marine Corps. I trained at the Naval Post Graduate School in Monteray. I flew in the Marine Corps for approximately nine years.

I worked at Scorsky Aircraft as an Aircraft

Accident Investigator and System Safety Engineer for 11 years. And I have been at the Safety Board as a Senior Air Safety Investigator for seven and a half years.

MR. HAUETER: Thank you. You can give your testimony.

MR. CONROY: Good morning, Mr. Chairman. On July 6, 1996, at 1424 central daylight time, a McDonnell Douglas MD-88 operating as Delta Air Lines flight 1288, registration N927DA, experienced an uncontained failure of the left engine, Pratt & Whitney, JTAD-219, serial number 726984, as the engines were reaching takeoff power.

A flight crew had already released the brakes and the takeoff role had begun, when the engine fan hub separated. A substantial approximately one-third portion of the fan hub traveled over the fuselage and came to rest near a schoolyard, approximately 2400 feet to the right of the runway.

A larger, approximately three-fifths portion of the hub, traveled through the grass to the left of the runway, coming to rest approximately 900 feet to the left and forward of the airplane. Note the airplane and two large portions of fan hub depicted in a view from above the airport. They can be seen on the picture board, on an easel to the left, to the audience's left, on the view graph and in Exhibit 7-B. The larger portion that I mentioned is at the top of the view graph, and the smaller portion which traveled farther and over the airplane is at the bottom.

A smaller, approximately 11 x 12 inch triangular piece of fan hub and some fan blades entered the left rear of the fuselage and struck four passengers. Two persons sustained immediately fatal injuries. The picture boards and view graph show three photographs of external damage to the left engine and the left side of the fuselage. These are the photographs in Exhibit 7-C.

The departure of the fan hub was accompanied by a loud bang, and the flight crew immediately began abort procedures and brought the airplane to a stop on the runway center line. The airplane had traveled approximately 1400 feet from the beginning of the takeoff role. As the airplane was brought to a stop, normal electrical power was lost to the flight crew and they switched to emergency power to call the tower.

Also, as the airplane was being brought to a stop, all three flight attendants attempted to contact the cockpit on the interphone system without success.

The two flight attendants nearest the rear of the cabin then initiated an emergency evacuation and deployed the tail cone slide, by which four persons, including a husband, wife, and their infant immediately evacuated. And you can see the stair door in the center picture board.

The third flight attendant went forward and notified the flight crew of the emergency. The captain sent the first officer aft to evaluate. The first officer reported back to the captain that there were serious injuries, major structural damage, and a left engine fire.

All four over wing emergency exits were opened by passengers, and passengers began to step out onto the wings and jump from there to the ground. A flight attendant deployed the L2 emergency slide, but upon seeing fire at the forward portion of the left engine, redirected passengers forward.

After the engine fire extinguished, the captain halted the emergency evacuation and ordered the remaining passengers to move forward in the cabin, as the first officer and a physician on board joined flight attendants attending to the casualties in the rear. Within two to four minutes of the accident, airport fire and EMS personnel arrived at the airplane and attended to the casualties.

After approximately 25 minutes, portable air stairs were brought to the airplane, by which the remaining passengers and the crew exited.

The Safety Board launched a major investigation's Go Team from Washington, D.C., which was assisted by two investigators from the Safety Board's Atlanta Southeast Regional Field Office and an investigator from the North Central Regional Office in Chicago. Mr. George Black was the Board member on site, and I was the Investigator-In-Charge.

Upon the team's arrival at Pensacola Regional Airport, about 2300 on the night of the accident, investigation groups were formed in aircraft systems and structures, maintenance records, operations in human performance, powerplants, and survival factors.

Parties to the on-site investigation were the Federal Aviation Administration, Air Line Pilot's Association, Delta Air Lines, McDonnell Douglas, Pensacola Regional Airport, and Pratt & Whitney.

A metallurgist from the Safety Board's headquarters arrived early on the third day of the investigation. Working with the powerplant's group, the metallurgist found an area of fatigue in the separated fan hub, emanating from a through-bolt hole in the hub. The hub was then packaged and shipped to the Safety Board's Material Laboratory at headquarters, Washington, D.C.

A metallurgical group was formed at the Material's Laboratory, which examined the hub and fractures in detail. Ms. Jean Bernstein, Safety Board Metallurgist, will follow with a discussion of her group's examinations.

The investigation team spent approximately six days on site. The powerplants group then reconvened at Safety Board headquarters and had visits to Pratt & Whitney at East Hartford, Connecticut, and Volvo Aero, which manufactured the hub, in Trollhattan, Sweden.

The human performance investigator made visits to engine non-destructive inspection facilities at Delta Air Lines and other U.S. air carriers' maintenance departments.

On July 29, 1996, the NTSB issued to the FAA safety recommendations A74 through 77. The recommendations asked that the FAA require an immediate inspection on those JTAD-200 series fan hubs with more than 10,000 flight cycles since new. The recommendation requested that those fan hubs most at risk between 10 and 15,000 cycles since new be inspected first. B) Require a recurring inspection of the fan hubs on a fixed number of cycles based on the risk of crack promulgation. C) Review the processes by which the accident fan hub was placed in service. And, D) review and revise with the engine manufacturers and operators the non-destructive inspection procedures for inspection of rotating parts -- that's engine manufacturers and operators.

On September 3, 1996, the FAA issued an urgent airworthiness directive to recall six fan hubs by serial numbers and remove them from service based on indications during the manufacturing process. The FAA has issued a second AD to recall a portion of the fan hub population that is most at risk for eddie current and fluorescent penetrant inspections.

The remaining hubs would be inspected when the engines were removed and disassembled at the piece part level. The Safety Board has stated its concurrence with the campaign recall regarding that portion of the hub population that are at higher risk, but has asked the FAA to require that the remaining hubs be inspected at the next engine shop visit.

Exhibit 8R contains relevant NTSB, FAA correspondence.

Ms. Bernstein will follow.

CHAIRMAN GOGLIA: Thank you, Mr. Conroy.

MR. HAUETER: Ms. Bernstein, would you provide your full name and place of employment for the record?

MS. BERNSTEIN: My name is Jean Bernstein, and I work for the National Transportation Safety Board in Washington, D.C.

MR. HAUETER: And could you provide your experience and background as a Metallurgist?

MS. BERNSTEIN: In 1970, I graduated from Polytechnic Institute in Saint Petersburg, Russia. Upon graduation from the Institute, I worked as an Engineer and then as a Senior Engineer for the Central Research Institute of Boilers and Turbines in St. Petersburg, Russia.

Between 1981 and 1990, I worked as an Engineer and then as a Manager of Materials Department at Arcdeck Corporation in Chantilly, Virginia. I've been employed by the Safety Board since 1990.

MR. HAUETER: Thank you. And you will

provide your statement.

MS. BERNSTEIN: The first overhead, please.

(Slide shown.)

MS. BERNSTEIN: The fan hub separated into three major pieces. The largest piece contained approximately two-thirds of the bore and conical section of the hub. The second piece contained approximately one-third of the bore section. And the third piece contained approximately one-third of the conical section of the hub.

The fan hub on the JT8D-200 engines are attached to other engine components, with 24 tierods. The holes for tierods are located around the web portion of the hub and alternate with the 24 smaller diameter stress redistribution holes, also used for weight balancing of the hub.

Two radial bore to rim separations were through tierod holes. One separation contained clear evidence of fatigue cracking. The other separation was typical of over stress.

The next overhead, please.

(Slide shown.)

MS. BERNSTEIN: The next illustration shows the fracture base on the larger separated piece of the hub. The fatigue fracture features emanated from two origin areas indicated by arrows "o1" and "o2" in this view. Both origins were located on the bore of the tierod hole. Origin o1 was of the distance of about .3 inch from the aft face of the hub. And origin o2 was of the distance of about .5 inch from that phase.

From both origin areas, the fatigue cracking propagated about 1.5 inches in radial direction, up to the approximate position indicated by the red dashed line in this view. Beyond the red line position, the fractured features were typical on over stress.

A fatigue striatoin count performed on the fracture base indicated that approximately 13,000 stress cycles occurred between the initiation and the end of the fatigue cracking. The number of striations was only slightly less than a total of 13,835 cycles on the hub, suggesting that the fatigue initiated very early in the life of the hub.

(Slide shown.)

MS. BERNSTEIN: The next overhead shows an angled view on the fractured face of the hub at the aft end of the tierod hole with brackets o1 and o2, indicating the two primary fatigue origin areas. This is the fracture. This is the fracture surface. This is the surface of the hole. And this is the aft end of the hub. Examination revealed that both origin areas were associated with what appeared to be scuff marks on the surface of the hole.

(Slide shown.)

MS. BERNSTEIN: The next illustration shows a scanning electron microscope view at a higher magnification of a portion of the hole at origin o2. This is the fracture face of the hub. This is the surface of the hole, and this is the extent of the origin area o2. As can be seen in this view, the scuff mark contained numerous parallel ladder cracks. No cracking was found in other than scuffed portions of the hole. A cross section indicated by arrows in this view, was cut through the middle of scuff mark o2 for metallographic examination.

(Slide shown.)

MS. BERNSTEIN: The next overhead shows the microstructure of this section. This is the surface of tierod hole. This is the fracture surface. And this point one -- if I can focus on that -- is a needle point of a fracture o2.

The material of the hub and the scuff portion of the hole was severely deformed and was much harder than the rest of the fracture. The microstructure was outside of the scuff portion was undistorted and appeared to be typical for a normally machined surface.

During manufacturing of the hub, holes for tierods are drilled, bored twice, and honed. The surface finish of the hole, including scuff areas, appeared to conform to surface finish requirements, specified for tierod holes by an engineering draws.

Blue etch anodize inspection is required by Pratt & Whitney inspection in the manufacturing process of parts made by titanium alloys. The inspection is used to detect microstructural surface anomalies, such as hard alpha, forging laps, or unusually large grains. These anomalies turn the affected area a different shade of blue.

During inspection of the accident hub, an indication described as a tool mark was found in a tierod hole located 180 degrees from the serial number on the hub. This location corresponds to the location of the fatigue crack. Because the type of indication was not rejectable based on a criteria used when the hub was manufactured, the hub was accepted and forwarded to Pratt & Whitney for installation in a production engine.

As a part of metallurgical examination, the fracture section was subjected to the same blue etch anodize procedure as the procedure used during manufacturing of the hub. The test revealed a dark blue indication in the area of the hole associated with the scuff mark.

(Slide shown.)

MS. BERNSTEIN: The next illustration shows again the fracture face on the hub. The portion of the fracture between the origin areas and the position outlined by the blue dashed line of this view, was slightly darker than the rest of the fracture. This discolored portion of the fracture extended approximately .6 inches inboard along the aft face of the hub, and about .9 inches forward along the wall of the hole from the aft inboard corner of the hole.

Eleven hundred forty-two cycles prior to the accident, Delta performed an overhaul of the engine. During this overhaul, the hub was subjected to dye penetrant inspection. The striation count indicated that at the time of the inspection, the size of the crack was consistent with the discolored portion of the fracture and extended about .9 inch along the aft face and about .9 inch along the wall of the hole.

That concludes my statement.

MR. HAUETER: Thankyou. We would call our first witness.

CHAIRMAN GOGLIA: Our first witness today will be Bertil Andersson.

(Witness testimony continues on the next page.)

BERTIL ANDERSSON, QUALITY MANAGER, DISCS AND MILITARY,
VOLVO AERO CORPORATION, TROLLHATTAN, SWEDEN

Whereupon,

BERTIL ANDERSSON,

was called as a witness by and on behalf of the NTSB, and, after having been duly sworn, was examined and testified on his oath as follows:

MR. HAUETER: Mr. Andersson, for the record, could you provide your full name and place of employment?

THE WITNESS: My name is Mr. Bertil Andersson. I work at Volvo Aero Corporation, Trollhattan, Sweden.

MR. HAUETER: And could you provide your background in engineering aviation?

THE WITNESS: My background is Quality Manager for seven years now in manufacturing. And before that, I was Supervisor both manufacturing and quality. I work in Quality Assurance, and I am a Mechanical Engineer.

MR. HAUETER: What year did you get your

Mechanical Engineering degree?

THE WITNESS: Excuse me?

MR. HAUETER: What year did you receive your degree in engineering? What year? How long have you had it?

THE WITNESS: Oh, '86.

MR. HAUETER: Eighty-six.

THE WITNESS: Yes.

MR. HAUETER: Okay. And Mr. Anderson -- George Anderson will be doing the questions. Thank you, sir.

MR. ANDERSON: Good morning, MrAndersson.

THE WITNESS: Good morning, George.

MR. ANDERSON: We want to continue to talk about the manufacturing procedures and controls involved at Volvo. And before we proceed with that, I wanted to ask you several other questions about your background.

The first question was, have you worked for any other company in your career as an engineer, other than Volvo?

THE WITNESS: No, I always worked at Volvo Corporation.

MR. ANDERSON: Okay. And has your employment in the last several years been focused in the area of titanium rotating parts?

THE WITNESS: Yes.

MR. ANDERSON: And could you tell us basically what the general progression was? In other words, what was your first introduction to the titanium rotating part and how did you progress to your present position?

THE WITNESS: Oh, the first time I worked as an inspector on the titanium part. And then I was involved in the manufacturing of it. And back in late '95, as a Quality Manager for Discs. So that is my area and experiences of titanium parts -- titanium parts since 1976, sir.

MR. ANDERSON: And part of that experience involves writing procedures for the shop processes. Is that correct?

THE WITNESS: Yes.

MR. ANDERSON: I see. My first question would be to ask you to provide to the Board an overview of the manufacturing process that is involved in the sequence of drilling, boring, and honing the tierod and counter weight holes at the time that the accident hub was produced.

THE WITNESS: Okay. Back in '89, we produced this hub starting by rough drilling operation. Rough drilling is that we -- means that we leave more than one 10 mils on the surface for additional remover and fine machining. In the drilling operation, we work with what we call the cool channel drill. It's right through the hole and overlook the hole.

And after that, we move the part to another machine, doing a fine bolting and a single point bolting operation, doing fine bolting of the holes, and ended up by honing the holes to the finer dimension.

MR. ANDERSON: And could you explain in some detail on the reasoning behind the, first of all, drilling the hole and then following it with the two steps of boring, I believe, you mentioned.

THE WITNESS: Yes. The reason why we were boring a hole is to open up the hole. And that we use -- well, that time we used cool channel drill, as I said before. And I would go through them on paper here. And we open up 24 hole for the tierod holes and 24 holes for the -- holes by this cool channel drill. And we do that in an NC control machine.

MR. ANDERSON: Would you say again the type of machine, Mr. Andersson?

THE WITNESS: The NC control.

MR. ANDERSON: An NC.

THE WITNESS: Yes.

MR. ANDERSON: Numerically controlled machine. Thank you. Next, I would ask that you give a more detailed physical description -- I'll say that again. I ask that you give a more detailed physical description of the coolant channel drill, which was the drill in use at the time. And we have two exhibits, 8L and 8M to assist you on the view graph.

(Slide shown.)

THE WITNESS: If you'll at the drill up here, it's the standard drill. It's a high-speed standard drill that we use today. Down here is a cool channel with the brace, tip, carbide tip on a steel shelf, with two holes up in there, where the coolant is coming down through the drill and feed it out near the cutting edge of the hole. That is for getting the coolants as close to the cutting edge as possible, to reduce the heat of the machining.

And I think you have a slide of the machine.

(Slide shown.)

THE WITNESS: As you see here, this is the head of the machine indicating. The drill is down here. The part -- you see the part from the rear. You have the fixture holding here at the table, and this is in a cabinet when the machine is opened up just for taking picture. Here is able to see how the coolant flow down and also the coolant coming down through the drill.

So that's the coolant around the part, drilling it.

MR. ANDERSON: While that is on the screen --

THE WITNESS: I -- you have to speak --

CHAIRMAN GOGLIA: Would you pull the microphone closer?

MR. ANDERSON: While that is the screen, would you discuss the use of coolant on when the coolant channel drill is in use? By that, I mean, was there coolant channel -- or was there coolant flowing through the drill itself and also as indicated in the picture, coolant flowing onto the surface, which is more conventional?

THE WITNESS: Yes, that's correct. I said, through this drill is coming down to the cutting edge. And also we have a lot of -- we don't use organizers in the picture, because you haven't seen anything in the pictures there. But flowing over the part. You see both have two channels down through the drill, the coolant, and the flooding all over the part to cool it down. And the purpose with the flood up here is to get rid of the chips coming up from the hole.

MR. ANDERSON: I understand. And the technique used in terms of the speed and feed for this drill and the stroke used -- in other words, was it a continuing drilling process?

THE WITNESS: This was a continued drilling process, yeah.

MR. ANDERSON: And it was approximate 2.9 to 3 inches depth was the hole?

THE WITNESS: Yes, 3 inches depth. Yeah.

MR. ANDERSON: And also the -- if we could go back to the previous slide, could you describe the nature of the tip on the coolant channel drill? Was it different from a conventional drill?

THE WITNESS: This tape is a carnitive drill. You look at a tape that is braced to the steel -- the steel shelf you have here. You also see that through that drill, the feeding of coolant is coming down there and out of two holes here, close to the cutting edge.

So, that is the design of that drill. And the purpose is to get the coolant down to the cutting area to cool that down.

MR. ANDERSON: Mr. Andersson, in your opinion, at the time this drill was used, what was the reasoning -- the engineering reasoning for selecting it over a conventional what we would perhaps call a high-speed steel drill?

THE WITNESS: We choose to use this drill, because we had a problem at that time with a banana hole or bent hole that was not stride. Those drills would give us a stride hole, and we would get rid of problems with activities related to -- we were not able to clean the surface of, but this drill will drill a very straight hole.

MR. ANDERSON: So you're saying that the coolant channel drill was a -- performed better in maintaining drilling tolerances. Is that correct?

THE WITNESS: Yes.

MR. ANDERSON: What was the procedure used at that time to sharpen the drill and also to determine when did the machine operator determine when it was dull?

THE WITNESS: At that time, the procedure was that the operator had to -- after one part, it changed it. So 24 holes, then it changed it. The sharpening of the tool was to a drilling of the tool. And the resharpening was made at the same people, in the resharpening area. And it was a half numerically controlled machine who sharpened it or resharpened the drill at that time.

MR. ANDERSON: And so the sharpening was accomplished after the drilling of 24 holes?

THE WITNESS: Yes.

MR. ANDERSON: And the -- do you have any estimate of the life of this particular type of drill?

THE WITNESS: No, I don't have that.

MR. ANDERSON: Going back to that period, the coolant channel drill was eventually discontinued for a time and then brought back again. Could you describe some of the issues that were encountered? First of all, were you involved in those changes?

THE WITNESS: No, I was not personally involved in those changes. But the changes was close, because of when we used the coolant channel drill, in some cases, we have probably the oversight of the hole. Look at oversight of the hole. So, we went back to the type of high-speed drill that you have on the top of this picture. It's working more strident than the first high-speed drill was used back in '84.

MR. ANDERSON: Yes.

THE WITNESS: And it also solved the problem with oversight at that time.

MR. ANDERSON: At the time the accident hub was produced, were any records kept of the drill replacements on the machine? In other words, any records of any discrepancies or malfunctioning?

THE WITNESS: Of a tool?

MR. ANDERSON: Of an individual drill? If a drill was not -- in other words, if a drill was not functioning properly, if it did not drill a proper hole, was this -- records kept of this?

THE WITNESS: The only information we have is from the shop traveler, and the operator will -- if there was some problem with the drill, that drilling process, he would have brought down some information about that from the shop traveler.

MR. ANDERSON: When the coolant channel drill was discontinued shortly after the 1989 time period, was the process in terms of drilling speed in our revolutions per minute and the advance rate of the drill bit in terms of millimeters per revolution changed or did the rates remain the same?

THE WITNESS: Do you mean from the high speed to the coolant channel drill?

MR. ANDERSON: In comparison. In other words, the coolant channel drill had a set of speeds and feeds, which are published in our report, the Powerplant Chairman's Report. But when that drill was changed back to a high-speed steel drill, were the speeds and/or feeds changed?

THE WITNESS: Oh, yes. We have another speed and feed for the high-speed drill than we have for the coolant channel drill. That's correct.

MR. ANDERSON: Could you explain to us some of the methodology that went into setting those speeds?

THE WITNESS: When we set the speeds, we have -- we do testing the drill prior to using it in the manufacturing. For instance, the cool channel drill that we had used back in '89, we test about 700 holes. From those tests, we put together the cutting data related -- the cutting data from those holes.

So we used the cutting data that is giving us a good hole, a good surface finish, giving us a good proper and assure lifetime enough drilling 24 holes. So that way, we work for putting -- setting our cutting data. And we do that all the time.

MR. ANDERSON: And in establishing these work processes, obviously, this line was set up some time prior to 1981. Do you remember if the drilling processes for the initial manufacturer of the hub were evaluated by Pratt & Whitney?

THE WITNESS: Yes.

MR. ANDERSON: Under their engineering source approval process?

THE WITNESS: Yes.

MR. ANDERSON: Can you tell us what was involved there?

THE WITNESS: Back in '84 when we get the first approval for this part drilling, we send them pictures, photos -- pictures of the holes, showing what type of metallurgic structure we have on the surface of the hole. And we also give them all the cutting data, all the operating drawing sheets, and then they approve that process from the resource of that.

MR. ANDERSON: At that time, were you aware of the microstructure -- the potential for microstructural damage? That is to say, damage that would occur to the metal, but not leave a visual signature without further testing?

THE WITNESS: No, we weren't aware of that.

DR. LOEB: Before we go further, I just want to follow up on -- I don't know whether you're going to get to it or not. On the tests -- on these 7 or 800 tests that were done, in determining the feed and speeds of the drilling, did you do any -- did Volvo do any inspections, such as either blue etch or sectioning and putting the sections under SEM to look and, in fact, determine what the microstructure looked like during those tests or as a part of those tests?

THE WITNESS: We made some blue edge tests. We didn't make any cut up of the holes.

DR. LOEB: And at any time during these tests with the varying speeds and feeds, did you see any blue etch indications that looked different from the rest of the --

THE WITNESS: No, we didn't see it.

DR. LOEB: So at no time did you see anything that would lead you to the point that you may want to go further and section and look under an SEM?

THE WITNESS: Yes, that's right.

DR. LOEB: All right. Thank you.

MR. ANDERSON: We'll talk just a little bit later about the blue etch inspection under both the engineering source approval and the general quality control oversight system, which is an important part, of course, of the manufacturing process.

But before we get to that, I would like to ask, Mr. Andersson, about the actual training of the operator producing the holes. Could you briefly explain to us the background, first of all, of a machine operator and what they are taught as far as operating the drill and the bore?

THE WITNESS: All our operators back in '89 was trained to what we call the workmanship -- of industrial workmanship. They were trained for having -- we call it the father will follow them the first year through the shops and work together with them. We also have what we call a driving distance, given the way that we tell them. They have to go through special courses, make some tests, and then they would be approved to work by their own in the machines.

It normally takes about one, one and a half year at that time. Then they are trained to -- we have also the operation sheet that we're trained to understand that and to the way they were trained also to report everything that was coming up during manufacturing of the operations, even something that was not in non-conformance, but something that had to remark on.

MR. ANDERSON: When the operator would see an error or felt that an error had been made, what was the procedure for him to bring it to the attention of either a foreman or a technical -- something with more technical oversight?

THE WITNESS: Yes. As soon as he was aware that there was something in non-conformance or he had something abnormal coming up in his operation, he had to stop that operation, and he had to contact the manufacturing engineer who is responsible, in part. And the manufacturing engineer would get together with the quality people in that shop. Go through the part and look at the part. Ask the operator what happened. Ask him to describe it. Ask him to describe the abnormality or the non-conformance in his way. And then they were able to make a decision if there is a non-conformance.

If there is a non-conformance, we have to put it in the MRB system together with Pratt & Whitney. Or Pratt & Whitney would have to relate and give us approval for that before we move the part forward in production.

MR. ANDERSON: I see. Before we go to the inspection, the operator took care of changing their own equipment on the machines. In other words, the machines were set up by the operator?

THE WITNESS: Yes, that's correct.

MR. ANDERSON: And at this time, was your quality system certified under ISO-9001?

THE WITNESS: No, we were certified back in 27 of December 1995.

MR. ANDERSON: At what point in time, approximately, did that process change begin? When did you start --

THE WITNESS: We changed our quality system, you mean?

MR. ANDERSON: Yes.

THE WITNESS: We changed the quality system back in 1992.

MR. ANDERSON: Okay, 1992. I would like to call your attention, please, to Exhibit 8B-1.

THE WITNESS: You said 8 --

MR. ANDERSON: Eight-B-1 and the title is Volvo Hub Front Drill Process History.

THE WITNESS: Yes.

MR. ANDERSON: On the first page of this, we have a -- essentially an instruction drawing. Could you explain to the Board basically the key or the outstanding features of the hole, such as how it is located, the surface finish required on this drawing, and any other features that contribute to describing the hole?

THE WITNESS: Okay. On the section page H to the left of the drawing, you have the dimension of 23 holes, who would be the tierod holes. Then you also show -- and that is the top of it -- the true position at that time is .4 millimeter. And that's equal split 24 holes. We drill that hole to 12.2 millimeter, and they have total runs for plus three tenths of a millimeter.

If you look at the bottom of the section, HH, you see one hole of those 24 would be single point boring up to another dimension that is for the location through the continuous processing of the part.

You also see a small -- in the middle drawing, you will see a small picture showing a hole with diameter 11.0 plus five tenths of a related tolerance. Those are the holes called the tierod holes.

The surface finish call out in the bottom of the drawing, in the middle, and says 1.6 array, as we have in Europe. That is your 6388. You will also see that we have operation drawing number, the issue number in the bottom left was important. We also on the top of it have the type of machine, the material we use. So they are aware of what type of material they're working.

As you also can see, we have stamps on the drawings showing that this is titanium part, we handle in a special way. All the parts and all the operation performed on the part is stamped critical.

MR. ANDERSON: Very good. On page 2 -- actually, it is sheet 404. That would be the second page of the exhibit. We have -- just show the or describe the purpose of that sheet as an operation sequence?

THE WITNESS: Yes. This is to give the information to the operator, which tool he will use. It says he could use it. He will use a center drill with a special number on it. And then you have the drills, the bore, mill tabs, and a difference with all the drilling number on the drill and the number of the -- the part number of the drill, I would say.

MR. ANDERSON: And finally, the addendum 1 or page 3 to the exhibit, would you explain the content of this chart and explain, perhaps, since the coolant channel used in the beginning of 1988, some of the other drill events here?

THE WITNESS: First, we satrted in '84. We have a high-speed standard drill. And you were able to see the speed on the meter. And back in the beginning of '88, we changed it to the cool channel. And in 1990, we changed to another cool channel drill, called the Sunbeam Delta drill, who is the supplier's name of the drill.

We also changed the speed at that time and the feed for the control type. We went back in September 1990 to high-speed drill. I will go back to the point three there in expanded. We use the Sunbeam Delta drill in two directions.

MR. ANDERSON: Would you explain --

THE WITNESS: That means that we drill half of the hole in one direction. Turn the part around in the machine and drill from the other direction, to reduce the problem with the oversize and to reduce the problem if the hole was bent away.

MR. ANDERSON: So it was not a problem --

THE WITNESS: So the hole was not so deep when we drill them that way.

MR. ANDERSON: I understand. Could you

discuss the variations in speed? We see initially using what would be a baseline of a high-speed steel drill --

THE WITNESS: Yes.

MR. ANDERSON: -- starting in 1984, speeds of 300 rpm. And we see the speeds increasing, which would lead us to believe that perhaps the newer drills would cut faster and that might have been the reason for their introduction.

THE WITNESS: Well, the reason why we increase the speed here is that the coolant channel drill of the carbide drill is working with high speed. That this was coming out from the -- to get the most sufficient cutting data out from it and get the most -- because we want -- we will not have a too dull drill after 24 holes, because they we have to strap the drill instead of resharpening. So, we will have the drill as good as possible through all the 24 holes. And that's the reason why we try to put the right cutting data in, and the hole -- the carbide data is used at a higher rate of cutting speed.

MR. ANDERSON: That as we're talking about increasing the cutting speeds, the -- perhaps the reason for the carbide being more effective, to higher speeds is that it is more resistent to heat buildup.

THE WITNESS: Yes.

MR. ANDERSON: And so would it be fair to characterize the amount of heat buildup in the coolant channel drill is higher than perhaps the standard high-speed steel drill?

THE WITNESS: No, because we -- at that time, we were able to -- using the high speed, the chips moved away faster from the area.

MR. ANDERSON: I see.

THE WITNESS: That means that you will have the area as cool as possible. If you decrease the speed by using carbide, it will heat up the area. So, it's necessary to have this higher level of speed to get rid of the heat in the area. The heat is coming -- going away from the cutting edge by the chips.

MR. ANDERSON: So as long as the chips are moving along, the temperature should remain the same.

THE WITNESS: Yes.

MR. ANDERSON: I understand.

THE WITNESS: And also at the time we feed the coolant down to the cutting edge.

MR. ANDERSON: Could youdescribe the malfunctions as far as chip clearance? In some cases, what is known as pecking was used where the drill would be withdrawn every so many millimeters during the drilling process. And I understand in some of the uses of the coolant channel, the plunge technique was used, where the drill was advanced continuously through the material until the hole was through the metal.

THE WITNESS: When we use the high-speed steel drill, we flood the coolant over the part. We're not able to flood it down to the coolant -- to the cutting edge. That means that we had to retract the drill each 5 millimeter, and that is in the computer system and the machine's doing that.

When we use the coolant channel drill, the flooding, the coolant coming down and coming out from near the cutting edge. And we will flood these chips out from the cutting edge, together with the coolant coming out there. So we don't need to have that retraction for the reason when using the coolant channel drill. Do you understand?

MR. ANDERSON: Yes.

THE WITNESS: Okay.

MR. ANDERSON: Yes.

THE WITNESS: Thank you.

MR. ANDERSON: The coolant channel drill has essentially got a dual stream, is what you're saying. The coolant flowing down through the two holes in the drill and also the conventional pattern of spray on the top of the part. Is that correct?

THE WITNESS: Yeah.

MR. ANDERSON: I would like to change to a different area, still related to the manufacturing process, dealing with the inspection systems, which, of course, are at least several significant inspection processes involved with inspecting the holes, both during the time that they're manufactured and after the part is ready to be shipped from Volvo.

Could you give an overview of the inspection system, starting at the manufacturing point? In other words, what processes are involved?

THE WITNESS: I think you have an exhibit showing our quality system down there. This is a way that our system controls the part today. We have the requirements coming down this way from the company management customer authorities, coming through the quality system. And we have that through the -- assigned, purchasing manufacturing and shaping of the part, which means that control of the contract, drawings, purchase orders, operations -- and release of the documentation. This is a very general picture of the system.

Then I will --

DR. LOEB: Could you identify for the record this Exhibit Number, please?

MR. ANDERSON: It's 8N, 8-November. And he will be talking about 8N through Q.

THE WITNESS: And then I -- 8Q, please?

(Slide shown.)

THE WITNESS: If you look at that picture over here, you see -- I will also tell you the system that we changed back in '92, the system prior to that is very equal. The only thing is that they have changed the name of some of the manual. We have in more detail explained the responsibilities for some of the operators and for the management also.

So, I just use that first picture showing the system. If we look at how we control the part when -- we look at the purchase order. We have the business contract between Pratt & Whitney and Volvo. The business contract is like an umbrella over everything. But in the purchase order, we have part and system requirements.

We also have requirements for -- operation of authorities coming to us, because the requirements from FAA are coming through Pratt & Whitney to Volvo. We have what we call our sister that I showed earlier, who handles the raw material, semi-finished part, unfinished part. Also gives us strict guidelines and requirements for personnel involved in everything, how they should work and what they should do in each step.

MR. ANDERSON: Okay. So, the -- you've shown the outline of the flow of communication. Could you talk a little more about the flow of communication between Volvo and Pratt & Whitney as far as the documents that would be in use? By that, I mean, what quality systems?

THE WITNESS: Okay. Up here, basically, we have photo requirements pointed out in the QA 6076 and then a lot of other requirements coming down there the same way. The raw material for rotating parts is released to Volvo by the MCL to Pratt & Whitney. So, we buy the raw material from an approved supplier, approved by Pratt & Whitney.

We machine the part to the requirements that's coming down this way. And that means that we have all this -- we have the system basically from this 6076. And for this part, we also have the ESA system working or from the 370. This means that we have to have Pratt & Whitney to approve all the processes and the whole process of the manufacturing from that we start the first operation until we ship the part. They approve everything for what we're doing with the part or manufacturing sheet inspection plans.

MR. ANDERSON: Yes. I think we can remove that slide now. What I would like to do with that as an overview is to talk, Mr. Andersson, about the individual inspection criteria for this hole, because that is really where the difficulties in this particular accident occurred. The first exhibit is 11-C for you, which is the Pratt & Whitney VIS standard or visual inspection standard.

The first thing I would like to ask you to explain is basically how an inspector conducting a visual inspection of the hole during the initial stages of inspection would -- what he would look -- he or she would look for in deciding whether that hole met the visual standards of this specification.

THE WITNESS: She or he would look for a certain finish. He would look at the VIS and he would look or she would look for different type of damage to the -- scratch from the gaging tools. And you have the requirements in the 61 -- general limits. There's at least 454.

This was released later than '89, but they are similar to the prior one. It was 2-77.

MR. ANDERSON: Yes. If we turn to page 2 of 13, we have a series of definitions, which are, of course, extremely important in communicating within the quality and inspection system, the nature of a defect. Could you go down and talk about the ones that seemed -- we will later see, seemed to be associated with the accident disc. I would suggest that burnish marks, chatter marks, and perhaps pickup would be worth commenting on.

THE WITNESS: What we are looking at is on the inspection is chatter marks and tool marks from the inspection, red portion from the shop traveler. The chatter marks is closest spaced to marks caused by the vibration of the cutting tool, deviation of that. The tool mark is deviation from normal surface plan, usually appearing as an undercut. Also defined as a deviated tool line. That is the definition of this tool.

MR. ANDERSON: Yes. And I guess a more specific question would be how would the inspector distinguish between a chatter mark and just a scratch?

THE WITNESS: The chatter mark is vibration over a -- it's a pattern over the surface. It looks down on the surface. And it looks like a surface on an orange when you look at it.

MR. ANDERSON: Okay. Having reviewed these -- and I might just add also, bring your attention to the superficial imperfection, which is an imperfection which disrupts the surface and appears smooth edged, but does not penetrate the surface roughture -- or excuse me, surface roughness texture. Taking these into consideration, how would you relate them to the condition described on the accident hole? Would any of these apply?

THE WITNESS: You mean if any one of these would fit into the accident hub?

MR. ANDERSON: Yes.

THE WITNESS: No, I don't think so.

MR. ANDERSON: Then what you're saying that probably none of these would apply to the origin sites pointed out on what was later seen in this section --

THE WITNESS: Yes.

MR. ANDERSON: -- after the accident?

THE WITNESS: In a visual inspection, you would not.

MR. ANDERSON: These would not occur?

THE WITNESS: No.

MR. ANDERSON: Mr. Andersson, moving to page 3, please, we are still, of course, talking about inspecting holes. And would you enlighten us as to the nature of a water discoloration, which is described here as light grey or light brown in color, what would be the nature of that kind of discoloration and titanium?

THE WITNESS: You have to explain that question.

MR. ANDERSON: Yes. On page three in the column --

THE WITNESS: Yes, I follow that, but --

MR. ANDERSON: Okay. When there is described an acceptable imperfection, one of those acceptable imperfections is called or described as a water discoloration, light grey or light brown in color.

THE WITNESS: Yes.

MR. ANDERSON: What is the likely cause of that type of a discoloration in your experience?

THE WITNESS: It can come from the cleaning, from the person -- for instance, from the coolant used.

MR. ANDERSON: Moving ahead, the page 9 of the Pratt & Whitney VIS 454 standard. We have a list of limitations and acceptable limits. We have on the fourth row down, the description nicks, dents, scratches, and tool marks. Could you read the acceptable limits, please?

THE WITNESS: The acceptable limits would provide, a substance -- so it's not to irritate the surface.

MR. ANDERSON: Is this the method by which Volvo inspectors measured the surface finish of these holes?

THE WITNESS: It's not -- we are not able to use it down in the holes, because the stilus is not designed that way. We use a comparison and look down the hole, just at the finish. If we have any problem, we use a surface finish nursing machine, nursing the surface. That's a KO.

MR. ANDERSON: So would you -- what would be the frequency of doing a special inspection on surface finish?

THE WITNESS: If you have any marks, if you look at the surface and see that it's something -- it's not your normal system, because we are looking at a very smooth surface on the holes. Like a mirror, close to a mirror. So anything that is coming up from the surface showing a normal surface lecture, it would be handled -- try to amercing the surface or look at for comparison.

