UNITED STATES OF AMERICA
NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C.

ABSTRACT OF AVIATION ACCIDENT REPORT
ALASKA AIRLINES FLIGHT 261, MD-83, N963AS
PACIFIC OCEAN ABOUT 2.7 MILES NORTH OF
ANACAPA ISLAND, CALIFORNIA
JANUARY 31, 2000
NTSB/AAR-02/01

Board Room and Conference Center
National Transportation Safety Board
429 L'Enfant Plaza, SW
Washington, D.C.

Tuesday, December 10, 2002
9:30 a.m.

National Transportation Safety Board

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P R O C E E D I N G S

9:30 a.m.

ACTING CHAIRMAN CARMODY: Good morning. Could we take our seats? Let's take our seats and close the door in the back, if you will, please.

I'm going to go ahead and begin since it is 9:30 and we have a long day in front of us.

On January 31st, 2000, about 16:21 Pacific Standard Time, Alaska Airlines Flight 261, a McDonnell-Douglas MD-83, crashed into the Pacific Ocean about 2.7 miles north of Anacapa Island, California. The airplane was completely destroyed. There were no survivors among the five crew and 83 passengers.

I'd like to extend a special welcome to the families of the victims who are here with us today as well as to all the other people who have come to observe the board meeting.

This is a sunshine meeting of the National Transportation Safety Board. That essentially means that federal agencies must conduct their business in the open, in the public. Therefore, board meetings are called sunshine meetings. While the public is invited today to observe the meeting, only the Board and the staff will be participating in the meeting.

A few weeks ago, the staff submitted for the

Board's consideration a Draft Accident Report of this accident. We've had several weeks to read it. I think most of us have read it numerous times, and we've had an opportunity to talk with the staff about it, but this is the first time we have met as a board to review and consider the report itself as well as the recommendations and the probable cause.

Because this document being considered is a draft, it does not necessarily reflect the views of the agency and it's not available to the public at this time. During today's meeting, you will observe the board members going through the draft section-by-section eliciting responses, asking questions of the staff. Once they have gone through the body of the Draft Accident Report, the board members will then consider conclusions, probable cause determination, and specific safety recommendations proposed in that report.

The board members will determine if they should approve the report, the draft, with editorial, analytical or factual corrections agreed to during the meeting or if it should be returned to the staff for revision. Such deliberations over a draft report can take anywhere from 90 minutes to the better part of a day. Sometimes all or part of a draft conclusion,

probable cause, or recommendation is revised or rejected by the members. That's because you're viewing our actual deliberations, our sunshine meeting.

About 30 minutes after the meeting, copies of abstracts containing the conclusions, probable causes, and recommendations will be available. It can be obtained from the Board's Public Affairs Office which is in Room 6201.

In the event of an emergency, such as a fire, the building alarm system will activate and a voice message will instruct persons to vacate the building. You should proceed to your nearest exit. There are emergency exits up front, to the left and right of the podium, and, of course, in the back of the room.

Also for your convenience, the restrooms and telephones are in the foyer in the back on your left as you exit.

To provide the appropriate meeting environment, I ask that you put your cell phones, your beepers, your pagers on silent. If you need to make a call, please leave the room to do so.

I'd like to introduce my fellow board members with me today. On my left, Member John Hammerschmidt. He was the member on scene for this accident. On my right, Member John Goglia, and at the end, Member

George Black.

I will now move to the Managing Director who will introduce the staff.

Mr. Campbell?

MR. CAMPBELL: Good morning, Madam Chairman, Members of the Board.

With me at the front table, to my left, is Ron Battocchi, the agency's General Counsel, and proceeding to my right, John Clark, the Director of the Office of Aviation Safety, Richard Rodriguez, the Investigator-in-Charge in this accident, Jeff Guzzetti, who is the Chairman of the Systems Group, and Joseph Kolly, who is the Chairman of the Grease Group. Mr. Rodriguez, the Investigator-in-Charge, has the opening statement.

Thank you.

ACTING CHAIRMAN CARMODY: Please go ahead, Mr. Rodriguez.

MR. RODRIGUEZ: Good morning, Madam Chairman, Board Members, ladies and gentlemen.

My statement and staff presentations this morning summarizes the significant findings of this investigation, including the failure mode of the horizontal stabilizer jackscrew, the relative effects of lubrication and inspection of the jackscrew, the

Alaska Airlines Maintenance Program, and the FAA oversight of Alaska Airlines.

Alaska Airlines Flight 261 departed Puerto Vallarta at 1337. This profile shows various significant points during the flight. The flight operated normally until 23,400 feet when the horizontal stabilizer jammed. From this point on, the aircraft generally continued climbing in a series of climbs and level-offs until the autopilot disconnected at 28,557 feet and 296 knots. During the next seven minutes, the aircraft began climbing at a much slower rate as the pilot was flying manually using up to 50 pounds of pulling force to maintain the climb attitude.

By 1400 hours, the aircraft had leveled at the assigned altitude of 31,000 feet, and for the next 24 minutes, the aircraft was flown manually at 280 knots with about 30 pounds of pulling force to maintain level flight. Then the crew accelerated to 301 knots and the pulling force was reduced to about 10 pounds.

About one hour and 15 minutes later, the autopilot was re-engaged and the crew contacted Company Dispatch and Maintenance Control in Seattle to discuss the stabilizer problem. During the next 17 minutes, the crew discussed operational details of diverting into Los Angeles with Dispatch and advised Los Angeles

Operations that they intended to land there.

At 16:08, a Los Angeles mechanic asked if the crew had tried the suitcase handles and the pickle switches and the captain responded, "Yeah. We tried everything together." One minute later, there was a click recorded on the CVR as the captain stated, "This'll click it off." During the next two seconds, the CVR recorded a clunk, the sound of two faint thumps, and a sound similar to the horizontal stabilizer in motion audible tone.

Following the autopilot disengagement, the horizontal stabilizer moved from the jammed position to full nose down and the aircraft pitched to nearly eight degrees nose down attitude. In the dive that lasted about 80 seconds, the air speed increased rapidly to 353 knots which is 10 knots above the maximum allowable air speed, and the aircraft descended to between 23,000 and 24,000 feet. Calculations indicate that a column force of a 130 to 140 pounds was required to recover from the dive.

At 16:11, the captain advised the controller, "We are at 24,000 feet, kind of stabilized." For the next several minutes, the crew discussed their problem with Los Angeles Maintenance, the cabin crew, and also advised the passengers that they had a control problem

and would be diverting into Los Angeles. During this time, the controller cleared Flight 261 to descend to 17,000 feet and assigned them a heading of 280 degrees to remain out over the water.

As the aircraft was leveling off at approximately 18,000 feet, the air speed had decreased to 253 knots and the captain asked for slats extend and then shortly requested flaps 11 degrees. Once configured, the captain commented, "Actually, it's pretty stable right here, but we got to get down to a 180." The captain ordered retraction of the flaps and slats and the air speed again began to increase from 245 to 270 knots.

At 16:19:21, the cockpit voice recorder recorded the sound of faint thumps and the horizontal stabilizer moved for the second time since the initial jam during the climb-out. The captain asked if the first officer had felt the thump and he replied, "Yeah." The captain then expressed increased difficulty controlling the aircraft and asked for the slats and flaps to be extended again. At this time, the aircraft was at 17,900 feet. The air speed had increased to 270 knots and the nose attitude was plus two degrees.

At 16:19:36.6, an extremely loud noise was

recorded. Within the next few seconds, the vertical acceleration changed to -3 Gs. The aircraft pitched down at a rate of 25 degrees per second and began rolling to the left. The aircraft continued descending in the relatively uncontrolled inverted attitude to water impact.

At this time, I would like to show a brief animation of the aircraft final maneuver. As a courtesy to family members who may not wish to see the animation, I will pause briefly for them to be excused before beginning. The animation begins approximately 25 seconds before the final dive.

(Pause)

MR. CAMPBELL: At the beginning of the animation, the crew is commenting on controllability and discussing damage. Then there are the faint thumps and the call for the slats and flaps and then the loud noise and the loss of control.

In order to more fully understand the conditions that the crew of this flight faced, we have prepared two additional presentations, the first begin Mr. Jeff Guzzetti, the Systems Group Chairman, who will describe the operation of the horizontal stabilizer jackscrew assembly and the failure sequence.

MR. GUZZETTI: Good morning, Madam Chairman

and Members of the Board.

The MD-80 is a twin-engine transport category airplane which the FAA certified in August 1980. The MD-80 was derived from earlier DC-9 series model airplanes and as a result much of the MD-80's structure, systems, components and installations are similar to the DC-9 which entered service back in December 1965.

Longitudinal trim control for the MD-80 is provided by the horizontal stabilizer. The tail surface is a critical flight control not only because it provides a constant aerodynamic balancing force that allows the airplane to maintain controlled flight but also because the movement of the stabilizer can be commanded to aid in controlling the airplane's pitch or up and down movement.

Staff has prepared a six-minute animation to show how the horizontal stabilizer operates and also to show the sequence of failures that occurred during the accident flight. So, if we can cue up that animation now, I'll narrate it, and while we're waiting, I'd like to thank Kevin Renze and Doug Brazy for producing this.

The horizontal stabilizer is mounted on top of the 18-foot high vertical stabilizer in a T-tail configuration. The horizontal stabilizer has a span of

about 40 feet and compromises a center box and a left and right outboard section. In this animation, only the left outboard section is shown. The leading edge of the horizontal stabilizer can be raised or lowered as the entire surface pivots about its hinge points. The stabilizer's normal limit of motion upward is 2.1 degrees. This upward motion tends to pitch the airplane's nose down abbreviated by the letters AND. The normal limit of motion downward is 12.2 degrees which tends to pitch the airplane's nose up or ANU.

Here you see the stabilizer move throughout its full range of motion before returning back to its neutral or zero degree position. For the purposes of this presentation, the speed of the stabilizer shown here is twice that of actual operation. The horizontal stabilizer is connected to the vertical stabilizer by hinges at its aft spar and with a single jackscrew actuator assembly at its front spar near its leading edge.

The animation will now provide a cut-away view of the tail assembly so that you can view the actuating mechanism for the horizontal stabilizer. As the view shifts, let me take this time to inform you that movement of the stabilizer can be commanded either automatically by the autopilot or manually by the

flight crew. Any of these commands activates either the primary or alternate trim motor shown here in purple. The motors are connected to a gear box shown in black which is needed to rotate the acme screw shown in blue by applying a torque to a titanium torque tube that is held fixed inside the screw.

The upper end of the jackscrew assembly is attached to the horizontal stabilizer and the lower end is threaded through the acme nut shown in yellow which is attached to the vertical stabilizer. The jackscrew assembly also has upper and lower mechanical stops shown here in green attached to the screw to stop screw rotation in case of a malfunction of the normal electrical shut-off controls. The entire jackscrew assembly is covered by a tip fairing on top of the vertical stabilizer. This fairing is attached with brackets that I will mention later in this presentation.

As the animation shows the stabilizer moving toward its upper and lower limits of travel, you'll notice that the rotation of the screw through the non-moving nut causes the screw to translate upward and downward. This rotation between the case-hardened steel screw and the softer aluminum bronze nut gradually wears down the thickness of the nut threads.

It is important to note here that the acme nut is by design the wearing component in this system. Therefore, frequent lubrication is needed to minimize the rate of nut thread wear in order to maintain the expected wear rate of about 1,000ths of an inch per thousand flight hours.

Additionally, a periodic inspection procedure to monitor this wear is also required. This inspection is known as the end-play check, and if the wear exceeds 40,000ths of an inch, then the jackscrew assembly is to be replaced. These maintenance and inspection requirements will be discussed in detail later in this meeting.

The animation will now depict the system operation and sequence of failures that occurred during the accident flight. Flight data recorder information indicated that the accident airplane's longitudinal trim control system was functioning normally during the airplane's descent and landing into Puerto Vallarta on the flight just before the accident flight. Later, while preparing for take-off from Puerto Vallarta, the accident flight crew had trimmed the airplane to a seven-degree airplane nose-up position as you see here.

As the airplane was climbing out after take-off, the horizontal stabilizer moved at the normal

primary trim motor rate of one-third of a degree per second from seven degrees to two degrees airplane nose up. Thereafter, as the airplane continued to climb through 6,200 feet, the stabilizer moved at the normal alternate trim motor rate of one-tenth of a degree per second from two degrees airplane nose up to 0.4 degrees airplane nose down. Operation of the alternate trim motor during this period is consistent with use of the autopilot. Again, for the purposes of this presentation, the alternate trim motor speed of the stabilizer shown here is twice that of actual operation.

As the airplane continued to climb through about 23,000 feet, the stabilizer stopped moving at the 0.4 degree position. This cessation of stabilizer movement is consistent with the mechanical jam. Evidence suggests that this jam occurred due to the deteriorated condition of the acme nut threads that resulted from a lack of lubrication.

Two hours and 20 minutes after this jam occurred, immediately after the autopilot was disconnected by the flight crew with the activation of the primary trim, the stabilizer traveled from its jammed position to about the 3.1 degree airplane nose down position. Aircraft perform and kinematic analyses

indicate that the severely-worn threads of the acme nut stripped out at this point, allowing the acme screw to be pulled upward through the nut until the lower surface of the acme nut contacted the lower mechanical stop on the acme screw. The airplane entered the initial dive as the stabilizer moved. The lower mechanical stop and the torque tube that was connected to it was not designed to withstand the aerodynamic loads produced by the horizontal stabilizer.