MR. ANDERSON: Would the -- what process would be to follow to repair a failure of the surface finish of this hole?

THE WITNESS: We have possibility to go back and do some what we call planning the hole, and see if that would be removed, the scratch from the mark in the hole.

MR. ANDERSON: And we will look at the manufacturing records in a minute, but would -- what would be the record in Volvo's manufacturing process of blending or --

THE WITNESS: It would be in -- you would find an extra operation, put it in for that blending, if there would be something like that.

MR. ANDERSON: So that if the manufacturing record did not have a record of any blending repairs, would it be safe to say that the hole was drilled without any imperfections --

THE WITNESS: Yes.

MR. ANDERSON: -- that would fail VIS?

THE WITNESS: Yes. For the VIS, yes.

MR. ANDERSON: Okay. You can put the VIS 454 back in the pile. And I would like to turn next to the fluorescent penetrant inspection as used at Volvo on the hub. This would be Exhibit 11-Echo, E.

THE WITNESS: Exhibit L-11?

MR. ANDERSON: E as in echo. Mr. Andersson, have you got 11-E?

THE WITNESS: Yes.

MR. ANDERSON: I believe this is a familiar document.

THE WITNESS: It is.

MR. ANDERSON: Could you describe the nature of this document for the Board?

THE WITNESS: If you look at the Exhibits 11, you will first find an operations list. With that list that we get the signature from, approved by Pratt & Whitney, all the change showing that this had been approved. It's using a rough information about -- or like I say, a brief information about the way we're machining the part.

And the first four pages showing when we do assembly of some of the hubs, the hubs that we will ship out as directly to the assembly line of Pratt & Whitney. Otherwise, we use just the second operation sequence list we're doing an assembly of, for spare parts, for instance.

MR. ANDERSON: I understand. Could you turn so we have a record here of the -- of essentially a batch of hubs that included the accident hub. Is that correct?

THE WITNESS: Yes.

MR. ANDERSON: And so if we are to know what happened to the hub during manufacture, we would look at this record, would we not?

THE WITNESS: Yes. On the first -- okay --

MR. ANDERSON: Is that correct?

THE WITNESS: Yes.

MR. ANDERSON: So, if we could turn to page 12 of the Exhibit, please. And I would like to ask you about several items on this page, but for the benefit of the people who are not familiar with the codes, perhaps I would ask you to describe what's going on here, but essentially, as we read down this list, we have several write-ups, one of which deals with another hub. That comment and I'll quote is, "Tool mark on bolt face due to wrong tooling. Applies to serial number 32977." That is not the accident hub.

THE WITNESS: Yeah.

MR. ANDERSON: Can you tell who made that -- tell us, who made that remark and --

THE WITNESS: That is a remark from one operator to another. It was on line that they had to observe that from this rough machining.

MR. ANDERSON: And does this constitute a failure of an inspection under VIS 454 or is it simply a remark?

THE WITNESS: It's simply a remark.

MR. ANDERSON: In other words, the process is finished or is not yet finished and ready for inspection?

THE WITNESS: It's not yet finished. It's semi-finished.

MR. ANDERSON: It is not yet finished.

THE WITNESS: Yes.

MR. ANDERSON: Moving ahead, can you read the one that refers to the accident hub, R32971, please?

THE WITNESS: Yes. We have this -- as you call a code is 110. It's means that you have to -- it's in the operation 110 that the remote is coming from. The two holes, then you have the diameasure, says that it fits oversize. It also says that it has some chatter marks in the two holes. Applies to serial number RV2971. That is also remark made from the operation to an operator further down the line. It's not a finished surface at that time.

MR. ANDERSON: So, if I understand you correctly, Mr. Andersson, the person making this remark was the operator of the drill?

THE WITNESS: Yes.

MR. ANDERSON: And he was --

THE WITNESS: That's a person -- it was an operator for the fine boring.

MR. ANDERSON: For the fine boring.

THE WITNESS: Yes.

MR. ANDERSON: Okay. So that he was communicating with who?

THE WITNESS: With the honing -- operating the honing operation.

MR. ANDERSON: Okay. And what would have been the disposition? How would this have worked out?

THE WITNESS: Because it's -- because this is not a finished hole, the disposition is going to be made on the finished hole, after the honing operation.

MR. ANDERSON: So that because there appears to be no further remarks dealing with chatter marks, that they were cleared during the honing?

THE WITNESS: Yes.

MR. ANDERSON: And so, therefore, we could conclude because of the nature of honing, that these marks were not very deep?

THE WITNESS: No, that's correct.

MR. ANDERSON: Would that be a correct assumption?

THE WITNESS: Yes.

MR. ANDERSON: I believe I would like to return the witness to the Chair.

DR. LOEB: Excuse me, I would like to just clarify an issue. Is it then your understanding, Mr. Andersson, that the honing process removed the chatter marks?

THE WITNESS: Yeah. The chatter mark we are talking about is very, very slight to the surface. It's just something that you see, because the surface -- so, you have a fine surface finish in the fine boring. So you are able to see very small variations of stress structure that would be removed by the honing.

DR. LOEB: The chatter marks if they were still there, if there was still a notation that chatter marks, after the honing, then this would not be acceptable. Is that correct?

THE WITNESS: That's correct.

DR. LOEB: And, particularly, in the hole, in the bore --

THE WITNESS: Yes, that's correct. Just look at the hole.

DR. LOEB: Okay. So, that the assumption is that the honing removed the chatter marks.

THE WITNESS: Yes.

DR. LOEB: But there is no indication -- positive indication on this form that that's the case. There is -- we're going by the absence of any further mention on the form that we're assuming that the -- that the honing removed the chatter marks.

THE WITNESS: Well, if you don't see any in the fine inspection, the visual inspection, and if they're not, the operator in the honing operation has not signed up and make any remarks of chatter marks, there was no chatter marks of the honing operation.

DR. LOEB: Do you think it would improve the system somewhat if it was a requirement to actually address something in a more positive fashion? In other words, stating chatter marks removed or not found after honing?

THE WITNESS: We have changed the system after this accident. So that today, we do that, because we need -- we have a feeling that we have to have the person's signature, who verified that everything has been taken care of in the proper way.

DR. LOEB: Thank you.

THE WITNESS: Yes.

MR. ANDERSON: At this time, I would like to turn the questioning back to the Chair, Mr. Goglia, for perhaps a break.

CHAIRMAN GOGLIA: At this time, I would like to take a break and 15 minutes.

(Whereupon, a short recess was taken.)

CHAIRMAN GOGLIA: On the record. Can everybody take their seats and we can reconvene?

(Pause.)

CHAIRMAN GOGLIA: The questioning of Mr. Andersson will continue.

MR. ANDERSON: Mr. Andersson, can you hear me? We're having a little trouble --

THE WITNESS: Oh, yes.

MR. ANDERSON: -- adjusting the gain on the microphone. Is that satisfactory?

THE WITNESS: Yes. Thank you.

MR. ANDERSON: We were talking about Exhibit 11-E. The title of that exhibit is the English Translation of Volvo's Manufacturing Records on Hub, Serial Number 32971. We had begun to explain. We had asked Mr. Andersson to explain the meaning of several remarks made in what a part of this document that is referred to sometimes as a shop traveler here in the United States. The meaning of that is generally that this document travels with the part and it serves as an in-process record of things that are done to that part, inspections that are performed on that part, during the intermediate steps and the manufacturing process.

Is this a correct characterization --

THE WITNESS: Yes, it is.

MR. ANDERSON: -- of this document?

THE WITNESS: Yes.

MR. ANDERSON: So we were --

THE WITNESS: It also gives you information about what type of machines -- and drawings also. It gives the requirements of the operation step.

MR. ANDERSON: Yes. Your comment is that in addition to those items, the processes are described, each step of the process. So, when a code is given on a page, one can go to a previous listing of those processes, such as step 110 is boring, I believe.

THE WITNESS: Yes.

MR. ANDERSON: The boring of the hole, which follows drillings.

THE WITNESS: Yes.

MR. ANDERSON: And these are important distinctions, because we're going to be talking about remarks are made at an intermediate point. And we will eventually get to the end of the process where the issue of inspection sign offs would be appropriate to describe.

We were on page 12 of the exhibit.

THE WITNESS: Yes.

MR. ANDERSON: And we had talked about the chatter marks. Did you have any more comments on that particular write-up?

THE WITNESS: No.

MR. ANDERSON: Do you know, is there any way for you, as being familiar with these forms, to know who made this write-up?

THE WITNESS: The write-up from the operation 110 was made by the operator who performed that operation.

MR. ANDERSON: And how would we know who that person was at this point?

THE WITNESS: On the page 10, if you look at operations 110, you will see that the operations has this employee number and the signature who performed that operation to the right.

MR. ANDERSON: And can we determine who that is by a number or by the --

THE WITNESS: By a number.

MR. ANDERSON: -- initials?

THE WITNESS: By the number, employee number.

MR. ANDERSON: Okay. Could you please read this comment into the record, Mr. Anderson, the comment after the 110 inspector's remark? On page 12, I'm sorry.

THE WITNESS: It says that it's two holes, the dimension 12.117 millimeter or plus 0.035 and one hole .13, .095 is plus 0.08. One of the dimensions, the first 12.117 is for a carbide hole. And the second one is for one of the tierod holes.

It also said below that, some chatter marks in the two holes applies to serial number R32971. Some chatter marks -- very small chatter marks.

MR. ANDERSON: And even though it is not written, we can correctly state that the dimensions are given in millimeters?

THE WITNESS: Yes.

MR. ANDERSON: Thank you. If we could turn, please, to page 28. You're on page 28?

THE WITNESS: Yes.

MR. ANDERSON: We have another remark, this one being of more direct interest. Certainly, has been seen by a number of people with the investigation. Could you interpret -- give us your interpretation from the Swedish code 50 there.

THE WITNESS: Okay. First, what we're looking at is page 28. It's an inspection record. The remarks in code 50, remarks related to VIS observation. It's not related to BEA process. And he has made a remark that on serial number R32971, is machining marks in hole diameter 13.145, located 180 degree from serial number marking. He also, to the right, has put out that this remark was noted down to the -- in the traveler or on the traveler, with address to the inspection department 473, who is the final VIS inspection department, because this was not reason for rejection due to standards in the BEA. So you have to

-- to cause them to make a decision if it was approved or not -- acceptable or not. I would use that word.

MR. ANDERSON: Yes. So, if I understand correctly, the person making this comment on this document was the blue etch inspector.

THE WITNESS: Yes, that's correct.

MR. ANDERSON: But that blue etch inspector was not recording the results of his blue etch inspection? This is not --

THE WITNESS: No, this is not a blue etch indication. No, that's true. That is an observation he made on the surface.

MR. ANDERSON: So, the blue etch inspector was merely making an observation to perhaps VIS 454?

THE WITNESS: Yes.

MR. ANDERSON: And so his comment was to the person who is responsible for conducting the visual inspection, which is department, what, 454?

THE WITNESS: Four seven three, yeah.

MR. ANDERSON: Four seven three.

THE WITNESS: At that time.

MR. ANDERSON: And it was whose responsibility to conduct a visual inspection of this finding?

THE WITNESS: That was the visual inspector. He had to look at the hole at that time, look at if there was any surface finish texture, damage to the texture of the surface, and make a decision that was acceptable or not. And his decision, we will discuss it later.

MR. ANDERSON: And he would have used the criteria that we had discussed previous in VIS 454. Is that correct?

THE WITNESS: Yes, that's correct.

MR. ANDERSON: Were there any other inspection criteria that would be used in conjunction with this remark?

THE WITNESS: Not for the inspection, no.

MR. ANDERSON: Would FPI have been an issue here?

THE WITNESS: No, because this doesn't -- didn't anything in the FPI.

MR. ANDERSON: I understand. Can you take us to the sign off of the inspector -- of the visual inspector and show us where that is in the record?

THE WITNESS: Yes. If you look at page 19.

MR. ANDERSON: Nineteen.

THE WITNESS: Yes.

MR. ANDERSON: And on page 19 that is code 230, which --

THE WITNESS: The code, yes, 230 is operations. It's a number for the inspection.

MR. ANDERSON: And can you tell me which inspection is it? Is this the last visual inspection or is it second to last?

THE WITNESS: Of the hole, it's the last one.

MR. ANDERSON: It is the last visual inspection?

THE WITNESS: Yes.

MR. ANDERSON: And can you show how this form of this write up or sign off occurred here?

THE WITNESS: On the code 21, which is the second code on this inspection record --

MR. ANDERSON: Yes.

THE WITNESS: -- youwould find that he has signed off by a dash, I would call it. That's -- the remarks from the early operation had been taken care of and fall within the -- meeting all the requirements that is on the part. Or their remarks prior to this operation has been removed by later operations between this remarks and the fine inspection.

As in this case, the chatter marks removed by the honing.

MR. ANDERSON: Yes.

THE WITNESS: You also have on page 26 --

MR. ANDERSON: Okay. I'm on page 26.

THE WITNESS: Twenty-six, you have it?

MR. ANDERSON: Yes.

THE WITNESS: Okay. As you can see, the code 1991 is the VIS inspection. The first code there indicates that the operator should look at all the surface on the part, including your holes. And if there was any remarks, it should be written down there. So it's shown that it's no remarks related to the VIS inspection, to the surface finish of the part.

MR. ANDERSON: So that the final inspector's stamp that we would expect to see would then have been carried forward to another page? Is there one more step in the sign-off process from page 26?

THE WITNESS: In that operation?

MR. ANDERSON: yes.

THE WITNESS: No. The only sign you would see is on the traveler for the --

MR. ANDERSON: Okay.

THE WITNESS: -- for that operation. You will see his sign off and approve that.

MR. ANDERSON: But we see other sign offs on earlier documents, such as page 10, where we have each operation signed off. And we go to page 230 -- I'm sorry, operation 230 -- this was operation 230.

THE WITNESS: Two thirty, yes.

MR. ANDERSON: Yes. And we see an inspector's stamp after that line. Would that constitute his approval and signify that this part had passed his inspection?

THE WITNESS: Yes.

MR. ANDERSON: And, therefore, it -- he is saying that this part met all the standards --

THE WITNESS: At that time, yes.

MR. ANDERSON: -- at that time in VIS 454?

THE WITNESS: Yes. I will correct you there, because at that time, it was 277 used, but this is a similar one and older one than of 454.

MR. ANDERSON: Okay. The VIS --

THE WITNESS: Seven, seven.

MR. ANDERSON: -- 77, Pratt & Whitney VIS standard.

THE WITNESS: Yes. It was working -- was in '89, but they are equal.

MR. ANDERSON: Do you remember approximately when the standards changed?

THE WITNESS: Nineteen ninety.

MR. ANDERSON: Nineteen ninety. So, shortly after --

THE WITNESS: Yes.

MR. ANDERSON: -- the accident hub was produced. Do you remember the significant -- any significant changes between the two documents --

THE WITNESS: No.

MR. ANDERSON: -- that relate to holes?

THE WITNESS: No.

MR. ANDERSON: Page 27 --

CHAIRMAN GOGLIA: George, before you change, I have one question for Mr. Andersson, and it's on page 26. When you're referring to this inspection that was performed on the entire part and there's no comments, I'm familiar with some work that was done here in the United States to determine the probability of detection, POD, for persons performing visual inspections. And I will ask the FAA for the exact numbers of this later. But I believe here in the United States, there's an 80 percent probability of detection. Has Volvo or are you aware of any work, similar work that would determine what the likely probability of detection would be for this inspector performing this task?

THE WITNESS: Volvo has by ourselves make tests of visual inspection. And I have been involved in that. And we say that something close to 90, 94 percent.

CHAIRMAN GOGLIA: Okay. Thank you.

THE WITNESS: That was back in late '70s, we made that test.

MR. ANDERSON: Page 27.

THE WITNESS: Yes.

MR. ANDERSON: On line 79, we have an English translation, but I would ask you to retranslate, again, the item or the write up there or the comment, please?

THE WITNESS: Once again, then, this is not a -- the notice is not related to the FPI. This is not an FPI indication that's filled out here. The inspector who is a her, she noted down that in one of the holes has what you call -- what she called a hole in the radius -- on this part, R32971. That is also something -- a note which she passed to the final inspector who is in the same area.

MR. ANDERSON: And can you read, for the record, what it said?

THE WITNESS: It said that hole in the red is a one-piece one hole. She's showed a very brief explanation of the -- she saw something abnormal in one of the radius. She looked like it at hole -- not an FPI indication. A very small hole then.

MR. ANDERSON: So, it would bea surface imperfection?

THE WITNESS: Yeah.

MR. ANDERSON: And the method of describing it as in the radius, could you explain further the meaning of that?

THE WITNESS: That means that is not in the hole itself under H of the hole to the surface.

MR. ANDERSON: I see. So, in other words, if that were an edge, described as an edge of the hole, this imperfection was along that edge?

THE WITNESS: Yes. And we do not really know if it is related to these holes, because there are several holes on this hub.

MR. ANDERSON: Yes. There was --

THE WITNESS: She is not pointing out any of the tierod or the carbide holes here.

MR. ANDERSON: I would like to ask a question at this point of this process. Is it normal for the people making these notations during manufacture not to specifically locate the hole?

THE WITNESS: At that time, I would say that this is where normal notes made by the inspector -- as a note if they have been related to the FPI. So, it was an indication from the FPI, which we wrote in a complete -- it would be explained and probably it would have a map showing where of the -- in which area of the part the FPI indication had been shown up. But just the remark would be like this.

MR. ANDERSON: So, in general, in summing up, in discussing all these remarks -- these three remarks that we've looked at, would they be characterized as remarks to aid the inspection process as opposed to observations by the individual inspectors?

THE WITNESS: Yes, to making them observe and being more observant, look at those certain areas.

MR. ANDERSON: In other words, if these remarks were not present, the inspection process would work correctly without them?

THE WITNESS: Yes.

MR. ANDERSON: Is that a correct statement?

THE WITNESS: Yes.

MR. ANDERSON: I would like to turn --

DR. LOEB: George, excuse me, I would like to just clarify, because I'm not certain I understand. The remarks were made for whom to take a further look to make --

THE WITNESS: For the final inspection.

DR. LOEB: For the final inspection.

THE WITNESS: Yes, because the people in the FPI or the people in the blue etch is not -- has not the criteria for the VIS requirements. They have the criteria for FPI or BEA process.

DR. LOEB: Now, how do we know that, in fact, the final inspector looked at these particular indications and ruled them out for himself?

THE WITNESS: Because we have a code, as I told you, a code 21 will take care of that. And when he marked that code out, he said he had taken care of all the remarks on the shock traveler and prior inspection records, because those was part of the report to the inspector, final inspection area.

DR. LOEB: We just have to assume, though, that those particular remarks were, in fact, noticed and addressed, because we don't have anything that is specific to them noted by the final inspector. Just that this -- is that correct or am I incorrect?

THE WITNESS: I would say that those are very specific noted to the final inspection, because you would find a sign on the traveler -- for operation 230 to be of service on notes early in the production. If you look at the shock traveler, page 10, you will across, behind the words "KON" on the operation 230, that's to indicate that he has to take care of notes made prior to that to different operations observations -- operator's observations.

DR. LOEB: Okay. All right. Thank you.

THE WITNESS: Okay.

MR. ANDERSON: I'd like to turn -- just before we leave this subject, I would like to say again that a visual inspector performing the final visual inspection on this part would have a set of instructions. Is that correct?

THE WITNESS: Yeah.

MR. ANDERSON: And would it be fair to say that those instructions would include the direction to inspect each hole?

THE WITNESS: Yes. It includes to inspect each hole.

MR. ANDERSON: Yes. So that if no hint, if you will, were given as to where possible damage might be, the inspector would still inspect each area of the hub?

THE WITNESS: Yes.

MR. ANDERSON: I'm sorry, I'm using the term disc, but hub is more correct.

THE WITNESS: That's correct.

MR. ANDERSON: I would like to turn --

CHAIRMAN GOGLIA: Before we escape that, are there any inspection aids used at this time, such as a baroscope or something to allow a visual inspection inside a deep hole?

THE WITNESS: Not -- we don't use baroscope for those holes, no. We use mirrors. We use the stylus. It's possible to use comparisons for surface finish and we use different live sources that is supposed to --

CHAIRMAN GOGLIA: Okay.

THE WITNESS: The problem is when you use a baroscope in this hole, you could be -- bare damage to the surface finish and you also would be fooled by looking down in the mirror. And the angle and the light would be coming down in the wrong way to the surface and hit it, and when you look back, as I told you earlier, it's like a mirror down there, because of the surface finish. So, it really don't help you. It could really fool you to make mistakes to use a baroscope down there.

CHAIRMAN GOGLIA: Thank you.

MR. ANDERSON: I would like to turn to the third of inspection that the hub receives, which is the blue etch anodizer or BEA process. Could you, so to speak, describe the general BEA process for those who are not familiar with it?

THE WITNESS: The BEA process was developed back in the 1970s by Pratt & Whitney. And the purpose is to detect the different type of structure damage to 14 laps, grain segregation. The process was developed for controlling of the variation prior to the manufacturing for the forging -- in that process. The process is not developed for looking at damage that could be caused by a manufacturing in the beginning.

Since that, they have been developing the process. So, they are looking for other things today, but in the beginning, the process was developed for looking for variation from the forging -- on the forgings.

MR. ANDERSON: Yes, could you -- we understand the purpose.

THE WITNESS: Yes.

MR. ANDERSON: Could you describe the physical nature of this process? In other words, basically without naming every step, just how one goes about applying this blue etch anodize and what it looks like roughly when you are ready to inspect. What does the inspector see?

THE WITNESS: Okay. The blue etch anodizer is first you clean the part and then you anodize the part and it can go dark blue -- and the inspection, look at the part at that time and see that it's -- the whole part is dark blue. And then they do stripping in the process step. And after that, you're looking at the surfaces, looking like slightly grey, some color to the blue, and from that, you will find variation from white to dark blue in the surface, if there is any abnormalities.

MR. ANDERSON: So, if I could characterize again, that the test that the inspector is performing is on a surface which has been anodized and that that anodized, based on the condition of the material or the titanium beneath it, gives different patterns?

THE WITNESS: Yes, that's correct.

MR. ANDERSON: As opposed to other inspection methods where you either identify a crack or have some sort of indication. The blue etch anodized process is directed at having an inspector look for patterns in this coating that is applied to the part. Is that a correct characterization.

THE WITNESS: Characterization, yes, that gives a pattern.

MR. ANDERSON: And how many conditions of failure does this blue etch anodize -- you have named, I believe, grain segregation, which is a metallurgical condition?

THE WITNESS: Yes, hard alpha, which is also something coming from the forging. The grey sites, segregations, forging depths.

MR. ANDERSON: And of those three discrepancies, the first is a physical discrepancy, is it not? It is a physical discrepancy. It could show up under other types of tests, forging laps?

THE WITNESS: Forging laps, yeah.

MR. ANDERSON: The other two, the grain segregation and the hard alpha are not detectable, is it not true, by the other process?

THE WITNESS: That's true.

MR. ANDERSON: So, that the BEA is the only test capable of detecting those -- at least two of the three situations.

THE WITNESS: Yes. As we look at the part, yes.

MR. ANDERSON: The indications after the accident on this hub, perhaps led Volvo and Pratt & Whitney maybe to reevaluate the potential for this process. Are you aware of any changes in the application of the blue etch process?

THE WITNESS: Well, during the tests that we have run at Volvo together with Pratt & Whitney, we have been able to see that the variation of counter is always showing up so strongly as this standard showed earlier. So, the standard has changed now to more take care of even a variation from the manufacturer -- related to the manufacturing.

MR. ANDERSON: And what kind of testing or studies have led to this type of actions?

THE WITNESS: During investigation of this accident at Volvo, we have produced more than 300 holes with different types of drillings. We have prepared the tools to create -- try to create similar damage that we are looking at on the accident hub. We have been able to create something who looks rather similar on just a few of those holes. So, it's very extremely real -- extremely difficult to create damage like this, even if you try to.

MR. ANDERSON: Yes.

THE WITNESS: And what we're seeing by the blue etch is that the variation is very small from the grey-blue surface, if you look at the hard work, hard area, very lucrative area. So, that is what we are tightening up the standards today.

MR. ANDERSON: Mr. Andersson, you have testified that Volvo drilled over 300 holes to attempt to duplicate the microstructural change that we see on the accident hub. Can you characterize in your opinion what that microstructural change is caused by?

THE WITNESS: If you look at that hole -- specifically, this hole and look at the surface as has been testimony earlier here, the surface finish is in the requirements. It seems that the only possibility to create this type of damage to the surface is by a very strong chip packing, because you're looking at a very local area of the hole and the chip packing occurs just for a few seconds and then the chip's coming up, burn away from the holes and leave that signature. And you're also looking at the surface that was very smeared. A lot of layers made out.

So, it's strong chip packing, local chip packing, or for few chips try to go over the margin of the drill instead of pulling up the chip shell, it created this type of damage.

MR. ANDERSON: Have you confidence that this was the mechanism by which your duplicate damage was caused?

THE WITNESS: This is the only time when we tried to duplicate it with other changes of drill. Can drills be without any coolant? And without any success, we have used the coolant channel drill, 24 hole without any coolant, increase the speed for 28 percentage, with no damage at all in the hole.

So, this is the only time when we have this similar damage. We have not been able to create any identical damage like this, but a similar damage. Very -- and the smearing seems to be related to that the heat -- the transportation of the heat from the area when the chips squeeze to the surface is so poor in titanium.

So, when you heat the local overheated area once again, it starts smearing that area out of the hole. That's the reason why you look at the pictures early here, and see that this very local and it's smeared and it's a very hard layer with a lot of smeared surface, with different structuring also.

The old --

MR. ANDERSON: Is it -

THE WITNESS: Yes?

MR. ANDERSON: I have an overhead slide here demonstrating what you're describing as far as chip packing.

(Slide shown.)

MR. ANDERSON: Is this the phenomena that you are referring to?

THE WITNESS: Yes, I was trying to explain. If you look at the chip channels coming up here, normally this goes in the channel. It does not call no problem. And at the time the coolant up here, it forces the chip up through the channel.

It seems, if you look at the damage on the hole, one of the chips or part of this chips had been trying to go over this margin -- have been forced over the margin. And when they hit that margin and also they hit the wall of the hole, increase the heat very rapidly also, I would say, just within a few seconds. You increase the heat enough to -- and the chip that is heated up would be very hard and have smearing material on the wall or the surface, which leaves a signature on the surface from the rough machining, the drilling operation.

MR. ANDERSON: I might comment -- thank you -- that the exhibit has not been assigned a number yet -- because of requests to get the rights to show it, and we will introduce it later.

You've mentioned several times that the -- that heat was involved in the change or the effect on the titanium. Would you suggest that heat is an integral part of changing the microstructure as opposed to the mechanical caring of the chip along the wall?

THE WITNESS: If you look at the chip, if the chip would be hard enough to create this damage, that it would be heated up to be that hard, so it's able to create the damage. And you also are able to look at the structure just behind the surface and you can see some change in the structure to show that they have been heated up.

MR. ANDERSON: The reason I ask that question, Mr. Andersson, is that we realized that after the hole is drilled, that there is further material removed from the hole. And are we to accept the fact that the chip packaging in the event that occurs there affects the material as deep as the hole when it's expanded?

THE WITNESS: As I said before, during our 300 holes tests, we have just been able to create some similar damage that is shown here in the fan hub. And the variation depth is very big. The variations from just a few hundredths of a millimeter to close to hundred millimeter in the rough machine surface. So, if you have the best conditions, it could be -- even if you have them move a little further much in the flight operations, there would still be small things that are left on the surface.

MR. ANDERSON: Is this -- yes. Is it also possible during this chip packaging that -- and I don't think you mentioned the effect of the coolant. It's possible to exclude the coolant in these local areas of the drill sides, just because there's no room.

THE WITNESS: Yes.

MR. ANDERSON: So, that takes away the possibility that the coolant is aiding and keeping the chips cool.

THE WITNESS: Yes.

MR. ANDERSON: But it is alsoopssible in

extreme and rare circumstances, that a chip is small enough and hot enough to spark or burst into be consumed? Is in a small flash?

THE WITNESS: I think so, yes.

MR. ANDERSON: Is this a sort of thing that may happen occasionally with drilling large holes in titanium?

THE WITNESS: No, I don't think so, because from what we have learned here, it's very extremely difficult to create the damage similar to that.

MR. ANDERSON: Yes.

THE WITNESS: So, I don't think that is something that is normal.

MR. ANDERSON: Would you characterize the accident hub's anomaly, the microstructural change as a relatively rare event?

THE WITNESS: It's a very extremely rare event, yes.

MR. ANDERSON: So, it would be extremely rare in the sense that it has not been seen, at least in Volvo?

THE WITNESS: Yeah.

MR. ANDERSON: As far as the follow up recommendations, you were doing 300 holes and you were looking to duplicate the process. This led to changes or proposed changes in the blue etch process. Can you tell us what -- physically what change in that process it led to, as we speak today?

THE WITNESS: The change in the process is that we have ad pictures showing up, filling holes, that we call it, holes that are showing up in the two pieces. Pictures showing this type of damage in the standards. We also have put to the lesson learned words that tells us that the variation of color is not only blue and white, it's also variations of grey, blue scale of color.

MR. ANDERSON: How many for theblue etched inspector -- under this new system, how many new patterns or pictures, standards are now used?

THE WITNESS: Four new pictures.

MR. ANDERSON: So, there are four new pictures. Are they very much the same? What are they based on? Are they based on the actual physical, one of the 300 or four of the 300 holes that you sectioned?

THE WITNESS: One of -- two of the -- three -- excuse me. Three of the 300 holes that we have produced at Volvo, yes.

MR. ANDERSON: Okay. And did you use --

THE WITNESS: And we handed over those pictures to Pratt & Whitney.

MR. ANDERSON: And did I understand you to say that there is also a visual -- an addition to the visual inspector's duties here to detect perhaps a visual indication of this condition?

THE WITNESS: No, not on the visual.

MR. ANDERSON: So, there is no --

THE WITNESS: Just a BEA.

MR. ANDERSON: It is believed that there is no visual way to detect.

THE WITNESS: That's correct.

MR. ANDERSON: And the reason I ask that is, as we look at the earlier pictures and the one behind the table, we do see a visual indication of the two origin sites.

THE WITNESS: Yes. If you look at that hole -- and that hole has been around for close to 14,000 cycles, you have this variation of color, because this is a whole layer there than in the normal section.

So, from what we have seen at Volvo, if you look at a part -- as a new part, in the surface finish, you were not able to see any variation by visual inspection of the holes.

MR. ANDERSON: What type of drill -- was one type of drill used to create all 300?

THE WITNESS: No, we have tried -- we have used all the different types of drills that we had used at Volvo since '84 up to today.

MR. ANDERSON: And was there any correlation between the type of drill and the ability to create the damage?

THE WITNESS: No, there wasn't.

MR. ANDERSON: My other question would be, in your professional opinion, is the new standards that are -- that have been developed have a high probability of identifying this microstructural change or is it still possible that this microstructural change, if it meets all other inspection criteria, cannot be detected?

THE WITNESS: I would say that the change that we have together with Pratt & Whitney made the blue etch will take care of this type of variation in the structure. I have a very high confidence for that process.

MR. ANDERSON: And what makes you confident of the process?

THE WITNESS: Because I know that we now have the pictures. We have also a lot of lessons learned. We have all people -- the inspectors have been able to look at this tape of samples that we have shown. We have shown the samples also from the inspection of Pratt & Whitney. So, we have a very high confidence for the process, because of that and the new pictures, the new words, and lessons learned, and so on take care of this type of variations that we were looking at in 1989 without understanding what it was.

MR. ANDERSON: So, the new understanding as a result of the information from the accident, as well as the experiments done in drilling holes, give you a high confidence that any future rare events of altered microstructure will be detected --

THE WITNESS: By the blue etch.

MR. ANDERSON: -- by the blue etch inspector.

THE WITNESS: Yes.

DR. LOEB: George, if I could just follow up on one question. Is that dependent -- is that strongly dependent upon the inspectors having these pictures?

THE WITNESS: Yes, and also the training of the inspector. So, there's always a human in there.

DR. LOEB: So if they see something in the blue etch, but there isn't a picture that looks like that and has some -- and it has been identified as a microstructural defect, what do they do with that then? In other words, if they see a blue etch -- some sort of difference in the blue etch, but there is no picture that identifies it as a specific defect, how is that --

THE WITNESS: But in the standard -- part of the standard. It's all variation, and the grey-blue color or grey color, white. And earlier, it was white and blue. So, all variations to the normal surface conditions will give signal there is something on the surface.

DR. LOEB: And so if it doesn't look like one of the pictures, then what will happen?

THE WITNESS: Because you have the word -- written words in the standards telling that you have to take care of all variations today.

DR. LOEB: But what will happen then? What will the steps be taken?

THE WITNESS: The inspector will have to call down the level 3. The level 3 is the specialist approved and trained by Pratt & Whitney. He will go down there. They will make a replica on this local area. Evaluate it, if there is a metallurgic damage. If there is something on the surface he's not sure of, they would do the -- the next step is to re-etch the part.

If there still is variation of discoloration, we reject the part and we have to within 24 hours give that information to Pratt & Whitney and inform them about they have rejected parts up on the blue etch.

DR. LOEB: If there is -- if the part is rejected or they re-blue etch it and that same indication shows up, is there an automatic process to section it and look at it then under an SEM or some other technique?

THE WITNESS: If the part were -- we will cut it up and section it.

DR. LOEB: Always?

THE WITNESS: We would always do that to understand what we're looking at.

DR. LOEB: Okay. Thank you.

THE WITNESS: Because there would always be a lab report coming up from that. A replica was shown there is something abnormal on the surface.

DR. LOEB: Okay. Thank you.

MR. ANDERSON: The inspection process for blue etch, I think has been -- we've pretty well covered, but I would like to turn to the other protection, which is proper drilling procedures. During this experimentation, did Volvo come up with any change or any recommended change to their -- to your processes that would reduce the probability of creating the condition? That is to say, perhaps modify the way the chips are handled. In other words, have your drilling procedures changed as a result of the -- what you have learned from the accident?

THE WITNESS: The drilling procedure that we use at Volvo today is that high speed steel drill specially designed for titanium, very small margin, and very different type of relief, angle zone. And the speed and feed and everything -- we have not been able to create any type of damage by using that too. So, no, we're not suppose to change anything in the process --

MR. ANDERSON: Iunderstand.

THE WITNESS: -- of speed and feed and drilling. What we have changed is that we have more specific training operators to be more -- evaluation of the chip's color and so on, because that is the only way they have the possibility to see if anything happened down there in the hole.

MR. ANDERSON: So, is it fair to say that at the present time, there is no higher probability of creating this condition with any of the types of drills that have been in general use at Volvo and perhaps at other manufacturers?

THE WITNESS: If you look at both the coolant channel drill, both types of the coolant channel drill, and the high speed drill that we use, and use in those drill by normal conditions, flowing down the coolant through the channel, flood over the part, we have not been able to create any damage of deformation to the holes.

MR. ANDERSON: I understand. So, that there are essentially no changes to the manufacturing or drilling process as a result of --

THE WITNESS: That's correct.

MR. ANDERSON: Does Volvo produce drilled holes in other titanium products for other manufacturers other than Pratt & Whitney?

THE WITNESS: Yes, we do.

MR. ANDERSON: Are these parts subject to the blue etch anodize inspection process?

THE WITNESS: Yes, they are.

MR. ANDERSON: Is this true with all of them?

THE WITNESS: Yes. That is a normal way of handling the titanium parts, rotating parts. We always do the blue etch.

MR. ANDERSON: And so this new standard will be applied to other parts, other than this particular part manufacturer?

THE WITNESS: Our operations and inspectors out there are trained to the new standards, to the knowledge that they have today. So, yes.

MR. ANDERSON: Yes. We talked about the blue etch process. And I would like to return briefly to cover the engineering source approval process, as far as the specific details with the accident hub. More specifically, we have an exhibit here that shows the exact transaction that authorized the use of the coolant channel drill. And I would like to present Exhibit 6-B-1.

THE WITNESS: What exhibit? Say that again? Six --

MR. ANDERSON: I'm sorry, Exhibit 8G is the first one.

THE WITNESS: Eight-G.

MR. ANDERSON: The Exhibit 8G -- excuse me -- is a rather bulky document, page 26. You're on page 26. Can you explain the circumstances and the activity being accomplished by this form?

THE WITNESS: Okay. What we're looking at is page 26. There is a process of a record. That is a record that we have to send in to Pratt & Whitney each time we do any changes on the rotating parts, manufacturing to Pratt & Whitney. It's to explain that we canceled and replaced by another drill. And it also tells that that is an operation. Operation 80 was a rough drilling operation. And we have the normal or the new drill and we also explain that this drill -- the drawing of that drill is in close to this.