About eight minutes later, after the airplane had recovered from the first dive, the torque tube and lower mechanical stop separated. The horizontal stabilizer moved upward from the 3.1 airplane nose down position to about a 3.6 airplane nose down position where it contacted the fairing brackets that were attached to the structure of the vertical stabilizer. These brackets were never designed to carry the tail loads. Several seconds after the horizontal stabilizer contacted the fairing brackets, the brackets failed, releasing the horizontal stabilizer. The resulting upward movement of the horizontal stabilizer's leading edge caused an uncontrollable downward pitching of the airplane from which recovery was not possible.

And that concludes my presentation.

ACTING CHAIRMAN CARMODY: Thank you, Mr.

Guzzetti.

MR. RODRIGUEZ: Our second presentation is by Mr. Joe Epperson, the Materials Group Chairman, who will describe recovery of the horizontal stabilizer jackscrew assembly and how it failed.

MR. EPPERSON: Good morning, ladies and gentlemen.

This morning, I will be giving you a brief description of some of the significant findings with respect to the metallurgical and mechanical behavior of the horizontal trim system.

As shown here, the jackscrew assembly was recovered from the ocean with the acme nut separated from the acme screw. At this point, the assembly had only received fresh water rinses and was still attached to the horizontal stabilizer. Acme nut thread remnants were found entwined around the center portion of the acme screw. This photograph shows a closer view of the acme nut thread remnants wrapped around the center portion of the acme screw in their recovered condition.

When examined shortly after recovery, no grease or lubricant was detected in the working area of the screw. Grease covered by sand from the ocean bottom was found on the lower end of the screw and an oily sheen was present on the upper end. Grease was

also found on the lower mechanical stop which had separated after the torque tube fractured at its lower end. The acme screw showed relatively minor wear and no evidence of abrasive wear.

The separated lower mechanical stop was recovered from within the vertical stabilizer structure and was partially covered by grease. The upper surface shown here after cleaning was damaged in several locations by contact with the lower end of the acme nut. These marks could have only been made after complete separation of the nut threads and the contact would induce offset loading and bending in the torque tube. Additional damage to the stop indicates that the screw rotated after the lower stop contacted the nut.

The acme nut was recovered separated from the jackscrew assembly but still attached in its original position in the vertical stabilizer. The threads on the interior of the nut were completely stripped and no grease was present inside the bore. However, red and green grease was found in various areas on the exterior of the nut and on surrounding structure. Additionally, the grease fitting passageway of the nut was found blocked by degraded grease containing wear particles and flakes from the acme nut.

This slide illustrates and compares the

internal threaded area of the accident nut on the right to that of a worn nut removed from service on the left. The sections -- the nut has been sectioned longitudinally here. Significant thread material remained in the used nut while on the accident nut none remained.

When the jam between the acme screw and the acme nut released at the beginning of the initial dive, the acme screw pulled upward through the acme nut until it contacted the lower mechanical stop, creating the previously-mentioned offset loading. The torque tube subsequently fractured at its lower end as a result of low-cycle fatigue due to the continued flight loads. The fracture was not characteristic of a single event.

The dash line in the inserted image here depicts the extent of fatigue on a portion of the crack. Mechanical tests established that similar fractures could be produced in as few as 100 cycles by applications of very high cyclic stresses, similar to those experienced by the accident components.

In order to address issues related to thread wear and failure mechanism and to the load environment in which the grease operated, the Safety Board and Boeing initiated finite element studies to analyze the stress and deformation in the jackscrew under

operational loads. Two actual models containing all 32 threads in the acme nut were analyzed to investigate load transfer between the screw and the nut and local 3-dimensional analyses were performed to study the contact pressure, nut thread deformation, and the influence of nut thread wear.

Analysis of these models showed that the actual stress distribution within the nut was non-uniform and that in certain conditions, as few as four threads could be carrying as much as 90 percent of the load. As wear progressed on more highly-loaded threads, the loads would shift or move to less-worn threads. The results also highlighted that the local contact stresses and distribution did not change as the wear progressed to well beyond the operational wear limits on the acme nut thread.

The contact pressures for an extreme load condition of 8,000 pounds averaged 3 to 4,000 pounds per square inch over the contact area. At extreme wear levels, the non-uniform load transfer caused bending deformation under normal flight loads, consistent with the unique shape of the remnants. The non-uniform loading of the threads is also consistent with the incremental shearing of the threads and production of the thread remnants.

Fractured remnants comprising approximately 75 percent of the acme nut threads were recovered from the working area of the screw. This view shows the end of one of these remnants. The remnants were sheared at the thread route and were less than 10 percent of their original thickness. They had multiple wear surfaces indicating multiple stages of wear and deformation resulting in the unique shape.

This slide illustrates the wear and deformation sequence as indicated by the shape of the remnants themselves. The first position shows a new condition with the remnant shape imposed upon a new thread. Wear would be expected to progress with a normal geometry up to Position 2. This corresponds to an approximately end play of 82,000ths of an inch.

As was just discussed, the finite element analyses indicated that beyond this level of wear, the thread would begin to experience large degrees of bending deformation. Position 3 shows the relative positions of the nut and screw after some deformation and additional wear. Position 4 shows the deformed and non-uniformly-worn thread remnants just before fracture and separation from the nut.

In conclusion, these are some of the findings that arose from the metallurgical investigation of the

jackscrew assembly and the overall investigation. There were no material defects or conditions that contributed to the wear nor were there any structural conditions, such as wobbling of the jackscrew, that would contribute to the wear.

Upon the recovery from the ocean, there was no lubrication in the working area of the acme screw. Furthermore, based on the presence of grease elsewhere on the recovered structure, the absence of lubrication on the screw cannot be explained by impact with the ocean, by exposure to seawater before recovery, or by the recovery and cleaning operations. Also, the lack of abrasive wear to the threads of the acme screw indicated that the jackscrew assembly grease had not been contaminated with abrasive particles.

The finite element analyses showed that local contact stresses and their distribution between the screw and the nut did not change as wear progressed beyond the operational limits of the acme nut. The wear was caused by sliding contact consistent with an unlubricated condition. The low-cycle fatigue crack in the torque tube was generated during the accident flight by unusual loading after complete loss of the acme nut threads.

This completes my presentation on

metallurgical findings.

Thank you.

MR. RODRIGUEZ: Our examination of the failed threads of the acme nut led to an immediate effort to ensure that there were no other jackscrews in the fleet that were about to fail. On February 9th, the day after the jackscrew was recovered, Alaska Airlines Maintenance Department and Boeing independently took steps to inspect all DC-9, MD-80, MD-90, and B-717 aircraft and to report findings of various inspection conditions of the jackscrew assembly. These inspections formed the basis for Airworthiness Directive AD-2000-0351, issued on February 11th, by the FAA.

During the initial fleet survey required by the AD, two additional MD-80s in the Alaska Airlines fleet, November 981 Alpha Sierra and November 982 Alpha sierra, were found to have jackscrews worn beyond limits. The wear rate on these two aircraft was over four times the wear rate anticipated by the manufacturer.

With three deficient jackscrews out of a fleet of only 34 aircraft, the investigation focused on possible unique differences in the Alaska Airlines operation of the MD-80s and that of other much larger

fleets in the industry. One factor was that Alaska Airlines was the only operator using Aeroshell 33 for lubrication. In order to assess the possible involvement of Aeroshell 33 on the wear characteristics of the Alaska Airlines fleet, we formed a Grease Group to study the relative characteristics of Aeroshell 33 and Mobilgrease 28 and the effectiveness of each as a lubricant.

Dr. Joseph Kolly was the chairman of this group, and he will now give an overview of the group's activities and findings.

MR. KOLLY: Good morning, Madam Chairman and Members of the Board.

This morning, I would like to present the results of the testing that was conducted as part of this investigation into lubricating greases. As you just heard from Mr. Epperson, the recovered jackscrew was lacking grease and did not exhibit any material or fabrication defects. These factors suggest that lubrication effects played a key role in the excessive wear of the acme nut threads.

To further evaluate what role lubrication played in the accelerated wear, the investigation focused on the two brands of grease that were in use for jackscrew lubrication at Alaska Airlines,

Mobilgrease 28 and Aeroshell 33. Until 1997, Alaska Airlines used Mobilgrease 28. Mobilgrease 28 had a long history of satisfactory performance at Alaska Airlines. In fact, a majority of other carriers also used Mobilgrease 28 for jackscrew assembly lubrication and they have also experienced satisfactory performance.

Beginning in 1997 and up to the time of the accident, Alaska Airlines specified the use of Aeroshell 33 for lubrication of the jackscrew assembly components, although Mobilgrease 28 was apparently still also used.

The picture on the left shows a magnified view of a small amount of residual grease taken from the accident jackscrew assembly. Only a small amount was recovered from the screw and only from the locations outside the normal operating regions of the screw. Its appearance indicates it is highly degraded. It no longer has the semi-fluid character of fresh grease, like that exhibited by the sample of new unused grease shown on the right.

Because of the limited amount of grease recovered and its highly-degraded condition, a perfect chemical identification of the grease was not possible. However, analysis of the residue was consistent with

the presence of both Aeroshell 33 and Mobilgrease 28.

These images are of higher magnifications of the degraded grease sample just shown. The image on the left shows the presence of a high concentration of metallic particles. The image on the right shows a magnified view of these particles. These particles are aluminum bronze wear particles that were shed from the acme nut as a result of sliding wear. Particles generated by sliding wear are easily identified by their flat flake-like shape. Sliding wear is the type of wear that is expected in jackscrew operation. These particles do not indicate that other wear conditions were present. There is no evidence that wear was caused by corrosion or wear caused by abrasive foreign materials.

One of the primary questions that our testing was designed to address was whether Alaska Airlines switch to Aeroshell 33 could have resulted in poor lubricating performance and contributed to the accelerated wear of the acme nut threads that led to the accident. Therefore, we developed a test program to determine the relative performance of Aeroshell 33 compared to that of Mobilgrease 28 under simulated conditions of jackscrew operations.

A test program was developed with three basic

parts consisting of grease testing, exposure testing, and wear testing. I will briefly describe the activities and results in each of these areas. Testing of the physical properties of Aeroshell 33 and Mobilgrease 28 was accomplished by the U.S. Navy Aerospace Materials Laboratory. The naval laboratory is the steward of the military specification or Mil Spec of both of these types of greases and has extensive experience in grease testing and interpreting their results.

Standardized grease tests were conducted on both Aeroshell 33 and Mobilgrease 28 and of many different mixture ratios of these two greases. These are the types of tests that are used to qualify greases under military specifications. The tests showed that the greases and their mixtures largely behaved in a normal or expected fashion. In a few instances of mixing, excursions from normal were marginal and considered to have an insignificant effect on performance. As a result, the investigation found that mixing of Aeroshell 33 and Mobilgrease 28, as for example would be caused by alternating use of these greases during maintenance, would not have significantly deteriorated the properties of either of the two greases.

Early in the investigation, there were questions raised regarding the possibility of corrosion. Therefore, a comprehensive set of exposure tests were performed to observe the effects of grease on aluminum bronze test specimens when exposed to simulated aircraft operating conditions. For this work, we contracted with the U.S. Navy Aerospace Materials Laboratory to conduct the exposure experiments. The subsequent chemical analysis was conducted by Science Applications International.

In these tests, a variety of conditions were examined. These include the effects of grease mixing and possible in-service contamination due to the aircraft's operating environment. Further, temperatures and durations of exposure were varied to represent extremes in the operating environment.

A sample test specimen from these tests is shown on the slide. Under certain conditions, Aeroshell 33 deposited a small localized discoloration on the surface of the test specimen. An example of this discoloration is shown in the slide just above the yellow arrow. The discoloration appears as a vertical stripe about one millimeter in width and occurred at the interface where the area of grease, the area covered with grease met an area that was not covered

with grease.

A chemical analysis of this area showed that it was not a corrosion product. Rather, it was a deposit caused by the reaction of anti-wear additives in the Aeroshell 33 grease. The presence of such deposits is not considered detrimental to the aluminum bronze.

The most significant element of this investigation's test program was the wear testing conducted jointly by Rensselaer Polytechnic Institute and Battelle Memorial Institute. These tests were designed to evaluate the effects that various factors of in-service operation have on the wear rate of aluminum bronze.

Before I describe the test results, I would like to briefly discuss the test method we selected for these tests. We chose a standard wear test method called the Block-on-Ring method. This test ring is shown on the slide before you now. The method employs a small stationary block that is forced against a rotating ring. These components are lubricated with grease where they come into contact. At this contact, the ring slowly wears a divot into the surface of the block. By carefully measuring the wear of the block during the test, we can very accurately determine the

wear rate caused by each type of grease.

The important features of actual jackscrew operation were captured by the Block-on-Ring test method. First, the materials used were the same as in-service jackscrew assembly materials. Test specimens were manufactured from actual jackscrew components with a block milled from a scrap acme nut and a ring turned from an acme screw forging. Second, the test pressures spanned nearly the entire range of pressures experienced between the threads of a jackscrew during aircraft operation. Third, the speeds at which the blocks-on-ring slide relative to each other are very close to that of the in-service jackscrew. Fourth, the type of motion used in the test is a reciprocating sliding motion which closely replicates the intermittent and reversing motion of the jackscrew. And finally, the geometry of the contact between the block-on-ring is over a discreet area, similar to the contact geometry of the jackscrew's mating screw threads.

Therefore, the block-on-ring test method was determined to be the best method to simulate the wear behavior of an actual jackscrew assembly under various lubricating conditions.