We also explained that the feed, speed, and coolant are the same as approved method.

MR. ANDERSON: So that, essentially this document was part of the engineering source approval. Is that correct?

THE WITNESS: Yes.

MR. ANDERSON: And that process in general was to communicate to the engineering authority at Pratt & Whitney significant changes -- and I'll use that word, because it's used in this document. There are three types of changes. There's a first submittal. There's a significant change. And there's an insignificant change.

In this case, the marking was insignificant. Could you tell me who filled in that block, insignificant?

THE WITNESS: That is a decision made by Pratt & Whitney engineering of the quality.

MR. ANDERSON: Was that --

THE WITNESS: But this was Pratt & Whitney.

MR. ANDERSON: Was that Mr.McCarter's signature at the bottom?

THE WITNESS: It could be Mr.McCarter, yes.

MR. ANDERSON: Yes. And what was his position at this time?

THE WITNESS: He was at Volvo as a quality guy. And this approval had been sent in by McCarter -- had sent in and discussed it with the people at Pratt & Whitney prior to approving that at Volvo.

MR. ANDERSON: So, he made the decision that this was an insignificant change. Is that correct?

THE WITNESS: I don't think that -- Tom McCarter made it by himself. He made it together with engineering and other --

MR. ANDERSON: No, I understand.

THE WITNESS: -- people.

MR. ANDERSON: But I'm just saying, I'm

trying to establish that he was the individual that put the marking on the form.

THE WITNESS: Yeah, it seemed so.

MR. ANDERSON: Yeah. I understand that he is not -- that he is working in conjunction with his engineering personnel and we'll discuss that. So is this, indeed, the coolant channel drill that we have described before as being in use at the time the accident hub was drilled?

THE WITNESS: It should be. Yeah, it is.

MR. ANDERSON: So, yes, it would be the same. It may not be the same diameter. I would want to check that, but it would certainly be the same --

THE WITNESS: It is the same drill.

MR. ANDERSON: -- physical description having the carbide cutting edges and the coolant holes.

THE WITNESS: Yes.

MR. ANDERSON: So, at the time of the accident, you were visited by several inspectors to look at the process. And one of the findings by the FAA, which is in this exhibit -- this same exhibit, was that there seemed to be some difficulty with the engineering source approval, ESA, process. Was this particular record, in your opinion, filled out improperly?

THE WITNESS: Oh, yes.

MR. ANDERSON: I don't meannithe sense that it was classified as insignificant, but was there any other error in the way it was processed?

THE WITNESS: The process was working. The ESA process was showing up.

MR. ANDERSON: So, that in your opinion, you and Volvo had communicated your intent to change to the coolant channel drill to Pratt & Whitney?

THE WITNESS: Oh, yes, as we always do.

MR. ANDERSON: Yes. One other question on this form. Going back up to the description, they talk about speed, feed, and coolant are the same as the approved method. Is that not an error, that aren't the described speeds for the coolant channel somewhat higher than the high speed steel that was in use prior?

THE WITNESS: Together with this process approval record, they will have all the operation drawing sheet showing all the feed and speed. So, if there is a written error, I don't show that, because we are looking at the feed and speed is based on this 700 test that we run. And by that, we mean that the process shown or approved that it's a good process.

So, that could be the word that we mean here. But remember, that behind this process approved record is both the old or that would be in use at that time and the new document that we will use approved by this document. So, in that document, you will see all operating drawing sheets, feed, and speed, and tooling, and also --

MR. ANDERSON: I understand.

THE WITNESS: So, that is not misleading information. No, I don't think so.

MR. ANDERSON: But I think if we read this document as it stands, that portion would appear to be an error.

THE WITNESS: Yes. But you had to look at the whole packs of paper that was in that.

MR. ANDERSON: Yes, which is not all present.

THE WITNESS: Yes.

MR. ANDERSON: Page 29, I believe, talks about predrilling. And it's -- I would simply ask in passing, is this telling us that the predrilling was used on the tie bolt or the counterweight holes?

THE WITNESS: It's just said that you change the information to another page -- to another operation drawing.

MR. ANDERSON: It is not a predrilling that applies to the counterweight holes?

THE WITNESS: It is a predrilling, but it is not removed or something like that, but it tells -- to change to another page of the package of paper.

MR. ANDERSON: I understand.

THE WITNESS: Yes.

MR. ANDERSON: Immediately after the accident, details were known as far as the metallurgy of the hub. Volvo took some action to identify some blue etch indications. Could you describe how that was undertaken?

THE WITNESS: First of all, we didn't try to identify any blue etch indication. We weren't able to do that, because all the blue etch indication historically have been taken care of prior to that. So, what we are talking about is notifications or -- yeah, notification from the blue etch inspectors that he has seen something on the surface related to the holes and reported that down the road, so to speak, and down to the final inspector to make a decision.

We were able to look at, oh, the 2,400 parts that we have produced. And we identified eight more hubs. Two of them were scrapped at Volvo prior to shipping. One of the six hubs has only a -- from the FPI, who has similar notes, as we were discussing earlier here.

So, there's another five parts out there with notification from the blue etch inspector, there was something in the holes similar to what we have seen on this accident hub. And those were identified, I think it was 13 or 14 of July, and we gave that report over to Pratt & Whitney and they took care of it immediately.

MR. ANDERSON: Yes. So, those were obtained, the ones that were in service. And was any discrepancy found in any of those in service?

THE WITNESS: No. No metallurgic damage in none of the six.

MR. ANDERSON: Have you since that event, gone and looked at the rest of the records of hubs and identified any other indications in the travelers, which know you have told are not blue etch? That you know -- unfortunately, that terminology has gotten into the record at various points. But they are either visual or FPI type indications.

THE WITNESS: The notes from the FPI was not an indication. It was a remark from the FPI.

MR. ANDERSON: Yes, yes.

THE WITNESS: So, you have to understand that indication is something that the part will never leave that operation, if they have an indication.

MR. ANDERSON: Exactly. So --

THE WITNESS: So, what we're looking at and discuss here is notification of remarks.

MR. ANDERSON: So, I need to correct myself and say they would --

THE WITNESS: Yes.

MR. ANDERSON: -- be limited to the visual criteria or visual criteria that were not understood and passed on to the visual inspector?

THE WITNESS: Yes, that's correct.

MR. ANDERSON: After that initial inventory, if you will, were any other hubs identified as perhaps being at higher risk or --

THE WITNESS: We have created what we call a method. When we put all the 200 -- 2,400 hubs and we had identified together with Pratt & Whitney other hubs that -- known to Pratt & Whitney and they have informed the operators about those serial numbers.

MR. ANDERSON: And how many, approximately?

THE WITNESS: It was -- with shoes at the time -- we're back in August '96 now. And we were focusing at that time on just the coolant channel drill. So, with shoes -- all the coolant channel drill was 720, including the fail. And then in late October, beginning of November, with by the method we would use going through all the information, we identify 258. And that means that 140 of those that we find at that time has been added to the other 720, because the other 180 pieces per hubs were in the first group of 720.

MR. ANDERSON: So, essentially, they would be considered to be at somewhat higher risk. If we go back to the assumption that this is a rare event, then those hubs would be the ones considered the most at risk, because of some sort of observation?

THE WITNESS: That this is a maybe. Perhaps, yeah.

MR. ANDERSON: Yes. But would it be -- would you conclude that given the inability of blue etch anodize inspection to detect this anomaly up till fairly recently, would allow the possibility that a similar damaged hub could have been produced?

THE WITNESS: The possibility is there, yes.

MR. ANDERSON: Yes, the possibility is there. I'm not suggesting that it is high, as those that had some indication, but because it's a rare event and because there is or was no way to positively inspect for his condition.

THE WITNESS: That's true.

MR. ANDERSON: I would likeotjust shift to another product of the documentation system between Volvo and Pratt & Whitney, and that is the Exhibit 11-D. Do you have Exhibit 11-D?

THE WITNESS: Yes.

MR. ANDERSON: Here we have as we interpret it, an example of a form used to report a supplier's report of non-conformance or a brief -- and the acronym is SRON. It is a United Technologies, Pratt & Whitney form. And we interpret this as being part of the material review board system, which jointly operates between Pratt & Whitney and Volvo to maintain in accordance with the aviation regulations, the quality and the integrity of the manufacturing process.

Could you tell us -- we find that this particular part of this hub is mentioned for a non-conformance. It is not a non-conformance that is related to the hole that we have been discussing, but could you describe the non-conformance here?

THE WITNESS: If you look at the item number

A, page 1 of this exhibit, you would the serial number 32971, as the fourth serial number at the top of that. And that is related to the diameter outside the hub, the turning diameter. You don't have a good picture in the hub here. It's related to diameter out here, in this area. It is not related to any holes.

MR. ANDERSON: I may have another -- is that sufficient?

THE WITNESS: We use that. That's okay. You would also on page 2 be able to look at item A and also find the same serial number. It is also diameter out in this area. It's in this area of the hub, not related to the holes at all.

MR. ANDERSON: And can you describe the condition that caused this discrepancy?

THE WITNESS: If you look at item A on page 1, it says that the diameter is adjusted to blueprint requirements of the tumbling, operation 220. The parts are tested and are subject to in entirety. So, there is in attachment page 1, which noted in here, to explain if there isn't -- there probably isn't over or around the size of the dimension -- diameter.

MR. ANDERSON: Yes. And I call your attention to page 2, investigation and follow up is going on in purpose to find out why this diameter is not all a shrink, is calculated. So, am I reading that correctly?

THE WITNESS: Page 2?

MR. ANDERSON: Yes. In the second --

THE WITNESS: Item A?

MR. ANDERSON: Item A, yes.

THE WITNESS: It is also diameter. It says that it's two ten thousandths of an inch over max.

MR. ANDERSON: And could you read the first part where it says "compensation in process sheet?"

THE WITNESS: The compensation process sheet, because of shrinking diameter, the part did not shrink as much as calculated. That means that during machining of the part, you had to take care of the variation of heat on the part, the titanium, and it's working up and down, and the diameter is increased and decreased because of the heat. And because of that variation here, it's not as normal or as calculated during the process of the turning of the diameter.

So, that's the reason why they, on the final part, have this deviation or non conformance. That is rather normal that we have to take care of variation from sharp pinning, tumbling, and processes between the

-- the operation was rather early in the steps of the manufacturing of the part and to the final dimensions. And sometimes we don't now why it don't work. The calculations are wrong or something like that for some part. You will have this oversize or under size because of that.

MR. ANDERSON: I understand. And in talking through this, we are essentially going through the material board process here that looked at a part, found it had shortcomings. In this case, they were dimensional shortcomings and took action to correct them. And if I read it correctly, it appears that the part was delivered meeting the blueprint specification. Is that a correct statement?

THE WITNESS: Well, on the first page, yes. On the second page, there still was an oversize of two ten thousands of a diameter. On the part -- from Volvo. But they accept it on the --

MR. ANDERSON: Yes, but I also see just reading below, that -- oh, I'm sorry. That's for a second part that's being discussed.

THE WITNESS: Yes.

MR. ANDERSON: So, yes, so that we can conclude by saying that the part -- the material review board concluded that the part was functional, even though the dimension was two thousandths --

THE WITNESS: Two ten thousandths.

MR. ANDERSON: -- two ten thousandths out of or oversized.

THE WITNESS: Yes.

MR. ANDERSON: That's the last question I have, Mr. Andersson. Mr. Chairman.

CHAIRMAN GOGLIA: Wewill proceed to the parties. The Federal Aviation Administration?

MR. DONNER: We have no questions. Thank you, Mr. Chairman.

CHAIRMAN GOGLIA: Pratt & Whitney?

MR. YOUNG: No questions, Mr. Chairman.

CHAIRMAN GOGLIA: Air Line Pilots Association?

MR. MCCARTHY: No questions, Mr. Chairman.

CHAIRMAN GOGLIA: McDonnell Douglas?

MR. STEELHAMMER: No questions, Mr. Chairman.

CHAIRMAN GOGLIA: Delta Air Lines?

MR. VALEIKA: Yes, we have one question. The blue etch procedure at the time of this disc inspection, just to clarify a point, was not used to find any type of machining mechanical process induced errors. It was strictly used to see if there was a problem with the base material after it's drilled. Is that correct or not correct?

THE WITNESS: The only in process that was related to the specification is the overheated of an area by grinding, for instance, or polishing.

MR. VALEIKA: So, but -- I heard you basically say the blue etch procedure then at that time -- not today, but then, are basically -- there was no action taken based on any of the blue edge findings, but there was action taken based on the visual findings of the hole and the various comments that Mr. Anderson referred to?

THE WITNESS: Yes, because it was not blue etch findings. It was an observation by the blue etch inspector.

MR. VALEIKA: But just explain that to me? The blue etch didn't show anything at all?

THE WITNESS: That's correct.

MR. VALEIKA: That's all I have. Thank you.

CHAIRMAN GOGLIA: Volvo?

MR. THOREN: No more questions.

CHAIRMAN GOGLIA: Okay. We'll bring it up to the panel here. I think Mr. Loeb -- Dr. Loeb has a question.

DR. LOEB: Yes, I have a couple of questions, but I want to follow up on the last question that was asked by Mr. Valeika. The blue -- your answer to this question, I believe, was the blue etch didn't show anything.

THE WITNESS: Yes, that's correct, because then you have had the note in there. The code 40 in that operation -- in that inspector record.

DR. LOEB: Would it be correct to say that there was nothing detected by the inspector in the blue etch anodized process?

THE WITNESS: Isn't that the same, because the operation --

DR. LOEB: Well --

THE WITNESS: -- depending on what the inspector --

DR. LOEB: Is it -- I mean, is it the same? And the reason I'm asking is because if the situation were the way it were today and the additional pictures made available, that same blue etch process may have been identified at that point as something to be concerned about today when it was not at that time. Is that correct?

THE WITNESS: During the test -- during the test here at Volvo, we have been trying to understand the blue etch -- the way the blue etch working. And unfortunately, it seems that sometimes the blue etch could be interfered by documentation -- and especially when we look at the smear surface like we're looking here. The layers could be -- could include, for instance, iron, which gives grey color instead of dark blue indication. And the grey color -- that's the reason why we have add this words to the standard today and showing that all variation, even in the grey color --

DR. LOEB: I --

THE WITNESS: We have samples that we -- the first etch operation and the test is to finish anything -- that people are looking at the part, looking down at the holes, so a good hole -- as I thought, we would cut the hole in two pieces, re-etch the part, and some very local area was dark the second time. But the first time when we look at that hole, we were able to look at the variation of the grey color. That's the reason why we put that statement out in the EIS 30 today.

DR. LOEB: And so I'm going to ask you again. If the conditions that exist today had existed -- the statement, the pictures, and so forth, had they existed then, then it is possible that that blue etch may have indicated something to the inspector that it wouldn't have at that time?

THE WITNESS: Yes.

DR. LOEB: I just wanted to clarify that. Now, just a couple of questions regarding the change approvals and so forth. It's my understanding and I just wanted to make sure that I'm clear on this, that any change from a type of drill bit to another drill, any change in the feed or speed, you would get Pratt & Whitney's approval for that?

THE WITNESS: Yes. All the change -- even if a change machine from another machine is standing behind that, beside that machine, change from machine A to B, we had to approve that by Pratt.

DR. LOEB: Regardless of whether it was a significant or insignificant change, you would get the --

THE WITNESS: We always sign all that document.

DR. LOEB: Now, would the FAA -- do you know whether the FAA would be notified about any of those changes?

THE WITNESS: I'm not able to answer that question, because we're not working the FAA.

DR. LOEB: Okay. That's fair enough. Can you describe very briefly, the changes -- the differences in the process that would take place between a change that was significant versus a change that was insignificant?

THE WITNESS: Repeat that again?

DR. LOEB: Yes. What are the differences that would occur in the process if that were a significant change rather than an insignificant change?

THE WITNESS: I think this question that a better witness should answer on, because they make the decision things can change.

DR. LOEB: That's fine. So, you would be more comfortable with them answering that?

THE WITNESS: Yes.

DR. LOEB: Okay. Thank you. I don't have anything further.

CHAIRMAN GOGLIA: Mr.Haueter?

MR. HAUETER: Just a few. One, just for the record, this part is designed by Pratt & Whitney. Is not designed by Volvo.

THE WITNESS: No, it's designed by Pratt &

Whitney.

MR. HAUETER: It's designed by Pratt & Whitney. When you first starting making the part, Pratt & Whitney provided all the specifications to be used in the --

THE WITNESS: Yes, they did.

MR. HAUETER: Okay. Was there any FAA involvement?

THE WITNESS: Well, as I told you earlier, we were working with Pratt & Whitney requirements -- and we are -- all the information, all requirements coming through Pratt & Whitney to Volvo.

MR. HAUETER: Did the FAA ever do inspections of your facility to --

THE WITNESS: No, but the Swedish authorities does twice a year.

MR. HAUETER: There were no FAA inspections of your facility or production?

THE WITNESS: Not in manufacturing.

MR. HAUETER: You mentioned you drilled numerous holes in other samples. And I want to check on this. Looking at the chip packing phenomenon, once again, how deep does this go into the material?

THE WITNESS: We have had about 20 different holes created by chip damage, was the only time when we had something similar to what we're looking at in the hub. The depth of those 20 damages had variation from a few hundredths of a millimeter down to close to one millimeter. We don't know why this variation, because the signal that we get from the machine that we use -- is the same signal.

MR. HAUETER: And the machine used, this is a computer controlled machine.

THE WITNESS: Yes, it is. And we continue to test at Volvo now. And we are suppose to in late May or beginning of June have that testing finished.

MR. HAUETER: How much operator involvement is there in this process?

THE WITNESS: The operator have the possibility to look at the chips, he starts the machine. The machines really control -- he changes the tool, but he changed the tool in the magazine behind the machine. So, the machine is picking up the tool from the magazine. So, the influence from the operator is very little.

MR. HAUETER: Minimal.

THE WITNESS: Yes, minimal. He is very important to look at the operation going on, listen if there is any special noise coming out from the machine. But as I explained, when we look at the picture, there's a closing cabinet around. So, it's not so noisy out there --

MR. HAUETER: Can the machine itself note whether there is a binding, drilling, or whether there's a problem? Does it have a back feed?

THE WITNESS: Today, we are incorporating that in some of the machines. And we had made the first incorporation back in March '96. Before that, we didn't have that equipment on the machines, no.

MR. HAUETER: Real quickly, looking at Exhibit 11-E, page 15, this is not necessarily the accident part, but I note at the bottom, there's a comment.

THE WITNESS: Will you give me the page once again, please?

MR. HAUETER: Page 15 of 11-E. Can you describe what's happening here? The dimensions -- I'm trying to read this -- is that there were parts sent to Pratt & Whitney for examination? I don't understand.

THE WITNESS: If you look at those, those was the findings that you're looking at of these runs. When you look at this run, you will find the same dimensions in this run. So, the area here, we have noted down the dimension, the variation, and what it is. And then we put it on a -- and send it over to Pratt & Whitney for -- or approval as it is.

MR. HAUETER: Is there a Pratt & Whitney representative on site to make that determination or do you have to ship it back to the U.S.?

THE WITNESS: I have to ship it back to U.S.

MR. HAUETER: For their examination. And what was the case of these two parts, why did they need to be examined again by Pratt & Whitney?

THE WITNESS: Because of the oversize and the dimension of the oversize.

MR. HAUETER: Okay.

THE WITNESS: Remember, that those notes on the back side of the page 15 here is in millimeter.

MR. HAUETER: Yes.

THE WITNESS: And you also -- in that note, you also will find that the part have been center crib. It's in a locked area that would keep the part as a non-conformance, until this position had been made by Pratt & Whitney.

MR. HAUETER: That's all the questions I have. Thank you.

CHAIRMAN GOGLIA: Mr. Conroy?

MR. CONROY: Yes, sir. One or two more questions on 11-E, which Mr. Haueter just addressed. And this me retrace a little bit of ground, but I would like to be clear on this. This entire document, English translation of Volvo's manufacturing records on hub serial number 32971, as the title reads, we call the traveler. Is that true of this entire document? Does it travel with that hub?

THE WITNESS: Yeah.

MR. CONROY: On page 12 that Mr. Anderson addressed, some chatter marks -- and you had talked about that at some length earlier this morning -- was a comment regarding two drill holes. Is that correct?

THE WITNESS: That comment is in the single point boring operation.

MR. CONROY: I'm sorry?

THE WITNESS: That comment is madein the single point boring operation.

MR. CONROY: Okay.

THE WITNESS: That he had some chatter marks on that surface.

MR. CONROY: All right. And we talked about -- Mr. Anderson asked you some questions regarding quality assurance inspections following those comments. What would be the last quality assurance inspection indication in this traveler regarding those comments?

THE WITNESS: Two hundred and thirty.

MR. CONROY: I'm sorry, I didn't hear your last sentence?

THE WITNESS: Two hundred and thirty. The operation coded 230.

MR. CONROY: Is that on page 10?

THE WITNESS: Page 10, yes.

MR. CONROY: All right. And we have a quality assurance stamp in that line. Is that correct?

THE WITNESS: Yes, that's correct.

MR. CONROY: Now, I noticed there are no comments there, and you discussed that, I think, briefly. When would comments, if ever, be appropriate regarding that action?

THE WITNESS: If he as an inspector did identify anything that is not within the requirements, he put those notes down on the inspection records. And then we have to discuss that or send the variations, non-conformance to Pratt & Whitney to reactivities.

MR. CONROY: I'm sorry, your last sentence?

THE WITNESS: We have to send them to Pratt &

Whitney for evaluation.

MR. CONROY: I see. Does that QA stamp indicate that the bore -- correction -- that the holes, the drill holes that were commented on in the first comments regarding chatter marks, passed his inspection?

THE WITNESS: Yes. And you don't find any notes in the inspection records. So, yes, they were approved to the standards.

MR. CONROY: Could there still be any indications in that, in those drill holes and meet inspection qualifications?

THE WITNESS: If you look at the surface finish and say that -- I would say the variation could be there, but not to the -- not a reason for a reactive part to the VIS specification.

MR. CONROY: Your last sentence, sir?

THE WITNESS: There was not -- there could be something in that hole, but not reason for reaction. That was approved by the or accepted by the VIS standard.

MR. CONROY: Okay.

THE WITNESS: Did you understand what I mean?

MR. CONROY: I think so. Are there documents that tell how much -- you mentioned it could be something.

THE WITNESS: If this is acceptable, you don't find any -- you will not find a note on it.

MR. CONROY: I guess my question is, are there objective criteria that say how much is acceptable?

THE WITNESS: In the VIS standard it is, yes.

MR. CONROY: And by that, I can assume that his stamp indicates that we are within an acceptable level.

THE WITNESS: Yes.

MR. CONROY: Now, you mentioned if he were required to make a comment, it would then go on back to Pratt & Whitney. Is that correct? If he found it unacceptable?

THE WITNESS: If there is anything who is not acceptable to the standard, to the drawings -- we have to go to Pratt & Whitney to get that approval or rejection.

MR. CONROY: Is there a Pratt & Whitney representative at Volvo or would you go to Pratt & Whitney in Connecticut?

THE WITNESS: We go to Pratt & Whitney in

Connecticut.

MR. CONROY: Okay. Thank you very much.

CHAIRMAN GOGLIA: Are there any further questions from the parties? Okay. Hearing none -- oh, Mr. Eindler.

MR. EINDLER: My name is Erik Eindler, and I represent the Swedish Board of Accident Investigation. Would you summarize the situation that Volvo and Pratt & Whitney and maybe the aviation world know more about the titanium alloy machining inspection today than -- after the accident than before the accident?

THE WITNESS: Yes, I will do that. We have shared information with the companies we work together with. And I know that Pratt & Whitney have shared the information to other companies, too, that we have lesson learned -- during the investigation at Volvo about the machining of titanium, the type of damage we are looking at, and so on. And also the BEA process.

MR. EINDLER: That means that also Volvo's routine instructions and Pratt & Whitney instructions regarding inspection has changed as a result of --

THE WITNESS: Regarding the BEA inspection, yes.

MR. EINDLER: What about -- do you have to calibrate the judgment of inspectors to define to approve or not to approve surface imperfections? Sometimes, it's difficult to -- just to read in the paper to define an imperfection. Sometimes, you need to physically look at the piece and the imperfections. Do you regularly calibrate that with the Pratt inspectors?

THE WITNESS: Yes, we do — that, we do, sure. And we also have very similar -- the same as both sides of the -- so, we use as a standard, looking at the surface, and we always do that. We have a lot of questions between each other about look at this piece, part. We have something that we would all ship out and they give their response on that question. That is a continuing going on between Pratt & Whitney and Volvo.

MR. EINDLER: Okay. So, does that mean that you have the feeling that a Pratt & Whitney inspector would judge about the same as your inspectors in your shop?

THE WITNESS: Today, yes.

MR. EINDLER: Or today, and, of course, the time of the manufacture?

THE WITNESS: Oh, yes. Yes.

MR. EINDLER: Okay. Thank you, Mr. Chairman. No more questions.

CHAIRMAN GOGLIA: Again, I'll go to the parties. Any further questions? Hearing none, then, Mr. Andersson, we will release you.

THE WITNESS: Thank you.

CHAIRMAN GOGLIA: Thank you very much for your testimony.

THE WITNESS: Thank you, Mr. Chairman.

(Witness excused.)

CHAIRMAN GOGLIA: And we'll call our next witness, Mr. Scussell. A little housekeeping issue here. We are running behind schedule, which we have a very aggressive witness list for these three days. So, the likelihood of us reconvening after dinner is high. So, if you -- if anyone needs to be excused, if we need to change the parties' spokesman, we will be very flexible in that. Just, I believe, we all should make plans to be here late. Thank you.

(Witness testimony continues on the next page.)

DOUGLAS J. SCUSSELL, MANAGER, MATERIAL CONTROL LABORATORY, QUALITY ASSURANCE CORE OPERATIONS PRATT & WHITNEY, EAST HARTFORD, CONNECTICUT

Whereupon,

DOUGLAS J. SCUSSELL,

was called as a witness by and on behalf of the NTSB, and, after having been duly sworn, was examined and testified on his oath as follows:

MR. HAUETER: Sir, would you provide your full name and place of employment for the record?

THE WITNESS: Douglas J. Scussell, Pratt & Whitney Aircraft.

MR. HAUETER: And whats' your position at Pratt & Whitney?

THE WITNESS: I'm the manager of the materials control laboratory. The material control laboratory is the quality laboratory for manufacturing operations. We are responsible for the chemical, mechanical, metallurgical, and non-destructive testing of supplier products and materials.

We are also responsible for supplier process control and approval.

MR. HAUETER: And could you give us a brief history of your background in your field?

THE WITNESS: I've been with Pratt & Whitney for 30 years in a variety of engineering and manufacturing disciplines. Most recently, in the quality control organization. I've been a member of Jet QC, the FAA Titanium Organization since its inception in 1990. And I have a degree in chemistry, and I've done graduate work in chemistry and material science.

MR. HAUETER: Thank you. Mr. Anderson.

MR. ANDERSON: Good morning, Mr. Scussell.

THE WITNESS: Good morning.

MR. ANDERSON: Would you tell me -- you've given me some of your background, if you have any -- if you have published any papers or members of any engineering or technical societies?

THE WITNESS: No, I have published any papers. As I said, I am a member of Jet QC, but I do not belong to any other technical societies.

MR. ANDERSON: And could you characterize for us briefly, your experience in working with titanium as far as rotating parts, as well as other static parts, please.

THE WITNESS: Initially, when I went to Pratt & Whitney, I worked in the materials engineering organization, doing chemical analysis of titanium components and other materials, which exhibited service problems. I've been involved with major rotating parts since about 1978 in virtually every aspect from raw material production, melting, conversion, forging, and machining.

MR. ANDERSON: I would like to start with something that's a little bit out of order, because it carried over from the last testimony. And that was the issue of, perhaps, unspoken was the industry in general familiarity with microstructural anomalies, if I'm going to use that terminology to take it away from the other types of defects.

In your experience with the industry with the titanium institute and also with various other organizations that are looking at improved methods of both forging and manufacturing processes, had this issue been the subject of any research that you know of?

THE WITNESS: Are you talking about the issue of the machining?

MR. ANDERSON: The issue of manufacturing, in general, where microstructural changes might have been induced. It would not necessarily have to be associated with the drill, but any cutting tool or any tool capable of creating heat would be a candidate from what we seen.

THE WITNESS: Yes. Well, I don't know of any industry-wide efforts, with the exception of efforts in the NDT area to evaluate these types of indications, but we've always been concerned with them from a manufacturing perspective, and that's why we have a variety of inspections on these components.

MR. ANDERSON: Since the accident when more was learned of how this could apply to a tie bolt hole, was there any initiatives taken with any of the professional societies or organizations?

THE WITNESS: Yes, at the 1996 Jet QC meeting -- and, as I said earlier, it's an FAA run meeting, but Pratt & Whitney, General Electric, Rolls Royce, Scorsky, all the major engine manufacturers have representatives. I did at that time show a photo and describe the damage that occurred on that bolt hole, so the rest of the industry was informed.

MR. ANDERSON: But, to your knowledge, there's been no guidance forthcoming in terms of general instructions or cautions or warnings about the consequences of, say, drilling in titanium?

THE WITNESS: Well, I think by virtue of the fact that we had this incident and that I presented this to the other jet engine manufacturers, I think that was a clear warning.

MR. ANDERSON: Yes, it was certainly -- you were saying it was communicated. The factual information was communicated to these groups.

THE WITNESS: That's correct.

MR. ANDERSON: When you did your initial investigation, could you share with us your impressions of what you were looking at as far as the accident hub, as far as the defect?

THE WITNESS: The investigation of the failed component was performed by the NTSB lab, the presentation that Ms. Bernstein gave earlier. Pratt & Whitney worked with her a little bit, our failure analysis people did, but the investigation was an NTSB lab investigation.

MR. ANDERSON: But you received information on the nature of the failure. And, I guess, the specific nature of my question is, in your experience, have you seen a similar type of altered microstructure?

THE WITNESS: Yes, we had. We had a situation in 1992, I believe, that had a microstructure that had similar characteristics.

MR. ANDERSON: I would like to bring up to your attention, Exhibit 8C and 8D. And on 8C, if you have that, Mr. Scussell, on the first page, page 1, if you would read the particulars of a previous accident here, which we will look at briefly.

THE WITNESS: Yes.

MR. ANDERSON: And down in paragraph D, the engine involved is a JT-8D turbine fan engine. It's an earlier model and it's in the 200. It's a JT-8D-7B. And the essence of this document is that a similar failure occurred. Were you aware of this failure?

THE WITNESS: Yes, I am.

MR. ANDERSON: Could we turn to the Exhibit 8D as opposed to 8C? And this is the Pratt & Whitney laboratory report of this failure, complete with several pictures. And I believe we have an overhead slide of at least two of the pictures showing these -- okay, just one, I'm sorry.

Could you -- speaking from this slide or from any part of Exhibit 8D, for that matter, describe the similarities between this particular hole damage or perhaps discrepancies, and what we have seen and talked about previously here on the accident hub?

THE WITNESS: The similarities are that both cracks emanated from fatigue that began in an area of a hardened microstructure. The microstructure on both of -- on this component and on the Delta 1288 component were similar and had a similar hardness.

MR. ANDERSON: Okay. Was the -- can you go on and explain what the result of that hardness was on this case? What did it lead to?

THE WITNESS: The hardness led to -- well, the 1982 part is -- while it has microstructural and hardness similarities, it also has dissimilarities. One of the primary dissimilarities was a rather large gouge, an eighth of an inch up to maybe even a quarter of an inch long, was in the -- was at the top of the hole.

The 1982 part also had the work hardened microstructure completely around the hole; whereas, the 1996 part had the work hardened microstructure about 30 percent around the hole.

MR. ANDERSON: Did you attribute either of these to have a -- to be significant differences?

THE WITNESS: I consider them both to be significant differences, yes.

MR. ANDERSON: And would you take them one at a time and describe for us the reasons for finding them different?

THE WITNESS: The 1996 part, the hole itself didn't have any indications on it when it was going through the -- when it was installed in an engine. The 19 --

MR. ANDERSON: May I interrupt at that point? The use of the term "indications" is perhaps too general. Do you mean indications of a visual nature, indications of a blue etch nature?

THE WITNESS: Yes, I mean rejectable indications by either etch, blue etch, FPI, or visual inspection.

MR. ANDERSON: Is it not possible thatboth these with what's been learned since the accident, that both would have had some sort of blue etch indication?

THE WITNESS: As I said, the 1982 part is different not only because of the mechanical damage, but the microstructure, the work hardened area was completely around the hole. There was never a conclusive determination as to where the work hardening of the 1982 incident occurred, unlike the Volvo's situation where we had an inspector identify the exact hole that failed.

Now, he didn't seea rejectable indication there, but that led us to do other things with our etch inspection and our procedures. The 1982 incident didn't have any of that. It had -- it was a part that had passed its blue etch inspection. It's fluorescent penetrant inspection. It's visual inspection. And no one noticed a mechanical damage that should been quite obvious.

MR. ANDERSON: So, it would be fair to say that this part does not and did not meet visual inspection standards for being released, released as a serviceable part?

THE WITNESS: No, I'm not saying that at all. What I'm saying is it's unlikely and Pratt's conclusion at the time was that we didn't believe that part left Pratt & Whitney in the condition that it was ultimately installed in an engine in.

MR. ANDERSON: I understand. But as we see the part -- we're not fixing the point in time when this condition was made to exist. But at what we see here, it would be a failure of visual inspection. Is that correct?

THE WITNESS: At some point, thapart had an indication, a mechanical indication in it. When it occurred, I don't know.

MR. ANDERSON: Right. But that part would not pass visual inspection was my question.

THE WITNESS: That is correct, it would not pass visual inspection.

MR. ANDERSON: Yes. Okay. So, the similarities are that we do have the same sort of altered microstructure. Is that correct?

THE WITNESS: That's correct.

MR. ANDERSON: So, that if we believe that the altered microstructure has some sort of maybe as yet, undistinguished blue etch indication, then it should have shown up on this part, assuming the blue etch was done after the damage?

THE WITNESS: Yes. If the microstructure was altered and the blue etch inspection was done after that, that's a reasonable assumption.

MR. ANDERSON: Was any -- do you know of any action taken after the lab report in Exhibit 8D by Pratt & Whitney to follow up on this phenomena and study it further?

THE WITNESS: Yes. Pratt & Whitney, as I said earlier, was unable to conclude where the work hardened microstructure occurred. However, we did tighten up the inspection process for the visual inspection at the facility where this part was produced.

MR. ANDERSON: Does Pratt & Whitney permit field installation of bushings in these holes or is that a factory only --

THE WITNESS: That's an area that I'm not familiar with.

MR. ANDERSON: I'll defer that. Were there any changes in procedures, subsequent to the recommendations that you know of, as far as recommendations to operators in the field for their visual inspection?

THE WITNESS: I'm not familiar with that either.

MR. ANDERSON: My next question is -- deals with the accident hub process at Volvo, going back to the process changes that have been discussed earlier. Were you aware at Pratt & Whitney in your role as monitoring the engineering source approval of the changes that we had discussed earlier?

THE WITNESS: Yes, we were.

MR. ANDERSON: And in at least one case, you were aware because the local, apparently, quality control inspector was handling the first step in the paperwork?

THE WITNESS: That is correct.

MR. ANDERSON: And could you describe for us, basically, the way things were working and how that process worked and, essentially, outline the lines of communication?

THE WITNESS: When a supplier, such as Volvo determines that they want to make a process change to a critical part, a part that is under the engineering source approval system, they first deliver the change to the on-site quality rep, if there is an on-site quality rep. In this case, we had a member of our dimensional quality organization was actually residing at Volvo. He reviewed the change and could not make the determination whether it was significant or insignificant.

At the same time, we had a member of our metallurgical arm of quality living in Europe, who visited Volvo on a regular basis every month or so.

The change was presented to him. He also looked at the change and couldn't determine whether it was significant or insignificant or wouldn't determine whether it was significant or insignificant.

He then took the change and forwarded it and discussed it with the engineering source approval representative that is stationed in our engineering department in Connecticut. They reviewed the engineering source approval manual for that change. And the guideline at the time was, if you're going to remove more than ten thousandths in subsequent operations, the change to an initial drilling hole -- to initial drilling operation would be considered insignificant.

Consequently, after that information was discussed, the change was deemed insignificant and it had to go no further than the on-site rep at Volvo for dispositioning.

MR. ANDERSON: So, in essence, the process was working, because communication was taking place from the highest engineering authority, which, I believe, is your office or your position?

THE WITNESS: Well, the highest engineering authority lays in our engineering department. We are in the manufacturing. The quality organization resides in the manufacturing department.

MR. ANDERSON: Yes, but in terms of just the engineering source approval authority -- that's the authority that we're discussing now. I realize the two lines of communication overlap at times.

THE WITNESS: Yes, the engineering source approval process is a joint engineering manufacturing approval. We are half of that approval and our engineering department is the other half. To answer your question, yes, it went through the highest levels of both organizations.

MR. ANDERSON: So, essentially, the highest levels were not prepared to find this type of defect, because there was no way to find it, other than perhaps metallurgical sectioning?

THE WITNESS: Yes, our history of machining of titanium holes, broach slots, and other titanium dimensions and features, indicated that if you were going to remove greater than ten thousandths in subsequent operations, the initial operations -- particularly, drilling in this case, that anything caused by the drilling operation would be removed.

MR. ANDERSON: I understand. So, if we had seen the engineering source approval process proceed to its complete cycle -- that is, had it gone passed the local sign off and gone to where you actually called in a hub and sectioned it, do you believe that it would have had any change in the sequence of events that we were talking about?

THE WITNESS: What you're saying is if the change were deemed significant rather than insignificant, would we have made additional interrogations of the part?

MR. ANDERSON: No. I believe you would. I believe that if I understand the process correctly, that you would have analyzed the first article after a significant change. You would have -- you, at Pratt & Whitney, would have looked at this part more closely.

DR. LOEB: I would like for the record an answer. Is that correct? Would you expound on that a little bit, please?

THE WITNESS: If we had deemed the change significant, we probably would have done somewhat more metallography on the part. It is very unlikely that we would have cut up the hole as it was drilled. We would probably have looked at the finished holes -- we would have probably sectioned the finished holes and evaluated them microscopically.

DR. LOEB: Let me just see if I understand this. If it had been greater than ten thousandths and it had been considered to be significant, you would have gone -- you would have requested that the process be finished and then you may section the holes and look at them?

THE WITNESS: Actually, if we had removed less than ten thousandths, we would have considered the operation significant, less than ten thousandths in a subsequent machining operation.

DR. LOEB: In a subsequent machining operation?

THE WITNESS: A single point boring and honing. It would have been considered significant if there was going to be less than ten thousandths removed in a subsequent operation.

MR. ANDERSON: Following on with the idea that the engineering source process would have delivered a first article, do you believe that -- you've said that they would not have sectioned it properly. But had it been sectioned, given that this is a very rare event, this microstructural change, what is the probability that the first article would have been so damaged?

THE WITNESS: I think it would have been very unlikely.

MR. ANDERSON: Would you say that again, please?

THE WITNESS: I believe it would have been very unlikely. We have to remember that after this incident occurred, we deliberately asked Volvo to create this condition, so that we could evaluate it and we could learn how it was created and, consequently, how to prevent it and how to inspect for it.

Volvo drilled 300 holes, and they were only able to produce abusive machining in five of the holes. They were very aggressive at trying to produce this condition, to the point of shutting off coolant, deliberately dulling tools, and we still had a very difficult time creating the condition.

So, based on that, plusthe fact that we had six other hubs in service that had similar blue etch inspector comments, we pulled all those hubs back, we inspected them with our level 3s in Connecticut, and we sectioned several of the holes. We were looking for virtually anything by blue etch, FPI, and eddie current, and we found absolutely no evidence of this condition on any of those parts.

MR. ANDERSON: This is interesting to discuss that just a little bit further. When you talked about the inspector's notations, we, I think, attempted to establish earlier that these would not have been blue etch indications, but visual indications. Is that your understand also?

THE WITNESS: The blue etch inspector noticed something. What he noticed or what she noticed was not a classical blue etch indication. A blue etch indication that was documented in our standard. But whenever a blue etch inspector looks at a part, they are required to report anything they see to the visual inspector that will ultimately release the part. And the reason we do that is we'll focus on any area that has any question associated with it whatsoever.

In this particular case, that's what the blue etch inspector did. And the other six comments, I believe, were all from the blue etch inspector.

MR. ANDERSON: But these would have to be described in the terms that a visual inspector could understand. The visual inspector would not understand a difference in the pattern of the blue etch. Is that correct?

THE WITNESS: That's correct. The job of distinguishing whether it's a legitimate blue etch indication is for the blue etch inspector or the level 3.

MR. ANDERSON: So, the initial step after this analysis was done, was to recall the -- or to suspect the hubs that were drilled with the coolant channel drill. What was the correlation there? In other words, for some reason, Pratt & Whitney believed that the coolant channel drill was the cause or was involved in the causal process of this machining anomaly?

THE WITNESS: The part that failed was produced using a coolant channel drill. The six parts that were recalled were recalled not on the basis of being produced by a coolant channel drill, but rather, on the basis of inspector comments.

MR. ANDERSON: But later in the study, if I remember correctly, Pratt & Whitney suggested or recommended that over 700 hubs that were drilled with the coolant channel drill were most at risk or most suspect of having this discrepancy?

THE WITNESS: That's correct. And that conclusion was drawn after evaluating the drilling process of the high-speed steel drill versus the coolant channel drill and determining that chips could, indeed, get hung up or lodged between the drilling and the part.

MR. ANDERSON: What -- in the, I guess, we perhaps did not catch this in the earlier testimony from Volvo. What is the physical difference between the coolant channel drill and the high-speed drill that would make the chip jamming more likely?

THE WITNESS: I'm not sure that I can explain that as well as someone more familiar with the drilling process.

MR. ANDERSON: So, is there somebody in the engineering approval process that deals with the speeds and feeds and the selection of drills at Pratt & Whitney?

THE WITNESS: Yes. The major difference would be that the coolant channel drill goes down in a single plunge. Whereas, the high-speed steel drill goes down about two hundred thousandths and it removes the chips. But beyond that, I couldn't get into any more detail.

MR. ANDERSON: I understand, and that's probably a very significant observation. The other observation going back just a moment to the previous 1982 accident, there was another difference between those two processes. Do you remember the type of drill that was used in the 1982?

THE WITNESS: A high-speed steel drill.

MR. ANDERSON: And do you remember who drilled the hole?

THE WITNESS: North Haven. Pratt & Whitney, North Haven.

MR. ANDERSON: Pratt & Whitney. Okay. Could you describe as a follow on to Volvo's testimony, your participation and actions in developing the new blue etch criteria?

THE WITNESS: Now, once we learned that the blue etch indications could be subtle in some cases --

MR. ANDERSON: I'm sorry. The word "subtle?"

THE WITNESS: Subtle. We then set out to determine why that was the case. We found that some indications could be smeared with iron during the drilling process. We hadn't recognized that before in holes. We hadn't seen it.

So, we set out to, as I said earlier, have Volvo reconstruct a damaged hole for us, and we didn't want to put it in the standard in the -- strictly in the drilled state, because we wanted the standard to reflect exactly what the inspector would be looking at.

So, we made them take the holes and finish them through the single point boring and honing operations. We then sectioned the holes and we noticed on some of them, that they were difficult to see, even sectioned. When we re-etched them, the blue etch indications came out very clearly. So, that told us that there were times when you had to etch apart more than once.

Our blue etch standard, by the way, does allow us to etch apart more than once, if we see something that we think is suspicious and we want to re-etch the part.

MR. ANDERSON: So that if properly done -- there is apparently some critical steps in this process. In other words, you can lead to false positives. Is that correct? A false positive indication?

THE WITNESS: In the blue etch process?

MR. ANDERSON: Yes.

THE WITNESS: The blue etch process is rye, very sensitive. Most of the blue etch indications we see and evaluate turn out to be innocuous. They turn out to be just minor differences in microstructure or chemistry. I wouldn't call them false calls. I would say that the indications are benign.

MR. ANDERSON: But they do make the process more time consuming, more difficult for the inspector?

THE WITNESS: We do encourage the inspectors to show us everything that they find. So, we don't see that as a debit. We see that as a very positive part of the inspection.

MR. ANDERSON: My point being that the inspector, as I understand it, is really making a decision based on comparing patterns in an anodized surface with pictures or masters. If he is confused and he cannot make up his mind, then he must take the part to a more expert person. Isn't that correct?

THE WITNESS: That's correct. He'll take it to the level 3.

MR. ANDERSON: And at that point, the most extreme case, the part will be cut up, because it will suspected to have microstructural damage?

THE WITNESS: If the level 3 is unable to make a decision, they will call in our laboratory. We will go down and do a surface replica on the part. The surface replica is taking a piece of cellulose acid tape, laying it on the part, putting acetone on it, and letting it develop. You can take the tape off and it's a perfect replication of the microstructure of the part. It's a non-destructive way to evaluate a microstructure.

We then review the replicas to see if they meet our microstructural standards.

MR. ANDERSON: I understand. But doesn't this bring back the concern about smearing and that the true microstructure that's unacceptable may be beneath a smeared surface?

THE WITNESS: If we were to have a smeared surface, such as the part that we saw, our replication would have shown acceptable microstructure on either side of the indication. We would have known that we hade something different there.

MR. ANDERSON: If I understand what you're saying, and this is based on your experience with a rare event. Is that correct?

THE WITNESS: It's based on our experience with replication. A replication is not an unusual thing for us to do. If an inspector calls out a part that he sees an indication on, if the part is clearly rejectable, they reject the part. Most of the time, the indications that they call out are not rejectable, and we have to evaluate them, interrogate them more thoroughly in our laboratory. And that's when we use the replication process.

MR. ANDERSON: I understand. So, as I understand, if I understand you correctly, the final step is replication. That is the last chance at Pratt & Whitney to find an altered microstructure.

THE WITNESS: Either that, or we do have a large stage scanning electron microscope where we can actually put in an entire fan hub. There's times when we'll do that. If the part is in a surface that's easy to see, that's easily accessible by our large stage sem, we'll put the entire part into the sem and evaluate the indication.

MR. ANDERSON: What consideration is being given to the difficulty of looking at the surface textures or patterns in a hole, because we've learned from this accident that this is a very deep hole, and that perhaps visual observation of these surfaces may be difficult. Is it possible to see different patterns if one looks at different directions?

THE WITNESS: Yes. Since this incident, we have changed our procedures -- several of our procedures. First of all, we've developed a blue etch standard that focuses on holes. We have verbiage in the standard that suggests using different types of lighting when looking in holes, mirrors, baroscopes. We also talk about the dangers of shining too much into a hole, so that you can wash out a defect. But we really -- the blue etch standard in itself really focuses on interrogating holes very thoroughly.

We also have created a prime reliable parts section within our quality organization. That is for hubs, discs, rotating spacers, and seals. Any change to any feature on those parts is now considered significant.

One step further, in our engineering source approval document, any changes to the drilling of holes is now considered significant. So, in this particular case, we will no longer have significant changes -- insignificant changes, excuse me.

MR. ANDERSON: So, to see if I understand correctly, as a result of the accident, the engineering source approval process has literally been rewritten?

THE WITNESS: The quality process has been rewritten from an inspection point of view with the blue etch. The prime reliable parts group is a part of the quality organization. The engineering source approval document, which is the joint quality manufacturing approvals for these critical parts has also been rewritten. So, yes, we've changed three areas.

MR. ANDERSON: So, I will talk -- I would like to talk later -- a little bit later about the quality system somewhat separately. But the engineering source approval simply now puts more surveillance on more of the process. Is that safe to say?

THE WITNESS: I would say that it would be more accurate to say it focuses more on drilling aspects of holes.

MR. ANDERSON: Okay. I would like to turn to the quality side and talk about the exhibit -- let's see, the quality manual and the methods of following through and assuring that the processes are being done correctly, starting with Pratt & Whitney at the highest level and flowing down to the duties at the partners. In this case, Volvo was a partner.

Could you basically outline that and tell us how that process is structured?

THE WITNESS: When Pratt & Whitney issues a purchase order, attached to it is what is called a requirement control card. The requirement control card lists for incorporation every part of the Pratt & Whitney quality system, the drawing, the engineering system, the inspection system. It's all laid out on the purchase order requirement. It's flowed directly to the supplier through the purchase order system.

MR. ANDERSON: I understand.And in this case, of course, this particular part has been in production for many years.

THE WITNESS: That's correct.

MR. ANDERSON: So that the -- really the active documents would include a lot more than just the original purchase order.

THE WITNESS: The purchase order invokes the quality and engineering system. For example, there's a change in the blue etch inspection standard. New purchase orders will go out. The purchase orders that go out invoke the blue etch inspection. As soon as the standard is revised, it immediately becomes incorporable.

MR. ANDERSON: Yes. Now, if I could call your attention to Exhibit 8H-1. And that's the -- that will be on the pink sheet of paper.

THE WITNESS: I don't seem to have 8H-1 here.

MR. ANDERSON: Could you identify this document for us? This is a Pratt & Whitney document.

THE WITNESS: Yes, this is Pratt & Whitney QA-6076. It's basically the overall Pratt & Whitney quality requirement for a supplier.

MR. ANDERSON: And using this as a reference, could you show us the section that establishes the engineering source approval program?

THE WITNESS: Yes, I can. On page 5, there is a reference to PWA specification 370. That invokes the engineering source approval system.

MR. ANDERSON: Could you tell us about Pratt & Whitney 370, since it is not in the record, basically who does it talk to? Who is bound by that document?

THE WITNESS: Any supplier that produces a part that has a feature that invokes PWA 370 is bound by it.

MR. ANDERSON: So, essentially, in real terms, a part that has a change in process, even though it may be a proprietary process to that vendor, flows to your evaluations back at Pratt & Whitney?

THE WITNESS: That's correct, if PWA 370 is incorporated.

MR. ANDERSON: Okay. And could you talk a little bit using the Exhibit 8I about some of your other quality processes that relate to the material that that --

THE WITNESS: I believe we have a slide for that.

MR. ANDERSON: Yes, we do.

(Slide shown.)

THE WITNESS: What this is is a summary of the Pratt & Whitney process controls and quality inspections for critical titanium rotating parts. All of the components that you see are controlled by not only our quality system through a series of supplier authorizations, each unique to the individual supplier, but also through our engineering source approval system, which locks in a frozen practice to each of these suppliers.

We were talking earlier about Volvo. They would fall down in this category here. In these two categories. Prior to the part even getting to Volvo, we've flowed our system of control. The companies that make the master alloy, the aluminum vanadium, are the titanium sponge or the recycled material, the titanium turnings. These companies all have supplier authorizations with Pratt & Whitney and are controlled using the engineering source approval system.

In other words, the producer of the aluminum vanadium master alloy cannot make a change in his process without reporting that change and getting approval by Pratt & Whitney, the same as Volvo changing from one type of tool bit to another. That goes -- that system flows down through the electrode fabrication, through the three melt cycles for these titanium hubs. We require that the material be triple melted. Any change in melting parameters or any variation from existing parameters has to be reported to Pratt & Whitney for disposition.

Once we're through the melt cycle, we go to the conversion facility where the titanium ingot is converted to billet. The same thing holds true there. Processing records must be adhered to. Processing parameters must be adhered to strictly. And processing records must be maintained for 40 years throughout this whole cycle for our review.

When you -- once you get to the conversion of ingot to billet, the suppliers -- all of the suppliers who subsequently touch that material must maintain its exact identity of location within the ingot.

For example, if you have a 15,000 pound ingot, that's 36inches in diameter and you're going to make a disc out of 8 inch round billet, you have to know exactly where each forging melt will come from that billet, so that if you stack them one on top of another, you could lay out the entire ingot. That is required for every single forging that goes into a Pratt & Whitney critical application.

Once the forging goes to the machining supplier -- and in this case, it was Volvo. First of all, they have to procure the parts from only Pratt & Whitney approved forgers. And the forgers must state in their certification to Volvo that it was produced to a Pratt & Whitney practice.

Pratt & Whitney gets all of the records of the forgings before they're even shipped to Volvo, all the NDT records. And Volvo has to maintain each forging as identified from the forge shop to Volvo. Volvo must maintain the identity of each forging throughout the entire processing sequence.

So, there's an awful lot of inspection that goes into these parts from the very beginning. And if we find a single defect in the melt, for example, we downgrade the material. If we find defects in the forgings, we immediately take action at that point in time to control the situation.

MR. ANDERSON: Thank you. If we could turn --

DR. LOEB: Excuse me. Let the record show that that's Exhibit 8I, and I think it's the first -- well, it's the only page in 8I.

MR. ANDERSON: While we're talking about this area, if we could turn to Exhibit 8G, please. That's attachment 1A in the evaluation report of Pratt & Whitney quality system.

THE WITNESS: Excuse me, you said 8G?

MR. ANDERSON: Eight-G, golf.

THE WITNESS: Okay.

MR. ANDERSON: Okay. On page 8, recognizing that the right hand, so to speak, of the process of assuring material, of assuring proper manufacturing standards is the quality function which audits and monitors the proper performance, which is in place at all levels of this process, we see here a report from the FAA that they found some shortcomings.

Could you comment on the first shortcoming there? I think it's a finding -- a system finding.

THE WITNESS: What page?

MR. ANDERSON: This is page 8.

THE WITNESS: Yes, Pratt & Whitney is divided into several product centers. One of them is the International Product Center. Each product center is supposed to perform internal audits of their suppliers and of their internal functions. In this particular case, the international organization -- the International Product Center was not performing internal audits on the schedule that they were supposed to.

These audits are systems audits as opposed to hardware audits.

MR. ANDERSON: And could you describe the impact of a lack of a periodic audit on the system?

THE WITNESS: Excuse me?

MR. ANDERSON: What is the purpose of a periodic audit of the system?

THE WITNESS: Well, the purpose of it is to ensure that everyone is following the practices that they're supposed to be.

MR. ANDERSON: So, that during a period that audits were overdue, there might not be personnel either having the proper guidance or even following the proper guidance. Is there any way of retrieving that information after the fact?

THE WITNESS: The only way that you could do that would be to go back and look at individual records for individual functions.

MR. ANDERSON: How about the next finding, which I believe is on page 12. It deals with the Pratt & Whitney's material laboratories section.

THE WITNESS: Yes. What happened in this particular case is that the materials control laboratory is required by our own manual sections to perform -- to submit reports at a periodic frequency. In this case, it was quarterly. When the FAA went through and reviewed our system, they found that two of the areas, the reports were not on file. What we found out when we reviewed this one, was that one of the reports had been misfiled and one of them was late.

MR. ANDERSON: And was there corrective action taken in that area?

THE WITNESS: Yes, we notified all of our field people that the periodic audits had to be performed on time. And we also notified our people who were doing the filing, to take special precautions to make sure that files were, indeed, accurate.

MR. ANDERSON: In this area, could you tell me approximately how many auditors are actively engaged in this process, approximately?

THE WITNESS: In the process for this particular item, we have 25 people located -- and they are mostly field reps located throughout the supplier base.

MR. ANDERSON: And they are full-time quality assurance representatives?

THE WITNESS: Yes, they are.

MR. ANDERSON: And they are, in this case, physically located at the forges or three forges -- I'm sorry, two forges that are providing raw forge material for titanium.

THE WITNESS: Yes, they are not located solely at that supplier, but they are located in that area where they cover geographic territories.

MR. ANDERSON: And following on to page 15, this -- again, this is a requirement, I believe, of the highest level manual. Is that correct?

THE WITNESS: That's correct.

MR. ANDERSON: Can you explain what the discrepancy that was found here?

THE WITNESS: Yes. There was, again, supposed to be audits performed on various suppliers.

Not only by Pratt & Whitney, but internally by the supplier. In these cases, they were not performed at the required frequencies.

MR. ANDERSON: And what was the required frequency?

THE WITNESS: I believe for these international audits, it was once every four years.

MR. ANDERSON: And would there be interim audits between that by the on-site quality people?

THE WITNESS: Yes. I have to explain the Pratt & Whitney systems audit group is a group that goes out and checks the functions, the systems of the suppliers on a given frequency, and I'm not really aware of what that frequency is.

We do have a dimensional side of quality, which is at the supplier very, very frequently, weekly, certainly monthly. Then we have the chemical, mechanical, metallurgical organization, which is also at the supplier base.

The fact that a sytems audit wasn't performed at the required frequency, should not be taken to mean that Pratt & Whitney hasn't done any surveillance of that supplier, because the chemical, mechanical, metallurgical organization, and the dimensional organization are there very frequently.

MR. ANDERSON: But are we interpreting it correctly to believe that these are the higher level of inspection? These are the inspectors that have the specialized knowledge to really do a good job of auditing as opposed to the --

THE WITNESS: These are the specialists in auditing, but the specialists in the dimensional arena and the specialist in the chem, mechanical, and metallurgical arena, are at the supplier very frequently. Much more frequently than the audit organization.

MR. ANDERSON: But if an audit is not done for an extended period, isn't there some concern that the quality system itself -- not necessarily the process, but the oversight is not there. And, therefore, is not reporting or documenting what is happening?

THE WITNESS: Yes, there is that concern. And to correct that situation as a result of this incident, Pratt & Whitney has required that for prime reliable parts, each supplier be audited annually.

MR. ANDERSON: But what part of the quality system at Pratt & Whitney broke down and allowed this audit to go so far overdue? Because that would be part of the system, I would think. That if an audit was overdue, it would flag a note to higher management to take action. Was there a lack of communication or was it something of that nature that --

THE WITNESS: When Pratt & Whitney went from a core manufacturing organization to product centers, the product centers were given the responsibility to conduct these types of system audits. They did not perform them to the frequency or staff their organizations to the levels that the previous core organizations were staffed.

The function has now been transferred back to the core quality organization, so that there can be better control of the systems types of audits.

MR. ANDERSON: So, in effect, more individuals are involved in the process?

THE WITNESS: That's correct.

CHAIRMAN GOGLIA: How long a period of time are we talking about, from the time it changed from the original core function to a product function back to the core function?

THE WITNESS: I believe we're talking from 1990 -- about the beginning of '94 to the end of '96.

CHAIRMAN GOGLIA: Thank you.

MR. ANDERSON: Move on to page 19, I believe. And we return briefly to the issue of engineering source approval. And here, again, the FAA has observed a finding that requires that a process approval record be issued for significant changes. We had already talked and found that they had attached forms with significant changes. What had -- what was wrong here?

THE WITNESS: In this particular case, this finding challenges whether or not the significant -- the change system was followed. The change system was followed. It was followed from Volvo to the on-site quality representative, to the quality representative for the mechanical, metallurgical side, and to the engineering representative, as well. The change was deemed insignificant.

The FAA position on this was that the change should have been significant, but the system was followed perfectly.

MR. ANDERSON: So, was there a problem with the wording of PSA 370 that was vague, perhaps?

THE WITNESS: Three seventy stated that items such as tooling. It didn't say that it required every change associated with tooling to be significant. It said changes such as tooling, sequence of operations, and then a judgment is made on the basis of what that change is.

MR. ANDERSON: I understand. Could we just finally with this document turn to page 31? Again, we seem to see an observation or a finding that lists some missing -- either missing records or no evidence of accomplishment. Are we correct in assuming that this is the same problem we discussed earlier, that there were a shortage of inspectors?

THE WITNESS: I believe it's a similar situation. The systems audit organization is not one that I have intimate knowledge of.

MR. ANDERSON: But, again, from a system and an organizational point of view, the lack of these reports should have triggered some internal communication.

THE WITNESS: Excuse me.

MR. ANDERSON: The lack of these -- if the quality system was working properly, it's supposed to pass up the line information on things that are not being done on time. Otherwise, it can't correct itself.

THE WITNESS: That's correct.

MR. ANDERSON: So, is corrective action in this area focused on the system and the systems reporting on its own discrepancies?

THE WITNESS: The corrective action in this area, again, I believe is for the core audit organization to assist the product centers in their internal audits.

MR. ANDERSON: Okay. So, we had talked earlier that certainly there was personnel added to improve the manpower involved. But I'm wondering if changes were made in the manual in the process to make this situation unlikely to occur in the future without management being made aware of it?

THE WITNESS: I believe they were, but I don't have knowledge of that.

MR. ANDERSON: I think at this point, we've been asked to return to the Chair.

CHAIRMAN GOGLIA: At this point, we're going to take a break for lunch for one hour, and we will resume with Mr. Scussell back on the stand. We stand adjourned.

(Whereupon, a luncheon recess was taken.)

A F T E R N O O N L U N C H E O N

(Time Noted; 1:35 p.m.)

CHAIRMAN GOGLIA: We will go back on the record and continue our questioning of the witness. Mr. Anderson, are you ready to continue?

MR. ANDERSON: Good afternoon. If we could turn to another exhibit, please, Mr. Scussell, Exhibit 8H, entitled "ANE-180 Evaluation Report of Pratt & Whitney, Quality System," attachment 2.

THE WITNESS: Excuse me. You said 8H, attachment 2?

MR. ANDERSON: No, it's -- I was reading the legend on Exhibit 8H.

THE WITNESS: Oh, okay. I have it.

MR. ANDERSON: Page 4. We wanted to pursue for several more questions, at least, the issue of engineering source approval, as it applied at -- with the FAA's findings at Volvo. Item 1 there had three findings, as far as the process not going to completion. Do you have any comments on the FAA write-up and any knowledge of corrective action that was taken, specifically to this finding?

THE WITNESS: I believe the first two findings were, indeed, met. The engineering source approval system was flowed the way it was intended to flow from Volvo to the Pratt & Whitney quality organization, to the Pratt & Whitney engineering organization.

The second finding concerned with the submittal of multiple changes, the multiple changes were submitted and by Pratt & Whitney's engineering criteria, were deemed as insignificant. The third finding regarding Volvo's auditing of the quarterly auditing of the ESA system is valid. Volvo had missed some of the audit requirements.

MR. ANDERSON: And, specifically, what was missed, a report or the actual audit itself?

THE WITNESS: They missed the actual audit. They didn't perform it within the quarterly period that they were required to.

MR. ANDERSON: Okay. What is the document that requires them to do that audit?

THE WITNESS: It's an internal Volvo requirement. And I'm sorry -- and it's an internal Volvo requirement imposed by QA 6076.

MR. ANDERSON: Okay. I have no more questions in that area. The next area of questioning is on the development of subsequent tests by Pratt &

Whitney. Namely, the eddie current system. Could you describe the reasons for bringing the eddie current on the scene?

THE WITNESS: Are you referring to the eddie current for the parts that are in service or --

MR. ANDERSON: Yes.

THE WITNESS: I wasn't involved in the service corrective actions.

MR. ANDERSON: But you're aware of the eddie current capability prior to it being implemented?

THE WITNESS: Pratt & Whitney, as a result of this, to conduct the surveillance of the field parts, did impose an FPI and an eddie current.

MR. ANDERSON: Did Pratt & Whitney consider using an eddie current manufacturer?

THE WITNESS: We are evaluating with Volvo a program to use an eddie current probe, to evaluate indications in holes.

MR. ANDERSON: Would the eddie current process have the capability or potential to detect these types of microstructural changes?

THE WITNESS: That's what we're working on. We're hoping that we will be able to develop an eddie current probe that will, indeed, show work hardened areas not associated with cracks.

MR. ANDERSON: Do you know in your capacity of any other process or non-destructive technique that will -- either has the potential or can now detect this microstructural phenomenal?

THE WITNESS: Only the blue etch.

MR. ANDERSON: So, blue etch -- at this time, in your opinion, is the only established procedure?

THE WITNESS: At this point, yes.

MR. ANDERSON: As a result of the information that you have obtained subsequent to the subfailure, have any of the other rotating titanium parts, inspection intervals, or inspection methods been changed?

THE WITNESS: The blue etch -- the fact that we have added some requirements for holes is not specifically related to this part. It's to any part that has a hole.

MR. ANDERSON: Okay. So, that the other procedures are in effect for other parts?

THE WITNESS: The blue etch goes across the titanium major rotating part -- the major rotator part system, yes.

MR. ANDERSON: Turning now to the issue of the Federal Aviation Regulations, Exhibit 8K. The title of that exhibit is 14 CFR, Parts 21 and 23, selected parts. It says selected papers, but it's just selected pages here.

On page 3, we have section 21.165, subparagraph B. And, essentially, the last part of that paragraph reads that the holder of a production certificate is responsible for airworthiness certification and the approval or required to approve that this conforms to the approved design and is in the condition for safe operation.

Can you explain the organizational and structural setup that Pratt & Whitney has in place to assure compliance with that section?

THE WITNESS: I cannot explain that. That is not in an area of responsibility that I'm familiar with.

MR. ANDERSON: So, that the ESA source requirement is not a part of the product certification for being in safe -- a condition for safe operation?

THE WITNESS: Yes, the engineering source approval system is a part of that. But this refers to certification to the approved design and ESA is not a part of the design system.

MR. ANDERSON: So, that the condition for safe operation is not a part of the ESA? I guess, I'm not quite catching the difference.

THE WITNESS: Anything that has to do with the quality system or the process approval system is a part of a condition for safe operation. The ESA system, as a part of the design system -- I can't comment on that. It's just something that's out of my realm.

MR. ANDERSON: Well, passing over to a previous paragraph, which deals with 21.125 -- I think it's on a previous page here. This perhaps -- the title of that section on page 2, paragraph 21.125, is titled "Production Inspection System, Materials Review Board." And listed in there are the requirements of a materials review board. And I call your attention to paragraph -- subparagraph 4. And it reads, "Processes affecting the quality and safety of finished product must be accomplished in accordance with acceptable industry or United States specifications." Can you comment on the applicability of that paragraph to blue etch? Does blue etch constitute an accepted industry standard as an inspection method?

THE WITNESS: Yes, it does.

MR. ANDERSON: And how would you characterize that?

THE WITNESS: Pratt & Whitney has been using the blue etch inspection technique for rotating components for -- since around 1970. The industry -- and it's part of our inspection procedure through the regulating agencies. The aerospace industry of the jet engine industry has adopted the blue etch fairly universally for its capability.

MR. ANDERSON: So, is there an accepted specification by an engineering society or a standard society that describes the blue etch process or is it still a proprietary process of Pratt & Whitney?

THE WITNESS: The blue etch was never proprietary to Pratt & Whitney. Upon its development in 1970, Pratt & Whitney did not patent the blue etch. Pratt & Whitney released it to the industry in the interest of aviation safety.

MR. ANDERSON: So, there is a -- it's a -- there is no standard other than the Pratt & Whitney standard that's been released?

THE WITNESS: Each engine company could develop its own standard, but the method for performing the blue etch is well known and was released to the industry.

MR. ANDERSON: Yes. I have no more questions for this witness.

CHAIRMAN GOGLIA: Anybody on the panel have any questions? Then we'll go to the parties. The Federal Aviation Administration?

MR. DONNER: We have no questions. Thank you, Mr. Chairman.

CHAIRMAN GOGLIA: ALPA?

MR. MCCARTHY: Yes, sir. I got the sense through your testimony, sir, that everything we are talking about, ultimately, involves a visual inspection of the component either after it has been blue etch anodized or after it has been fluorescent dye inspected or after it has been simply visually inspected for tooling marks. And that there is some difficulty involved with inspecting the inside of these bolt holes, because of their depth and that the lighting and the mirror and such are critical. Is that essentially correct?

THE WITNESS: Yes. We recognized as a result of this incident, that we had an opportunity to enhance the inspection of holes.

MR. MCCARTHY: I suppose what I'm trying to find out, when you rewrote your process, did you give consideration specifically to the mounting, the lighting, the orientation, the positioning of the piece, the positioning of the inspector? In other words, physically how this was to be accomplished with any kind of particularity? Or are these methods still left to the discretion of the individual conducting the inspection?

THE WITNESS: We took into account the difficulty of inspecting a deep hole. In the wording that accompanies the photographs of our blue etch standard, we advised the inspector that they should be looking with lighting, but that if you're not careful, the lighting can impede the operator, as well as assist the operator -- the inspector rather.

So, we do have a standard that shows what a subtle indication would look like and we also say that special care must be taken when evaluating these holes from an operator perspective.

MR. MCCARTHY: Is it still left up to the discretion of the individual inspector as to how, in fact, physically he or she conducts the inspection?

THE WITNESS: There is some latitude given the inspector, because we don't say that you have to put a particular light in at a particular angle. But we do tell the inspector that aids, such as baroscope and mirrors can be used to enhance the inspectability of holes.

MR. MCCARTHY: And these procedures that you are setting out, would you give the same guidance to operators for post-manufacturer inspection? I mean, general guidance as opposed to specific guidance?

THE WITNESS: Yes. Generally, once the parts leave the -- leave Pratt & Whitney, they are not blue etched a second time.

MR. MCCARTHY: No, not blue etched. For any type of non-destructive inspection of these holes was my original question.

THE WITNESS: Excuse me?

MR. MCCARTHY: Any type of inspection, which requires a visual inspection. I was not limiting the question to blue etch anodized inspections.

THE WITNESS: Yes, I'm not familiar with the after-market portion of Pratt & Whitney.

MR. MCCARTHY: Thank you, sir.

CHAIRMAN GOGLIA: McDonnell Douglas?

MR. STEELHAMMER: Yes, sir. I have one question.

CHAIRMAN GOGLIA: Mike for McDonnell Douglas.

MR. STEELHAMMER: Here we go. I think we're here now. Yes, when you were talking to, I think it was Exhibit 8I, which is a flow chart, you mentioned that if a defect was noted in melt, that melt would be downgraded or the material would be downgraded.

Could you explain what you mean by that?

THE WITNESS: Yes. If we notice a confirmed defect within a melt, none of the product of that 15,000 pounds of titanium can be used for a major rotating part for Pratt & Whitney. In other words, the whole product of that melt must be used for a non-critical application for Pratt & Whitney.

MR. STEELHAMMER: Thank you, sir. No further questions.

CHAIRMAN GOGLIA: Volvo?

MR. THOREN: No further questions.

CHAIRMAN GOGLIA: Delta?

MR. VALEIKA: No questions. Thank you.

CHAIRMAN GOGLIA: We'll come up here to the Tech Panel. Vern? Oh, I'm shutting you guys out. You've already had the floor.

(General laughter.)

CHAIRMAN GOGLIA: I'm sorry about that.

Pratt & Whitney?

MR. YOUNG: Thank you, Mr. Chairman. Mr. Scussell, earlier in your testimony, you were discussing the write-up we received from the FAA regarding our lack of audits of our partners and vendors. Could you tell us what time frame that was in effect?

THE WITNESS: They conducted an audit right after this incident. It was, I believe, in the fall of '96.

MR. YOUNG: Okay. But the requirement for the component centers to provide their own audits of their vendors, for what period of time were they responsible for those audits?

THE WITNESS: I believe it was from 1994 through '96.

MR. YOUNG: Thank you, Mr. Scussell. No further questions, Mr. Chairman.

CHAIRMAN GOGLIA: All right. Thank you. Dr. Ellingstad?

DR. ELLINGSTAD: Just a couple of questions with respect to the blue etch anodized procedure. I believe I'm understanding this correctly that the detection an indication -- at least a rejectable indication involves a pattern matching operation from the specimen to a photograph or some other template?

THE WITNESS: We have a blue etch standard that shows various conditions of segregation, overheating, inclusions, et cetera. It doesn't confine the reporting of an indication strictly to that. The blue etch standard states that any indication that contrasts with the background must be reported and evaluated.

We have classical photographs of indications that we've had in the past. The things that I just mentioned, plus overheating. And now we have one for abusive, a distorted microstructure within holes. But that does not restrict the etch inspector to only those types of indications.

DR. ELLINGSTAD: Are the criteria for rejection with respect to these particular kinds of instances defined. So, that if it matches one of these examples, that would be a basis for rejection of a part?

THE WITNESS: That's correct.

DR. ELLINGSTAD: Okay. If it's something that doesn't match one of those templates or patterns, what is done with it? What's the procedure?

THE WITNESS: The procedure is that the etch inspector reviews it with the level 3 inspector. That's the highest level inspector at the facility. If the level 3 inspector cannot make a determination regarding the acceptability or rejection of the indication, it is then sent to the quality laboratory. The quality laboratory will perform replication analysis wherever possible. And if that's not possible, we will destructively evaluate the part.

DR. ELLINGSTAD: At the time that the accident hub was inspected with this procedure, how many of these templates or of these standards existed, how many of the photographs? How many different conditions could establish rejection at that point?

THE WITNESS: Probably about a half a dozen.

DR. ELLINGSTAD: And since that time, you've added one circumstance. Have there been any others?

THE WITNESS: We've actually added a hole that was contaminated with iron. So, that the etch inspectors could see what an obscure indication looks like. And we added one that was not contaminated with iron that has the classical sharp contrast.

DR. ELLINGSTAD: How are these -- are these samples or these templates or patterns generated? Are these failures that you detected and serviced that are photographed and used as a standard or you indicated that you had, in this case of the contamination with iron that you had created?

THE WITNESS: Most of the standards that we've generated have been the result of indications that we found during the inspection of parts that we've manufactured.

DR. ELLINGSTAD: How often is an -- how often does an indication occur with this process, just to give a kind of a sense of how rare an event this is?

THE WITNESS: We get indications on blue etch -- on parts that have been blue etched, a half to 1 percent of the time of the parts that are inspected.

DR. ELLINGSTAD: And of those -- this is any kind of an indication?