The tests were conducted for a variety of

conditions that were designed to replicate actual in-service conditions, such as various average pressures, grease mixtures, contaminants, grease aging, and sub-freezing conditions. A total of 49 tests were run using the block-on-ring test method.

The results shown here are from an extensive set of tests conducted at high average pressure loads. The data are shown as colored bars with green representing tests using Aeroshell 33 grease, red representing Mobilgrease 28, and blue representing a 50-50 mixture of the two greases. The scale on the left indicates the wear rate of aluminum bronze experienced during the test. The height of each bar represents the wear rate produced by that particular grease.

The first series of tests shown before you was conducted on the grease in its new out-of-the-container condition. These tests showed that Aeroshell 33 had the lowest wear rate. The highest wear rate was achieved using Mobilgrease 28 and the test using a mixture fell in between these values.

We know that the exact wear rate experienced by the accident airplane since the last end-play check cannot be determined. However, the condition of the recovered acme nut remnants indicates the wear rate was

severe. Based on this information, we can arrive at a conservative estimation of a minimum wear rate for the accident aircraft. This minimum value is shown on the graph as a horizontal purple line.

Because these tests replicate the wear behavior of an actual jackscrew assembly in service, we can compare the wear rates of these tests to that of the minimum value estimated for the accident aircraft. These data demonstrate that the use of Aeroshell 33 or a mixture containing Aeroshell 33 cannot account for the severe wear experienced by the accident aircraft.

The next set of tests examined the effect of fluid contamination of the grease. Water was added to the grease representing condensate generated during flight. As you can see, the addition of water had little effect on wear rate. We also tested Aeroshell 33 contaminated with salt water representing conditions of a coastal environment and de-icing fluid representing inadvertent exposure during de-icing procedures. Neither of these conditions significantly altered the wear rate of test specimens lubricated with Aeroshell 33 and continued to exhibit wear rates below those lubricated with pure Mobilgrease 28. As you can see, none of these contamination conditions could account for the severe wear rate experienced by the

accident aircraft.

Another test examined Aeroshell 33 after it had been used in the previous tests. This used grease contained significant amounts of wear debris which was allowed to age for several months before being retested. The results show no significant effect on wear rate.

Another series of tests examined the grease's performance at subfreezing temperatures. The tests were conducted in an environmental chamber at temperatures of -20 degrees Fahrenheit to simulate flight temperatures. Subfreezing temperatures also had little effect on the wear performance of either grease. At this point, we can see there is no indication that the use of Aeroshell 33 produces a higher wear rate than Mobilgrease 28. Additionally, there is no indication that any of these conditions could have resulted in the severe wear experienced by the accident aircraft.

The last condition shown here is one in which the test was run without any lubrication. The results of this test are shown as the gray bar. This produced wear rates on the order of 10 times that of Mobilgrease 28. The dramatic difference in wear rate is easily identifiable. Thus, the unlubricated condition is the

only condition that was found that could explain the severe wear rate of the accident aircraft. We have uncovered no other explanation for that severe wear.

We examined the role of lubrication from a number of angles. In the end, there was no evidence that the use of Aeroshell 33 would have caused the severe and accelerated wear experienced by the accident aircraft's jackscrew. The only factor found to explain this level of severe wear is a lack of lubrication.

This concludes my presentation.

MR. RODRIGUEZ: Madam Chairman, at this time, before we proceed to other presentations on other issues, we're prepared to answer questions on the jackscrew failure sequence or grease and wear testing.

ACTING CHAIRMAN CARMODY: Thank you, Mr. Rodriguez. Thank you, Mr. Kolly, for your presentation. They've all been excellent this morning.

Member Hammerschmidt, any questions on this section?

MEMBER HAMMERSCHMIDT: No questions at this time. I would like to commend the staff for those outstanding presentations.

ACTING CHAIRMAN CARMODY: Member Goglia?

MEMBER GOGLIA: Yes, Madam Chairman.

Mr. Kolly, we have seen in the press a number

of concerns raised by folks involved with this accident, parties to this investigation, about the loads that were used by the NTSB in determining the wear rates.

I wonder if you would explain to everybody why we chose the loads that we did and the effects of those loads on the testing.

MR. KOLLY: First, it starts with a calculation of the aerodynamic loads imparted to the jackscrew that were conducted by our Performance Group through aircraft simulation.

Those loads were then transferred to a finite element analysis which showed a non-uniform distribution of loading across the screw threads. We used that average pressure across the screw thread flanks to conduct the majority of our wear tests. We also spanned -- we were also very conservative in that we spanned a pressure range much lower and much higher, covering basically every pressure range that could be conceived in the jackscrew mating threads.

MEMBER GOGLIA: Now, you mentioned that the loads vary over the screw, the length of the nut and screw contact. Would you expand that explanation just a little bit? How can that happen if it's precisely machined?

MR. KOLLY: It has to do with the way the loads are transferred through a material and the amount of elastic deformation that a mating thread goes through, that the threads closest to the applied load share more of the load, and then as you go away from the applied load through the series of threads, the load diminishes.

MEMBER GOGLIA: And what effect does that have on wear of the threads? In this case, the nut because it's the sacrificial piece.

MR. KOLLY: Wear is proportional to pressure, and so the threads with the highest pressure would tend to wear and then the pressure loads would tend to even out and start to become more and more involved with the wear of the other threads and it would progress towards a more uniform pressure distribution and a more uniform wear distribution.

MEMBER GOGLIA: So, you're saying in time, over time, the load, although in the beginning it may be carried by a few threads on either end closest to the load, over time, it gets spread over the entire nut?

MR. KOLLY: Yes. An average over the life of the screw is that all the threads eventually obtain the same wear.

MEMBER GOGLIA: Okay. Thank you. I have no further questions on this area.

ACTING CHAIRMAN CARMODY: Member Black?

MEMBER BLACK: Just a couple.

I guess we'll start in order. Mr. Epperson, could you talk a little bit about how the grease gets on to -- gets from the application point into the nut and what you found when you examined that passageway on the accident nut assembly?

MR. EPPERSON: Yes. One of the means of application of grease is through a grease fitting on the nut. It's referred to -- commonly referred to as the "zerk" fitting. You see it in every-day applications everywhere.

The zerk fitting is a one-way check valve on the outside of the nut. It's actually located on the upper forward surface of the nut, but then it's connected to the interior of the nut, the thread area, by a drilled passageway. This passageway also has a large counterbore so that it supplies grease to both thread paths.

On the accident aircraft, as it was recovered, this counterbore and part of the passageway were blocked with a hard crumbly degraded grease containing wear particles. We had to physically remove

this to get the passageway opened.

MEMBER BLACK: What did you find in the channel? This assembly was supposed to have been lubricated a couple of months before the accident, is that correct?

MR. EPPERSON: That is correct. We found some remnants of red grease that was very similar to Mobil 28 inside the grease fitting and around the grease fitting.

MEMBER BLACK: But if this were blocked, it would be difficult for the grease to get inside the nut which is part of the lubrication process?

MR. EPPERSON: We didn't fully test whether the blockage that was there would impede grease flow, how much it would impede grease flow. It certainly would to some extent. Whether it would totally stop grease, we didn't investigate that for some investigative reasons. We decided to take the blockage out before we passed additional grease through it which would have contaminated what we had there. So, we had to make a choice there. The blockage certainly would have impeded grease flow. How much is a question.

MEMBER BLACK: Did the blockage appear to be of some age or could you tell?

MR. EPPERSON: Difficult to say at what age.

It was definitely severely degraded. It had no grease-like appearance at all. It was more like charcoal, if you will.

MEMBER BLACK: Okay. We don't have a slide of that?

MR. EPPERSON: Figure 17. It's in the report.

MEMBER BLACK: Actually, I have one, if worst comes to worse.

MR. EPPERSON: That's following Page 125 in the report, Figure 17.

MEMBER BLACK: There you go.

MR. EPPERSON: Yes. This is my poor drawing illustrating the arrangement of materials. The threads are on the right side. I put threads in this case just to show that that's where they were supposed to be. In the accident, there weren't any obviously. The blockage there extends into the -- from the counterbore and back into the smaller diameter passageway.

MEMBER BLACK: Do you have Exhibit 50 that shows the material once you got it out?

MR. EPPERSON: It's not part of the report, but we can --

MEMBER BLACK: Okay. That's all right if you don't have it. But it was a dry material, --

MR. EPPERSON: It was --

MEMBER BLACK: -- clumps of dry material.

MR. EPPERSON: -- very dry. It basically resembled crumbled-up charcoal.

MEMBER BLACK: Okay.

MR. EPPERSON: If you can imagine how that has a dry crumbly consistency, and it was embedded with -- heavily embedded with wear particles.

MEMBER BLACK: Wear particles. Second question for you. You mentioned that it took about a hundred cycles on the torque tube to produce the low-cycle failure. You think, are a hundred loadings and unloadings off axis?

MR. EPPERSON: In our mechanical tests that we performed to reproduce the fractured surface, we could get it -- this was on a subsize specimen. So, it was not an exact replication of the torque tube. At very high cyclic loads, very high uniform cyclic loads, we could get it to fracture in a hundred cycles.

Looking at the loading that was on the acme -- on the jackscrew assembly following the first dive, it's very much non-uniform. It's typically referred to as spectrum loading.

MEMBER BLACK: Perhaps Mr. Bower has a diagram of that he might be going to produce later or

-- what I'm -- I'm afraid some people in the audience will confuse cycles of loading with cycles on the airplane. In other words, a take-off and landing, and the graph of the variances in the load after the first event might show how that could have accumulated between the time of the first event and the final failure of the torque tube.

DR. BOWER: Stand by, Member Black. We have one of my charts coming up.

MEMBER BLACK: Well, if you're going to do it later, Dan, you can explain it then.

DR. BOWER: Except I don't have a planned presentation.

MEMBER BLACK: Okay.

DR. BOWER: To, this should come up in a second.

MEMBER BLACK: Thank you.

DR. BOWER: It should be the eighth slide in my presentation. What this slide will show is the calculated tensile load on the jackscrew assembly that we calculated here at the Safety Board in the Performance Group and also a comparison with calculations provided by Boeing.

MEMBER BLACK: Perhaps next time, I should give you a list, John.

DR. BOWER: There we go. There, we have it now.

MEMBER BLACK: So, what we're seeing is the load on the left side and the first event is that peak on the left side?

DR. BOWER: Yes. This starts -- this time of this graph starts about the time right at the first initial dive, and we see the load is the calculated, the dark blue line here, and also for comparison, the dots are the numbers provided by Boeing for the same time period, and we start out on the left-hand side with the -- right at the initial dive and during the time when we are going through the dive and reach about the maximum overspeed portion is when we have our maximum load, 24,000 pounds, and that's the tensile load on that jackscrew assembly, again all developed the aerodynamic loads on the stabilizer. And after that, we have through the rest of them, the next eight-nine minutes, just a very cyclic loading approximately between 13 to 15,000 pounds, up until the final failure.

MEMBER BLACK: And of course, the airplane is changing speed during this time period and attitude, pitch angle and that, and the earnest efforts of the pilots to try to recover, so you can easily see in all

of those wigglings there that this -- each of this -- these would have been loading that torque tube right at the very bottom, Joe, and that's where --

DR. BOWER: Correct.

MEMBER BLACK: -- the cycles come from.

DR. BOWER: On the bottom graph is actually the FDR elevator. You see with each elevator input, it does also change the load, also.

MEMBER BLACK: Right. Thank you. Sorry to slow things down there, but I thought those were important points.

Actually, I have one more for Mr. Kolly. You mentioned a minute ago that -- or someone mentioned that there were 34 aircraft in the fleet about the time this accident occurred, and we had three airplanes that had extraordinary wear rates. That would be 981, 982 and the accident airplane 963.

So, if there had been some sort of grease contamination by mixing or by all Aeroshell or all 28 or some mixture, all of these airplanes were being lubricated in the same general locations, were they not?

MR. GUZZETTI: Yes. I could probably address that a little bit better.

Pretty much, yeah. Most of Alaska Airlines

fleet of MD-80s were being lubricated either at Oakland during their C check, or during -- at San Francisco on the line. Maybe 20 percent of their fleet were getting lubes on the line in Seattle or Los Angeles, but for the most part, San Francisco and Oakland were the places that the lubrications were occurring.

MEMBER BLACK: So, I think I pulled one out of your data and it was a sister ship to 963, I believe it was 965, and it had almost identically the same lubrication history, yet it had an average wear rate.

MR. GUZZETTI: That's correct. We found that other than those three airplanes that were high-wearing, the rest of Alaska's MD-80 fleet, no matter where it was lubricated, had an excellent wear rate, less than -- less even than the Boeing average of 1,000ths per thousand flight hours.

MEMBER BLACK: About 70 something percent of them, I think, had less than average, yes.

MR. GUZZETTI: Right.

MEMBER BLACK: So, thank you.

ACTING CHAIRMAN CARMODY: Mr. Kolly, this is on grease. As I recall, you said in your presentation that there was no evidence of corrosion, that the damage, the wear damage you saw was what you would expect, but it was not corrosive, is that correct?

MR. KOLLY: Yes, and our chemical analysis in the exposure tests did not indicate that the grease would be -- is corrosive, but further, the most significant evidence is on the recovered remnant itself. The opposite side -- the thread of the acme nut has a wear side and a non-wear side. The opposite side, the non-wear side, is original. It's original with its as-machined surface and the recovered condition still shows the original machining. So that, we know that the surface wasn't attacked in any significant way by corrosion during its entire life.