THE WITNESS: Mm-hmm.

DR. ELLINGSTAD: And of those, what proportion are found to warrant rejection?

THE WITNESS: About 10 percent of those.

DR. ELLINGSTAD: So, it's a very, very small proportion that --

THE WITNESS: Yes, it is.

DR. ELLINGSTAD: -- are effectively rejected?

Thank you. No further questions.

CHAIRMAN GOGLIA: Mr. Loeb?

DR. LOEB: I think I need a bit of clarification, Mr. Scussell, on that. One-half of 1 percent of the inspections that are performed, the blue etch inspections that are performed for Pratt result in something that is then looked at by a level 3 or perhaps even replication.

THE WITNESS: A half to 1 percent of the parts are looked at by a level 3 and returned to the core laboratory for analysis or evaluation.

DR. LOEB: And you have a fair number of parts going to a manufacturer at any given time. And certainly over a period of time of more than a fair number. Would you agree with that?

THE WITNESS: That's correct.

DR. LOEB: So, that number is probably not that small. Would you agree with that?

THE WITNESS: In absolute terms, it's not.

DR. LOEB: So, that even 10 percent of that is probably not -- we're not talking about one a year. Is that correct?

THE WITNESS: No, we're talking more than one a year.

DR. LOEB: Okay. I wanted to clarify that. I want to move on to a couple of other questions. I wanted to clarify one other point, as well, because I'm not certain I totally understand. The cracked point here in the accident hub and the particular hole, did a level 3 look at that blue etch indication -- at the blue etch at all? I mean, did anyone other than the inspector look at it?

THE WITNESS: At the time --

DR. LOEB: At the time that it was going --

THE WITNESS: Yes, when the blue etch inspector at Volvo noticed something that was not characterized as a classical blue etch indication, he took it to his level 3. The level 3 looked at it and agreed that it was not a classical blue etch indication and, indeed, thought that it may be something mechanical. He, in turn, passed it on to the visual inspector.

DR. LOEB: And it was at that time it was determined to be okay?

THE WITNESS: That's correct.

DR. LOEB: Right. So, we've now added another indication, set of words, and so forth, to this picture book and directions and guidance to the inspector. What assurance did we have that we're not going to be adding another picture to the book with another set of instructions at some time -- further guidance at some time in the future?

THE WITNESS: We're hopeful that this indication in this photograph will prevent this sort of occurrence from happening again.

DR. LOEB: This one? And this particular work hardening or heating or whatever, created this particular --

THE WITNESS: That's correct.

DR. LOEB: But, I guess, I'm asking, do we really have any assurance that we won't be adding another picture again in the future?

THE WITNESS: No, if we find something in our manufacturing or inspection cycle that is unusual and that we haven't addressed, we will, indeed, add another photo to our etch inspection standard.

DR. LOEB: Of course, my concern is that this last one was added through -- unfortunately, through an accident. And I would hope that there's a way of avoiding another accident, that may result in adding another picture. And, I guess, what I'm saying is, while it appears if you have the -- all of the wherewithal and know all of the things that are potentially going to come in the future, blue etch could -- it's not a failure of the blue etch. It's a failure of our ability to interpret what the blue etch was telling us. Is that pretty much correct?

THE WITNESS: In this case, that was the case, yes.

DR. LOEB: However, we now have to rely on this inspection, especially, in a deep bore hole, that 2-1/2 to 3 inch hole, that we try to use some kinds of tools and proper lighting. Do you specify the lighting intensity to be used?

THE WITNESS: I believe we specify a maximum intensity not to exceed.

DR. LOEB: But not a minimum on it?

THE WITNESS: I don't believe so.

DR. LOEB: Okay. Mirrors, are you talking about mirrors that we can actually get down into the hole or at the back end of the hole?

THE WITNESS: At the back end of the hole.

DR. LOEB: So, you don't actually physically insert the mirror into the hole?

THE WITNESS: That's correct.

DR. LOEB: So, now we have a light source at one end and a mirror at the other end. And somehow with this disc, which has got some size to it -- this hub, excuse me, how likely is it we're going to be able to develop an eddie current that may be able to replace a blue etch or any other visual inspection of that nature inside a deep bore hole?

THE WITNESS: We're quite hopeful that we'll be able to do something that will -- with the eddie current, that will help us further evaluate holes. We don't intend to discount the blue etch of the hole. We will keep that on as an inspection, as well, but we hope to develop some -- we're hopeful that we'll be able to develop an eddie current.

DR. LOEB: Do you recommend the baroscope be used in conjunction with this?

THE WITNESS: We have some very small diameter baroscopes at Pratt & Whitney that we've used to inspect these holes in the development of this recommendation. They've worked out well with us. There is no question that it's an enhancement. It takes more time. It takes better technique or different technique, I should say.

DR. LOEB: Is it easier to use or more difficult to use or about the same?

THE WITNESS: To use than what?

DR. LOEB: Than a combination of light, mirror -- lights and mirrors alone?

THE WITNESS: That's a difficult question to answer. Some people are more adept at one way of inspecting than another.

DR. LOEB: So, either one of them is a form of art, in a way?

THE WITNESS: Theinspection of a feature that's hidden is somewhat difficult.

DR. LOEB: If we had an eddie current that we can demonstrate that would work with a higher degree of confidence and so forth, that would be less of an -- is that correct, or would that not be any different in that regard than a blue etch -- than the mirror lights or the baroscope?

THE WITNESS: We don't know the answer to that question right now, but we're hopeful that we will be able to get -- to develop an eddie current technique that we have confidence in.

DR. LOEB: Are any of your -- the manufacturers who are manufacturing hubs for you now, discs, anything that has a deep hole in it, in fact using baroscopes at this point? Or is this just in the development stage?

THE WITNESS: No, we're using them at Pratt & Whitney.

DR. LOEB: You're using them at Pratt, but are the manufacturers who are building hubs for you using them?

THE WITNESS: I'm not aware of that. The standard just went out within the past month.

DR. LOEB: Okay. Ihave one other area of question and that is regarding the audits. Has Pratt done anything very recently to improve its ability to perform these audits in a more timely fashion?

THE WITNESS: Yes. The audit function for the supplier base has been turned over to the quality core organization. The quality core organization, particularly for prime reliable parts, has a procedure in place, which states that producers of prime, reliable parts will be audited on an annual basis.

DR. LOEB: Well, I guess myquestion -- and I heard all of that. My question is, you were unable to do these in a timely -- in as timely a fashion as you would have liked and as your materials said you should. Why is it that they're going to be in a better position to be able to do it in a more timely fashion?

That is, do they have more people that are -- whose responsibility or sole responsibility is to do this?

THE WITNESS: Yes. The core audit group was increased in size.

DR. LOEB: From how much to how much?

THE WITNESS: I believe it went from approximately eight people to 12 or 13.

DR. LOEB: And so do you believe that that's going to be a sufficient increase to actually keep up with this now?

THE WITNESS: Yes, I do.

DR. LOEB: All right. I have no further questions.

CHAIRMAN GOGLIA: Mr. Haueter?

MR. HAUETER: Just a few. Following up on Dr. Loeb's question on audits, do you ever do random inspections of parts that come in from your outside vendors?

THE WITNESS: Periodically, we do.

MR. HAUETER: Andhow do you select what to be pulled or how many or is there any reason for that or --

THE WITNESS: From a mechanical properties, chemical, metallurgical prospective, we pull at least one part per year per supplier.

MR. HAUETER: Even on very large hubs and discs, things of -- do you test these in destruction or you just --

THE WITNESS: We don't pull one of each component. We'll pull one of a particular part that a supplier has produced.

MR. HAUETER: And do you test it to destruction or is it just --

THE WITNESS: We cut it up and evaluate it. We destructively evaluate it.

MR. HAUETER: Okay. Going back to the P&N hub, you mentioned you couldn't tell what caused that. Could you rule out what didn't cause it? Is it likely that it would have been caused by field service through normal usage?

THE WITNESS: I wouldn't be able to answer that.

MR. HAUETER: I was just kind of wondering, because it indicates it takes, what, high temperature and pressure to create such a metallurgical change?

THE WITNESS: That's correct.

MR. HAUETER: Would you expect to see that in just normal operation of the engine?

THE WITNESS: No.

MR. HAUETER: So, you think it could happen during original manufacturer or a rework type cycle?

THE WITNESS: I think it happened at some place when the part was being worked.

MR. HAUETER: Okay. Has Pratt & Whitney taken the position of the cool channel drilling versus a high-speed drill? Do you have any --

THE WITNESS: Right now, no one is using coolant channel drills on Pratt & Whitney components. But that does not mean that that will always be the case.

MR. HAUETER: Also, finally, on the change when Volvo asked to change the drilling type, you, obviously, had to approve the processes we've send? Did you have to inform the FAA of a process change in the manufacturer?

THE WITNESS: No, we didn't. The FAA has endorsed our quality system with the controls that it has in place, including the engineering source approval system.

MR. HAUETER: Is there a DER involved in that process to sign off these changes or --

THE WITNESS: No, there is not.

MR. HAUETER: Okay. Thank you.

CHAIRMAN GOGLIA: Mr. Scussell, you heard Volvo a little bit earlier today mention that they had a 90 plus POD, probability of detection, which is considerably higher than what I believed that we have found through research in the United States.

Given that we only have one set of eyes looking at the process, the blue etch process -- and this is such a critical part -- what kind of safety nets are in place to pick up the, just to pick a number out of possibilities, 10 percent that won't be detected?

THE WITNESS: Well, first of all, I think -- I don't understand. You're talking the 10 percent from the probability of detection?

CHAIRMAN GOGLIA: That's correct.

THE WITNESS: We don't utilize blue etch or any inspection as a backstop for our processing. That's why we have an engineering source approval system, a process control system, a process evaluation system, periodic cut ups, why Pratt & Whitney certifies the level 3s at the various suppliers that produce our parts, why if one inspector -- in this case, with Volvo, the blue etch inspector noticed something, he was obligated by our requirements to notify the next inspector in the chain. All of those things give accumulative effect to increasing the lack of an indication getting out.

CHAIRMAN GOGLIA: If the inspector, the blue etch inspector missed something, what is the safeguard that would pick it up at the next step?

THE WITNESS: A visual inspector may. But if a blue etch inspector misses the blue etch indication, there's not a second blue etch inspection.

CHAIRMAN GOGLIA: I realize that. I'm just asking what is the safety net to come in behind it?

THE WITNESS: Every inspector that looks at that part, including the persons who assemble the part or put the part in a box to ship it as a spare, look at the part.

CHAIRMAN GOGLIA: Oh, now, wait a minute.

THE WITNESS: I didn't say they were inspectors.

CHAIRMAN GOGLIA: Yeah, you're flying -- you know, I've lived in this environment and I don't like being spoon fed -- let's not go down this road. You know, when you tell me that someone packaging a part is looking for something, he's looking for the shipping label. That's what he's looking for. When I receive your part and it has your tag on it, you think I'm looking at it for anything more than shipping damage? That's all we're looking at it for.

When this part is shipped from Volvo or any other manufacturer to Pratt & Whitney, what's the process? From the minute it arrives on the loading dock, what happens?

THE WITNESS: From the minute it arrives on the loading dock?

CHAIRMAN GOGLIA: The minute it arrives on the loading dock, if I'm out of your area, I want you to tell me and I want you to tell me whose area it is?

THE WITNESS: That's out of my area. That would be in receiving at Pratt & Whitney.

CHAIRMAN GOGLIA: Okay. Is there anybody -- never mind. That's not for you. Is there any inspections, receiving inspections that you aware of when a component arrives on your shipping dock, especially pertaining to critical parts?

THE WITNESS: That's out of my area.

CHAIRMAN GOGLIA: Okay. In this particular hub is a life limited part. Is that correct?

THE WITNESS: That's correct, yes.

CHAIRMAN GOGLIA: And we've -- as we've walked through the records earlier with Volvo, there were a number of flaws on the part, dimensional flaws, and other flaws considered to be minor. How many, if any -- is there a trigger for minor flaws that would result in material review board action?

THE WITNESS: Each of the dimensional characteristics that Volvo discussed did receive material review board action.

CHAIRMAN GOGLIA: Including the tool marks that we're talking about here?

THE WITNESS: The tool marks were not classified as anything that was outside of the specification requirements.

CHAIRMAN GOGLIA: So, as long as they're not classified as outside of the requirements, we could have an unlimited number of -- I'm looking for the right word, discrepancies -- but I know that's too strong -- to a part and it would not trigger any action from anybody?

THE WITNESS: If we have determined that a particular indication on a part meets out standard, that becomes -- that there's no criteria for rejection, it is accepted.

CHAIRMAN GOGLIA: Now, if -- let's go to the type of insignificant flaw that we believe -- you believe was in one of these holes in this hub. if we had similar damage in an adjacent hole, would that trigger any action?

THE WITNESS: Yes.

CHAIRMAN GOGLIA: So, two holes abutting one another would trigger action?

THE WITNESS: Oh, I'm sorry. You're saying the indication that the Volvo inspector saw --

CHAIRMAN GOGLIA: Yes.

THE WITNESS: -- if we saw that in two holes?

CHAIRMAN GOGLIA: That's correct.

THE WITNESS: We don't have anything in our procedures that would -- we would evaluate each hole on its own merit.

CHAIRMAN GOGLIA: Not as in its entirety?

THE WITNESS: The more information you have, the more -- the better the decision that you can make.

CHAIRMAN GOGLIA: That's assuming the information is communicated to the persons for the process that can make those decisions. I will hold the rest of my questions for a later P&W. Mr. Loeb would like to revisit something.

DR. LOEB: Again, just for clarification. I'm not certain I still understand. Let's go back to the blue etch at the time it was done on the part. And the inspector saw something. I'm not quite sure what. And got the level 3 involved and so forth. Did that inspector see anything on the blue etch itself? A discoloration or something in the blue etch that looked strange or was it the other -- the marks in the hole that was seen visually rather than through the blue etch?

THE WITNESS: The inspector reported that as some sort of marking attributed to -- to the best of his knowledge, to a mechanical condition.

DR. LOEB: But it wasn't something that was noticed on the blue edge itself? A variation in the blue?

THE WITNESS: No, it was not.

DR. LOEB: Okay. And so the level 3 did not look to see if there some variation of discoloration or change in color in the blue?

THE WITNESS: The level 3 also reviewed the part.

DR. LOEB: But did the level 3 see anything strange, different in the blue -- of the blue etch?

THE WITNESS: No, he did not.

DR. LOEB: Do you have any idea why that's the case since we now go back and do a blue etch admittedly at a later period of time and do see a discoloration?

THE WITNESS: Yes. We believe that the part was -- that the indication was obscured with iron.

DR. LOEB: And that re-etching cleaned that off and allowed that to now become visible?

THE WITNESS: That's correct.

DR. LOEB: All right. Again, I want to go back one more time to -- this is a question that the Chairman was also asking. If that could happen then, I mean, how can we have any assurances that we won't be doing this again in another period of time? In six months, a year, or two years?

THE WITNESS: Here again, we have revised the blue etch standard to focus on holes. We also in the verbiage of the standard, talk about different shades of grey in the blue etch. We have a hole that has a -- that's sectioned. That shows an indication that's contaminated with iron, as well as one that isn't.

DR. LOEB: Shouldn't there be a backup, a second set of eyes, a second review in the form of the assumption that now exists in the design and certification of air frames? And that is, namely, that there will be some damage, that there will be a crack, and that we will develop an inspection program that will be able to catch it before that happens, subsequent to the manufacture. Wouldn't this be a rational thing to do until we have inspections that we can absolutely rely on?

THE WITNESS: That's why we're working to develop the eddie current to give us --

DR. LOEB: I understand that, but we don't have it right now. And as a result, shouldn't we really have a subsequent air worthiness program that continuing air worthiness program that has some required inspections in it?

THE WITNESS: That would be a question that would be better directed at someone else, I believe.

DR. LOEB: Well, we'll be doing that. All right. Thank you.

CHAIRMAN GOGLIA: Any further questions from the Technical Panel?

MR. CONROY: Yes, sir. I have a couple of brief questions. Dr. Loeb spoke to you just a few moments ago regarding quality audit staffing levels.

And prior to that, Mr. Anderson talked to you about it, I believe in Exhibit 8G, paragraph 15, this morning before the lunch break, if you can recall that. It is when the first issue first came up, I believe. And you mentioned that the staffing levels were changing briefly. When Dr. Loeb asked you, you mentioned, I think, that your staffing levels had gone from eight to 13. Is that a fair characterization?

THE WITNESS: Yes, it is.

MR. CONROY: About five years ago, what was the staffing level? Can you give me a number there?

THE WITNESS: I don't know.

MR. CONROY: You don't have any past numbers at all?

THE WITNESS: That the audit area is not my area of responsibility.

DR. LOEB: Well, why don't we just have Pratt provide that for the record? Would you be so kind as to do that for us, please? Later on, come back and just provide it for the record to us.

MR. YOUNG: I'm sorry, sir. The request is--

DR. LOEB: The question that was asked to Mr. Scussell was, how many quality audit people were there five years ago. Is that what --

MR. CONROY: Yes, sir.

DR. LOEB: And his answer was, he didn't know. And I'm asking if you would just provide that to us.

MR. YOUNG: Yes, we will.

DR. LOEB: Thank you.

MR. CONROY: Thank you. Regarding another answer that I believe you gave, sir, you stated that the accident hub was written, signed off by a quality -- correction, by a level 3 inspector. Is that true?

THE WITNESS: That's correct.

MR. CONROY: Do you have written evidence of that?

THE WITNESS: Volvohas written evidence of that.

MR. CONROY: Okay. Two more, sir. How long does it take for an inspector to complete a blue etch anodized inspection?

THE WITNESS: Approximately, 20 minutes.

MR. CONROY: And how hubs could he do in a day?

THE WITNESS: There is a requirement that he take a break periodically. And I don't know exactly what that frequency is.

MR. CONROY: And you don't know what an average would be?

THE WITNESS: No, I do not.

MR. CONROY: I see. The last question is regarding coolant channel drills. I believe you mentioned that Pratt & Whitney does not now use coolant channel drills in any case?

THE WITNESS: To the best of my knowledge, that is a correct statement.

MR. CONROY: And to paraphrase you, I think you said that does not mean that we won't use it in the future. Is that a fair paraphrase?

THE WITNESS: That's correct.

MR. CONROY: Is there a company directive or a policy regarding the non-use of coolant channel drills at this time?

THE WITNESS: No, thereisn't.

MR. CONROY: Thank you very much.

CHAIRMAN GOGLIA: Anyone else on the panel?

MR. EINDLER: Yes, I have a question. Going back to the basic discrepancy of the actual disc, have you any theory how it has not been possible for Volvo to duplicate the discrepancy with their brutal drilling of 300 holes in similar discs? I understand they have been able to come up with the same type of discrepancy. Is that correct?

THE WITNESS: Volvo has been able to reproduce the condition. It was very difficult. They drilled approximately 300 holes, and I believe they came up with four or five instances of this condition.

MR. EINDLER: But if I understand, they have not been able to come up exactly the same type, not that much as this actual case or did I miss that?

THE WITNESS: I believe they have.

MR. EINDLER: Thank you, sir.

CHAIRMAN GOGLIA: Any of the parties? Pratt? Do you want to go last, in case there's any others? Do any of the party members have any questions? Okay. Pratt?

MR. YOUNG: Thank you, Mr. Chairman. Mr. Scussell, just a clarification on the subject of the Pratt & Whitney audits of our vendors and suppliers. Was there any lack -- to your knowledge, was there any lack of audits conducted during 1989 when this hub was produced?

THE WITNESS: To my knowledge, no.

MR. YOUNG: Thank you. Thank you, Mr. Chairman.

CHAIRMAN GOGLIA: Mr. Scussell, you know, in my past life, I've come to rely upon Pratt & Whitney in the supply of parts that we receive from Pratt & Whitney as being gold plated, if I can use that word -- impeccable. And what I've heard today calls some of that feeling that I had in question. I would like to ask you, when you go back to work and you perform your duties as you have been in the past and I hope that you will continue for a long time in the future, would you please keep that in mind, that we rely upon you. We rely upon the product as being essentially flawless. And we can't live with parts that are not flawless.

The traveling public can't rely upon a system that has parts that are not flawless. So, please, take that into consideration for all of us that are now living in this industry and rely upon you and your coworkers.

THE WITNESS: Yes, sir, I will, and I will see to it that that reaches the highest levels of Pratt & Whitney.

CHAIRMAN GOGLIA: Thank you.

THE WITNESS: And the lowest levels.

CHAIRMAN GOGLIA: Thank you. You're released.

(Witness excused.)

CHAIRMAN GOGLIA: The next witness is Mr. Gidious.

(Witness testimony continues on the next page.)

RICHARD E. GIDIOUS, AVIATION SAFETY INSPECTOR, MANUFACTURING, FEDERAL AVIATION ADMINISTRATION, WINDSOR LOCKS, CONNECTICUT

Whereupon,

RICHARD E. GIDIOUS,

was called as a witness by and on behalf of the NTSB, and, after having been duly sworn, was examined and testified on his oath as follows:

MR. HAUETER: Good afternoon, sir.

THE WITNESS: Good afternoon.

MR. HAUETER: Would you, please, provide for the record your full name and place of employment?

THE WITNESS: My name is Richard E. Gidious. I'm a Principal Aviation Safety Inspector for Pratt & Whitney Aircraft. My address is located in New England MIDO-41 in Windsor Locks, Connecticut.

MR. HAUETER: You're with the Federal Aviation Administration?

THE WITNESS: Yes.

MR. HAUETER: And what's your title?

THE WITNESS: Principal Aviation Safety Inspector.

MR. HAUETER: Would you, please, provide us a brief history of your background in aviation?

THE WITNESS: Sure. In 1967, I started off in the Army. I spent three years in the Army as a helicopter crew chief and mechanic. After that, I worked for six years for the Army as a civilian as an aircraft inspector on fixed wing and rotary wing aircraft. After that, I worked for the Air Force as a civilian and nine years at Pratt & Whitney assessing Pratt & Whitney's quality control program.

For the last ten years, I've worked for the

FAA, where I've been the Principal Inspector of Scorsky, Textron -- Command Aerospace, Hamilton Standard, and now Pratt & Whitney since August of 1995.

I have also spent 17 years with the National Guard as a Senior Aviation Inspector on fixed wing and rotary wing also.

MR. HAUETER: Currently, Pratt & Whitney is your only organization you surveil or do you --

THE WITNESS: I have six other small companies I do also.

MR. HAUETER: Thank you. Mr. Anderson, your witness.

MR. ANDERSON: Thank you. Good afternoon, Mr. Gidious.

THE WITNESS: Good afternoon.

MR. ANDERSON: Can you tell me how much help you have performing your duties as it relates to Pratt & Whitney?

THE WITNESS: Well, I'm the only inspector stationed at Pratt & Whitney right now.

MR. ANDERSON: And so, you have to go outside your organization for assistance when the workload gets beyond that associated with one person's normal workload?

THE WITNESS: Yes.

MR. ANDERSON: How often does that happen?

THE WITNESS: Oh, probably a good example would have been this incident, where I was provided with outside help from my regional office to conduct audits and review this matter.

MR. ANDERSON: I can well imagine that your duties are quite broad. On a technical sense, could you give us a sense of the types of processes that you regularly and routinely audit and inspect?

THE WITNESS: Sure. Primarily, I'm responsible for overseeing the overall quality system at Pratt & Whitney and its control of its suppliers. I am also responsible for any changes to the quality assurance manual, policy changes I have to approve. Any changes -- major changes to the quality organizational structure, I have to approve. I have to oversee the entire FAA designee work force at Pratt & Whitney and suppliers.

I have performed service difficult investigations. I have to oversee the manufacturers maintenance facility of Pratt & Whitney. I have to perform PI audits, principal inspector audits at Pratt & Whitney and its suppliers. And et cetera, et cetera.

MR. ANDERSON: I understand. Thank you. prior to the accident in July of last year, were you aware of any problems with the quality system as it applied to overseas vendors and partners?

THE WITNESS: I don't think there was a direct history of foreign supplier problems prior to this incident. However, I did have some violations against Pratt & Whitney under its supplier control system.

MR. ANDERSON: Were these corrected?

THE WITNESS: Yes, they were.

MR. ANDERSON: Have you had the opportunity personally to inspect any of the overseas vendors in their facilities prior to this?

THE WITNESS: No. No, I haven't.

MR. ANDERSON: That gets me to a question that I really appreciate your sharing with us your specific duties that were associated with the investigation, subsequent to the accident, which took you to Volvo and also back with the quality system at Pratt & Whitney. Could you describe some of your duties and some of your observations there?

THE WITNESS: Sure. Well, one thing that we did, we performed an audit at Volvo subsequent to the accident. And we had a team of three people, including myself. And we specifically tailored the audit to five different systems at Volvo, using FAA's ACSE of criteria. That is aircraft certification systems evaluation program. That is our formalized audit structure or methodology that we use when we perform audits of production approval holders and of suppliers.

We use this criteria to -- and we center our audit basically centralized around major rotating parts. During the course of this evaluation, we did find some problems there and we documented them. This information was formally transferred to Pratt & Whitney via a letter of investigation.

Since that time, Pratt & Whitney has given cause and corrective action. At this point, all our corrective action is closed out in that regard. And that's where is stands right now.

MR. ANDERSON: I understand. Could we turn to the record of some of your participation, which would be Exhibit 8 -- oh, let's start with Volvo 8H. And turning to page 4, I wonder if you could -- since this is the document that I'm sure that you had some involvement with producing the final result, even though it's an interim document in itself, could you explain to us the significance of the findings under engineering source approval?

THE WITNESS: Okay. Sure. Let me read it over just for a minute here. All right. This was written up against the engineering source approval system in regards to changes to the processes, various processes. And primarily what was said here, that these -- as these changes did go through the formal process, through Volvo, through Pratt & Whitney. However, the FAA questioned the classification insignificant versus significant.

These are issues that were strongly Pratt & Whitney addressed incorrective action in regarding to us. I think you've heard some of those things changed at PWA 370 and so forth. But that was one area that we had a lot of concern with, because we felt that it was a situation of human judgment that in the case of the criticality of the characteristics involved, that the system need be enhanced in regard to singular type judgments.

The second, if you would like to go on?

MR. ANDERSON: Yes.

THE WITNESS: In manufacturing operations, we had no findings there. In blue etch, there was no findings. In final inspection, we had some areas of concern regarding two areas. One was the surface finish requirements of the holes, that it wasn't definitive in the work constructions.

And the other was in regards to the stylist. That if the inspector detected any type of spiral tool marks, it's required that he have a 7,000 stylist to further investigate the extent of those spiral tool marks. When asked for that, they were not presented. They were not available.

MR. ANDERSON: So, the other two were no findings. Could you comment more on your -- during your investigation, even though you did not record any findings as far as the blue etch process, in light of the previous discussion here, you must have looked at the original records that we have covered again here, looked at the actual remarks, and had some opinion about the significance of the way that the blue etch process was carried out on the accident hub. Could you share some of your observations with us?

THE WITNESS: Yes. Well, one concern I had was that any basic quality system, if something doesn't fit within parameters of a standard, okay, that's normally considered a non-conformance. Okay. If it doesn't fit, it doesn't belong. It's not part of the type design, okay, and should be treated as such. And I think during the time frame that the incident hub was manufactured, that this type of system wasn't in place. Meaning, let it -- document what you see and then allow inspection to make a determination, if it fits into another standard. And this was one concern that I had.

The way the system is set up now, as you heard previously, where a level 3 gets involved, but I think to take that a little bit further, that if a level 3 gets involved and says, no, we have no criteria to accept this, that they must put that on a preliminary review form, as Volvo form QPC-1117.

Now, that goes to a preliminary review, which is Volvo quality people. If it comes to acceptance, the preliminary review people cannot accept. They can only rework. They can only scrap. Or return to vendor. They would have to send out to Pratt & Whitney's material review board system.

Pratt & Whitney's MRB system has a whole litany of support groups in Pratt & Whitney to make determinations, such as MCL, design engineering structures. So, just to say that something is just going to be reviewed by one person and we're just going to end it there, that is not the system that is in place that I have reviewed for corrective action.

MR. ANDERSON: I understand. And in this specific case, the item in question was an observation by a blue etch inspector who found a visual indication.

THE WITNESS: Yes.

MR. ANDERSON: Now, if that visual indication was passed to a visual -- qualified visual inspector and that visual inspector found it to be in acceptable condition, how would the system elevate this problem to an MRB?

THE WITNESS: Well, let's just say that the present VIS standard is very restrictive, as far as acceptance criteria in comparison to what the standard would use back in 1989. I can understand looking at the standard in '89, how somebody could accept that. For example, a superficial tool mark. You know, without illustrations or figures, how would you know whether some thing is a superficial tool mark or it's a smear or a tear? I don't think your average inspector is going to know that without some type of visual aids.

The present standard, as it's written, is much more restrictive than that one. Meaning, if you had a smear or a tear that could have possibly gotten through blue etch, to that standard, it's not acceptable. Meaning, it doesn't fit and that item should be placed on the MRB, if the system is working correctly.

DR. LOEB: Excuse me. Let me just follow up with that. How do you know that? I mean, are you suggesting that at the time, it was clear that there was a difference in the blue etch from the areas that were smeared with the iron versus the areas that weren't and it was just nothing done?

THE WITNESS: No. Based upon the fact that the BEA inspector brought up that there is a mark in the hole -- meaning, that there is something in the hole that doesn't fit the standards that I have to use to accept. So, they made that notation to see if that mark fit within the visual inspection standards. Meaning, surface finish, any other type of criteria that was listed under the standard at the time -- tool marks, et cetera.

DR. LOEB: So, that wasn't identified through the blue etch. It was just identified through some visual citing of a tool mark or a mark of some sort.

THE WITNESS: A mark by the blue etch

inspector.

DR. LOEB: And, so, is the standard now that anything that has a mark in it is automatically scrapped?

THE WITNESS: No, basically, it's this. It's very restrictive right now on what you can accept in a tie bolt hole. For example, a spiral tool mark with depths no greater than, say, five tenths. All right. Anything beyond that, it doesn't fit within those confines of the standard. It has to be put on.

DR. LOEB: But we have no indication right now that this -- that these marks had any depth to them. I mean, other than just something that was barely visible. I mean, is there any -- do we know the depth of those marks?

THE WITNESS: No.

DR. LOEB: They were gone at honing?

THE WITNESS: Excuse m?

DR. LOEB: They were apparently gone at some point before it was finally done, because they didn't see anything that had any depth to it?

THE WITNESS: No, just to go back over this again. A BEA inspector indicated a mark in the tie bolt hole.

DR. LOEB: Looked at by level 3 and looked at by a visual inspector and passed.

THE WITNESS: Correct.

DR. LOEB: What is different today? I mean, are you suggesting that the level 3 and then the visual inspector saw deep holes of whatever depth you're talking about and let them go?

THE WITNESS: No.

DR. LOEB: All right. So, then you didn't. So, then what is different?

THE WITNESS: What is different? For example, back then you had a thing called superficial tool marks. Could you take a mark as being superficial?

DR. LOEB: I don't know. There is language throughout here that indicates that there are marks that are important and there are marks that are superficial. And I don't know how you do that and I don't know how you determine it. Again, I'm going to go right back at it. If these gentlemen saw these things, looked at them, did everything they were supposed to do, and they got out, I would like to know what's different today? I mean, whether that same work wouldn't be treated -- have been treated the same way.

Now, what we are told today is that there, in fact, may have been a blue etch of a part that has some iron smeared on it, is not likely to look the same in the area where it's smeared versus the area that it isn't, because that surface is different.

THE WITNESS: Sure.

DR. LOEB: Now, they have that in a picture book. That's different. They have some guidance. I don't see what else is different. I mean, are you saying there are some marks now that would be -- the part would be rejected for those marks when it wasn't -- when it wouldn't have been before?

THE WITNESS: No, no. I'm not saying that.

DR. LOEB: That's what I thought. So, in the end, there isn't any difference in that regard. We just hope they're looking a little bit more carefully or --

THE WITNESS: No, no. What I'm trying to say is, what occurred back then, okay, with the present criteria that they had to accept on blue etch, which that mark did not fit within the criteria of that standard, when it was eventually subsequently processed to final inspection with the type of standards that they had, it could fit within those standards. Does that make sense now?

Now, what does it differ than today? Today, first of all, they now have the revised EIS-13, a standard, okay, that will detect work harden abusively machined material in tie bolt holes. That's number one.

Number two, even if you developed a different type of mark inside a tie bolt hole, that again does not fit the new photographs that we just put on the job. Again, the difference in the system today is that would be considered a non-conformance. That would not be processed to the VIS standard. That would be put on -- that would be a non-conformance, processed through the preliminary review board, which would probably end up on MRB. And I doubt very seriously those parts would be accepted.

So, that's how things have differed.

DR. LOEB: What would be the basis for the MRB rejecting that today? What is the guidance that they would have? What would be the standards that they would use that would reject that part today?

THE WITNESS: Well, if it doesn't fit within the standard, it's rejectable.

DR. LOEB: So, then you're saying -- I asked that question in the beginning. Now, let me go back at it again, because I'm a little confused. Anything that looks different is going to automatically result in a rejection?

THE WITNESS: It's going to reject in a temporary rejection for further evaluation.

DR. LOEB: My concern is not so much temporary rejection. But getting back into service, especially given that it's life limited with no fixed inspection interval, no requirement that when the engine is in the shop that it be piece parted. And unless it is piece parted, it will get no inspection. My concern is that there is not an automatic rejection, if the system doesn't work any better. I'm at a loss right now.

You're saying to me that the MRB would have likely rejected that. And I'm going to repeat, what is the standard and what is the guidance by which you can be certain or feel fairly confident the MRB would have rejected that for you?

THE WITNESS: Well, I just -- with a change of the system -- first of all, with the change of the standards, the blue etch standards, for one thing. For incorporation of QPC-1117, which is Volvo's process control record for preliminary review, that's been added. That was not in place in 1989.

DR. LOEB: I'll buy that.

THE WITNESS: Okay. So, what I'm saying here is, the bottom line is whether you have blue etch or a visual dimension -- if you have something that doesn't fit within your standard of your type design, you have to have that evaluated. And how any quality system works to evaluate that, you have to document that and process it through the proper group within your organization to do that.

DR. LOEB: You can continue.

MR. ANDERSON: The next question I would ask is, on the issue of the altered microstructure, in your experience -- and you've had considerable experience looking at the production line of Pratt & Whitney, at least, have you found any similar instances which would be part of your personal experience?

THE WITNESS: No. No, not in work hardened material. No.

MR. ANDERSON: Do you get the feeling as uyo are doing this investigation, that you were working with anybody in the industry who was comfortable with this phenomena, that truly understood it?

THE WITNESS: I would say that my dealings with Pratt & Whitney and the individuals that I dealt with, understood the aspects of it and the creation of it. I don't think there was ever a doubt in my dealing with Pratt & Whitney that they did not understand the problem. Meaning, that they had necessary individuals to be able to detect and be able to analyze and determine a difference of abusive machining versus some other anomaly.

So they had -- certainly had the professionals there to deal with it. Now, what their experience is on a whole? Personally, I don't know.

MR. ANDERSON: The point I'm soliciting here is that the hub was manufactured in 1989. And the knowledge that was exhibited was just recent. And during this interim period, a lot of these hubs have been manufactured. And it would appear from what we -- what little we understand at this point about the blue etch process and the drilling procedures, there may be a significant population of these hubs that could be slipping through the manufacturing process. Is that possible?

THE WITNESS: Well, that's a bit of a judgment call here, which I don't think I would be very likely to say yes or no on. However, I would like to say that I think the Volvo, Pratt & Whitney, and the FAA have looked at that risk and have addressed that risk. I think also that the corrective actions that had been in place by Pratt & Whitney and Volvo is certainly going to prevent recurrence or give us confidence that recurrence will be very limited in comparison to what it was before. We certainly know a lot more now.

MR. ANDERSON: I understand that the actions that are taken and anticipated, but the time period between manufacturing this hub and the present, if the system was in control and was continuing to understand the nature of this process, shouldn't some level of inspection, including perhaps the FAA, receive some incline that this could be a problem? Or was this a complete surprise?

THE WITNESS: Well, I think it was a surprise for us. It's not that we had these types of machining problems that cause this kind of catastrophic failure this often. And, certainly, I don't think our experience was that great with that.

MR. ANDERSON: So, indeed, the expert opinion, while maybe it had been aware basically of the phenomena, there didn't seem to be a connection of an immediate threat to the process or any real movement toward increased surveillance?

THE WITNESS: Not to my knowledge.

MR. ANDERSON: Which would seem to be indicated by the fact that the blue etch process has not changed until fairly recently?

THE WITNESS: True.

MR. ANDERSON: I'm not sure. Is that true or has there been some change in the process?

THE WITNESS: No, that was a true statement you made.