ACTING CHAIRMAN CARMODY: I raise that because I was reading the Alaska submission, the party submission, and they were talking about Aeroshell and saying it was corrosive to material and that jackscrew assembly wear rates associated with Aeroshell 33 use are three to 10 times greater than wear rates associated with Mobil 28.

Do you have any comment on that?

MR. KOLLY: Alaska Airlines and some consultants working for them conducted a wear test program and that is where that three to 10 times wear rate comes from.

We had several independent reviews of that entire volume of information, one by Rensselaer

Polytechnic, one by the FAA, another less formal one by Boeing, and the data do not support that conclusion. It was -- they were extensively looked at and there's no evidence in the data that that conclusion can be supported.

ACTING CHAIRMAN CARMODY: Good. Thank you, Mr. Kolly.

Member Goglia had a follow-up question, I believe.

MEMBER GOGLIA: Yes. Mr. Kolly, this goes to you.

The -- as we've just mentioned in Mr. Bower's presentation, the loads got as high as 24,000 pounds. Where does that fit with the upper end testing that you performed?

MR. KOLLY: Well, that was during the failure sequence and that doesn't have anything to do with the operating conditions associated with wear of the jackscrew. That was during the failure. So that, that wouldn't be a normal wear-operating environment.

MEMBER GOGLIA: And what was the higher limit that you used in the testing?

MR. CLARK: The highest pressures we examined were above 8,000 psi.

MEMBER GOGLIA: Okay. Thank you.

ACTING CHAIRMAN CARMODY: No other questions at this time. Let's move to the next presentation, please.

MR. RODRIGUEZ: Because -- thank you, Madam Chairman.

Because the acme nut threads on the accident airplane failed as a result of excessive wear, the investigation examined the lubrication and end-play inspection procedures and the intervals that were in place for these procedures prior to the accident.

At this time, Mr. Jeff Guzzetti will describe the procedure for lubrication and inspection of the jackscrew and discuss the extension of intervals between these activities.

MR. GUZZETTI: As we have already noted, lubrication of the jackscrew assembly is required to minimize the rate of wear of the acme threads. Previous service history has shown that inadequate lubrication causes accelerated wear of the jackscrew assemblies. This is documented in three Douglas All Operator Letters issued in 1967, '84, and '91, and they were issued to remind airlines to lubricate the jackscrew as per their recommended procedure. These three All Operator Letters were prompted after discoveries of several prematurely-worn jackscrews due

to a lack of lubrication.

The lubrication procedure first involves gaining access to the top of the tail assembly. Typically, this is performed with the use of a small lift bucket truck as shown here in this slide while the airplane is parked overnight. Several panels are then removed. Grease is then applied under pressure to the single acme nut fitting that Mr. Epperson referred to with the use of a grease gun. The mechanic is to pump the gun until grease exit out of the top of the acme nut.

The procedure then calls for a brush application of a light coat of grease to the jackscrew threads. So, not only do you have to hit the zerk fitting but then you have to apply grease to the entire length of the acme screw. This is followed by cycling the jackscrew through a full range of travel to distribute lubricant across the jackscrew.

Staff noted many differences in the methods used by personnel from various airlines to accomplish certain steps of the lube procedure, including the manner in which grease was applied to the acme nut fitting and to the screw. For example, several of the methods observed by or reported to investigators did not involve application of the grease to the entire

length of the jackscrew. There's two access panels that you have to get to and to get the top part and the bottom part of the jackscrew.

Staff also noted that the size of the access panels was not the optimum for the procedure and you could see in that slide Dr. Malcolm Brenner's hand just beneath one of the access panels to give you a sense of the size. Additionally, laboratory demonstrations established that applying grease only through the acme nut fitting did not provide an adequate amount of grease over the remainder of the acme screw. It was also noted that the lube procedure is not required to be inspected after it is to be performed.

As a result of these observations, Safety Board recommendations were issued last year and since the lubrication procedure has been revised. However, staff is proposing additional recommendations in this draft report.

A very significant aspect of this investigation focused on Alaska Airlines extension of the lubrication interval. A review of records indicates that the interval for jackscrew lubrication was extended four times with no objection from the FAA between March 1987 and July 1996. As you can see here, the Alaska Airlines interval criteria was based

exclusively on flight hours in 1987 at 500 hours as shown by the top yellow bar. Eventually, in July '96, the criteria was changed to eight calendar months without regard to accumulated flight hours. It was just by calendar time. Because of the increased utilization of Alaska Airlines airplanes during this time, this eight-month calendar interval was equivalent to 2,550 hours as shown by the bottom yellow bar.

The investigation did not determine what information, if any, was presented as justification for the interval extensions in '88, '91, and '94. However, according to an FAA inspector who reviewed and accepted the 1996 extension, Alaska Airlines presented the recently-extended manufacturer's lube interval, shown in the lower blue bar, as justification with no internal airline data to support the extension.

Staff believes this was inappropriate because each airline operates their airplanes under unique circumstances that require unique FAA oversight and data justification, regardless of the manufacturer's recommended intervals.

Additionally, in the wake of the most recent extension there in 1996, in '97, Alaska Airlines replaced Mobilgrease 28 with Aeroshell 33 for jackscrew lubrication without following appropriate internal and

standard industry practice procedures which dictate that the intervals should actually be decreased when a grease change is made until data shows its successful service history has been achieved.

In sum, Alaska Airlines extended lubrication intervals increased the likelihood that a missed or inadequate lubrication would result in excessive wear.

As I mentioned on the previous slide, the manufacturer's recommended lubrication interval was also extended. In 1964, the original Douglas lubrication specification for the jackscrew called for an interval of between 300 and 350 flight hours. One year later, when the DC-9 was introduced into service, the recommended interval was increased to 600 to 900 flight hours. In 1996, this interval grew to 3,600 flight hours through a process that's coordinated by the FAA that involved maintenance steering groups or MSGs and maintenance review boards or MRBs.

The investigation found that this process, these processes, MSG, MRB as well as local airline extensions, by which manufacturers recommend and operators establish their maintenance task intervals is deficient in several ways. For example, those processes do not ensure that the resulting intervals account for the assumptions of the original airplane

designers, are supported by adequate technical data, and take into account the possibility of missed or inadequate accomplishment of the task. The draft report contains several recommendations aimed at addressing these deficiencies.

The jackscrew also requires an inspection procedure known as the end-play check, and first, I'd like to give you a little background about the genesis of this end-play check procedure. When the DC-9 first entered service in the mid-'60s, the jackscrew was a life-limited part at 30,000 flight hours. There was no procedure to monitor wear. There was no end-play check. However, in 1965, Douglas initiated a sampling program to monitor how their new jackscrews were doing. Jackscrews were removed from airplanes that were part of this sampling program. The jackscrews that were removed were placed on a bench and they had their end play bench checked under a controlled environment. This effort led to the discovery of six high-wearing jackscrews.

In 1967, as a result of these findings, Douglas made some changes to the screw metallurgy and they also increased the wear limits for the jackscrew and acme nut. They also developed a procedure to monitor the wear while the jackscrew remained on the

airplane and this is the birth of the end-play check back in '67, and it basically allowed the operator to check the wear without having to remove the jackscrew from the airplane.

This ad hoc procedure was developed with common tools that were already available to the airlines. The tools included a horizontal stabilizer restraining fixture that had been used solely to remove and install jackscrews, a dial indicator, and a torque wrench.

The purpose of the end-play check is to monitor the wear of the acme nut threads without having to remove the jackscrew from the airplane. The procedure involves pulling down on the horizontal stabilizer by applying a specific amount of torque to the restraining fixture to change the load on the acme screw from tension to compression. The movement or end play between the gap of the acme nut and the acme screw is measured with a dial indicator. The movement is picked up by a plunger at the back of the indicator and read in thousandths of an inch.

A new jackscrew has a gap of between 3,000ths of an inch and 10,000ths of an inch, as shown in that top illustration. Eventually, the gap increases as the acme nut threads wear down, as shown in the bottom

view.

To quickly summarize how the end-play procedure works, the stabilizer is moved to a pre-determined position from the cockpit, tail fairings are then removed, and then the restraining fixture is installed between the horizontal and vertical stabilizer, as you see here. The dial indicator is then clamped to the bottom of the screw. The indicator plunger is positioned against the bottom of the acme nut, as you see there. A pre-load is applied to the indicator probe and a reading is recorded. Then the restraining fixture is rotated with a torque of between 250 to 300 inch pounds to change the load direction on the jackscrew assembly. The dial indicator is then read and there's some interpretation required that I'll mention in a moment.

The torque on the restraining fixture is relieved and the dial indicator is checked to ensure it has returned to the initial setting. The steps are repeated several times to ensure consistent results within a thousandths of an inch and then, finally, the mechanic checks that end-play limits are between the upper -- excuse me -- between the lower limit of 3,000ths of an inch and the upper limit of 40,000ths of an inch. Readings less than the 3,000ths limit or

greater than the 40,000ths inch limit is cause for replacement of the jackscrew assembly. That's when you know your jackscrew is worn.

Another significant finding in the investigation was Alaska Airlines extension of the end-play check interval between March '85 and April '96, again with no objection from the FAA. This bar chart shows the airline's extension in yellow. The beginning interval was set at every other C check or 5,000 hours. In July '88, the airline no longer used the flight hour limit for the C check. Rather, it based C checks on calendar time only, so that the end-play check was being performed at a 26-month calendar interval. Based on the airline's utilization rate at that time, this equated to 6,400 flight hours between inspections. This interval was increased again in April 1996 and the end-play checks were being performed every 30 months, again with no regard to flight hours.

Because the Alaska Airlines increased fleet utilization at that time, the interval between the end-play checks occurred approximately every 9,550 flight hours. By contrast, the manufacturer's recommended interval at that time, shown in the lower blue bar, was every 30 months or 7,200 flight hours, whichever comes first.

After the accident, the FAA established more stringent lubrication and end-play check intervals by way of the Airworthiness Directives that Mr. Rodriguez mentioned. However, during the investigation, we learned that extremely rapid wear mechanisms are possible and we became concerned that the 2,000-hour end-play check interval that's currently in effect may still not be conservative enough. Therefore, the draft report recommends that the FAA establish a more scientifically-based end-play check interval.

The Systems Group conducted hundreds of on-wing end-play tests at several airline maintenance facilities across the country. We found that the end-play check procedure was somewhat cumbersome and susceptible to measurement error. We determined that several variables could affect the accuracy and the reliability of end-play readings, such as installation of the dial indicator, difficulty in reading the dial indicator due to its small size, its upside-down mounting, and its backwards needle movement, adverse working conditions, restraining -- the condition of the restraining fixture, the amount of torque applied to the restraining fixture, and the direction in which that torque is applied. The amount of rotation the acme screw would experience during end-play check also

had an effect.

In the case of the accident airplane, a fabricated restraining fixture was used during the last end-play check in 1997. This Alaska Airlines-fabricated tool did not conform to Boeing specifications and the Systems Group documented several differences between the two tools.

Because the Systems Group discovered that there are many variables that can affect the end play, we were concerned about its reliability and its validity for monitoring the wear of such a critical item. Therefore, we asked Dr. Jana Price to perform some statistical work on end-play measurement data that were reported to Boeing and the FAA as a result of the Airworthiness Directive issued after the accident.

So, before we invite questions on this part of the report, I would like to ask Dr. Price to briefly describe her work in this area.

Dr. Price?

DR. PRICE: Good morning, Madam Chairman and Members of the Board.

Today, I will discuss the Safety Board's statistical end-play data study. I will describe results from two analyses that were conducted to assess the reliability and validity of the on-wing end-play

measurement. Reliability and validity are two necessary features of an effective measurement system.

By reliability, I'm referring to the ability of the on-wing end-play measurement to yield consistent or repeatable results. If a measure is not reliable, then it cannot provide accurate results. Reliability was examined using end-play data collected as a result of an Airworthiness Directive mentioned earlier by Mr. Rodriguez which directed operators to perform end-play checks at intervals of 2,000 flight hours or less.

The Board received a total of 3,174 on-wing end-play measurements from 1,493 airplanes and 44 operators. According to Boeing estimates, very little change in actual end play is expected to occur over a 2,000-flight hour interval and all changes are expected to be in an increasing direction.

In order to assess the degree of similarity between two consecutive measures, we used a correlation analysis that determined the relationship between the first and second measures for 852 jackscrew assemblies. The correlation analysis produces a value known as the correlation coefficient or R. R can range between negative 1 and positive 1. An R value of positive 1 would indicate a perfect correspondence between two measures, such that, when one increases, the other

increases proportionally. R values closer to zero would suggest that the measure is not repeatable and there's more measurement error.

In the current setting, we would expect a very high R value since we would expect very little change in the end-play measure over the course of 2,000 flight hours. As an example, if there was a measurement error of plus or minus 5,000ths in the end-play measure, the R value would be around .85.

This scatter plot represents the raw data collected at Time 1 which is shown on the X axis along the bottom and Time 2 which is shown on the Y axis along the side. The blue line represents where we would expect all of the dots to be tightly clustered if there was a strong positive correlation between end-play measures at Time 1 and Time 2. This line represents the anticipated wear based on Boeing's estimate of 1,000ths of an inch per 1,000 flight hours, positioned to agree with the initial end play.

In fact, as you can see, the dots are fairly widely scattered, and in addition, there are numerous cases in which the second measure of end play was substantially smaller than the first measure. For example, in the case I have circled, the end play measured 35,000ths at Time 1. At Time 2, it decreased

to 8,000ths. Since this is not physically possible, we assume that it was due to measurement error.

The wide scatter in the data you see is represented numerically by the resulting R value for Time 1 and Time 2 which was .553. Based on the resulting correlation values, the study concluded that the on-wing end-play test had low reliability.

This slide provides another way to see the same data. It displays a histogram representing the differences in end play between Time 1 and Time 2. Positive numbers, shown in blue, indicate increases in end play between Time 1 and Time 2. Negative numbers, shown in red, indicate decreases. Since it is not physically feasible for end play to decrease, it is likely that all changes in that direction are attributable to measurement error.

If the on-wing end-play measure were highly reliable, we would expect to see a large majority of the cases with differences between zero and 2,000ths. As you can see in this graph represented by the dark blue bar, only about 40 percent of the cases were in this range. The light blue bars represent about 22 percent of cases where the end play increased by more than 2,000ths with differences ranging from 3 to 35,000ths. The red bars represent about 38 percent of

cases where the end play decreased with differences ranging from negative 1,000ths to negative 31,000ths.

Although I have only shown graphs depicting the relationship between Time 1 and Time 2, the results were all additional analyses were similar.

A second portion of the end-play study focused on an examination of 157 jackscrew assemblies that were returned to Integrated Aerospace, the manufacturer of the jackscrew assembly, during the 2000 calendar year. At Integrated Aerospace, jackscrew assemblies are cleaned and end-play checks are conducted in a controlled setting known as the bench check described earlier by Mr. Guzzetti. Because the bench check is conducted in a controlled environment, it should provide a better representation of actual end play.

For each jackscrew assembly returned to Integrated Aerospace, Boeing contacted operators to obtain matching on-wing end-play data and they were able to do so in 63 cases. Our goal in this analysis was to determine how closely related the on-wing end-play measure was to the bench check measure. If they had a strong correlation, it would suggest that the on-wing measure is valid.

In this histogram, positive numbers indicate

cases where the on-wing check was greater than the bench check and negative numbers represent cases where the on-wing check was less than the bench check. The dark blue bar you see here represents six cases or about 10 percent where there was no difference between the on-wing and bench check end-play measures. To the right of the dark blue bar, in about 70 percent of cases, the on-wing check produced larger end-play measures than the bench check. To the left of the dark blue bar, in about 20 percent of the cases, the on-wing end-play check produced smaller measures than the bench check, suggesting that in these cases, the actual state of the assembly was more worn than the on-wing test indicated. In about 10 percent of the cases we studied, this difference was 11,00ths or greater.

We also conducted a correlation analysis to look at the relationship between the on-wing and bench check measure. We used the same correlation techniques that I described for the reliability analysis. In this case, the resulting correlation coefficient or R was .442. Based on this analysis, we concluded that the on-wing end-play test had low validity as compared to the bench check measure.

In conclusion, the reliability analysis examining repeated on-wing measures suggested low

reliability. This is important because reliable or repeatable measure is a necessary condition for an accurate measure. Furthermore, the validity analysis using on-wing and bench check measures also suggested low validity.

As a result of this study and work done by the Systems Group, the NTSB issued a recommendation asking Boeing to revise the measurement procedures and demonstrate that the new method is valid and reliable.

This concludes my presentation.

ACTING CHAIRMAN CARMODY: Thank you, Dr. Price.

I think in light of the hour, we'll take a short break and then come back for questions because I think there will be quite a few.

Why don't we return at 11:15? Thank you.

(Whereupon, a recess was taken.)

ACTING CHAIRMAN CARMODY: Let's come in and take our seats. I'd like to resume.

All right. Let's resume the hearing. Would those who are standing in the door either come in or go out, please? We'd like to get started again.

I guess I have some questions about the intervals and I'll start with Mr. Guzzetti or whoever wishes to answer. I was struck by the fact that the

manufacturer has intervals which include both calendar as well as flight hours, and yet in 1988, I believe you said, Alaska Air went to calendar time only, and I presume -- well, in fact, you said that was approved by the FAA.

Do we know what the FAA's analysis of that was or what the rationale was?

MR. GUZZETTI: No, we don't, Madam Chairman. Since it happened so long ago, the personalities involved and the paperwork involved disappeared, and so we really don't know exactly how that process worked where the airline was allowed to remove that whichever comes first caveat. So, we just know that it was removed.

ACTING CHAIRMAN CARMODY: Do we know if the FAA inquired after that as to what the actual effect of this was? In other words, what are the flight hours that are -- that correlate to the calendar times as -- because the flight hours kept increasing?

MR. GUZZETTI: That's correct. The fleet utilization of Alaska did keep increasing within that calendar time. I don't know if the FAA, even in the recent past, were aware that when you escalate -- when they extended their C check to, say, 13 months to 15 months, that -- and then they increased their

utilization, I don't know if they put two and two together to realize that specific tasks, the flight hour limits, were being extended either.

ACTING CHAIRMAN CARMODY: This is your opinion, I realize. Would you expect that's something the FAA should be looking at or should have looked at?

MR. GUZZETTI: I would expect the FAA to --

ACTING CHAIRMAN CARMODY: So would I.

MR. GUZZETTI: -- ride herd on that.

ACTING CHAIRMAN CARMODY: I have another thought along those lines and it's floating around up here. I think it's just floated out.

Let me go to another question I had. On Page 253, middle paragraph, we're talking about the MRB-3 extension of the manufacturer's recommended interval, and there's a sentence there, starting on Line 8, that says, "Further, Boeing design engineers were not consulted about nor aware of the extended 3,600-hour MRB recommended lubrication interval."

Who made the decision about this interval, if none of the engineers at Boeing were consulted?

MR. GUZZETTI: Well, the MRB process involves people coming together from industry, airline representatives, manufacturer representatives, but not necessarily the original design engineers from the

manufacturers. They're usually folks that work in the maintenance area and don't typically talk to the design folks, and by committee, with the FAA simply setting up the meetings and kind of coordinating it all, by committee consensus, they look at whatever data they have and make decisions about extending certain maintenance task intervals.

So, we don't have any -- we asked whether there were meeting minutes for the particular MRB-3 MD-80 meetings. There were none to be found. So, we really don't have a firm idea on exactly who proposed 3,600 hours or why it was proposed and what type of data was presented.

ACTING CHAIRMAN CARMODY: I believe you used the words "FAA sets up the meetings and coordinates it", and I think those words were the same that FAA used in our hearing about three years ago on this or two years ago.

Is that your understanding of the FAA's role, strictly coordinating the meetings?

MR. GUZZETTI: IT is. It is my understanding. They play a very limited role. We had the chairman of the MD-80 Maintenance Review Board at the public hearing, and he concurred with the fact that the FAA kind of hosts these meetings and coordinates

them, but in terms of approving the intervals or playing an active role in them, that doesn't appear to be taking place.

ACTING CHAIRMAN CARMODY: I remembered my other question about intervals. We were talking about the fact that Alaska was using a calendar as opposed to calendar hours. Any other airlines do that?

MR. GUZZETTI: There are other airlines that do that for other maintenance tasks, and I don't know exactly which airlines and which specific maintenance tasks, but yes, there are other airlines out there that strictly use calendar time, but a survey that we did of 13 operators of DC-9s and MD-80s for the C check that's involved with the jackscrew end play and for the lubrication, all of them, except for Alaska Airlines, had a calendar time or a flight hour, whichever comes first, according to our survey.

ACTING CHAIRMAN CARMODY: Okay. Thank you.

Member Hammerschmidt?

MEMBER HAMMERSCHMIDT: Well, just following up on Chairman Carmody's last question, at the time of the accident, how did a time frame of 9,550 flight hours for end-play checks as an interval, how did that compare to, say, other airlines that were operating MD-80s?

MR. GUZZETTI: According to the survey that we performed where we contacted these 13 operators, and by the way, each of these airlines had at least 10 airplanes, so they were the big ones, it was the second highest of those 13 airlines. The first highest was an airline that had an interval of 10,500 hours and then Alaska Airlines came in second with 9,550, and then most of the rest of them, there was one here at 8,400 hours, and then the rest were around the 7,200 flight hour, and then there were a few that were down into the 3,000 and 5,000 range.

MEMBER HAMMERSCHMIDT: Okay. Thank you.

We point out in the Analysis Section of this report on Page 274 that, on Line 7, the Safety Board is aware that Boeing is currently developing improved end-play check procedures.

Could someone elaborate on that? Because it was my understanding that some time early this year, that Boeing briefed the Safety Board on these new procedures and in fact many of you actually went over to Reagan National Airport and participated in and experienced how those new procedures -- how they were effective.

MR. GUZZETTI: Certainly. Yeah. As a result of the hundreds of end-play checks that the Systems

Group did over a period of, you know, two-three years, the Systems Group started experimenting with what we thought might be better ways, improved ways to get a more repeatable measure on the jackscrew end play, and Boeing took the ball and ran with it, and they actually are working on, and I think they're very, very close to fielding the new end-play check procedure.

According to Boeing, it's greatly improved because they take a lot of the variables out of the process. It will involve a restraining fixture where it'll just have a green band and a red band. Rather than worrying about whether you're putting 250 inch pounds of torque on the restraining fixture or 300 inch pounds of torque, you'll be able to just intuitively look at a needle and once you're in that range, you're okay.

Also, the dial indicator face is mounted on top of the acme nut instead of below it and if you noticed on top of the acme nut, there's this very large banana fairing that you have much more access to access -- to install the dial indicator. The new dial indicator is also a very large dial. You don't need an inspection mirror to view it, like you did with the old procedure, and you don't have to interpret what the indicator is saying. With the old dial indicator, you

had to kind of subtract from 100 and with an inspection mirror and it was a bit cumbersome.

So, they've implemented that, and they've also implemented an anti-rotation device where you don't have to worry about the jackscrew rotating which the Systems Group found can throw off your reading. So, that's just -- those are just some of the major aspects, and it's -- according to Boeing, they tested this procedure and they have greatly enhanced the repeatability of the measure.

MEMBER HAMMERSCHMIDT: Hm-hmm.

MR. GUZZETTI: Also, just to conclude, you're right. Boeing set up a -- partnered with American Airlines and set up a demonstration for several Safety Board staff to actually perform this new procedure. Mr. Rodriguez and myself and several others here did it at night, at about midnight, several months ago.

MEMBER HAMMERSCHMIDT: Did you take various end-play measurements?

MR. GUZZETTI: Yes, we did.

MEMBER HAMMERSCHMIDT: I mean, among yourselves?

MR. GUZZETTI: Yes, we did.

MEMBER HAMMERSCHMIDT: How did those compare?

MR. GUZZETTI: They -- we all came up with

the same number.

MEMBER HAMMERSCHMIDT: Same number. Okay. Do you recall what that number was, by any chance?

MR. GUZZETTI: I think it was -- I don't recall. It was within limits. It was in the 18,000ths or 22,000ths. I don't recall.

MEMBER HAMMERSCHMIDT: Not important. I was just curious.

Speaking of Mr. Rodriguez, I was with the investigator-in-charge at Alaska Air's Oakland maintenance facility, observing an end-play check and lubrication, months ago, and you had mentioned in reference to one of Member Black's earlier questions that most of the lubrication in the Alaska Airlines system was accomplished at Oakland and at San Francisco International Airport, is that correct?

MR. GUZZETTI: Yes. Yes, that's correct.

MEMBER HAMMERSCHMIDT: Okay. I'd like to shift from the process of intervals to the actual work where the grease meets the metal, so to speak, and on Page 249, which is in the analysis, we have a sentence on Lines 16 and 17 which I'll just read.

It says, "This suggests that the SFO mechanic", meaning the mechanic at San Francisco International Airport, "who was responsible for

lubricating the jackscrew assembly in September 1999 did not adequately perform the task", and this was the mechanic who was responsible for performing the last lubrication of the accident airplane's horizontal stabilizer components, including the jackscrew assembly.

When we say that this mechanic did not adequately perform the task, what leads us to that conclusion?

MR. GUZZETTI: There are several things that leads us to that conclusion. Let me list some of them. First of all, Mr. McGill and Mr. Rodriguez interviewed that mechanic and that mechanic didn't appear to have a solid knowledge on the actual lubrication procedure.

Secondly, the Systems Group went back to the wreckage at Oxnard, granted it was two years after the wreckage, but we examined every single grease fitting on that tail of the wreckage, and we noted that at least 40 percent, about 40 percent of the grease fittings on the -- that are used in that task card for the jackscrew and the elevators were either dry or semi-dry. We compared that with other systems, most notably the rudder system, which was lubricated several months before the SFO lube, and just about all of the fittings on the rudder had fresh, what we would

determine as fresh, grease.

So, that was the second aspect, and the final aspect and perhaps the most compelling is when we pulled the jackscrew out of the ocean, the working area of the acme screw was void of grease. It didn't have much on it, and when you compare that fact with Dr. Kolly's aspects about what salt water does to grease, which isn't much, as well as other jackscrews we pulled out from the bottom of the ocean, most notably the China Air jackscrew, even an impact with the ocean and sitting on the ocean floor for a few days, you should still be able to see some remnants of grease on a jackscrew, and we didn't in the case of Alaska Airlines.

If the San Francisco lube would have been done adequately, staff feels that we would have seen some evidence of that on the screw.

MEMBER HAMMERSCHMIDT: Hm-hmm. And how long should it typically take for a mechanic to perform the lubrication procedure?