MR. ANDERSON: Going back to the surface finish for a minute. I think your remarks are very significant. Could you talk a little bit about the -- I know we've reviewed the VIS standard, but because so much of the product assurance of these holes depends on a proper surface inspection, could you talk a little more about what you found there? I know you've already told us about the stylus. But how would that be used and what would be done if the surface finish proved not to measure up?

THE WITNESS: Sure. Well, primarily they -- what I found at Volvo was, again, that the surface finish for the tie bolt holes were individually spiked out in the work constructions at final. So, that was one of the reasons why I wrote it up.

I felt that the seriousness of the surface finish of that hole should have its own separate sequence versus being lumped into the hole part and all the other different surface finishes.

Secondly, in regards to the stylus and the spiral tool marks, when I questioned the fact that if an inspector did reveal a spiral tool mark and he had to assess that spiral tool mark, that which tool would he use. And, of course, it was listed in the instruction that he would use a 7,000 stylus. And when I asked for that, it was not presented. They did not have it in the department.

MR. ANDERSON: And what -- excuse me, sir. You had a -- you wanted to say something? What was the significance of the missing stylus? Do you feel that it was not there because it was not routinely used?

THE WITNESS: Well, I have to go by what Pratt & Whitney and Volvo both stated to me, and their response was that the stylus was in another department being used against another visual inspection standard and was not available at that time.

MR. ANDERSON: Are you possibly suggesting that the stylus was not in general use for some period of time with Volvo?

THE WITNESS: Well, when I was there, I told myself, I'll be here for three days.

MR. ANDERSON: So, it was simply an observation?

THE WITNESS: Right.

MR. ANDERSON: I think I'll return the witness to the Chairman.

CHAIRMAN GOGLIA: What we would like to do right now is take a brief facilities break. We'll go for about 15 minutes, and we will return with Mr. Gidious.

(Whereupon, a short recess was taken.)

CHAIRMAN GOGLIA: We're back on the record. Mr. Anderson, do you still have some questioning? I remind the witness that you're still under oath.

THE WITNESS: Yes.

MR. ANDERSON: We had left off with inspections, and we'll take up again with inspections. I know that you weren't a signatory to the Pratt & Whitney audit, but you were present at the out-briefing. Could you share with us, again, some of the observations that you personally made of the Pratt system, since you're, of course, closely familiar with its evolution?

THE WITNESS: Are you familiar -- are you just talking about the phase 1 audit?

MR. ANDERSON: Yes, the phase 1 audit.

THE WITNESS: The phase 1 audit.

MR. ANDERSON: And that would be --

THE WITNESS: And the close out briefing --

MR. ANDERSON: Excuse me. Exhibit 8G.

THE WITNESS: Eight-G. Okay. And specific, what question was this now?

MR. ANDERSON: There were various findings in that, which we've already to some extent gone through and we may revisit. But basically, you were personally involved in the process. Did you have any specific areas that you contributed to the written findings?

THE WITNESS: Well, in the phase 1 audit, I wasn't involved with the phase 1 audit.

MR. ANDERSON: Yes, I see your name as being present in the --

THE WITNESS: Right.

MR. ANDERSON: -- audit in-briefing.

THE WITNESS: Right. Just from that phase, yes.

MR. ANDERSON: Okay. So, did you have any observations on the findings? You've read the report.

THE WITNESS: Yes.

MR. ANDERSON: And on the -- I would like to get specific here and just talk about the ISO-9001 changes. Were you aware of the changeover at Pratt & Whitney associated with 9001?

THE WITNESS: Yes, I was.

MR. ANDERSON: And could you tell us somewhat or what that involves somewhat? What type of change?

THE WITNESS: Well, primarily Pratt & Whitney was seeking approval under ISO-9000. They were structuring and still are restructuring their quality system. However, the FAA in that respect doesn't recognize ISO-9000. We only look at the aspect of meeting the intent of the Federal Aviation Regulations.

So, regardless how Pratt & Whitney restructures its quality system and must meet the prior approval that we gave them, plus all the regulations as they stand now. So, in regards to comments to ISO-9000 and Pratt & Whitney system, I don't have any.

MR. ANDERSON: So, therefore, the ISO-9000 -- excuse me. It's 9001 for manufacturing, really shouldn't have been mentioned perhaps in the report as a factor? In other words, your -- the fact that ISO-9001 is being implemented really didn't affect the suitability of the quality program?

THE WITNESS: No, it didn't. No.

MR. ANDERSON: Okay. Do you feel that the information that you obtained on the anomaly here and the information on the blue etch is an issue that goes beyond Pratt & Whitney's manufacturing process and Volvo's process? That it may affect other manufacturers of rotating titanium parts?

THE WITNESS: Well, I feel it's an anomaly that obviously just through history isn't something that appears that often. And I've actually -- and to replace any machining of titanium for that matter, it would be subject to the same type of conditions or same type of anomalies.

So, would it affect others? I'm sure it could. Absolutely.

MR. ANDERSON: Do you see some need for further academic research in this area to help inspectors identify bad practices or new practices that would be -- provide a lower probability of damage?

THE WITNESS: I think that would have to be predicated on the industry. Meaning, how do other aerospace manufacturers control critical processes, critical parts? I'm familiar with Pratt & Whitney's control of their critical processes and parts. However, I'm not familiar with many others that do that or by what names they call it or how they go about it.

So, in order to answer that, you would have to be familiar with these other types of systems.

MR. ANDERSON: Yes. Now, that you and we are all aware of the seriousness of this problem, who in the FAA would you go to for technical assistance in evaluating these kinds of processes?

THE WITNESS: Well, there's one thing we are doing is myself and another individual from the region, Dan Kerman, are working with Washington on developing criteria to address these concerns. That we do feel that there isn't enough methodology right now in our acts of criteria. So, we are developing criteria as we speak.

MR. ANDERSON: Is -- to your knowledge, is the titanium consortium participating in this with the FAA?

THE WITNESS: That, I'm not aware of, no.

MR. ANDERSON: Mr. Chairman, I have no more questions for the witness.

CHAIRMAN GOGLIA: To the parties. The Federal -- well, you're last. Pratt & Whitney?

MR. YOUNG: No questions, Mr. Chairman.

CHAIRMAN GOGLIA: Volvo?

MR. THOREN: No questions.

CHAIRMAN GOGLIA: Delta?

MR. VALEIKA: No questions.

CHAIRMAN GOGLIA: McDonnell Douglas?

MR. STEELHAMMER: No questions.

CHAIRMAN GOGLIA: ALPA?

MR. MCCARTHY: No questions, Mr. Chairman.

CHAIRMAN GOGLIA: The FAA?

MR. DONNER: Thank you, Mr. Chairman. No questions.

CHAIRMAN GOGLIA: Is everybody hungry?

(General laughter.)

CHAIRMAN GOGLIA: Dr. Ellingstad?

DR. ELLINGSTAD: Have you reviewed and did you approve the templates or standards for the blue etch anodized inspection procedure?

THE WITNESS: No. How that works, sir, is Pratt & Whitney's quality control system, which includes the formulation of non-destructive test standards overall is approved by the FAA. Their system, which includes changes to the system and acceptance of the system contained within the body of Pratt & Whitney in its non-destructive test organization approves those changes. What we do is approve the methodology or the methods that they do in order to approve these systems or changes to the systems.

DR. ELLINGSTAD: Okay. So, what specifically do you look at when you render your approval?

THE WITNESS: Initially when any company applies for a production certificate, we have to look over a whole quality system, which includes going out and performing audits of non-destructive tests, special processes, and the like. When we eventually initiate and approve the production certificate for a company, Volvo standards are subsequently approved by the FAA in that fashion. Meaning, the systems to control the processes in non-destructive tests.

The FAA doesn't individually approve each non-destructive test method. However, it is approved by the systems that control that.

DR. ELLINGSTAD: So, there isn't a specific assessment that the FAA makes of the ethicacy of a particular inspection procedure?

THE WITNESS: No, it does. No, no. It does. It does that in the formulation, again, on the original approval of a manufacturer. Those systems are audited. They are conformably inspected by the FAA. If there's any changes, which -- for example, if the company was to put on holography, which they never had before, they would present that to the FAA. The FAA would go out and perform conformity inspections to the proposed techniques that they use. And subsequently, we approve that. But most of the systems in Pratt & Whitney today have been in place for many years and what we and the original approval basically says is that your systems that you have in place to control your non-destructive tests are accepted by the FAA and the methods that you approve that.

So, if they do have to make a change to blue etch or if they do make a change to their FPI process, that they have people in place to ensure that these changes are correct and they're proper. But the FAA doesn't individually go out and approve each and every one of those changes.

DR. ELLINGSTAD: So, how large a change in a company system would it take to invoke some kind of a re-examination and a re-approval?

THE WITNESS: It would have to probably be a new type of non-destructive test or if it was so critical where it would affect the airworthiness of the product.

DR. ELLINGSTAD: How many Pratt & Whitney suppliers are you responsible for?

THE WITNESS: In excess of 400.

DR. ELLINGSTAD: And what is the nature of your oversight of them?

THE WITNESS: The oversight of them is based upon Pratt's quality system and its flow down requirements. Quality flow down requirements, that we ensure that, number one, that they have a system in place to flow down the proper QA requirements. That the production certificate that it was originally approved for, that that data is flowed down through its suppliers. We oversee that in areas of performing audits as suppliers, and also our review of external audit reports. We review service difficulties, causing corrective action reports, to see what the health indicators are of the suppliers out there. It was Pratt's primary responsibility to control their suppliers.

DR. ELLINGSTAD: How many of those 400 suppliers do you visit in the course of a year?

THE WITNESS: Of a year? Myself as a principal inspector. I have this --

DR. ELLINGSTAD: Yourself or anyone else that's doing this work for you?

THE WITNESS: Well, what we've done recently is is that we've realized that we have to, let's say, perform more inspections or random inspections as suppliers. Even though they're supposed to be controlled by the production approval holder, the FAA still does audits of suppliers. What we've done is under our ACSEP system, we've included audits of suppliers, foreign and domestic, and they are being put on a schedule for auditing.

Now, how many have been done totally in our region over the past year, that number I don't know. However, we've just recently in November audited three suppliers over in Europe.

CHAIRMAN GOGLIA: Before we go further, would you, for the record, explain what the ACSEP system is?

THE WITNESS: Yes. Again, that is the aircraft certification systems evaluation program. That is the FAA's formal audit program, to audit production of approval holders and its suppliers. And this is done on a two-year basis for priority parts manufacturers and its suppliers.

CHAIRMAN GOGLIA: Since I have the floor and I have the gavel, I think I'll continue. You mentioned about 400 suppliers to Pratt & Whitney. Do you know how many of those are outside of the country?

THE WITNESS: I think we have a grand total of, I believe, it's 36 outside the country.

CHAIRMAN GOGLIA: And you mentioned that three suppliers were audited in Europe.

THE WITNESS: Yes.

CHAIRMAN GOGLIA: Is that all your -- is that in total how many were done? What I'm getting at here is Volvo mentioned when they were on the stand that they --

THE WITNESS: Yes.

CHAIRMAN GOGLIA: -- have never been audited by the FAA. And now we have three. Is this the only three since you've had your job?

THE WITNESS: Since being a principal inspector of Pratt & Whitney, it is in regards to Pratt & Whitney.

CHAIRMAN GOGLIA: That's my question. Thank you. And, again, how long have you had the job?

THE WITNESS: Since August of '95, a year and a half.

CHAIRMAN GOGLIA: In your work plan, what does the work plan say for future audits of foreign facilities?

THE WITNESS: Well, for one thing is that I think our region understands that we have to do some more audits. So, what I've recently done is given our ACSEP coordinator out of the region all prime reliable parts suppliers, along with all foreign supplier listing. What they'll do is they'll take that and try to coordinate that into the ACSEP schedule for the upcoming fiscal year.

CHAIRMAN GOGLIA: And do you have a sense for how many inspectors you think that will result in?

THE WITNESS: Sir, I don't. I don't. But I'm sure there are budgetary constraints, too, so.

CHAIRMAN GOGLIA: I'm sure there are lots of budgetary constraints, but there is also the question of compliance, and I know that's above your pay grade. Okay.

DR. ELLINGSTAD: How many people do you have doing these inspections?

THE WITNESS: Doing the inspections?

DR. ELLINGSTAD: Well, with respect to this task of overseeing these 400 suppliers, what are we talking about in terms of manpower to do this?

THE WITNESS: Well, for one thing, when we equate that into the ACSEP program, we take people -- we take FAA inspectors from all over the country and we formulate teams, usually, anywhere between three to six person teams to do these audits. So, when you say the number of people, it would be equated to the quantity of people of inspectors there are in aircraft certification.

DR. ELLINGSTAD: And that number is?

THE WITNESS: Well, it was about, I believe, active around 100 manufacturing inspectors in the country, but we also use engineers, too. Engineers are also certified auditors and they also participate in all of these audits.

DR. ELLINGSTAD: Are you satisfied that that program is sufficient to the task?

THE WITNESS: Well, I think we have to get back to the response -- the basic responsibility here, again. It certainly doesn't do us any good to formulate large quantities of people and travel all over the world auditing suppliers when the production approval holders themselves aren't adequately performing audits of their foreign suppliers.

And so the area that we're looking into is ensure, first of all, that all our production approval holders are adequately controlling their foreign suppliers. And then from that point on, the FAA then randomly selects these foreign suppliers and does audits to get a health check on how well our production approval holders are doing. But we can't ever forget the responsibility rests with the production approval holder.

DR. ELLINGSTAD: Thank you.

CHAIRMAN GOGLIA: Mr. Haueter? I need a little more time to get my blood cooking.

MR. HAUETER: Okay. I'm trying to understand some of this. You mentioned you oversee Pratt & Whitney and six other manufacturers.

THE WITNESS: Yes.

MR. HAUETER: About what percent of your time is dedicated to Pratt & Whitney?

THE WITNESS: Probbaly around three days a week.

MR. HAUETER: About three days a week. Prior to you taking this job, was there more than just yourself overseeing Pratt & Whitney or has it always been one person?

THE WITNESS: Always one person. At least for the past -- about the past 14 years.

MR. HAUETER: So, there is one FAA person overseeing, what, 45,000 people effectively?

THE WITNESS: Well, there's not that many, but there's -- it's big.

CHAIRMAN GOGLIA: Does that include Pratt in Florida also?

THE WITNESS: No, it doesn't. No. It includes the production facilities in Connecticut, Maine, Georgia.

MR. HAUETER: So, you're required to travel to Maine and Georgia as part of your surveillance of the --

THE WITNESS: Yes. Random surveillance, I do, yes.

MR. HAUETER: You don't use geographic surveillance for Georgia or --

THE WITNESS: In Georgia, sometimes we do for Georgia. We'll do a handoff to Atlanta down here and they'll go in for us. In the case of Maine, normally, I'll go up.

MR. HAUETER: Are any of these 400 vendors out there or so, are they FAA approved manufacturers in their own right or --

THE WITNESS: Well, there are some. There are some PMA, TSO holders out there. But for the most part, when Pratt places the purchase order with a supplier, they're not predicating it upon their -- any types of FAA approval they hold. It's strictly controlling them by their QA requirements.

MR. HAUETER: But now is Volvo a -- does Volvo own or have an FAA certificate of any type?

THE WITNESS: No, they don't.

MR. HAUETER: Is there any special oversight you give to an operator, a vendor who happens to have a production certificate for other parts?

THE WITNESS: Well, let's just -- what our policy basically says, that if a supplier does hold its own FAA approval, okay, that the production approval holder can reduce his amount of surveillance over that supplier.

MR. HAUETER: Interesting. We had mentioned earlier today that there had been some changes to the Volvo manufacturing, such as change in the drilling process. Should that have been reported to you that there was a change in the process involved?

THE WITNESS: No, no. The ESA process and the specification, that specification has been approved by the FAA and the system in place, so that the -- that all parameters are processed through there and properly coordinated is in the body of that specification.

MR. HAUETER: Would should engineering changes be reported to the FAA?

THE WITNESS: When they are of a minor major change. When it affects the part design. However, in the case of PWA-370, the purposes of 370 is to control processes and parts. It's not to incorporate design changes into parts.

MR. HAUETER: I'm trying to understand this. If they change the finish coating, would that be reported to you?

THE WITNESS: Sure, if it was a change that was major in capacity, sure. Then, again, understand what ESA is, it's controlling that coating or plating process. Okay. It's not to approve the bases of the specification, that performs the coating process. It's just to ensure that that process is in control. It's a controlling document.

MR. HAUETER: But you wouldn't necessarily take a look at a part approval based on just a coating change from, say, aluminum nitrate to a titanium nitrate or something like that?

THE WITNESS: Oh, it's -- oh, absolutely. Any type of change like that, first of all, would go through an FADER stationed at Pratt & Whitney. And if you make a plating change, which can be critical at times, he determines that that is a major change, not a minor change, it will be submitted to the FAA for approval.

MR. HAUETER: You were here for the previous testimony.

THE WITNESS: Yes.

MR. HAUETER: Okay. There was some discussion that the blue etch process may not have caught the flaw in this hub. Does that -- what comfort does that give you to the blue etch process, I guess?

THE WITNESS: Well, I don't think it was a situation where it didn't catch it, per se. I just think it was a situation of it caught something, but it was defined.

MR. HAUETER: Well, hasn't the process failed then if it caught something, but it still --

THE WITNESS: Sure. No, I agree. I think that's why they made the changes to EIS-13 to include one X photographs of abusively machined tie bolt holes, to give the inspectors an illustrative view of what they're describing in words of abusive machining.

MR. HAUETER: There was discussion, too, that maybe if you blue etched twice, you could more readily pick something up. Do you recommend that in your --

THE WITNESS: That's true. That's true. That is very true. Each time you etch, you're taking something off a little bit. So, I'm sure that can reveal something a little bit further down in the surface that you couldn't pick up the first -- through the first pass.

MR. HAUETER: Would you recommend such a change in your position to the manufacturer or --

THE WITNESS: Sure, absolutely.

MR. HAUETER: Okay. Thank you.

CHAIRMAN GOGLIA: As part of your duties, how much time do you spend in the Pratt & Whitney facility?

THE WITNESS: On the average, three days a week.

CHAIRMAN GOGLIA: How much time do you spend in actual shops, in the production facility?

THE WITNESS: Oh, working in the production shop itself?

CHAIRMAN GOGLIA: Yes.

THE WITNESS: Well, that time, probably, I'd say 20 percent.

CHAIRMAN GOGLIA: And you would consider that normal surveillance?

THE WITNESS: Well, I think with the limited manpower, being just myself, it's adequate for me, only because of, let's say, the other duties that I have to do that take me away from that.

CHAIRMAN GOGLIA: And the assumption is that you very infrequently visit Maine once or twice a year?

THE WITNESS: Once or twice. Twice a year, normally.

CHAIRMAN GOGLIA: And what about all the facilities scattered around Hartford and elsewhere?

THE WITNESS: I try to get to them about every month and a half to two months.

CHAIRMAN GOGLIA: You heard mention that Volvo had never been visited, and I'm sure there are many other facilities that have never been visited. Do you have any concerns over that?

THE WITNESS: Well, I think that -- to say that the FAA has to go to each and every supplier, foreign supplier, I don't think is a real statement. I think the statement of -- what we find is when you go to a supplier for a particular production approval holder, you go to three and you find one thing wrong at one, you're going to probably find the same thing wrong at the other two, if the production approval, A, didn't properly slow down its QA requirements. Or if they did, that they're non-compliant.

So, we normally see system type deficiencies. So, let's just say that a certain number of selection of suppliers will give us a good feel for how well they are controlling that. And I think what happened this past fall, auditing three suppliers over in Europe, plus they gave us a different look of how well these companies are being controlled.

CHAIRMAN GOGLIA: Now, are you familiar with the -- all the activities recently around the unapproved parts issue?

THE WITNESS: I have some knowledge of that, limited.

CHAIRMAN GOGLIA: And one of the defenses that the industry has put the operator's side of the house, has put in place is receiving inspections on virtually everything coming in the door. We heard testimony here earlier today that that is not happening at the manufacturer's level. Does that cause you any concern?

THE WITNESS: Well, I think what has to be understood here is, number one, in regard to the incident hub, that incident hub was source inspected by a Pratt & Whitney inspector. So, that hub was inspected by Pratt & Whitney.

Number two --

CHAIRMAN GOGLIA: Now, wait a minute. Let me stop you there for one minute.

THE WITNESS: Yes.

CHAIRMAN GOGLIA: We have one person in the facility. Are you telling me that to your knowledge, that he inspects every single piece part that comes out of that facility?

THE WITNESS: Back then in the '89 time frame, all hubs that were shipped to Pratt & Whitney had to go through a Pratt & Whitney source inspector, an on-site Pratt & Whitney source inspector.

CHAIRMAN GOGLIA: Okay. Keep going. I had interrupted you.

THE WITNESS: Okay. There is one issue here, too, though, we have in the regulations called major inspection authority. That a production approval holder has a right to give its suppliers after a certain length of time and after evaluating their quality history, to give them major inspection authority. Major inspection authority means that they may make inspections and determinations subsequently shipping the parts into their production approval holder without the production approval holder reinspecting the parts.

When they do that, the companies must make that list or listing of suppliers that have major inspection authority available to the FAA for review. Where these companies then are subject to our approval or disapproval if we see something we don't like, for example.

CHAIRMAN GOGLIA: Out of the 400 suppliers to Pratt & Whitney, are you aware of how many have such approval? And you don't have to be exact.

THE WITNESS: I'll just rough it. I'd say probably three-quarters of them do.

CHAIRMAN GOGLIA: Okay. And of the roughly 36 foreign suppliers, do you know the breakdown there?

THE WITNESS: I'd say, again, probably three-quarters of them do.

CHAIRMAN GOGLIA: Okay. I have no further questions. I will put it back up to the Tech Panel and then to the parties.

MR. CONROY: Yes, sir, I have a couple. Mr. Gidious, regarding your position with the FAA, you mentioned that you became the principal inspector for Pratt in August '95.

THE WITNESS: Yes.

MR. CONROY: What did you do prior to that, sir?

THE WITNESS: I'm sorry?

MR. CONROY: What was your position prior to that?

THE WITNESS: Prior to that, I was the principal inspector of Hamilton Standard.

MR. CONROY: Hamilton Standard. And you mentioned that you had six other manufacturers or contractors that you also are responsible for in addition to Pratt?

THE WITNESS: Yes.

MR. CONROY: Are they subcontractors to Pratt or are they contractors on their own?

THE WITNESS: No, they are PMA and TL

holders. They hold their own FAA production approval.
MR. CONROY: In other words, they do not necessarily have a subcontractor. I believe the term now is partner relationship with Pratt?
THE WITNESS: No, no.
MR. CONROY: Some may; is that correct?
THE WITNESS: Correct.
MR. CONROY: Prior to August '95, do you have any knowledge of audits regarding Pratt from your department? I realize you weren't -- you didn't hold that position?
THE WITNESS: Other than knowing that it was being audited every two years by the FAA, under the ACSEP and the old Quasar system that we had, which was our old audit --
MR. CONROY: Say that again a little more slowly, please? Under the?
THE WITNESS: Other than knowing that it was being audited every two years by the FAA under its formalized audit program.
MR. CONROY: All right. How about the subcontractors or partners to Pratt, do you have any knowledge regarding audits of them prior to your arrival?

THE WITNESS: Yes. There were audits of foreign suppliers, I believe, back then. And with some affiliations with another company, that these audits were performed. Meaning that another company, meaning, International Aero Engine, who were also suppliers to Pratt & Whitney. So, audits were performed of those suppliers.

MR. CONROY: By the office that you currently hold?

THE WITNESS: By the FAA, meaning both individuals out of our office, out of the MIDO, and also formal ASCEP audits.

MR. CONROY: I'm sorry, formal?

THE WITNESS: ASCEP audits.

MR. CONROY: All right. Do you have any idea of numbers regarding, for example, five years ago, how many audits of subcontractors, both foreign and domestic, may have taken place?

THE WITNESS: No, I have no idea at all.

MR. CONROY: You mentioned that you knew of some foreign subcontractors --

THE WITNESS: Yes.

MR. CONROY: -- that were audited?

THE WITNESS: Right. But not a specific

quantity over a five-year time period or five years ago.

MR. CONROY: You have no knowledge regarding the approximate number for any one year?

THE WITNESS: No, no, I wouldn't.

MR. CONROY: You mentioned random inspections. I think the word was random inspections. Would those be called surprise auditor inspections or are they preannounced?

THE WITNESS: No, those are what -- when I refer like -- we call them PI audits, principal inspector audits. It's just that we will randomly select a particular -- maybe a certain production facility.

We will pick out areas of certain production area and go audit that for several days. For example, we may get into special processes in one production facility. We may go to the assembly floor at another time. Test facilities and so forth.

MR. CONROY: Are they preannounced inspections or audits or are they something that you do by surprise to the manufacturers?

THE WITNESS: No, it's something that we usually -- we'll tell the company, look, we're going down to Middletown tomorrow and look at some areas down there. However, in many cases, we don't tell them which areas we're going into. We just say we'll be in this -- we'll be down in this particular facility.

MR. CONROY: You say, we're going down tomorrow. That's a fair characterization?

THE WITNESS: Yeah, sure.

MR. CONROY: Regarding one last area, sir, do your audits cover receiving inspections of subcontractors back to Pratt & Whitney, whether it's an initial issue or a part coming back to Pratt from a subcontractor?

THE WITNESS: Yeah. Well, Pratt has a receiving inspection. And understand like -- like I was explaining before, not every supplier has major inspection authority to make determinations on their own without being looked over by Pratt. So, certainly, they have a full range of receiving inspection for the type of suppliers that require over inspect of their product coming in.

MR. CONROY: And do you audit -- is that part of your audit, the receiving inspection --

THE WITNESS: Yes.

MR. CONROY: -- the paperwork trail?

THE WITNESS: Absolutely. Absolutely.

MR. CONROY: Thank you.

CHAIRMAN GOGLIA: Anyone else in the Tech Panel?

MR. GATTOLIN: Yes, I would like to ask a question, a few questions, if I may, Mr. Gidious.

THE WITNESS: Sure.

MR. GATTOLIN: It's my understanding that you said you have -- there's about 400 manufacturers, and I hate to be redundant, but I need to get some things clear in my mind. You have about 400 manufacturers. And you say about every two years, these people are visited by either yourself or teams throughout the country. Is that correct?

THE WITNESS: Correct.

MR. GATTOLIN: Okay. Doing some simple mental work here, it's about one inspection every 1.3 days, seems to have been going on for just the people you have based on 200 a year --

THE WITNESS: No, no.

MR. GATTOLIN: How does that work? Could you tell me?

THE WITNESS: Let me explain that again. Pratt may have 400 suppliers, but like I stated before, it's not like you go out and do 400 suppliers over a two-year bases. Okay.

MR. GATTOLIN: That's how it came across.

THE WITNESS: Right. What I stated was that what we're trying to do now is put these suppliers into, let's say -- into a system with our audit program, to selectively audit these suppliers, certain suppliers every two years to get an indication on how well the production approval holders are doing in controlling their suppliers.

It doesn't necesarily mean we're going to do a 100 a year or 50 a year or 30 a year. The number that, again, that we do is certainly predicated on other factors. But for the most part, it's basically a health check of how well our production approval holders are doing controlling the suppliers.

MR. GATTOLIN: Okay. Then how many -- again, I must have missed this, but how many inspections are accomplished per year from your knowledge since you've been there, maybe a year or two before you were there?

THE WITNESS: A suppliers?

MR. GATTOLIN: At suppliers, yes.

THE WITNESS: Okay. Well, since I've been there, there has been a grand total of three foreign

and around six or eight domestic.
MR. GATTOLIN: So, six or eight domestic, you get a pulse of how the other 300 plus are doing. Is that correct?
THE WITNESS: Sure. Right. You try. You try. You use it as a measure.
MR. GATTOLIN: I'm having a little problem understanding how that would work if someone in California and then you go to a supplier, let's say, in Arizona, how you can relate --
THE WITNESS: Well, let me --
MR. GATTOLIN: -- to know how they're doing in California, if they're doing fine. And how do you know the boys in Arizona are doing --
THE WITNESS: No, I understand. Again, let me -- let's get back to the basic bases of the Federal Aviation Regulations. It's the responsibility of the production approval holder -- if someone holds a production certificate to control these suppliers. There's the responsibility. That's where it lies.
The FAA oversees that. They ensure that there are systems in place to do that, to say that the FAA has to now go out and audit all of these suppliers is not the realm of the responsibility here, within the

confines of the law. We ensure that they had the system in place. We ensure they are controlling them. We have measures to review, to ensure that they are. And those are the things that we look at.l

MR. GATTOLIN: All right. And one last thing. You said that this hub -- excuse me -- this hub had a source inspection in 1989, the accident hub.

THE WITNESS: Yes, it did.

MR. GATTOLIN: Is a source inspection the same thing as a receiving inspection?

THE WITNESS: No. It's --

MR. GATTOLIN: The source -- go ahead. I'm sorry.

THE WITNESS: It's basically almost like reversing it. Rather than doing the inspection upon receipt, you do the inspection at the source.

MR. GATTOLIN: So, basically, it's a shipping -- it's a preshipping inspection?

THE WITNESS: Exactly right.

MR. GATTOLIN: All right. Thank you.

CHAIRMAN GOGLIA: To the parties. Pratt, ALPA, Volvo, Delta, FAA? Dr. Ellingstad?

DR. ELLINGSTAD: Just one quick follow up. You've made a point on a couple of occasions. That your principal job is to hold the manufacturer responsible for overseeing the quality control of these suppliers. What kind of examination do you do to ensure that there is inspection by Pratt & Whitney of these suppliers?

THE WITNESS: Well, for one thing, ensure, number one, that they have an audit schedule in place to conduct audits of these suppliers in a timely fashion. Number two, that there are let's say field personnel -- Pratt & Whitney field personnel, quality personnel to deal with the suppliers on an as-needed basis and on a somewhat of a regular basis. Three, again, reviewing of service difficulties that we get in. Supplier accreditation methods and how they rate their suppliers, their rating systems we review. We have a lot of different measures that we can look at.

DR. ELLINGSTAD: Do you review regularly how much Pratt invests in doing these inspections?

THE WITNESS: Invests in regards to --

DR. ELLINGSTAD: In inspecting the suppliers doing the oversight of the suppliers?

THE WITNESS: What we require is Pratt & Whitney provide us with an audit schedule each year of who they're going to audit and when they're going to audit.

DR. ELLINGSTAD: Thank you.

CHAIRMAN GOGLIA: We heard earlier that some audits weren't accomplished in accordance with their procedures. Did that trigger any alarms or any -- raise any flags in your shop?

THE WITNESS: I'm sorry, I'm unfamiliar with that one. Was it said by a previous witness?

CHAIRMAN GOGLIA: Yes, it was. Okay. Just disregard it. We have no further questions for you. We will release you. Thank you very much for your testimony.

(Witness excused.)

CHAIRMAN GOGLIA: Our next witness is Daniel Kerman.

(Witness testimony continues on the next page.)

DANIEL KERMAN, AEROSPACE ENGINEER, ENGINE CERTIFICATION OFFICE, FEDERAL AVIATION ADMINISTRATION, BURLINGTON, MASSACHUSETTS

Whereupon,

DANIEL KERMAN

was called as a witness by and on behalf of the NTSB, and, after having been duly sworn, was examined and testified on his oath as follows:

MR. HAUETER: Mr. Kerman, could you please provide your full name and place of employment for the record?

THE WITNESS: My name is Daniel Kerman. My place of employment is the FAA, Engine Certification Office in the New England Region. I'm an Aviation Safety Engineer.

MR. HAUETER: Please provide your background in aviation?

THE WITNESS: Okay. In my current position, which has been for the last eight years, I've worked in the FAA Engine Certification Office as an Engine Certification and Airworthiness Project Manager. In this role, I'm tasked with enforcement of all applicable FAA safety regulations for certification of new engine products and for continued airworthiness management of existing fleets of aircraft engines.

In my past experience, I graduated from Northeastern University in Boston, Mass. in 1982, with a Bachelor's of Science in Mechanical Engineering. Upon completion of my education, I began work at Raytheon Missile Systems Division, and worked there from 1982 to '83. And in 1983, I began work at the General Electric Aircraft Engine Business Group as a design and test engineer. And I was there at GE until 1989.

MR. HAUETER: Thank you. Mr. Anderson.

MR. ANDERSON: Good after, Mr. Kerman.

THE WITNESS: Good afternoon.

MR. ANDERSON: I wanted to ask some questions relative to your involvement in the inspection of Volvo by the FAA. That would be Exhibit 8G and H. H is the active one.

THE WITNESS: Eight-G first?

MR. ANDERSON: No, H, please, first.

THE WITNESS: Okay.

MR. ANDERSON: In this investigation, your name was mentioned with respect to further work that would be done in defining engineering source approval documents and trying to deal with some of the issues that we've already discussed, which is the classification of manufacturing changes as, you know, significant or otherwise.

Could you talk about your progress in that area for us, please?

THE WITNESS: Yeah. The first item that I think was mentioned earlier was the engineering source approval specification, PW-370. At the time that we conducted the audits, both at Pratt and Volvo, it was found that the terms and the requirements for classification of the process changes significant versus insignificant was somewhat subjective. And as we've referenced previously, there were some findings relative to that fact.

In an attempt to take that subjectivity out and make it more of a precise definitive decision-making process, the spec was changed to remove the term "insignificant" and to essentially require that all engineering source approved processes be reviewed through the full rigors of the ESA system, which included engineering source approval engineering, materials control laboratory review, and the local on-site quality rep review.

At the time that these 12 changes were made, the subjectivity was such that the supplier could use their own judgment and make that finding on their own. Some of the other changes in the PW-370 spec were to require special emphasis for high aspect ratio of holes, such as the one in this particular hub and other Pratt & Whitney hubs, and to require an even further heightened review of the qualification of the processes leading up to approval of that vendor to produce the part.

As far as other process developments that the spec was changed, there was -- as has been mentioned previously, the prime reliable parts program, which basically changed the audit frequency of suppliers and reduced it from four years to one year and so forth. There is some other additional activities that I'm involved with, that Pratt is involved with, conducting box experiments or tool trials to better understand the sensitivities and the process controls that turn on this problem as opposed to turn off this problem. And that's in the process right now and it's probably going to be another six months before that research is completed. The hopes being that we will have a better understanding of the turn-on factors that cause abusive machining.

There is other activities looking at process controls, and I believe this is true of other manufacturers right now where we had these initiatives going with the other manufacturers, to better flag, if you will, when an upset occurs in the processing of hole drilling.

Some of those measures include torque measurement systems, that measure the torque and the tool bit, and it gives you an indication that, perhaps, there's a breakage of the tool or a dulling of the tool. It takes -- as I said, it takes away the subjectivity of what's a dull tool versus a sharp tool.

There is another system that's being looked at, which measures the power consumption of the machine. And, once again, that's an indicator that there's a higher resistance in the tool processing the hole.

The MCL lab -- to step back a little bit. The ESA process starts with a document called an ESA requirements memorandum. And that document defines what evaluations the supplier or a perspective supplier has to satisfy to become ESA approved. In the case of Volvo, they had to do metallography and microstructural analysis.

In order to -- as we have looked at other suppliers, we found that there seems to be some variation or, as I said earlier, some subjectivity.

So, we're working with Pratt & Whitney and other suppliers to try and more precisely define what the requirements are for acceptance, for source qualification of a process such as hole drilling, and to make sure that that's consistently implemented, and take that subjectivity out of the specification and that judgment away from the supplier and put it back into the Pratt & Whitney system of engineering and quality.

Once this requirements document is provided to the company -- in this case, Volvo -- if it requires destructive evaluation, the outcome of their process development is a document called the qualification report. And that report will have micros in there and then assessment of the feasibility of their process and Pratt & Whitney will review that.

One of the issues that came out in my review and others that reviewed Pratt was the acceptance standard that the MCL lab uses to decide whether the microstructure is acceptable or not. And in the original specification, there was no latitude. It was rather vague.

Pratt & Whitney, to my knowledge, just recently published a greatly enhanced acceptance specification -- materials acceptance specification to provide a better assessment of abused material or damaged microstructure.

MR. ANDERSON: What you seem to be saying is that as opposed to the FAA surveillance of the audit process, that in response to this engineering problem, that there seems to be some engineering leadership being provided by the FAA in this area?

THE WITNESS: Yes. I'm sure we've all heard it said before a million times. The way to manufacture a product is to build the quality into the processes. And, obviously, having the blue etch inspection at the end of the process is good, but I think the real emphasis needs to be with the development and appropriate approval and review of the process to assure that you won't have these kinds of difficulties.

MR. ANDERSON: I understand. But I also hear you saying that you are studying the process and making the recommendations to Pratt & Whitney on how to improve or making the process acceptable?

THE WITNESS: I, personally,manot studying it. I'm involved with the manufacturer's studying it. They are doing the work, the evaluations.

MR. ANDERSON: Have you in any of your

previous experiences with other rotating titanium parts, had experience with similar microstructural or abusive machining events -- abusive machining events, meaning difficulties caused by the use of tools?

THE WITNESS: I have not.

MR. ANDERSON: Have you found that other processes, other than the titanium, say, with ink and all have been sensitive to the use of boring or drilling tools?

THE WITNESS: I, personally, am the Pratt & Whitney JT-90 project engineer. And, yes, I've drafted and published an airworthiness directive in 1991 to address a similar problem, not the same, because you don't produce alpha case and you don't get the hard layer. You do get distorted grains, but, yes, for the JT-90. And we published an AD on that in 1991, and we just recently published another AD against the Pratt & Whitney JT-90.

MR. ANDERSON: I understand. Would you characterize -- you used the term alpha case. Would you characterize this particular microstructural anomaly as being primarily alpha case?

THE WITNESS: I'm not a real expert at it. I just know that it's a phenomena and that it occurs with titanium and not with the nickel base alloys.

MR. ANDERSON: So, I understand your organization works with the titanium consortium and with the University of Iowa in studying titanium manufacturing issues?

THE WITNESS: This team that I'm involved with does have members from that team, from the titanium consortium.

MR. ANDERSON: Have you participated in meetings with the titanium consortium?

THE WITNESS: In the past, not in the recent past, though. I wanted to emphasize also, that these tool trials that I mentioned came about as a result of the JT-90 problems that we experienced in the past year or so. And it was a result of that that we requested the manufacturer to do these studies, to try and isolate other potential problems. And, unfortunately, to our surprise, before we got smart enough, the Pensacola event occurred. But we were attempting to be very pro-active and aggressively addressing potential airworthiness issues, such as this.

MR. ANDERSON: Referring to a previous question again, the Part 21 of the FAR, 14 CFR 21.165, which talks about the manufacturer or the certification of an air frame delivering a safe part. Do you have any guidance in that area as related to an engine part or a rotating part?

THE WITNESS: I'm not specifically knowledgeable in that FAR.

MR. ANDERSON: So, in fact, the FAA, in general, when inspecting the procedures for manufacture and rotating parts, does not use that definition for making a determination whether the product is ready to be released?

THE WITNESS: I'm not sure I understand your question, George. Could you repeat that?

MR. ANDERSON: Turning to the document -- I think it's U here. Did you get the regulation? Eight-U is the regulation. Exhibit 8U is what we're referring to.

THE WITNESS: Exhibit what, George?

MR. ANDERSON: Exhibit 8U.

THE WITNESS: Eight-U, okay.

MR. ANDERSON: Eight-K, I'm sorry.

THE WITNESS: Okay.

MR. ANDERSON: Have you gotten to page 3?

THE WITNESS: Yes, 21.165.

MR. ANDERSON: Yes. Okay. And it starts

there and I quote, "The holder of production certificate shall..." and then there's two paragraphs. The second paragraph essentially, paraphrasing, "determine that each part and each product conforms to the approved design and is in a condition for safe operation."

Now some of that, it could be stated, flows down to an engine part.

THE WITNESS: Yes.

MR. ANDERSON: However, the definition of what constitutes safe operation would seem to be the purview of the FAA to define that and that's my question to you. Is there some methodology or some way that inspectors and people who approve manufacturing inspections apply that requirement? In other words, what constitutes a part that is in condition for safe operation? Is that a part that it leaves the factory in perfect condition or, like has been mentioned earlier, a part that has passed all known inspections, but can still have defects, but there's a continued airworthiness inspection schedule that will catch those if they are still in the part?

THE WITNESS: We don't envision that there will be any defects. I think the premise is that the quality system will assure that all defects are removed in the production process. But the definition of airworthiness is it's an approved type design and it's in a condition for safe flight.

MR. ANDERSON: So, that the objective -- the FAA's objective is really to ensure that the manufacturer provides a safe part. That is --

THE WITNESS: That's conform --

MR. ANDERSON: -- essentially, it will operate to its projected or forecast lifetime --

THE WITNESS: That's correct.

MR. ANDERSON: -- without failure? Do you envision your additional studies in checking and the way of improving the processes to be -- result in any changes in the immediate future as far as guidance?

THE WITNESS: Absolutely.

MR. ANDERSON: Do you believe --

THE WITNESS: As far as regulatory guidance?

MR. ANDERSON: Not necessarily regulatory guidance, but policy guidance in approving individual manufacturer's processes, such as the blue etch processee -- process. And also, perhaps, I envision -- if I heard you correctly, that you might have some information on controlling the actual machining process, such as drilling and the selection of the tools?

THE WITNESS: I thinkRichard mentioned it earlier, as part of the ASCEP program, we have drafted some more precise ASCEP evaluating criteria under design data control, which is one of the ASCEP subsystems. And that's one that's primarily audited by engineers.

And that those procedures -- those ASCEP evaluation criteria have been written and directed to engineers to sensitize them to help them understand the ESA process or the process qualification systems at a supplier or at a production certificate holder, and to make sure that we do give focus to this in a more direct way. But that's not to say that we've overlooked this. I mean, I've always understood that this was a -- for instance, was a system that needed to be assessed and looked at.

MR. ANDERSON: Yes. In your present capacity, you're essentially looking after the engines that you're charged with sort of from cradle to grave. Is that true?

THE WITNESS: Yes.

MR. ANDERSON: In other words, you look upon the certification process and you make judgments and approvals there. And then you deal with the in-service problems as they develop. Is that correct?

THE WITNESS: Yes. And with the in-service aspects, it's a multi-faceted role. I work in a team fashion. It's -- I guess, we call it in our office, a certificate management team, in which we work with the applicable arms. I'm usually the first one, the project engineer, to become aware of service difficulties.

If I'm not, flight standards may become the first to become aware of it. But we work in concert to address the potential problems. If it's a manufacturing or a potential of a manufacturing quality problem or something of that nature, I'm going to be working with Rich Gidious right away.

MR. ANDERSON: Yes.

THE WITNESS: If it's appears obvious that it's a maintenance deficiency or a problem with the maintenance procedures, then we're working with flight standards aggressively in the aircraft evaluation group. If it's a design issue, then, of course, it's just left with the aircraft certification engineer and the manufacturer. But that's the whole closed loop.

We address airworthiness, not just from the type design, but from the way the part -- the way the product is maintained and operated and manufactured.

MR. ANDERSON: Since you're still fairly close to this particular problem, do you believe that the surveillance of the in-service hubs that are currently in service should be altered in any way?

THE WITNESS: That's a tough question.

MR. ANDERSON: Is that being assessed at the present time?

THE WITNESS: I'm familiar with the fact that it's been assessed using our risk management programs. And I, personally, use those on a regular basis for my programs and I find it to be a very useful tool that allows us to evaluate an unsafe condition, in a more structured way. It enables us to prioritized unsafe conditions, so that we're not focusing on the wrong areas and giving zero attention to areas where there's much higher importance. And I understand that it's been used in this case, and I would have to say that it's probably a very good management plan that's been developed.

MR. ANDERSON: Yes. You're referring to the continued airworthiness assessment method, the CAAM acronym? The program?

THE WITNESS: In risk management, yes.

MR. ANDERSON: And could you explain just to close that out, basically, what that system is and who actually does the actual work in generating the statistical concepts there?

THE WITNESS: It's a statistically-based system that's predicated on, I believe, 150 million hours of operating history, assessing the hazard ratios of different types of failure modes, and what their criticalities are. And it's using statistical analysis and Monte Carlo analysis to develop risk factors and to assess probabilities of the unsafe condition occurring again during the duration of a campaign or an AD program. And it -- as I said earlier, it enables us to prioritized risks and to make sure we're giving it the necessary focus.

What generally happens is the manufacturer -- in this case, Pratt & Whitney for me -- develops the risk models. And then myself as a project engineer -- and this is true for all the other project engineers in my directorate -- will meet with the manufacturer and we'll discuss all the boundary conditions and assumptions.

So, things, such as POD, which we take very seriously, because we want to make sure that the inspection has the reliability that has been envisioned in the risk model. Other parameters like the fracture mechanics, the stress numbers, the fleet utilization rate, the mission mix of the fleet, all of that is built into the model to make sure we've got out ducks in a row.

MR. ANDERSON: I understand. And it's a management tool, as you say. You don't --

THE WITNESS: It's not the only tool.

MR. ANDERSON: That's right. You're not basing your decisions -- however, I would like -- you mentioned some of the elements that go into it, and I would like to just clarify some of them, if I could. You mentioned the Monte Carlo method. Would you explain to the non-engineers -- perhaps, basically, what that means?

THE WITNESS: Well, that's a statistician's question, and I'm not a statistician. So, I wouldn't -- I don't think I'm qualified to answer the question.

MR. ANDERSON: Why would they use the term "Monte Carlo?"

THE WITNESS: Monte Carlo analysis is a type of statistical analysis. There is Marcov analysis. And I'm not, as I said, intimately familiar with the way the analysis is performed at the OEM. My role is to make sure that the boundary conditions going into that analysis are correct. The statistical analysis is a well-founded system that has been around for many years.

MR. ANDERSON: Yes. Who in the engine directorate would we look to for technical guidance in the knowledge of this type of risk assessment?

THE WITNESS: I believe in our 110 standard staff, we have people that are experts in that area.

MR. ANDERSON: So, they are aware of the analyses and they review these?

THE WITNESS: We -- that's a god question. If I have any questions or concerns or if I have a lapse of understanding, myself and others will also coordinate with that individual or individuals that is more familiar with the CAAM process. And I, once again, regularly do that to make sure that I'm not off base with the risk management program and with the issue, in general.

MR. ANDERSON: And just one last question in that area. If you are doing a risk analysis, but you have a condition, which, you know, even though rare, such as in this case, but can be quite serious if it leads to failure, what is the offsetting reason to simply follow a statistical risk assessment when, perhaps, a more conservative role could be taken? In this case, for example, if we thought that there was one failure in an entire -- or one potential failure in an entire fleet of parts, what would keep us from going out and in some reasonable fashion, retrieving all of those and inspecting them and assuring their airworthiness? What would be the counter veiling?

THE WITNESS: I guess, it depends on the unsafe condition that you're trying to mitigate.

MR. ANDERSON: Imagine the condition that we have been talking about today.

THE WITNESS: I would assure that the risk factors that are assessed in that risk management plan have been satisfied and met. And that the risk factors are below the necessary goals to assure that for the duration of the program, there is less than .5 risk of this event occurring again for the duration of the program, whatever that may be. For the AD, in this case.

One of the other things that we do is -- I know that the manufacturer tries to, and we try and do it with them, is to calibrate the analyses by looking at other service experience. And we're continually recalibrating the analysis if we see shifts in POD or in other parameters like crack growth rate. If we've got an inspection program and we see that how the crack's growing faster than anticipated in the fracture mechanic's model, it's a continuous improvement process. We don't just stop at the publication of the AD. We're constantly revalidating all the assumptions.

MR. ANDERSON: In the case of the fleet-wide inspections that are now in progress, it's my understanding reportedly that four -- up to four indications have been found in the fleet. Could you share with us the status of those indications?

THE WITNESS: I'm not familiar with it. As I said, I'm not the project engineer for this particular engine. I got involved in it from the supplier end and from the engineering source approval aspects, but I'm really not the person to really ask the specifics about the risk management plan for this AD.

MR. ANDERSON: Right. But are you aware of the four indications that reportedly have been found?

THE WITNESS: To my knowledge, I thought it was less than that, but, no, I'm not. I don't know exactly what the specific details were and what the metallography was, what the results of the destructive evaluations were. I have no experience with that.

MR. ANDERSON: Thank you. I have no more questions, Mr. Chairman.

CHAIRMAN GOGLIA: Anyone else on the Tech Panel? Mr. Conroy?

MR. CONROY: Yes, sir. One question. Were you involved in the FAA's ADs that I mentioned in my opening remarks this morning, subsequent to this accident regarding cycle to inspection?

THE WITNESS: No, sir.

MR. CONROY: Not at all?

THE WITNESS: Not at all.

MR. CONROY: Okay.

CHAIRMAN GOGLIA: To the parties. McDonnell Douglas?

Mr. STEELHAMMER: No questions, Mr. Chairman.

CHAIRMAN GOGLIA: Delta?

MR. VALEIKA: No questions, Mr. Chairman.

CHAIRMAN GOGLIA: Volvo?

MR. THOREN: No questions.

CHAIRMAN GOGLIA: ALPA?

MR. MCCARTHY: No questions, Mr. Chairman.

CHAIRMAN GOGLIA: Pratt?

MR. YOUNG: No questions, Mr. Chairman.

CHAIRMAN GOGLIA: I love it when we get close to dinner.

(General laughter.)

CHAIRMAN GOGLIA: It gets better and better. The FAA?

MR. DONNER: No questions. Thank you, Mr. Chairman.

CHAIRMAN GOGLIA: Dr. Ellingstad?

DR. ELLINGSTAD: Justa couple of quick questions to clarify the FAA role with respect to this risk management plan and the risk models. Are you approving the risk management plan? Are you exercising some approval over the specific statistical or mathematical models that are exercised under that plan?

THE WITNESS: Yes, we are. The precursor to an airworthiness directive is a lot of leg work with the manufacturer, developing the inspection techniques, running the tests and analysis necessary to understand the failure mechanism, the crack promulgation rate, the crack initiation intervals, the inspection capabilities of the inspection that's going to be used, and that's the role of the certification engineer, is to make sure that those parameters are satisfied first and foremost, and that the risk goal objectives outlined in our risk management system have been satisfied. And that we do that, of course, with the least impact possible to the operator.

DR. ELLINGSTAD: Okay. You had indicated, a principal role that you had with respect to working with the manufactures on these models was determining the appropriateness of boundary conditions in various of these empirical parameters. How do you exercise that aspect of the oversight? Are you -- you're dealing with data that they supply --

THE WITNESS: Yes.

DR. ELLINGSTAD: -- and passing judgment on it?

THE WITNESS: Yes, we -- for instance, for the inspections, we witness the inspection. If it's an inspection that goes up the back end of the engine and it's a very complicated and arduous inspection, then we try and encourage or -- maybe that's not the correct use of the word, but we try and assess the POD at a lower level. We want to anticipate that it's a difficult inspection.

Ideally, we would like to have the most reliable inspection. We can. So, that's factored in. We witness the inspection. We actually do it ourselves. I've, personally, done inspections on my own. From the structural standpoint, we assess the risk -- the stress analyses and the vibratory analyses to make sure, as engineers, we feel comfortable with the stress numbers and the vibratory numbers or the thermal calculations that go into assessing what ultimately will come out of the fracture mechanic's model. And then we review the fracture mechanic's model to make sure that it's correct and appropriate in accordance with all the necessary engineering parameters and that it's been validated by testing or service experience or both.

And so that's the role. We make sure that the boundary conditions that most impact the risk have been addressed and that they are the correct boundary conditions.

DR. ELLINGSTAD: So, you are effectively certifying those kinds of parameters, the POD, for example?

THE WITNESS: Well, we don't formally approve the risk analysis, if that's what you mean, no. We don't publish the airworthiness directive until we have the necessary requirements satisfied. And that's a precursor to the AD, is all of that up front activity.

DR. ELLINGSTAD: Thank you.

CHAIRMAN GOGLIA: Mr. Haueter?

MR. HAUETER: Yes. Just a few. The FAA doesn't do an independent risk analysis of any --

THE WITNESS: We've been trained -- me, personally, I've taken Marcov analysis and Monte Carlo analysis courses at MIT and at other graduate schools. And our whole office has been trained in these disciplines. We understand some of the basic principles, but, no, we -- it takes years of education to become a good statistician and that's not for engineers. And we've been given the necessary understanding, level of understanding, to be able to assess it and to make sure that it's correct and appropriate. And quite honestly, I've never had a risk program that was invalidated. The record has been impeccable that way.

MR. HAUETER: Have you seen major differences in the risk models between one manufacturer and another?

THE WITNESS: Unfortunately, I only work with one manufacturer, Pratt & Whitney. But I can tell you that in the past, I think we were way off market times, because we were, in essence, pulling numbers out of a hat and not really giving it a structured review. And so, I -- you know, at times we were impacting operators with very aggressive programs when we need not have done that, because the risk was extremely low. And at other times, we were under impacting. And actually, running higher risks than we had anticipated.

This is a very structured and systematic way to understand the risks. From my standpoint, it's good stuff.

MR. HAUETER: Based on the failure of the PanAm disc back in '82 and this failure, have you asked to have the model rerun based on the information you have now?

THE WITNESS: Oh, yes. The PanAm event is in that risk model, I'm sure.

MR. HAUETER: In the most recent one now, too?

THE WITNESS: Yes.

MR. HAUETER: And has that -- how did that change the model, do you know? What kind of impact did those two failures have on the hole?

THE WITNESS: Well, if it had -- it certainly -- if there were more events in the past, as an example, the risk would certainly have been much higher. And so, we would have had to have driven down the compliance requirements, the inspection intervals, the removal requirements or what have you. So, that's how it impacts it.

If there was an event in 1982, the risk would have been even lower statistically speaking. And, so, we would, in theory, not have had to impact the operators as much.

MR. HAUETER: Have you done a sensitivity analysis as to how much the model is affected by, say, if you have one accident? How does that affect --

THE WITNESS: Oh, yes. Absolutely. In many of the models, it's -- we take a conservative approach and assume that there's been one additional event in the model. There's a lot of conservative assumptions that go into the model. I'm not saying it's perfect, but as I said before, it's a much more structured approach than the kind of seat of the pants techniques that we were using in the past.

MR. HAUETER: That's all I have. Thank you.

CHAIRMAN GOGLIA: Does anybody on the the

Panel have additional questions? I already asked. Who said yes?

MR. EINDLER: Yes.

CHAIRMAN GOGLIA: Oh, okay.

MR. EINDLER: Concerning the difficulties to detect this type of surface imperfections, why does not the FAA require torque monitoring while drilling in this critical titanium alloy parts? I mean, that is a method that some engine manufactures require, because it gives you an indication that the drill is sticking and that consequently requires some extra inspection?

THE WITNESS: We're still studying that. We still don't have all the data we think we need. And it may be -- it's quite likely, it will be something that we will see in the near future. I can't speak for the industry, but I think it's something that could and may very well come about. As I said, it takes away a lot of the subjectivity and such.

One of the issues at Volvo was the question of when you qualify a process and in the initial engineering source approval requirement, it's stated that you had to qualify a process for a tool immediately prior to resharpening, but nobody could answer what that was.

It was told to us later that at Volvo, it was every hub. But that's very subjective. And if you're going to develop a process, you really ought to know what a dull tool is. And if you have a system like that, it takes all that subjectivity away, because -- you know, there is random variation in the tools. You may have some tools that last longer than others. And, so, for one tool, it might be good for two hubs. And for one, it might be good for half a hub.

This is a more definitive way to know when the tool is dull and to know when you're causing potential damage to the microstructure.

MR. EINDLER: Okay. No further questions, Mr. Chairman.

CHAIRMAN GOGLIA: Mr. Kerman, I would like to thank you very much for your testimony. And it was also a pleasure to hear someone else who talks properly.

(General laughter.)

THE WITNESS: Thank you.

CHAIRMAN GOGLIA: I was feeling lonely.

THE WITNESS: Theprior people talked well.

CHAIRMAN GOGLIA: Thank you very much.

THE WITNESS: You're welcome.

(Witness excused.)

CHAIRMAN GOGLIA: Warm up, Al. Do you want to take a break? Do you want to take a few minutes? All right. Why don't we take 15 minutes, so Al can get enough stamen. I've been threatening to take him through the coals all day today. And why don't we collect all those pink sheets. There's no further need for them. So, there's no need to leave them hanging around. Here's your chance to give me a pink sheet.

(Whereupon, a short recess was taken.)

CHAIRMAN GOGLIA: We'll go back on the record. And our next witness is Mr. Al Weaver.

(Witness testimony continues on the next page.)

ALAN WEAVER, FELLOW, ACCIDENT INVESTIGATION AND AIRWORTHINESS, PRATT & WHITNEY, EAST HARTFORD, CONNECTICUT

Whereupon,

ALAN WEAVER,

was called as a witness by and on behalf of the NTSB, and, after having been duly sworn, was examined and testified on his oath as follows:

MR. HAUETER: Mr Weaver, could you provide your full name and place of employment for the record?

THE WITNESS: My name is Alan Weaver, and I work at Pratt & Whitney Aircraft, East Hartford, Connecticut.

MR. HAUETER: And what's your title and job function there?

THE WITNESS: My title is Fellow in the field of accident investigation and airworthiness. And that entails a job function as the leader of the disciplines at Pratt & Whitney in that field of accident investigation and airworthiness, as responsible for leading the processes, affecting accident investigation and airworthiness, as well as being a recognized technical leader within the industry in those fields.

MR. HAUETER: Could you provide a little background of your aviation history?

THE WITNESS: I've worked at Pratt & Whitney for over 40 years. I originally started as an apprentice, worked my way up as an engineer, and gained a degree in Bachelor of Science, and have progressed in that field, up to the position, which I hold now.

MR. HAUETER: Do you hold any FAA certificates or licenses?

THE WITNESS: No, I do not.

MR. HAUETER: Okay. Thank you. Mr. Anderson.

MR. ANDERSON: Good evening, Mr. Weaver.

THE WITNESS: Yes.

MR. ANDERSON: Could you start off in the area of this risk assessment and tell us what you know of the term Monte Carlo?

THE WITNESS: Monte Carlo is one of the many tools that a statistician uses in assessing the probability of something happening, given known inputs. And I am certainly not an expert in the statistical methods. I haven't taken any courses in that regard.

I have, of course, been around statisticians who use that term. And it basically -- the Monte Carlo has to do with many different facets contributing to a probability of something happening. And it's equivalent to something with like running a thousand cases, a thousand trials, and seeing how many times the answer comes out one way versus another way, but that's to some extent of my knowledge about Monte Carlo.

MR. ANDERSON: Thank you. Could you describe your involvement in the investigation of the Pensacola accident and the follow-up actions at Pratt & Whitney regarding the hub and the work involving that?

THE WITNESS: Well, my group was involved in assisting the NTSB in the investigation of the Pensacola accident. I was not in any of the particular NTSB groups in that regard that I recall. But I assisted the program office at Pratt & Whitney and the people -- statistical people in establishing the conservative set of assumptions by which they would identify what we felt were the likely causal factors at that time versus the need for a corrective action long before, of course, we can complete such a hearing, such as this.

MR. ANDERSON: Could you briefly describe the

-- was there some change in the -- over time, as far as the assumptions or what was learned?

THE WITNESS: Yes, there was. There was an original assumption that there was a single part, which had escaped, and been installed on an engine, which, of course, was the part that fractured. And that we had addressed the issues as if there was one other part that there might be out there in the fleet, at a very high risk. And then as a further investigation was done, we felt that there was a possibility there might be other populations at risk. However, as soon as the population size increases, actually, the probability that this thing is going to promulgate the fracture in a short period of time decreases.

So, we simply continually updated our assumptions based on the findings in the investigative process.

MR. ANDERSON: Were you aware of these reported additional hubs that were found with crack indications, either through the new eddie current process or so on, that were discovered in the field?

THE WITNESS: I was aware of the field findings, relative to the inspections going on in the field and what changes they made in our assumptions.

And in this particular case, those findings made no changes in our assumptions, because they were not what we would call positive findings of same as the disc that it fractured.

MR. ANDERSON: Yes. In other words, they were either cracks or indications of cracks, but were not altered microstructure. Is that a correct --

THE WITNESS: The last part I agree with. They were not altered microstructure. They were visual findings. And to some extent, eddie current and ziglo findings that were later examined and determined that they weren't the same thing at all. They were like surface conditions.

MR. ANDERSON: Were these hubs taken out of service?

THE WITNESS: In order to make that finding, yes. That's how they were found.

MR. ANDERSON: Yes. Were they subsequently returned to service or were they condemned?

THE WITNESS: They were brought in to East Hartford where they were thoroughly examined and cut up. There was no intent of returning them to service, because they were too valuable as a laboratory tool.

MR. ANDERSON: In what way would they be

valuable?

THE WITNESS: In examinations, metallurgical examinations to determine what was causing the indication. They help us calibrate further inspections. They also help us calibrate the original assumptions used in our corrective action in the fleet.

MR. ANDERSON: I understand. But isn't the fact that there have been three cracks discovered in the fleet, in and of itself, significant regardless of the fact that it hasn't been confirmed to be this problem?

THE WITNESS: You presuppose that those were cracks. And, indeed, they were not cracks. They were surface conditions. And by examination, we determined they had no significance from a safety standpoint.

MR. ANDERSON: You say surface conditions. We originally talked about eddie current inspections. Now, they would have started out, I would imagine, as eddie current indications.

THE WITNESS: That is correct.

MR. ANDERSON: Okay. I would like to move over to the -- we agreed to talk a little bit about the continued airworthiness assumptions. Could you tell me just a little bit about your background in testing, rotating parts, any experience you've had in assuring the integrity and life cycle of parts?

THE WITNESS: Personally or Pratt & Whitney --

MR. ANDERSON: Personally.

THE WITNESS: Personally. Well, I was responsible for the initial fatigue testing of commercial gas turbine engines for the first engine that went in commercial service. This is, obviously, before there was any FAA, before there were any FARs. But there was a recognition that there should be a limit on the life of a disc and we had to establish what that was.

And, so, I was responsible in my young years of running the testing. That started to establish or gather the data, by which we established the lives of discs.

MR. ANDERSON: Bringing that up to that knowledge and experience to the present situation. Did you talk about the -- as best you could, the methodology for establishing a lifetime on a hub, such as this one, how that process takes place?

THE WITNESS: The Pratt & Whitney process was an extensive amount of material testing and component testing. And that included rotor discs, when I talk about components, with blades in them.

We evaluated the various materials that we were considering for our disc designs. And we evaluated the fatigue resistance of those materials or capabilities under the conditions that you could expect to find in the engine, including the stress conditions, the sharp KT conditions, with bolt holes and with blade slots. We considered the temperature.

We did a very, very extensive testingn i order to calibrate a method by which we could validate a safe fatigue life for a disc in commercial service.

MR. ANDERSON: So, you're essentially saying that the published lifetimes for these parts are based on tests?

THE WITNESS: That is correct, in that they are called safe life. They have a considerable amount of margin in them. Typically, it's a two to one type of margin, if there is no other anomalies with the disc.

MR. ANDERSON: So, as we take a disc that has been properly tested, properly inspected, and properly manufactured, not necessarily in that order, and we install an engine and put it in service, we then come under the features of 14 Code of Federal Regulations 33.4, which is in -- again, we'll turn to the exhibit that I now have in front of me, 8K.

THE WITNESS: Yes.

MR. ANDERSON: And to paraphrase, the applicant or engine type certificate must prepare instruction for continued airworthiness in accordance with Appendix 8 of this part that are acceptable to the Administrator. And I'm quoting a portion of the appendix A. "The applicant must include an inspection program that includes the frequency and extent of the inspections necessary to provide for continued airworthiness of the engine."

Could you outline Pratt & Whitney's program of compliance as it relates to the hub?

THE WITNESS: Can you point out where you are in appendix A?

MR. ANDERSON: Yes, 34.4, the first two sentences -- or the first sentence. And that's -- I'm sorry. That's on page 4. Go to page 4, paragraph 33.4.

CHAIRMAN GOGLIA: You're not looking on the right one.

THE WITNESS: Could somebody provide me with the exhibit?

MR. ANDERSON: Eight-K is the exhibit number.

THE WITNESS: Now, I've got page 4.

MR. ANDERSON: Okay. On page 4, in the lower left-hand corner, paragraph 33.4 entitled, "Instructions for Continued Airworthiness."

THE WITNESS: Oh, I'm sorry. I misunderstood. I thought you were into the appendix.

MR. ANDERSON: We do move there after we stop here for a moment.

THE WITNESS: Go ahead.

MR. ANDERSON: Just to read it again, "The Applicant must prepare instructions for continued airworthiness in accordance with appendix A to this part." And then the last significant statement here is, that are acceptable to the Administrator. In other words, this implies that the FAA approves these submissions.

Moving to the appendix, that would be page 6, and it would be paragraph A-33, subparagraph 6. And if you read through subparagraphs 6, which is talking about what must be in the manual provided by the engine manufacturer, if you go down to the last two sentences starting with -- well, let me start at the top, so as not to be confusing.

"Scheduling information for each part of the engine that provides the recommended periods at which it should be cleaned, inspected, adjusted, tested, and lubricated, and the degree of inspection, the applicable wear tolerances," and so on and so forth.

THE WITNESS: I think that I can save you some time. My view point of that is that there is a conditional statement that immediately stopped me from reading any further on that.

MR. ANDERSON: Okay.

THE WITNESS: It's not applicable to this part. The conditional statement right up in the front, it says that scheduling information for each part of the engine that provides the recommended periods. There is not a portion of this that is applicable to this for recommended periods relative to being cleaned, inspected, adjusted, or tested. So, this statement does not apply to this particular part.

MR. ANDERSON: And that's really essentially part of my question. Are you saying that Pratt & Whitney does not recommend in-service inspections of the hub?

THE WITNESS: No, I'm not saying that. Pratt

& Whitney did not require in-service inspections of the hub. And, therefore, it did not validate this part on the basis of this particular statement.

MR. ANDERSON: But once again, you're saying because the -- we have to read the rest of this for this to make sense, I think. Jumping down, it says, "Airworthiness limitations section of the manual..." -- and then it says, "....must also be included. The applicant must include an inspection program that includes the frequency and extent of the inspections necessary to provide for the continued airworthiness of the engine."

THE WITNESS: That's correct. Then I do believe that limitation section is the section that applies to the fan hub in this regard. We established a safe life. And that safe life is the published life, and it goes in the limitation section. And, therefore, being a limitation and being validated by the FAA, the operator should not go beyond that safe life. What he does when he achieves safe life is up to him. The disc is no longer useable in an engine. If you're not going to use it in the engine, then there is no requirement to inspect it or do anything else with it. Just don't put it back in an engine.

MR. ANDERSON: I understand. And I understand perfectly that the most important airworthiness issue with a rotating part is its established life, as we -- as you pointed out earlier.

However, we do have the issue of the continued airworthiness, which involves inspection. And I seem to understand you to say that Pratt & Whitney feels that their inspection intervals, as published in the Pratt & Whitney shop manual, are recommended intervals and not approved procedures that are binding.

THE WITNESS: No, I'm trying to clarify. I have no intervals published in the shop manual that apply to this particular part.

MR. ANDERSON: They are not intervals applied in what manners?

THE WITNESS: Well, we're talking about a disc, which is safe life. I have nothing in the shop manual that is a recommended interval relative to that part. The shop manual may have recommended intervals relative to other parts of the engine or the engine as a system, but it does not apply to the disc.

Now, from the standpoint of continued airworthiness, once we have delivered that part in a safe fashion and once we have published the limitations in this manual, that is sufficient to maintain the safety of this part, providing that nothing else happens. But when the part is removed, for any reason, because the engine is being overhauled to refurbish it for some reason, now there is the responsibility of the owner of the part to return it to service in an airworthy condition. That does not come under Part 33, in my view point.

MR. ANDERSON: And I think I understand you to say -- and let me give an example and see if this is correct. That if a part, such as this, that had no inspection interval published in the manual could be run to its lifetime without inspection?

THE WITNESS: That is correct.

MR. ANDERSON: And the other side of this question and we can go on to something else, is that when you say there is no inspection interval in the shop manual, do you mean none whatsoever or just none that are set to hard intervals? Isn't on condition or on exposure an interval, even though it may not be a hard interval?

THE WITNESS: Your statements of uncondition or exposure, I do agree are what might be referred to as soft times. But that is on condition of what? What are you tracking? In that particular case, you're tracking the condition of the engine, other than the safe life parts. These are the parts of the engines that can show wear and tear, such as your gas flow parts, your blades, and things like that.

A safe life part is exactly what it is. It's safe for the total life in the engine, if you do not remove it. There is no recommended interval. The thing that controls that has to do with if the engine is disassembled for any reason, you must determine that that part is returned to service in an airworthy condition.

MR. ANDERSON: So, my final question in that area is that if an airline is following the Pratt shop manual procedures, they are expected to inspect this part as to the detailed Pratt procedures and standard practices at some point during disassembly. Is that correct?

THE WITNESS: That is correct. But it is, too, Pratt & Whitney publishes now the recommended procedures in the standard practice manual, and it's up to the operator to demonstrate to his FAA oversight that whatever he does is acceptable to the FAA. Most people would take the Pratt & Whitney procedures as is and show the FAA that they're meeting them, but that is not required. They may alter them to the satisfaction of the FAA.

MR. ANDERSON: Is the inspection -- excuse me, the life limit on the part, the one that is published in the continued airworthiness section, based primarily on crack promulgation rates or does it also include issues, such as corrosion and abnormal surface?

THE WITNESS: It does not include the issue, such as abnormal service, such as corrosion, as an example of abnormal service, or handling damage. However, its safe life has a degree of conservatism in it. I mentioned that typically, that the safe life would imply that you have like a two to one margin. However, we can get more detailed.

We do assume that in the safe lifedesign, that there is redundancy in the part to crack promulgation. We are using materials that have a significant factor of toughness, and it will take a long time to promulgate to fracture. That assumption is borne out when we validate this to the FAA, to their satisfaction, that no more than one in a thousand parts will actually develop an inspectable crack, should somebody inspect one after it has been retired from service at full retirement life.

So, no more than one out of a thousand would have that very small minute crack just at the portion where you can just inspect it. And then you can see that had you continued to run it, it would still take a very long period of time for that to promulgate the fracture.

There is where your margins are. There is where your redundancy is.

MR. ANDERSON: I understand what you said. Along that line, does Pratt & Whitney have a method of verifying the performance of its parts in the field? Do you require reporting of failures, cracks, abnormalities -- abnormalities, excuse me, that are found in these parts on a -- in the shops in the field?

THE WITNESS: Pratt & Whitney cannot require, of course, but Pratt & Whitney does have a method in place by which we gather that kind of information from the operator. They are reporting requirements under Part 21 between Pratt & Whitney and the FAA for what we know in that regard, as well as between the operator and the FAA in what they know in that regard.

And, so, yes, we do track all abnormalities that we are aware of and we constantly will review our lifing system to determine that it is adequate.

MR. ANDERSON: Have you recently reduced the life -- published life limit on a rotating part?

THE WITNESS: I believe we have.

MR. ANDERSON: In another area, one of the additional requirements in the section 33 is the requirement for the manufacturer to provide for timely and approved updating of the repair manual. And I would ask you under that provision, to describe to us the general plan at Pratt & Whitney for updating a repair manual when an unexpected event causes a change to the assumptions, the engineering assumptions or the test assumptions with a rotating part.

THE WITNESS: I'm not personally familiar with the repair manual that my first reaction is if there is anything that is learned, I need to update my limitation section under 33.4. Exactly what piece of paper that goes into, I leave that up to somebody else.

MR. ANDERSON: Mr. Chairman, I have no more questions.

CHAIRMAN GOGLIA: To the TechPanel.

MR. CONROY: Yes, sir. One or two questions, Mr. Weaver. You talked about the inspection of parts, such as the accident fan hub, when engines come in to the shop and engines are disassembled. But I believe you said words to the effect that this was not required. Is that correct?

THE WITNESS: That is correct, by Pratt & Whitney.

MR. CONROY: By Pratt & Whitney. But it is done anyway, is that a fair characterization?

THE WITNESS: Well, we have to look at who does require it. I believe it's required by the FAA.

MR. CONROY: Okay. Pratt & Whitney does not recommend it?

THE WITNESS: Could you repeat that, please?

MR. CONROY: But Pratt & Whitney does not recommend it?

THE WITNESS: No, I'm sorry. Pratt & Whitney certainly does recommend. We can't require. We recommend that when the part is available, that it be inspected. That's prudent. That's where your redundancy comes from in flight safety.

MR. CONROY: Thank you. Now, is there a statistical -- I know you mentioned that you have not taken a course in statistics, but you've talked to statisticians in their work. Are there statistical

analyses that go into the Pratt & Whitney
recommendation for examination during disassembly?
THE WITNESS: Under part 33 with a normally operating part, no. The only time that any statistical analyses are performed in that regard, is when there is knowledge that there may be a deficiency in the part for any reason, including wear and tear that was not anticipated. But should there -- most parts do not ever have that deficiency in a safe flight part, then there's no statistical analysis that goes into that from a safe flight part.
MR. CONROY: Thank you.
MR. GATTOLIN: Yes, I would like to ask a couple of questions, if I may, Mr. Weaver. When you were talking, you said that -- perhaps establish the fact that the hub needs no inspection, the 219 hub. How do they establish that? How do you come up with that or how would Pratt come up with that? I mean, what type of testing do they do? If they set it at 20,000 cycles, why was it set at 20,000? Would you, please, define that? Explain it to me?
THE WITNESS: Pratt & Whitney did extensive material testing on the material that was used in that hub, as well as similar shapes to that hub and similar

stresses under the same temperature conditions, to establish that with those stresses, that it could safely take 20,000 start and stop cycles and no more than one of a thousand of those hubs would have the minutest crack indication in it. And that there was no danger of the part fracturing within the 20,000 cycle life limit. That was then presented to the FAA as a validation of our lifing system applicable to that part number.