MR. GUZZETTI: We asked that of Boeing and they put their maintenance task folks on it, and they came up with an estimate, including removing access panels between, I think, three and a half to four person hours, and however, when we asked the mechanic

that did perform the lube, he indicated it took him about an hour to do the whole thing which also led us to feel that perhaps the procedure wasn't done adequately.

MEMBER HAMMERSCHMIDT: Okay. In this Section 1, Other Questions, going back to end-play checks, we mentioned in the analysis some work that's been done at Sandia Laboratories concerning a new method of computing the end play on a jackscrew.

Could someone describe that somewhat for us?

MR. GUZZETTI: Yes, Member Hammerschmidt, I can describe that just to the best of my knowledge. I haven't been keeping up with what they've been doing, but right after the accident, Alaska Airlines, through some sort of FAA grant to experiment with new technologies, worked with Sandia to try to devise another method of performing an end-play check.

They came up with two experimental procedures. One was simply an x-ray where you bring an x-ray up to the jackscrew and take an x-ray film of it, so you can actually see the wear of the acme nut threads, which is something you can't do now, and then the other technology they used was ultrasound. They would just kind of like when -- during a pregnancy to determine the sex of the baby, the same principles

would apply to the jackscrew. You run an ultrasonic transmitter over the length of the acme nut and the readings you get on the screen would indicate the thickness.

The FAA pulled the funding on those, but I think Alaska Airlines later on began their own initiative to look into that. The Safety Board, the staff really didn't have much of an involvement, other than to report that there could be other technologies out there for this.

MEMBER HAMMERSCHMIDT: Very good. I just found that of significant interest. Thinking outside the box a little bit, as the saying goes.

One final question. You had mentioned that the staff at least has given us a position that this 2,000 flight hours that the Airworthiness Directive calls for to be a limit for an end-play check was perhaps not as conservative as it needs to be, and you mentioned that it was based on a particular occurrence or event, and I believe that's the Hawaiian Airlines jackscrew situation where the garnet ingredients had gotten into the grease and had caused excessive wear.

MR. GUZZETTI: That's correct.

MEMBER HAMMERSCHMIDT: Is there anything else that that's based on, that position, that 2,000 hours

is not adequate?

MR. CLARK: Well, several things. One is, we don't know possibly what the worst wear rate is out there. I think Alaska -- the Hawaiian one, we're looking at a wear rate of approximately 13 times the 1,000ths per thousand hours. Can it be worse? We don't know that. So, there's a concern there, and then we would like the -- there's quite a variance in the end-play measurements that you see in Dr. Price's data. There's also concern that since this is a critical -- quite a critical item, that in other systems and structures, we always try to achieve at least two good inspections or have the opportunity to discover a flaw twice before we reach a failure mode.

So, if you start adding all of those bits and pieces up, we're not convinced that 2,000 hours is an appropriate inspection interval. Very well could be less. If they go through a systematic process, it may be greater than 2,000 hours, but we don't know that answer yet.

MEMBER HAMMERSCHMIDT: All right. And what is our suggested solution for that?

MR. CLARK: Well, there's several. One is to work at the reliability and validity of the measurements and also the -- one solution that would

simply take it off the table is to put on some sort of fail-safe device or some device that could mitigate any type of failure and that buys you the extra protection and then you don't have to worry so much about the appropriateness of the 2,000-hour inspection interval or the inspection techniques.

MEMBER HAMMERSCHMIDT: Okay. Thank you. That's all I have.

ACTING CHAIRMAN CARMODY: Member Goglia?

MEMBER GOGLIA: Excuse me. I have a few questions.

Mr. Clark, I'd like to take your comments just one step further. We just heard Mr. Guzzetti talk about the reliability of the new tooling that Boeing has designed to accomplish this task and its repeatability.

Would that have any effect on the comments that you just made?

MR. CLARK: We'll certainly take an improvement anywhere we can get it in the entire process. I think there's a number of things we don't know. We were going to address this a little more directly a little later, but if you want to interject that now, I guess we can.

MEMBER GOGLIA: In what way?

MR. CLARK: Well, --

MEMBER GOGLIA: Where are you going to put it later?

MR. CLARK: -- I think Mr. Rodriguez is going to discuss the Alaska Airlines Maintenance Program, the FAA oversight of that program, and then we're going to get into a number of issue areas, such as the possible design changes or fixes. Let's see. Another area is the crew decisionmaking process.

MEMBER GOGLIA: Flight crew or maintenance crew?

MR. CLARK: Flight crew.

MEMBER GOGLIA: I think I'd like you to talk about it now.

MR. CLARK: Okay. Okay. The -- what I'd like to do is there's been a lot of discussion about trying to devise a fail-safe system. We consider this as a single point failure mode that is catastrophic. So, I'd like to step through and describe what we had proposed to -- and why we proposed certain recommendations.

As this accident demonstrates, the total loss of the acme threads constitutes a catastrophic single point failure mode. To address this, the draft report contains recommendations to eliminate those

catastrophic effects of thread loss by incorporating the fail-safe mechanism or preclude single point catastrophic failure modes in any new horizontal systems, any new designs coming out. We think the regulations need to be fixed. Ensure that the certification process addresses wear-related failures so that they will not be catastrophic. There was an issue of whether this was a system or structure and where wear should be considered in the design process of this actuator.

I want to make one thing clear, that when we raised this design and certification issue by proposing these recommendations, we don't mean to minimize the importance of the maintenance and inspection failures that occurred to allow --

MEMBER GOGLIA: You sure could have fooled me by the words you used in the report.

MR. CLARK: How's that?

MEMBER GOGLIA: That's exactly why I'm pushing on this issue.

MR. CLARK: Okay.

MEMBER GOGLIA: The words that are used in the report had my blood pressure spiked because of some of the -- especially in the Conclusions where we can't rely upon the maintenance and inspection because that's

the foundation for the whole aviation system.

ACTING CHAIRMAN CARMODY: Let me just jump in for a minute. We have not covered the areas that the staff prepared on maintenance and oversight, and I think you raise valid points, but I think we ought to at least have the chance to hear the full picture before we get into this.

I wondered if we might go back to the natural order and get into John Clark's presentation a little later. Would that be agreeable? So we can cover the maintenance issues. I think we need to finish that part and then go on to this one and then we can have a full airing of everything. So, let's continue with --

MEMBER GOGLIA: Okay. I have some additional questions.

ACTING CHAIRMAN CARMODY: Okay.

MEMBER GOGLIA: Mr. Guzzetti, you mentioned one carrier had higher times of lube intervals?

MR. GUZZETTI: Yes, that's correct, Member Goglia.

MEMBER GOGLIA: And did we look at what kind of a history they had with jackscrews and replacements and --

MR. GUZZETTI: Not in-depth. They did have -- well, we cite it in the report. It's Delta Airlines

that had the highest end-play interval before the accident, of course. There were some interesting findings about that. They did have a handful of acme screws that were slightly higher wearing than some of the other airlines, but most notably, they had the highest wear on a jackscrew that we had ever seen. It was 75,000ths of an inch, and they had -- this was three or four years ago. We never got a chance to look at the screw, but it was pulled from the airplane and the records indicate it was 075 inches. So, we didn't take an in-depth look at that airline's jackscrews like we did with Alaska, however.

MEMBER GOGLIA: And you also made a comment when talking about the MRB and the FAA's role there, and you made the comment that the FAA approving. Don't they accept?

MR. GUZZETTI: That's -- in a way, you're correct. They do accept task card changes. For example, the individual -- some of the individual task card changes that extended the lube intervals were accepted by the FAA, but we're really talking about semantics here in that Alaska Airlines' entire maintenance program in which this acceptance is discussed is -- that entire maintenance program is approved by the FAA.

So, technically, in the case of the lubrication extension, the FAA did accept it. In the end-play inspection, technically, you would say approval because that did involve a C check extension, but overall, as it relates to the Maintenance Review Board or the MRB process, there really is no approval by the FAA of a specific manufacturer's recommended program.

The FAA does approve continuing airworthiness instructions, but I'm not too clear on the actual semantics of acceptance versus approval as we discussed this topic.

MEMBER GOGLIA: Okay. I wonder if you would talk a minute, one of you talk a minute about the tooling that was used by Alaska Airlines. We just talked about the new tooling that Boeing has designed.

Can you give us a little sketch on what the differences were and what the problems were between the tooling that was used to check the accident airplane and the Boeing-designed tooling and the newly-designed Boeing tooling?

MR. GUZZETTI: Certainly. We discovered that Alaska Airlines had fabricated a tool that did not meet Boeing specifications. We discovered it. It took us awhile to discover it. We noted that Alaska's -- we

requested information from Alaska regarding where they got the tool, how they fabricated it. Finally, they provided us the information the day they disclosed to the FAA that they had been using this non-compliant tool on their airplanes and they actually grounded some airplanes and redid the end-play check as a result of that.

But basically, we don't know exactly how Alaska Airlines tool was put into their system. We just know it existed there, went all the way back into the '80s, and as you can see on the monitor, it looks different. The Alaska Airlines-fabricated tool is on the left there. It's cylindrical, and -- excuse me. It's on the right. It's cylindrical and has two long turn buckles that go into it.

The Boeing tool on the left is red. It's rectangular, and it has an open area in there where you can actually see the turn buckles. The turn buckle screws themselves are much shorter than the Alaska tool. So, there's an extension issue.

We looked at the -- after the accident, when the AD came out and Alaska really needed to do a lot of end-play checks to conform to the Airworthiness Directive, they actually took the non-compliant tool and made a clone of it. They kind of reverse

engineered the improper tool and made 11 more of them and used those tools for several months. Meanwhile, the Systems Group finally found out about it and we wanted to perform an investigation on whether or not this Alaska Airlines-fabricated tool could provide a different end-play reading than the Boeing tool. So, we ran several series of laboratory tests as well as some on-wing end-play checks, and we determined that for the most part, the Alaska tool, it would always give a slightly -- in several cases, it gave us slightly lower end play, no greater than 5,000ths of an inch. But for the most part, head-to-head, it gave about the same end play as the Boeing tool.

We also put it on a force gauge and the Boeing tool provides adequate force, 3,000 pounds of pulling force to really get that jackscrew to unload and go in the opposite direction. You only need about 1,700 or 1,800 pounds to get a full end play, and the Alaska Airlines tool kind of hovered -- its force output kind of hovered around 1,700-1,800 pounds. So, it was right on the margin, but for the most part, it put out about the same reading.

We don't know the condition, Member Goglia, of the fabricated tool that was used during the '97 end-play check. We could have -- different readings

could have been attained if the tool was dry, if it wasn't properly lubricated, if it was in a different position. Did the jackscrew rotate back then in 1997? We just don't know. So, we -- our staff's belief is that we can't come up with a solid determination on whether the fabricated tool had any effect or skewed the reading on the '97 end-play check.

The Boeing tools, every one we tested, were fine, but it still involved using this torque wrench and it gave a range between 250 inch pounds and 300 inch pounds of torque that the mechanic would choose, but now, to answer the last part of your question about what Boeing is proposing, they took all the guesswork out of that. The tool has a little force gauge on it and you just torque it until the needle goes into the green and you're there. You don't have to worry about a specific torque amount. You don't have to worry about a lot of these variables.

MEMBER GOGLIA: Okay. And I have one additional question for Dr. Powell.

MR. GUZZETTI: Dr. Price.

MEMBER GOGLIA: Dr. Price. I'm sorry. I wrote it down wrong.

During your presentation, you talked at great length about the findings of the jackscrews that were

returned to overhaul facility and the numbers essentially of findings, the bench level and on-wing, comparing them on-wing.

Now, it's my experience in doing these checks that we really didn't care very much about the number and consequently, many of those tags that I filled out for other people, I just put a number down that would keep me out of trouble, essentially putting it over the 40,000ths limit, and it had really no relationship in fact. We would often change jackscrews, replace jackscrews that were close, if we had a jackscrew available, the airplane was in a tail doc, and if we had manpower. It's just a heck of a lot easier to do it at our convenience than it was to run the thing to the end and maybe have to do it in some place that's less convenient or a time when we may not have a spare jackscrew.

So, I felt as you were going through those numbers that it would skew the results considerably. Is my feeling correct?

DR. PRICE: Well, I think I can answer that in a couple of ways. First of all, not all of the jackscrews that were used in that analysis came off because they were too high. I think what you're saying is that if a mechanic noticed it was too high, higher

than 40, for instance, he might not be concerned with what the actual number was, knowing that it would be removed anyhow.

The jackscrews that were looked at in that analysis had been removed for a variety of reasons and represented a range of different end plays that were taken when they were removed. Another thing, I think, that would be important to note is that these were all removed in the year 2000 and after the accident, and I think at that time, I would suspect that after the Airworthiness Directive was issued and that mechanics knew that their results were being reported to the FAA and the importance of that, that they may have been recording them as well as possible during that period.

MEMBER GOGLIA: You mentioned other reasons for removal. What were the other reasons?

DR. PRICE: If there was pitting, for example, on the screw or if there were problems with the free play. Those are two examples. Chips and flakes. That was another reason that they might have been removed. Some of them were removed because they were out of tolerance, but there was a variety of reasons that they were removed.

MEMBER GOGLIA: Do we have a sense for how many were removed for the flaking, pitting, the wearing

materials showing up?

DR. PRICE: I believe it was just a very few that had that reason listed. If I remember correctly, it was just a handful.

MEMBER GOGLIA: Okay. Thank you. No further questions.

ACTING CHAIRMAN CARMODY: Member Black?

MEMBER BLACK: I have a couple here.

First of all, Jeff, Mr. Guzzetti, going through the -- listening to you talk about the sequence of the -- how the end-play checks and lubrication intervals were arrived at, I'm a little curious as to how those long maintenance -- those long manufacturer's intervals got in there because at the same time, I believe in the docket, in the factual, there were several All Operator Letters that went out, the first one in the '60s, then maybe one or two more in the '80s, from McDonnell-Douglas to the operators saying we're getting wear rates that are higher than we expected. We know what they were from this test that we did back during the '60s, and we believe that it's lubrication, based on some basis.

Is there a disconnect somewhere between whoever is writing those letters and whoever is giving advice to the FAA and these maintenance steering

groups?

MR. GUZZETTI: Just based on my review of the facts, I would say there very much was a disconnect. You're correct. There were three AOLs that were issued that I mentioned, '67, '84, and '91, and then when the -- in 1996, I think, when MSG-3, MRB came out for the MD-80, suddenly it went to 3,600 hours which was a five to six times jump in lube interval for the jackscrew, and I think part of the problem was, is the lube interval itself wasn't really looked at specifically by the MRB. They kind of were looking at the C check extensions as a package, and the lube happened to kind of fall nicely into a C check, and so they just -- for whatever reason, it got absorbed into that C check and turned into 3,600 flight hours.

But I would agree with you that there was plenty of literature out there spanning three decades that indicated that frequent lubrication is very much needed for the jackscrew assembly.

MEMBER BLACK: Okay. Thank you.

I'm going to take them in order that I wrote them down. Something you didn't mention on this lubrication overnight at SFO, to perform the lubrication as required in the manual. It actually requires two people at least at one point to do that,

two mechanics, does it not, because of running the jackscrew up and down?

MR. GUZZETTI: Oh, yes, sir.

MEMBER BLACK: Somebody has to be in the cockpit. There has to be power on the airplane, and --

MR. GUZZETTI: And then somebody has to be in the tail.

MEMBER BLACK: -- someone has to be in the tail talking and also there has to be a headset run out so that they can talk to each other. So, that further complicates that process and makes it take longer.

MR. GUZZETTI: That's correct.

MEMBER BLACK: I'm not criticizing that. I'm just saying that's something else that needs to be done during that interval.

MR. GUZZETTI: That's correct, and there was more than one -- I believe there was more than one mechanic working at that station that evening. So, it's certainly feasible that that happened.

And if I may just make a quick comment here about the SFO mechanic and this issue? As you made a note in our factual analysis, we certainly don't -- staff doesn't assert the fact that the procedure simply wasn't done. We just assert that the acme screw wasn't adequately lubricated, and there could be several

reasons for that.

MR. CLARK: One other key point on that last lubrication is we also, looking at the wear rates and the testing that Dr. Kolly's performed, is that that last lubrication in and of itself isn't the problem one.

MEMBER BLACK: No.

MR. CLARK: It's to -- if the grease can perform that 2,500-hour interval, it will -- we expect it to go some time beyond that 2,500-hour interval before we start getting into a problem. So, if we missed the last lubrication and/or performed it inadequately and there's not a lot of grease up and down that jackscrew, we would have had to have gone some period beyond that and then gone into an extremely high wear rate, orders of magnitude greater than anything we've ever measured to get to that failure point. So, that in and of itself, that last lubrication isn't the one that put us in a high wear rate.

MEMBER BLACK: And just another benchmark, I guess, that it ought to be fair to point out here, is that this airplane at the time, this airplane series at the time of the accident had close to a 100 million fleet hours on it and never one of these -- never

documented and apparently never had one of these catastrophic jackscrew assembly failures before. So, that means that a wide range of lubrications out in the field over the years had kept these things going and there had not been one before.

So, whatever it was, it couldn't be just a simple issue. It had to be a complex issue. Would you agree with that?

MR. CLARK: I agree.

MEMBER BLACK: Going through, we have mentioned American here a couple of times and their splendid cooperation in this investigation. Three of us at least visited Tulsa once to look at their operation. You might talk a little bit about their interval and their practices and what it led to with regard to wear rates, if you could.

MR. GUZZETTI: Certainly. American Airlines was one of the lowest interval --

MEMBER BLACK: It's also the largest operator in the world of the airplane, too.

MR. GUZZETTI: That's correct. Now that they've acquired the old TWA, they've got 400 and some DC-9 MD-80 series.

MEMBER BLACK: I think they'd be willing to sell you a few right now, too.

MR. GUZZETTI: And they were, I think, the largest operator even before they acquired TWA. But in any event, their interval was -- let me find it here -- 940 hours for lubrication and that is, you know, fairly consistent for the 600 to 900 hours that the original lube interval came when the DC-9 was rolled into service in '67 or '65.

American Airlines also, even before the accident, were tracking the end-play checks on --

MEMBER BLACK: We haven't said that before I don't believe in the meeting. When a mechanic checked one of these, they weren't required to write in the aircraft forms what they got, what the results of the check were.

MR. GUZZETTI: That is correct. It wasn't mandatory to actually write down what the end-play check was.

MEMBER BLACK: So, for instance, on the accident airplane, it had one or two previous end-play checks and we don't know what they were.

MR. GUZZETTI: That's correct.

MEMBER BLACK: Because they were not recorded nor were they required to be recorded.

MR. GUZZETTI: And that somewhat hampered our ability to really zero in on the wear rate of the

accident jackscrew, but American Airlines did, and we looked at -- they provided us the data and just an anecdotal note, you would expect a normal slope of -- if you were to plot wear versus time, the jackscrew would slowly -- would wear out as time progressed, but American had kind of a flat line. It was as if their jackscrews were not wearing at all.

MEMBER BLACK: Didn't their two oldest airplanes still have the original in them?

MR. GUZZETTI: They all -- every airplane in their entire fleet had the original jackscrew and some of those airplanes were fairly old.

MEMBER BLACK: If you followed the guidance given by the manufacturer way back in the '60s, you got a very good result and these things are $60,000 a piece.

MR. GUZZETTI: That's correct. So, you know, we found that American -- and also, I think they were one of the few airlines that, when the AD came out and they had to inspect and report any jackscrew that had any kind of shavings or an end play that was out limits, they had to report it. They reported no jackscrews out of 267 airplanes.

MEMBER BLACK: Thank you.

Let me transition one more, Madam Chairman,

to Ms. Price who's helped me two or three times on the phone trying to understand because we engineers are normally statistically challenged.

Do you think -- a lot of these numbers that you worked with were as a result of the original urgent AD for all airlines after the accident to measure, go out immediately and measure all of their airplanes, is that true?

DR. PRICE: That's correct. All of the data that I spoke about today was measured as a result of the Airworthiness Directive.

MEMBER BLACK: Okay. What makes me wonder about something is on the scatter that you got on the slide that at least is on our monitor here but is not being shown but it's the wide scatter, at Alaska Air, I noticed that some of the people who are performing end-play checks, when they were interviewed, they had only performed one or two or three in their entire career.

I'm wondering if during this race to get these things measured by the airlines so they could put their airplanes back in service, if we didn't get people doing this who had come off the 757 line or the Airbus line or somewhere who really didn't know how to do this, that might have further scattered your data. Do you think that's possible?

DR. PRICE: Well, I do think that inexperience or confusion with how to do the procedure may lead a mechanic to have a problem, yet I feel that that's important because if a mechanic -- a mechanic may never have had to do them very often in the past, and yet the decisions that they were making based on those were so of great importance.

One of the --

MEMBER BLACK: I totally agree.

DR. PRICE: However, in addition, we have made recommendations about training mechanics on this procedure, on the newly-developed procedure, and that is part of what is in the draft report.

MEMBER BLACK: Excellent. I agree with that. And just as a general comment, I would at some point and maybe later is a better time to do it like to hear a little bit more about this accept versus approve in the maintenance programs and maybe we can talk a little bit more about that when we get into findings. As the husband of a lawyer, I smell a lawyer somewhere around that, and I'm just wondering what the significance of those two words are.

Thank you very much.

ACTING CHAIRMAN CARMODY: Member Goglia had a follow-up.

MEMBER GOGLIA: Yes. Mr. Guzzetti, go back for a second to the San Francisco lubrications. It's my understanding that there was no tail doc available in San Francisco, is that correct?

MR. GUZZETTI: We don't know, Member Goglia. We tried to vet that issue as best as we could. I believe that they did have one. I'm not sure. Mr. McGill may have -- or Mr. Rodriguez may have a better perspective on whether or not there was a lift available at SFO.

MR. RODRIGUEZ: We visited the facility a year and a half after the accident or so and the lift at that time was broken, but it was our understanding that the Alaska Airlines folks borrow a lift if one is broken and they need it.

MEMBER GOGLIA: And did we make an attempt to find out? How long was the out-of-service lift truck that was there when you visited, how long was that in the station?

MR. RODRIGUEZ: How long was it out of service or how long had they owned it?

MEMBER GOGLIA: How long was it in the station? They can own it and it can be somewhere else.

MR. RODRIGUEZ: I have no idea, sir.

MEMBER GOGLIA: And did we ask who they would

borrow one from?

MR. RODRIGUEZ: I know we did. I don't recall who it was. I made no notes on it.

MEMBER GOGLIA: Okay. Thank you.

MR. RODRIGUEZ: Yes, sir.

ACTING CHAIRMAN CARMODY: Member Hammerschmidt?

MEMBER HAMMERSCHMIDT: Thank you.

Just two quick points. Following up on Member Black's insights and questions, I might mention, I thought Member Black made sort of a preeminent point when he made fleeting reference to the 100 million hours of experience on the DC-9 series fleet and how really until this tragic occurrence we're in this room talking about occurred, there was really not very good situational awareness or context for much of the hindsight that we now have.

My quick question is concerning the intervals for lubrication of these components. I'm reminded of what we have in the factual report as sort of a lead-off sentence on Page 60, and I'm not sure if Mr. Guzzetti has referenced this already in his presentations, but they're on Line 8, beginning on Line 8, we say that "Original DC-9 certification documents specified a lubrication interval for the jackscrew

assembly of 300 to 350 flight hours."

Now, how did that in the early stages of DC-9 operations get extended?

MR. GUZZETTI: We asked that question, Member Hammerschmidt, and again when you go back to the '60s, it's tough to find any kind of paper trail. However, Boeing's best estimate is that it rolled into the 600 to 900 flight hours a year later when the airplane was put into service because that was kind of their minimum convenient maintenance interval for that.

The 300 to 350 flight hours probably didn't fit conveniently into the on-airplane maintenance program that came with the DC-9 when it was rolled out of there.

MEMBER HAMMERSCHMIDT: Okay. Well, I just point that out as a point of information, that that was what the original certification documents called for.

MR. GUZZETTI: That's correct.

MEMBER HAMMERSCHMIDT: So, that's all I have.

ACTING CHAIRMAN CARMODY: All right. I think the next item is Alaska's Maintenance Program, Item 3.

Mr. Rodriguez, please.

MR. RODRIGUEZ: Yes, ma'am.

As a part of our investigation, we evaluated the Alaska Airlines Maintenance Program and, in

addition to the extension of intervals for both lubrication and inspection of the jackscrew assembly, we found other significant deficiencies in the Maintenance Program.

For example, Alaska replaced Mobilgrease 28 with Aeroshell 33 without following appropriate internal and standard industry procedures and there was no follow-up evaluation of the grease performance. Alaska used a non-conforming restraining fixture for the end-play check procedure and fabricated 11 more after the accident and did not acknowledge the discrepancy until August 2nd, 2000. The high wear rates of the three jackscrew assemblies could not be explained by contamination, surface finish, or anything other than inadequate lubrication, as Dr. Kolly pointed out.

2-0 end-play readings resulted in replacement of the jackscrew assemblies on two different aircraft at Alaska Airlines as recently as Spring 2002. Inadequate lubrication was found on rudder control tab bearings on two separate aircraft also in the Spring of 2002. One bearing fell apart when removed. One of these aircraft had been lubricated about six months earlier while the other was just short of the next scheduled lubrication. This information was not

released until issuance of a Maintenance Information Letter, dated July 19th, 2002.

The latter two items serve to underscore the need for maintenance personnel training on jackscrew assembly lubrication and inspection recommended in Recommendations A-0143 and A-0144, respectively, which were issued October 1st, 2001. Both of these recommendations are currently classified in an open unacceptable response status.

With respect to FAA oversight, we found in our investigation that FAA surveillance of Alaska's Maintenance Program in general and the Oakland facility in particular had been deficient for several years prior to the accident. The principal maintenance inspector who retired in November 1999, after eight and a half years, stated that they were too busy with administration to do any surveillance. The chief of the Seattle Certificate Management Office stated in a formal memorandum to the Director, Flight Standards Service, November 12th, 1999, that the staffing had reached a critical point. Alaska was in a state of aggressive growth and expansion and the FAA staff was not able to meet the work demands. He concluded that, "The risk of incidents or accidents at Alaska Airlines is heightened."

Following the accident, an FAA Headquarters-led team conducted a special inspection of Alaska Airlines in April 2000. Deficiencies which should have been apparent much earlier were identified in a June 2nd, 2000, press release, and they included lack of management personnel in that there was no director of maintenance. That job was shared by two people with no delineation of their duties. No director of operations and no director of safety reporting to the highest level of management. This function was actually combined with director of quality control and training.