MR. GATTOLIN: Okay. Who set the level of risk at one in a thousand, if I may ask? How was that -- just through your testing of -- you said extensive testing. Could you give me an example?

THE WITNESS: Well, there was a variation in fatigue life, a metallurgical variation.

MR. GATTOLIN: Right.

THE WITNESS: Okay. And variation in fatigue life gives you that one in a thousand. The one in a thousand is only acceptable on the basis that you have fractured toughness materials, and the materials that we are characteristically using in gas turbines today and that we know that it has by testing, that it has extensive crack promulgation resistance. That's the only way we could ever accept the one in a thousand.

We would never accept one in a thousand as far as fractures is concerned.

MR. GATTOLIN: I see. Okay.Thank you.

CHAIRMAN GOGLIA: The parties? McDonnell Douglas?

MR. STEELHAMMER: No questions.

CHAIRMAN GOGLIA: Delta?

MR. VALEIKA: No questions.

CHAIRMAN GOGLIA: Volvo?

MR. THOREN: No questions.

CHAIRMAN GOGLIA: ALPA?

MR. MCCARTHY: One, Mr. Chairman. In setting up the service life conditions, what assumption did you make on probability of detection of an anomaly at the time of manufacture as an entry way into your whole service life experience?

THE WITNESS: There is multiple inspections used in manufacturer, and it assumed that the service life of numbers that I gave you, the 20,000 cycle life, with no more than a one thirty-second crack in one in a thousand discs and no ruptures is based on the largest undetectable flaw that we felt could escape through the manufacturing. And so it resumes that there is a size of flaw that could escape some of the time. The disc must, therefore, be designed, with that flaw in mind, that the disc will still not rupture in service.

MR. MCCARTHY: I mean, but do you have any particular percentage of what percent of the time an otherwise detectable flaw would go undetected? What that assumption was?

THE WITNESS: No, I do not have a number like that, other than it would be extremely rare. We cannot argue with the fact that it has gone undetected. But we certainly cannot sit here and lists several others.

MR. MCCARTHY: Well, I'm actually asking in the context, I believe, that there were -- I think it was four additional hubs that were after this accident brought back, as you said, to Pratt and analyzed thoroughly. And if I make it correctly, all of those hubs did escape detection.

THE WITNESS: No, that has not been established. Those hubs were brought back and they were felt to be surface anomalies. They were not -- there was no conclusion made that those were rejectable anomalies during the manufacturing process.

MR. MCCARTHY: So, there is then no particular number. It's just very low?

THE WITNESS: That's correct.

MR. MCCARTHY: Thank you.

CHAIRMAN GOGLIA: FAA?

MR. DONNER: No questions, Mr. Chairman.

CHAIRMAN GOGLIA: Pratt?

MR. YOUNG: No questions, Mr. Chairman.

CHAIRMAN GOGLIA: Dr. Ellingstad?

DR. ELLINGSTAD: No questions.

CHAIRMAN GOGLIA: Mr. Haueter?

MR. HAUETER: I guess, I'm somewhat bothered, but you mentioned there were four discs returned that had surface anomalies. Were these anomalies a result of an engine failure before the service life?

THE WITNESS: Not that I'm aware of.

MR. HAUETER: You mean, there wouldn't have been a loss of a blade or something else?

THE WITNESS: Not that I'm aware of, but I must point out, these are still under the investigation of the NTSB, and we have not completed this full investigation. So, that has not been -- as far as I'm concerned -- fully established until the report is written.

MR. HAUETER: On these anomalies, on the high time hub, how much percent life did it have left in it?

THE WITNESS: I do not know.

MR. HAUETER: I guess, we take a look here at the accident bore and also the previous PanAm. We have had two that failed well before they reached their service life.

THE WITNESS: That is correct. And both of those had damage well beyond what our acceptable limits would have been, had we been able to detect it. We, of course, had the problem with the PanAm one. We do not know when and how the damage was produced.

So, we don't know how much of that comes under manufacturing versus what might have come under the operation or the repair of that disc in service. That investigation is done. We only have the facts that are available to us. In the case of the particular accident hub we're dealing with today, we are certainly concentrating on the damage that was done. It was done in a machining operation, and it was able to escape the inspection criteria that we had in place at that time.

MR. HAUETER: Well, I guess, that comes to the heart of my question. That from what we've heard today is that that disc passed all the best knowledge you had at the time, but failed. So, why didn't back then reduce the life based on the fact that you couldn't find something like what happened?

THE WITNESS: Because we have inspection records available to us on all the other discs. And based on those inspection records, we can establish those discs that may be at similar risk of might having passed through inspection and not been rejected. And we are going out to look and retrieve each of those disks to examine it and make -- to certain to ourselves that they, indeed, are not unacceptable to today's standards.

MR. HAUETER: Well, I mean, you know this one group. That, I assume, is why you picked it. But why isn't there similar conditions in other discs that weren't produced by Volvo, that were -- why aren't there similar little flaws that may have gotten through the system? How do you work that risk calculation, I guess, I'm trying to understand?

THE WITNESS: Well, first of all, it has to be a fairly big flaw.

MR. HAUETER: Do you characterize what we have here as a big flaw?

THE WITNESS: Relatively speaking, we told you the disc was designed for a certain size flaw size that was just at the point of detection. So, in order for the disc to fracture, the flaw size has to be bigger than that. So, I'm going to use a relative, okay. Beyond that, we'll let the metallurgist characterize it further.

You do have all the successful experience of the so-called fan hub experience in Pratt & Whitney, which includes the small JT-8D engines, as well as a large JT-8D 200, which are all being manufactured in the same time period by similar manufacturing processes.

The simple success of it tells you that you do not have a very large population at risk. As we gather more information for the discs that we are going after, we will adjust the population that may be at risk based on that information.

If I go out to investigate six discs and I pull six discs and I cut them up and do all metallurgical examinations and there's nothing wrong with them, that's good news. Now, I go out to inspect 700 discs. That's better news. I go out to inspect another 500. That's better news. The more discs you inspect, without finding anything unacceptable, confirms that you had a simple escape.

MR. HAUETER: Is there an acceptable number of failures you might have? In your calculation, you accept that there will be one or two failures of these parts before they reach their service life?

THE WITNESS: Not failures, but we must be careful about the definition of failures. I certainly told you we accept that there could be one out of a thousand with a crack in it. That doesn't mean a failure. And for this particular disc that has the ratio that this disc has, we will not accept any fractures at all.

MR. HAUETER: So, your analysis is no fractures to service life in the history of all of these components?

THE WITNESS: In the future. Do you mean -- yes. I will not accept any more fractures, and all my actions are based on a corrective action program that will not accept the fracture.

MR. HAUETER: But two years ago, you probably would have told me the same thing, that you wouldn't have accepted a fracture.

THE WITNESS: That's correct. That's correct.

MR. HAUETER: Okay. But you've had one.

THE WITNESS: I had one, and now I'm taking corrective action for that fracture. I cannot take corrective action on something I know nothing about.

MR. HAUETER: Right. But I what I was trying to get at, did you ever believe -- you know, when the part was really designed, that you would have a failure?

THE WITNESS: No.

MR. HAUETER: Not at all?

THE WITNESS: Not at all.

MR. HAUETER: Even with something that just got through the detection phase barely or if you want to --

THE WITNESS: Could you repeat that?

MR. HAUETER: Well, I guess, my question still is, is that you have a part that passed what was considered the best at the time. But a flaw that would pass the best of time can still result in a failure prematurely.

THE WITNESS: That's correct.If the flaw is greater than what I had assumed in my design analysis, the part could fracture.

MR. HAUETER: Then --

THE WITNESS: So, I do everything possible to inspect for a flaw that's greater than what I have assumed.

MR. HAUETER: Why didn't you say divide by two on the flaw to increase your --

THE WITNESS: Because there's not a relationship between the divide by two and the service life.

MR. HAUETER: Wouldn't it have given you a factor of safety, though, to ensure that you had accounted for --

THE WITNESS: The factor -- well, let's understand where the factors of safety come from. Obviously, we design with a factor of safety. The one out of a thousand with crack promulgation resistance and the factor of two from a stress standpoint in a typical LCS life are significant factors of safety. All you're simply pointing out is that you can use up every single factor of safety you design for if you have a big enough flaw.

MR. HAUETER: But I'm getting back to the point, that this big flaw, as you point out, will escape detection by the best means you had available.

THE WITNESS: At that time, I grant you, it -- we'll accept that it did escape detection. It escaped being rejected. It really was -- it could have been detected, okay. It was not rejected, which is an escape.

MR. HAUETER: Okay. Thank you. I have nothing further.

CHAIRMAN GOGLIA: Any follow-up questions form the panel? Mr. Weaver, you are released. You're going to be here for all three days, right?

THE WITNESS: Three days, yes.

CHAIRMAN GOGLIA: Okay. I may bring you back.

(Witness excused.)

MR. HAUETER: So, he's not released.

CHAIRMAN GOGLIA: You're not released.

THE WITNESS: I -- well, thank you very much.

CHAIRMAN GOGLIA: The next witness will be our final witness for today and it's Jose Hilerio.

(Witness testimony continues on the next page.)

JOSE HILERIO, FPI INSPECTOR, DELTA AIR LINES, INC.
ATLANTA, GEORGIA

Whereupon,

JOSE HILERIO,

was called as a witness by and on behalf of the NTSB, and, after having been duly sworn, was examined and testified on his oath as follows:

MR. HAUETER: Mr. Hilerio, correct?

THE WITNESS: Yes.

MR. HAUETER: Would you provide your full name and --

THE WITNESS: Jose Hilerio.

MR. HAUETER: And your place of employment?

THE WITNESS: Delta Air Lines.

MR. HAUETER: And what is your job at Delta?
THE WITNESS: I'm an FPI inspector.
MR. HAUETER: And would you provide your aviation background and FAA certificates?
THE WITNESS: In 1980, I worked for Lockheed Aircraft Corporation a Sheetmetal Mechanic and an Inspector. I then worked for Lockheed Air Service, Rockwell International, Western Airlines. And when Delta acquired Western, I came out to Atlanta.
MR. HAUETER: And what FAA certificates do you hold?
THE WITNESS: An A&P license.
MR. HAUETER: Okay. Thank you. Mr. Byrne.
DR. BYRNE: Thank you, Mr. Haueter. Good afternoon, Mr. Hilerio.
THE WITNESS: Good afternoon.
DR. BYRNE: You mentioned you were an inspector at Lockheed?
THE WITNESS: Yes, I was, a sheetmetal inspector.
DR. BYRNE: A sheetmetal. Would you, please, describe for us the positions that you've held at Delta?
THE WITNESS: When I came out here to

Atlanta, I was in the hydraulic shop removing and installing landing gears and rigging flight control surfaces. I then became an inspector. I've been with the Inspection Department for six years.

I'm a level 1 MPI inspector, eddie current inspector, ultra-sonic inspector, and level 2 FPI inspector.

DR. BYRNE: And when you became an inspector at Delta, what process did you go through? Was that a selection process or a promotion?

THE WITNESS: Yes, it was based on a bid system. If there was an inspector needed in a given area, a bid would be posted on bulletin boards throughout Delta. Anyone interested in the position would sign the bid, submit a resume. All the resumes are collected, ballots are sent throughout the various shops. Three individuals are picked and interviewed and the best one for the job got it.

DR. BYRNE: Okay. And when you moved over to the FPI -- becoming an FPI inspector, you've mentioned that you are level 1 qualified in eddie current MPI, ultra-sonic, and the train records indicate that you were level 1 qualified in 1995 on FPI, and you are now level 2 qualified on FPI. What's the major difference between level 1 qualification and level 2 qualification at Delta?

THE WITNESS: Well, the level 1 qualification is basically a 20 hours classroom time and 80 hours on-the-job training. The level 2 is just an additional 12 hours classroom time.

DR. BYRNE: Okay. Would you elaborate for me on your classroom training in FPI?

THE WITNESS: Classroom training was theory of FPI and a process standard, reviewing it, and practical.

DR. BYRNE: How were those 20 hours spread out?

THE WITNESS: That was a classroom time.

DR. BYRNE: Was it across --

THE WITNESS: Through the week.

DR. BYRNE: -- across a week, half days --

THE WITNESS: Yes.

DR. BYRNE: --or --

THE WITNESS: Half days.

DR. BYRNE: In what format was the course?

THE WITNESS: Theory, basic principles of FPI. There was a practical written exam, handouts.

DR. BYRNE: Was it primarily lecture?

THE WITNESS: No, it was actually doing.

DR. BYRNE: Okay. And you said the process standard was used. Were there any other course materials used in that course, structural materials?

THE WITNESS: There was a handout booklet for the basic techniques in FPI. It was a general dynamics book.

DR. BYRNE: Okay. You were evaluated based on a written exam and practical exam, if I understood you correctly?

THE WITNESS: That's correct.

DR. BYRNE: What did the written exam cover?

THE WITNESS: Just level 1 theory.

DR. BYRNE: Was it an essay type exam?

THE WITNESS: I don't recall.

DR. BYRNE: Okay. And how did the practical -- describe how the practical was administered?

THE WITNESS: Well, it was 80 hours. It was -- along with the OJT training, where you're looking for cracks or parts.

DR. BYRNE: So, the OJT, was that -- did that cover two weeks?

THE WITNESS: Yes, that was a two-week period.

DR. BYRNE: And how did you work during the OJT? Was there an instructor assigned to you?

THE WITNESS: Yes, I worked with a level 2 instructor.

DR. BYRNE: Who is that instructor?

THE WITNESS: Jim McMillan. He's our level 3 instructor.

DR. BYRNE: He was your OJT instructor?

THE WITNESS: No, he wasn't. I don't recall who was.

DR. BYRNE: Okay. But it was a single person throughout the two-week period?

THE WITNESS: Yes, it was.

DR. BYRNE: And would you describe the scope or where you worked during this two-week OJT period?

THE WITNESS: It was -- at that time, I was working on the class 4 penetrant line, inspecting brackets and bushings.

DR. BYRNE: And what is a class 4 line?

THE WITNESS: It's a -- the class 4 penetrant is for inspecting non-critical rotating parts.

DR. BYRNE: Okay. How did your OJT instructor teach you or lead you in the inspection process?

THE WITNESS: Well, I actually did the inspection. And he would -- I would ask a lot of questions and we review the process.

DR. BYRNE: Did you receive guidance or instruction during the OJT on how to handle parts?

THE WITNESS: Yes, I did, constant.

DR. BYRNE: And were any parts used for -- that other inspectors found used for instructional purposes during your OJT?

THE WITNESS: I don't recall that.

DR. BYRNE: How were you evaluated during the OJT period?

THE WITNESS: Well, the OJT, it was just a continuous process. You were signed off after the 80 hours, but if you didn't feel comfortable, you would just continue. So, it just wasn't a two-week period. It was until you felt you were ready to inspect parts properly.

DR. BYRNE: Okay. At the end of the two-week OJT period, did you then receive your stamp authorization or signature authority to sign off on parts?

THE WITNESS: Yes.

DR. BYRNE: After your classroom and OJT

training of the 80 hours, how well prepared for your job did you feel?

THE WITNESS: I felt I was prepared.

DR. BYRNE: Is there anything you would change about this training?

THE WITNESS: None that I know of. I can't speculate on that.

DR. BYRNE: Okay. What type of recurrent training or requalification requirements do you have?

THE WITNESS: Well, we have a yearly recurrent classroom training on theory and a process standard. And every three years, we're recertified in a process.

DR. BYRNE: Okay. Is there an examination or --

THE WITNESS: It's an exam and a practical.

DR. BYRNE: And are there also medical requirements or medical tests associated with your job?

THE WITNESS: Not that -- other than a two-year vision exam, that's it.

DR. BYRNE: What's covered in that vision exam?

THE WITNESS: Color. I haven't had it in a while, so.

DR. BYRNE: Okay. Is there any type of -- is there any other type of performance appraisal that you receive working as an inspector on the FPI line at Delta?

THE WITNESS: No.

DR. BYRNE: Mr Hilario, I would like to shift now from your training into how FPI is conducted at Delta, how you would process a part. Let me begin by asking what shift you would have worked or you worked in October of 1995?

THE WITNESS: I was on the second shift at that time.

DR. BYRNE: Were you a stable second shift employee or did you rotate between second and first?

THE WITNESS: I was stable, second shift.

DR. BYRNE: During second shift, how many people would work with you on the FPI line?

THE WITNESS: There was two of us on second shift.

DR. BYRNE: And these two people, you were an inspector. Was the other individual an inspector?

THE WITNESS: That's correct, yes.

DR. BYRNE: Were there processors on the second shift, as well?

THE WITNESS: I don't recall. I'm sure there was.

DR. BYRNE: And if there is no processor, who then is responsible for running the parts through the FPI line?

THE WITNESS: Well, as an inspector, I can also process.

DR. BYRNE: Since you started working on the FPI line, has the number of inspectors increased, decreased, or remained the same?

THE WITNESS: It's remained the same.

DR. BYRNE: Who is your supervisor at Delta?

THE WITNESS: Oh, my foreman is Lee Clements.

DR. BYRNE: Okay. How long has Lee Clements been your supervisor?

THE WITNESS: Three years.

DR. BYRNE: Are there lead inspectors at Delta?

THE WITNESS: No, there's not.

DR. BYRNE: All inspectors are then beyond their level 1, level 2 qualifications. Are they treated equally?

THE WITNESS: Yes, we are. We all do the same function.

DR. BYRNE: How frequently do you interact with your foreman?

THE WITNESS: Lately, more than I would like, but all the time.

(General laughter.)

DR. BYRNE: What is the nature of that interaction?

THE WITNESS: Pertinent information, any changes, or anything. Anything he wants to relay to us.

DR. BYRNE: Does he ever come in and observe you inspecting a part?

THE WITNESS: Occasionally.

DR. BYRNE: On a typical day on the FPI line, how much of your time is spent inspecting?

THE WITNESS: I would have to say 75 percent.

DR. BYRNE: And what happens in the remaining 25 percent?

THE WITNESS: Breaks and rerouting parts.

DR. BYRNE: How do you take your breaks? When?

THE WITNESS: When I deem -- excuse me, Ray. When I need it. Stress breaks.

(General laughter.)

DR. BYRNE: And what do you do during your breaks?

THE WITNESS: Just get out of the tent and walk around.

DR. BYRNE: Okay. Let me go back. I missed something in your training. You were working on the class 4 line. What line is the critical rotating part line at Delta?

THE WITNESS: At that time, it was class 1. It is now class 2.

DR. BYRNE: When you moved over to the class 1 line, did you receive any additional OJT or --

THE WITNESS: No, I did not.

DR. BYRNE: When you -- once you have completed your OJT, are you then qualified to inspect or sign off on any part?

THE WITNESS: That's correct.

DR. BYRNE: How often do you consult with other inspectors during this -- when you are inspecting a new part?

THE WITNESS: Daily.

DR. BYRNE: Could you estimate for me approximately how many 200 series hubs come through the line at Delta on a weekly or a daily basis?

THE WITNESS: Well, it would be a hard estimation, but I would say I inspect about three a week.

DR. BYRNE: What other types of parts do you inspect on the class 1 and class 2 line?

THE WITNESS: All engine parts, rotating parts, critical parts?

DR. BYRNE: Do you have any choiceover the type of part that you inspect?

THE WITNESS: None at all. Parts are parts.

DR. BYRNE: Who checks your work after you've signed off on a part?

THE WITNESS: Well, it depends on where it's going. Could you -- I don't understand -- elaborate on that?

DR. BYRNE: For example, the 219 hub, after you're done with the inspection and you have signed off on it, does anybody recheck or confirm your inspection?

THE WITNESS: If it was an acceptable inspection, it would get routed to the next shop.

DR. BYRNE: And on a daily basis or a weekly basis, what type of quality control checks are you required to perform as an inspector?

THE WITNESS: Well, we have a process control sheet. I believe you have that. It lists the various inspections. There's daily checks and weekly checks.

DR. BYRNE: I would like to move now to the inspection of the accident hub. Records indicate Exhibit 11O, which is the JPC for this part, that you completed the inspection of the accident hub on October 27, 1995. Tell us what you remember about that inspection?

THE WITNESS: I don't recall that inspection.

DR. BYRNE: Had you inspected 219 hubs before this date?

THE WITNESS: Possibly.

DR. BYRNE: And since?

THE WITNESS: Yes.

DR. BYRNE: Did any of these hubs ever stand out?

THE WITNESS: No.

DR. BYRNE: Have you ever detected a crack in a 219 hub?

THE WITNESS: Not that I recall.

DR. BYRNE: Based on your training and experience and the policies and procedures in place at Delta in October of 1995, would you, please, describe for us how a 219 hub would have been inspected or would have been processed, let's take it up to the inspection tent at that time? And if we could put Exhibit 11U, a flow chart of Delta's inspection process or FPI process, so that we can help follow along.

(Slide shown.)

THE WITNESS: Okay. When a 219 hub comes from the cleaning shop, we have processors that do a general inspection of the part, checking for cleanliness. And they would pick the part up on a hoist and put it on a plastic donut. That donut goes down rollers on the line. They dip the part in a tank of penetrant. The part sits at that time for 30 minutes, which is the dual time.

They then rinse the penetrant off the part, and then they dip it into an emus fired tank. It is then rinsed of excess emus fire and penetrant. The part is then dried in an oven. It is then -- the developer is then applied to it. And at that time after that, I inspect the part.

DR. BYRNE: Okay. I have a few follow-up questions here. What paperwork accompanies the hub when it comes into the FPI shop?

THE WITNESS: Back in '95, it was a JPC. Now, it is a shop order. That JPC would reference the maintenance manual and a process that you're going to use.

DR. BYRNE: And what criteria are used to check whether the part is clean?

THE WITNESS: It's just a visual inspection. We would have Q-tips, white gloves for swiping the surface, checking for dirt.

DR. BYRNE: And does the hub sit in the penetrant for 30 minutes or does it sit out?

THE WITNESS: No, it doesn't. It's dipped and then it just stands on the side.

DR. BYRNE: And for the rinse, the pre-rinse and the pulstriants (sp) after the emulsification, as well as the application of the developer, how is the part handled? How is the underside of the part treated?

THE WITNESS: The processor would tilt the part on its side. He has rubber gloves on.

DR. BYRNE: Okay. And how is it determined when the part is dry?

THE WITNESS: It's a visual.

DR. BYRNE: In Delta's process standard for FPI, which is Exhibit 11N, it describes a time-out period after the developer has been applied, a time of two hours, after which the part needs to be routed back through for processing. How in October of 1995 were parts tracked after the developer was applied? How was this time established?

THE WITNESS: It was a verbal. The processors would work with the inspectors. There was no timer.

DR. BYRNE: Okay. What happens as time goes on? Why is that time period in place?

THE WITNESS: It's critical. You don't want to exceed the time for the developer. Possibly, the penetrant could weaken.

DR. BYRNE: Okay. And before we move onto the actual inspection of the hub in the tent, what written guidance is there for a 200 series hub on how to conduct the actual FPI inspection in the tent?

THE WITNESS: In '95, we just had the manual reference, which was a general FPI inspection of the part. The more detail inspection went to our Department 544, where they had critical areas noted. But as an inspector, I want to know where those areas are.

So, I look at a part as if it's -- if it has a crack and I have to convince myself that it's not a crack. So, I look at the different areas. I know that blade slots are critical.

I know the holes are critical and we do the best we can with what we got.

DR. BYRNE: Did the maintenance manual contain any critical area or list critical areas on October 19, 1995?

THE WITNESS: It did for the Department 544. For the FPI, it was just a general. A general inspection of the hub.

DR. BYRNE: And rejection criteria in October 1995 would have been?

THE WITNESS: No cracks allowed.

DR. BYRNE: And Department 544, what's -- is there another name for that?

THE WITNESS: That's a -- they do a dimensional and a visual inspection.

DR. BYRNE: Okay. If we could now, Mr. Hilerio, walk through the actual inspection of the hub in the tent. If you could tell us what you would be -- what you're looking for, what an indication looks like, and how you work through the part in as much detail as you can?

THE WITNESS: Normally, when I bring a part into a tent -- we'll take the 219 -- I would use a white light and inspect the outside diameter of the hub, looking for any noticeable defects.

I would then index the hub, use the black light, and inspect at 360 degrees. I would then turn the hub on its side, and I would inspect the inside.

DR. BYRNE: What tools do you have available to you in the tent to help you do your job?

THE WITNESS: We have magnifying glasses, mirrors.

DR. BYRNE: Did you have bore scopes?

THE WITNESS: Not dedicated to the 219, no. We do have one in the shop.

DR. BYRNE: And the black lamp, is there one or two in the booth?

THE WITNESS: There's two. There's an overhead and one that you hold.

DR. BYRNE: Does the hand-held black lamp have a fixture or a stand that it can -- in October of '95, where you could put it in a position and it would stay where you positioned it?

THE WITNESS: Yes.

DR. BYRNE: And you wouldn't have to hold it?

THE WITNESS: Yes, it does.

DR. BYRNE: Okay. How did you -- or how would you have inspected the holes on a 219 hub in October of '95?

THE WITNESS: When I -- as I do today. Tilt the hub on its side and just look in the holes with the black light. It's not a very good inspection technique for that.

DR. BYRNE: Why?

THE WITNESS: Because you have holes that are 3 inches in length, and it's very difficult to see in there. We've got -- I believe there's 46 holes. It's very difficult to do a complete 360 degree inspection of these 3 inch holes.

DR. BYRNE: I would like you to go into some detail about how -- what your specifically looking for in FPI? What an indication looks like, what can cause one? How you determine whether an indication is a defect or a false indication?

THE WITNESS: Well, any penetrant goes into a part through capillary action. So, when a part comes into the inspection booth, it would fluoresce and you would look for a fluorescing glow.

So, you would -- if I had an indication on a part, I would use solvent to remove that indication.

If it comes back -- if it still fluoresce, then I would use a magnifying glass and look at it, and then I would also spray NAD on it, which is another developer more sensitive, because it's in solvent. I would wait for the indication to reappear.

DR. BYRNE: How long would you wait?

THE WITNESS: About five minutes.

DR. BYRNE: On a typical 219 hub, how many indications would you diagnose in this manner?

THE WITNESS: I haven't found any indications. I've found fretting on the blade slots, and I've re-route it for that reason, but other than that, I haven't found anything.

DR. BYRNE: You wouldn't -- would you be applying the solvent and then the non-acquiesced developer?

THE WITNESS: Yes, to these areas. Yes.

DR. BYRNE: But on a typical hub, would you be doing this diagnostic process -- when it comes into the booth, is it clean or are there several indications that you're faced with trying to diagnose or further evaluate?

THE WITNESS: Only if I see an indication.

DR. BYRNE: Do you have any idea how many indications would be typically on a part or a hub?

THE WITNESS: No. There's no way of telling. Every part is different.

DR. BYRNE: What method do you use to track what indications you have done this diagnostic follow up, spray the developer on, and wait? What method or strategy do you use to go back and look at these spots?

THE WITNESS: You would use the black light again. And if the indication reappeared, then you would use a magnifying glass.

DR. BYRNE: And when you're working across the part in October of 1995, what method did you use as an inspector to know where you were?

THE WITNESS: Well, we would normally index the part. We still do that today.

DR. BYRNE: And by index, you mean?

THE WITNESS: Just make a mark on the part or use a serial number as a reference point. That's all that is.

DR. BYRNE: And do you process all 200 series hubs? Do you work through the same flow or path across that hub?

THE WITNESS: Our processors do the same thing, yes.

DR. BYRNE: You, as an inspector -- I guess, if you start from the top and work down and then turn it upside-down and work the interior bore, the steps or the stages that you work across that hub, does that remain consistent from one hub to the other?

THE WITNESS: Yes, it does.

DR. BYRNE: Can indications be rubbed off through mechanical means?

THE WITNESS: It's possible.

DR. BYRNE: Mr. Hilario, as an inspector, what is unique about the 219 hub compared to other parts or other front hubs?

THE WITNESS: There is none.

DR. BYRNE: Do you treat a 219 hub differently?

THE WITNESS: No, I don't. My job is just to look for cracks.

DR. BYRNE: How do you maintain your alertness while you're working through the inspection?

THE WITNESS: I concentrate on the task at hand.

DR. BYRNE: And how long does it take to inspect the 219 hub?

THE WITNESS: It can go anywhere from 40

minutes to an hour and a half, two hours. It depends on what you find.

DR. BYRNE: Do you take breaks -- when you're working through a part, do you take breaks in the middle of the part?

THE WITNESS: No, I don't. No.

DR. BYRNE: Do you work a part completely through?

THE WITNESS: Yes, I would like to complete the inspection.

DR. BYRNE: Do you ever get interrupted when you're inspecting a part?

THE WITNESS: No, I don't.

DR. BYRNE: What changes have been made in the inspection process -- FPI inspection process at Delta that you're aware of between how parts are processed and inspected in 1995 to how they're inspected and processed today?

THE WITNESS: Well, we're still processing the parts the same way, but we've enhanced the inspection with the addition of technique sheets and that will give us critical areas to look at.

DR. BYRNE: Do the technique sheets -- do they just outline the critical areas or is there additional information on these sheets?

THE WITNESS: Yes, on handling the part and just location of critical areas, type of penetrant to use.

DR. BYRNE: Do the technique sheets offer any guidance to inspectors about how to inspect parts or the flow to work through a part?

THE WITNESS: They tell you where to look for indications, possible areas, critical areas.

DR. BYRNE: You're qualified in several other areas of NDI. Would you characterize for us what is unique about FPI or your job as an FPI inspector as compared to other methods of NDI that you are qualified in?

THE WITNESS: Well, the FPI inspection itself is tedious. It's monotonous. You have to remain focused. It's just something you do.

DR. BYRNE: Mr. Chairman, I have no further questions. Thank you, Mr. Hilario.

CHAIRMAN GOGLIA: The Technical Panel?

MR. CONROY: Yes, sir, one or two questions. Mr. Hilerio, do you remember the accident hub?

THE WITNESS: No, I don't.

MR. CONROY: Do you remember the accident engine?

THE WITNESS: No, I don't.

MR. CONROY: Do you do -- you mentioned that you were an inspector. You discussed at length your qualifications. Do you do any maintenance or assembly work? Or is your work entirely inspection?

THE WITNESS: Entirely inspection.

MR. CONROY: Okay. One last area. You mentioned difficulty in examining into the bolt holes and specifically on the 219 hub. Is that correct?

THE WITNESS: That's correct.

MR. CONROY: Could you elaborate on that a little bit? What difficulties have you had? Have you discovered any means of helping yourself?

THE WITNESS: The difficulty is you have 3 inch holes and because of the shape of the part, it is very difficult to shine the black light in the holes and do a complete inspection.

MR. CONROY: Have you found a means of helping yourself in that inspection?

THE WITNESS: After the accident, we've enhanced the inspection process by adding eddie current. But as far as FPI is concerned, no.

MR. CONROY: Can you see into the holes any better now than you did before?

THE WITNESS: No. Not with FPI, no.

MR. CONROY: Thank you.

CHAIRMAN GOGLIA: Anyone else on the Tech Panel? Okay. ALPA?

MR. MCCARTHY: No questions.

CHAIRMAN GOGLIA: McDonnell Douglas?

MR. STEELHAMMER: No questions, Mr. Chairman.

CHAIRMAN GOGLIA: Volvo?

MR. THOREN: No questions.

CHAIRMAN GOGLIA: Pratt?

MR. YOUNG: No questions, Mr. Chairman.

CHAIRMAN GOGLIA: FAA?

MR. DONNER: Thank you. No questions.

CHAIRMAN GOGLIA: Douglas -- Delta?

MR. VALEIKA: No questions. Thank you.

CHAIRMAN GOGLIA: Dr. Ellingstad?

DR. ELLINGSTAD: Just a couple. You're also certified as a processor. Is that correct?

THE WITNESS: Yes, I do both.

DR. ELLINGSTAD: With respect to that part of the process, are there other difficulties there? Can you reliably, for example, get developer into the holes? How is that applied?

THE WITNESS: A developer is sprayed on a part, after it comes out of the oven, with a spray gun.

DR. ELLINGSTAD: And that gets into the holes easily or --

THE WITNESS: Yes, it does. And they also tilt the part and spray underneath.

DR. ELLINGSTAD: Okay. You had indicated to Dr. Byrne that you deal on a day-to-day basis with quite a mixture of different parts and didn't have much control over that.

THE WITNESS: That's correct.

DR. ELLINGSTAD: And I believe you said that you might see two or three hubs a week.

THE WITNESS: Possibly, yes.

DR. ELLINGSTAD: Okay. So, you're looking at quite a variety of different parts. Are there very different techniques for inspecting these different parts?

THE WITNESS: No, there's not. No. The FPI technique is the same.

DR. ELLINGSTAD: But in terms of manipulating the parts, that kind of thing --

THE WITNESS: Yes.

DR. ELLINGSTAD: -- are some things easier to find --

THE WITNESS: Yes. We have, for instance, an overhead hoist. If you have heavy parts, you pick it up. It just depends on the part, shape.

DR. ELLINGSTAD: Okay. You indicated, I believe, also that you had not found any defects in hubs. Is that correct?

THE WITNESS: Nonethat I can recall.

DR. ELLINGSTAD: Okay. With respect to the overall process, how -- in the course of a week, how many defects in all of the parts that you're inspecting would you find?

THE WITNESS: Well, I find a lot of cracks, if that's what you're relating to.

DR. ELLINGSTAD: Yes, that's what I --

THE WITNESS: Yes, I do, but I can't give you a specific number.

DR. ELLINGSTAD: But it isn't an extremely rare occasion?

THE WITNESS: No, it's not.

DR. ELLINGSTAD: You find -- it wouldn'tbe surprising to find several in a day?

THE WITNESS: Yes, maybe three, four, five.

DR. ELLINGSTAD: Okay. And what kind of

parts do these tend to be in?

THE WITNESS: Well, it's hard to say. For instance, fur trees might have nicks on them. Better indications. They might not be -- they are probably repairable, but it's different parts. It would be hard to give --

DR. ELLINGSTAD: Okay. But not on most.

THE WITNESS: -- you an answer on that.

DR. ELLINGSTAD: Thank you.

CHAIRMAN GOGLIA: Mr. Haueter?

MR. HAUETER: Yes, briefly. How do you support the hub while you're inspecting it? It's a fairly --

THE WITNESS: It's on a plastic donut.

MR. HAUETER: How can it be -- it has to roll over to look?

THE WITNESS: Yes, we use the overhead hoist to pick it up. We have a fixture that screws to the top. We use the hoist and we pick it up. After you inspect the outside diameter, you would tilt the part on its side.

MR. HAUETER: Normally, do you have a helper to help you do this?

THE WITNESS: No, we don't.

MR. HAUETER: You do it by yourself. Going back a little bit to Dr. Ellingstad's question on the process. Normally, you're at the end of the process and you don't do any of the cleaning or the emulsifying or anything else. It comes to you ready to inspect?

THE WITNESS: I can do the processing, but normally it does come to me prepared already, processed.

MR. HAUETER: Have you ever had any difficulty when the part got to you, that you send it back, because you didn't think it was adequately prepared?

THE WITNESS: Well, that's one of the problems we have is cleanliness. The FPI process -- having a clean part is very critical. Any dirt, water, entrapment in cracks, you could possibly mask that area.

MR. HAUETER: How often do you have to send a part back?

THE WITNESS: Oh, gees, every day. It's an ongoing thing.

MR. HAUETER: Okay. In looking at -- you inspect a lot of critical parts. Have you ever found a crack in the critical part, like a hub?

THE WITNESS: In a 219 hub, no.

MR. HAUETER: In any hub, down in the bore type area?

THE WITNESS: Not that I recall, no.

MR. HAUETER: Okay. Thank you very much.

THE WITNESS: It is possible, though.

MR. HAUETER: Okay.

CHAIRMAN GOGLIA: Any further questions from the parties? From the Tech Panel? Okay, Jose, you're released.

THE WITNESS: Thank you.

(Witness excused.)

CHAIRMAN GOGLIA: And as I mentioned earlier, this is our last witness for today. So, we will stand in recess until tomorrow morning at 8:00 a.m.

(Whereupon, at 6:30 p.m., the hearing was adjourned. To be reconvened on Thursday, March 27, 1997, at 8:00 a.m.)

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