Alaska Airlines Training Manual did not specify formal training curriculum or on-the-job training procedures or objectives. The program had no structure, no identification of subjects, and no criteria for successful completion. The General Maintenance Manual procedures were not being followed and did not include how-to procedures for heavy check planning and/or production control. Two aircraft were released to service from C check without completion of necessary paperwork, raising questions about the completion of the work and the airworthiness of the airplane being released to passenger service.

There were numerous examples of incomplete or deleted work cards. Absence of a functional continuous

analysis surveillance program led to numerous other areas suffering from lack of oversight and reform. Alaska's program was being controlled by an under-staffed quality assurance department. Audits were not being completed in a timely manner and were incomplete, so problem areas were not being identified.

As a result of this inspection, the FAA proposed the suspension of Alaska Airlines heavy maintenance authority. However, because of Alaska's efforts to work with the FAA to correct the deficiencies outlined in the inspection, no suspension was issued. The FAA accepted an action plan proposed by Alaska Airlines on June 29th, 2000, to correct all problems. In July 2001, the FAA finally prepared a briefing document on their assessment of Alaska Airlines Maintenance Program. It stated in part that Alaska Airlines "convincingly demonstrated its completion of all initiatives and commitments", and the FAA panel had reached a consensus that Alaska Airlines met or exceeded all commitments set forth in their action plan.

In light of the recent maintenance errors by Alaska maintenance personnel, that is, the inadequately-lubricated rudder control tab bearings on two separate aircraft, and the two erroneous end-play

checks,, we remain concerned about the overall adequacy of Alaska's Maintenance Program and the ability of the FAA Certificate Management Office and the Northwest Mountain Region to monitor and assess its capability.

Accordingly, the draft report contains a recommendation for the FAA to conduct a Headquarters-led in-depth on-site follow-up safety inspection to evaluate the adequacy of the corrective measures implemented in Alaska's June 2000 plan.

At this time, we are prepared to answer questions on Alaska's Maintenance Program and FAA oversight.

ACTING CHAIRMAN CARMODY: Thank you, Mr. Rodriguez.

I was struck by your comments on the lack of training, lack of training for the maintenance personnel at Alaska. Would there not have to be -- should there not have been a maintenance training program which was FAA-approved for the airline or not?

MR. RODRIGUEZ: Mr. McGill will handle that.

MR. McGILL: Typically, Madam Chairman, maintenance training for mechanics is what we call OJT or on-the-job training. Perhaps initial system training is given at various times. It's not regulated. It's not defined. It's not maintained in

any manner and that's typical of the entire industry. Training records are kept on each individual mechanic, however, and in the past, this has been the justification that the FAA has used to accept maintenance training on large aircraft.

ACTING CHAIRMAN CARMODY: Thank you, and you mentioned the two FAA recommendations that were in an unacceptable status. They had to do with training.

Could you elaborate on the FAA's response on those two, please? I'm assuming they thought it wasn't necessary. I'm just curious to know what they may have said beyond that.

MS. WEINSTEIN: They said that their current procedures were adequate and the Board has asked them to reconsider their position.

ACTING CHAIRMAN CARMODY: What was the last time we asked them to reconsider?

MS. WEINSTEIN: It was in June 14th of this year --

ACTING CHAIRMAN CARMODY: Okay.

MS. WEINSTEIN: -- in our last letter to them.

ACTING CHAIRMAN CARMODY: All right. Thank you.

Member Hammerschmidt?

MEMBER HAMMERSCHMIDT: Thank you.

As has been described, the FAA has been a prominent presence at Alaska Airlines since the time of this accident, and I know from information that I've received from Alaska Airlines that they've been increasing their internal safety audits significantly. I believe I've heard they've conducted something like 1,040 separate internal audits since the time of the accident.

When you suggest that the FAA needs to go back and take yet another look-see at Alaska Airlines maintenance, are we really basing that on just a few mistakes, let's say, that have been brought to our attention or is there a more pronounced need for that? Because for those of us that have been -- who have visited Alaska Airlines and have been briefed on the new systems that they've implemented in terms of their Safety Committee, their reporting right to the top of the organization, in various ways, it would seem that they have gone a long way to improving their internal methods for enhancing their maintenance safety.

MR. RODRIGUEZ: Mr. Hammerschmidt, the staffing at Alaska Airlines Maintenance Department has been increased in accordance with their action plan. I'm not sure what the totals are. I really wasn't able

to keep track of the comings and goings, but mechanics have been hired, I think it's somewhere in the neighborhood of a 170 additional positions, since the time of the accident. There have been a total of perhaps 340, I think, was the figure that they used total people added in the Maintenance Department. They have filled these positions that were vacant for two and a half years, and were you also interested in the FAA or just the --

MEMBER HAMMERSCHMIDT: Well, --

MR. RODRIGUEZ: -- Alaska maintenance?

MEMBER HAMMERSCHMIDT: -- FAA, too. Might as well complete the picture.

MR. RODRIGUEZ: Yes. At the time of the accident, Alaska PMI had just retired and a new PMI was in training actually when the accident occurred.

My recollection in rough figures is that there were perhaps seven to nine people assigned to that ticket, to the Certificate Management of Alaska under their Surveillance Program and that figure is now in the neighborhood of over 30. I believe we've heard figures of 32 and 34 and it seems to vary because for quite awhile there, the personnel were not stable. They were advancing and then going other places for promotions and that sort of thing which is

understandable.

MEMBER HAMMERSCHMIDT: Okay. Well, I was just trying to get more at the aspect of over-auditing an organization.

MR. CLARK: We're not interested in, I mean, trying to force an over-audit, but several things that Rod talked about are kind of the underlayment. We had several incidents that there were jackscrews being pulled off for zero end-play measurements which indicates that mechanics didn't know how to properly do the job. We had this issue on the lack of lubrication and then a general down-scaling of lubrication intervals, and I'm not sure how widespread that was at Alaska Airlines, but a number of their intervals were down-scaled, and I think the troubling thing to us is it seems that after the accident and what we found on the accident, that these types of things would keep coming up, especially in end-play measurements and especially anything doing with flight control lubrications was troubling.

And then, I think that's worrisome to us. The -- and that is -- those are very recent events, after a lot of this infrastructure has been put in place, and then, back in the time of the last audit, they had the ATOS Program in, the PTRS, and there's no

indication -- at the time of that inspection, has all that settled down, and are we back on an even keel? So, it's a worrisome thing because of the several specific things, but even at that, the FAA took more significant action on the cutting back on lubrication intervals.

MR. RODRIGUEZ: I would -- I guess I would point out, also, that the composition of the safety inspection that was done at Alaska Airlines was done by an outside source. When the final analysis, they call it the Gate 4 meeting, they were unable to meet the deadlines that were established initially and so they expanded it into several segments that they would approve as they were going along, and the final one was at Gate 4 when they met again to assess the adequacy of the Maintenance Program. That's what I quoted in here where they reached a consensus that Alaska Airlines met or exceeded all commitments.

I'm not sure what that means in the final report, but to me, it suggests that it was not unanimous, and I see a difference in that word "consensus" versus "unanimous", and we continue to get reports of problems in the maintenance area, unsolicited comments, and for that matter, undocumented largely, but it is troubling to us and it was because

of that that the staff felt that perhaps one more independent look at Alaska from the outside would be very worthwhile.

MEMBER HAMMERSCHMIDT: Okay. Thank you. That's all I have.

ACTING CHAIRMAN CARMODY: On that point, did the IG, the DOT IG, not do an investigation of Alaska Air, and could you comment on that, please?

MR. RODRIGUEZ: The answer is yes, ma'am, they did. At this point, my recollection of what all they found, I'm not sure that I ever saw the final report from the DOT IG. But there were --

ACTING CHAIRMAN CARMODY: The timing of it. Do we know when it was done? Was it after the FAA's report?

MR. RODRIGUEZ: No. It was already in process. It had been in process for a year and a half or so at the time --

ACTING CHAIRMAN CARMODY: Oh, I see.

MR. RODRIGUEZ: -- of the accident.

ACTING CHAIRMAN CARMODY: Oh, okay.

MR. RODRIGUEZ: There were significant investigations of Alaska Airlines prior to the accident for quite some time.

ACTING CHAIRMAN CARMODY: All right. Member

Goglia, any questions in this section?

MEMBER GOGLIA: I'm a little bit -- I think I understand what you're saying with the audits and you said a lot of they and they, and I'm assuming that or I get the feeling that some of that was blended.

Who did the last audit at Alaska? Do we know when the last audit was done?

MR. RODRIGUEZ: Yes, sir, we do. I don't have it on the top of my head, but it was -- the last audit was run in the Spring of 2000, after the accident. That was a safety inspection that was done, and then the follow-up of completion of those complaints that had been -- findings that had been listed, that was done and ended on July 19th, 2002.

The composition of the team, I have it in the documents here. I don't have them on the top of my head, but it was headed by -- the inspection was headed by Mr. Ed Hugg from Headquarters of the FAA and included quite a few of the staff from the Certificate Management Office and the region, and the subsequent assessment of the actions by Alaska Airlines was headed by Mr. Brad Pearson, who was the Flight Standards regional director for the Northwest Mountain Region.

MEMBER GOGLIA: You mentioned the increased staffing that has occurred there. Obviously you don't

go from -- I think you said it was seven people at the time of the accident?

MR. RODRIGUEZ: Yes, sir. It was less than 10. It was an odd number. It's either seven or nine. I'm sorry, I can't bring it accurately.

MEMBER GOGLIA: That's okay. It doesn't matter. And bringing that number up to 30+, that doesn't happen overnight. What kind of time frames are we looking at before they finally got up to their end numbers?

MR. RODRIGUEZ: We did some interviews in November of 2001. That would be roughly a year and a half after the accident. I think at that time, it was basically the Certificate Management Office had been staffed out with the exception of an analyst to analyze all of the data that would be generated by the ATOS Program.

MEMBER GOGLIA: Okay. And given --

MR. RODRIGUEZ: And there have been changes in that since -- obviously since November of 2001.

MEMBER GOGLIA: And given, you know, if they're up to snuff in manpower levels by then, by the end of 2001, and then in the middle of 2002, this audit team that's been in place for more than a year?

MR. RODRIGUEZ: Yes, sir.

MEMBER GOGLIA: Then comes to a consensus agreement that they think that progress has been made and the airline is going in the right direction, what's the value added of another high-level team going in and looking at Alaska again, given the resource issues that all of us in government have today?

Those people are going to come from somewhere. They're going to come off --

MR. RODRIGUEZ: Yes, sir.

MEMBER GOGLIA: -- somebody else's certificate.

MR. RODRIGUEZ: There are within the FAA, there are agencies and offices that are designed to do just that sort of thing, and it would simply mean that rather than inspect a given carrier, they would use those resources on Alaska, and it's a matter of priority for higher than me to make that decision, but if I was in charge, I'd look at Alaska.

MEMBER GOGLIA: Now, I'm not so sure that I would agree with that because, you know, we only have a finite number of people that know what they're doing, that understand the process, and where do you put them? I mean, after -- are we going to move people here and then have a problem pop up somewhere else that -- on another carrier that should have received an inspection

that didn't because we've diverted the resources to satisfy us?

MR. RODRIGUEZ: As a matter of fact, Mr. Goglia, we did make a recommendation, I have it here somewhere, in '96, 1996, based on the Tower Air accident up at Kennedy, that the FAA apply resources to fast-growing carriers and that they focus on that effort with the resources they do have. As a matter of fact, that recommendation is still open, unacceptable, and I believe, let me check since it's here, they want to -- and they have requested us to close it acceptable.

My position is or my point would be that Alaska was a rapidly-growing and aggressive operator. They have introduced the 737-700, the 737-900. They have the MD-80s still flying and, of course, the generic 737-200s and -400s, and while their growth increased in terms of total numbers of aircraft, they also have increased their aircraft daily utilization significantly and -- well, I've said enough. That's my position and I'll rest.

MEMBER GOGLIA: No, you won't. You'll come back, I've got another question for you.

MR. RODRIGUEZ: Okay.

MEMBER GOGLIA: All right?

(Laughter)

MEMBER GOGLIA: Let's go to the other side of it now. All right. We now have two major carriers in this country in bankruptcy. What should the FAA do about that? Substantial reductions in personnel across the board. Do they not need additional oversight as well?

MR. RODRIGUEZ: Yes, I would say they do, and --

MEMBER GOGLIA: So, should we take the inspectors off of those and send them to Alaska?

MR. RODRIGUEZ: Well, --

MEMBER GOGLIA: I mean, this is a dilemma that everybody that has to make public service management decisions on how to allocate their resources is faced with, and right now, we're faced with a very troubled industry, and how do we divert six months after the closing of a major audit, how do we justify diverting those resources back to this carrier when there are other areas that need to be looked at?

MR. RODRIGUEZ: Well, for one thing, the industry is several years down the road with respect to the implementation of ATOS. Those other carriers that you're referring to have had and I assume -- of course, I have no direct knowledge, but they have surveillance

teams and a Certificate Management Office in place at each place, and I assume that they have not rapidly expanded in the recent past, but I don't know that because I don't know which ones you're referring to.

MEMBER GOGLIA: Expansion wasn't the issue. It's the other way. You know, like this -- in a speech recently by, I think it was Norm Mineta but it may not have been, he talked about over 100,000 people from the airline industry that are now out of work as a result of events of September 11th. Many of those people have come from the maintenance and engineering community. So, I think the entire industry needs watching now.

The FAA does not have unlimited resources to do the watching, and I think that that has to be a concern of ours. I guess maybe not of staff but as the Board, that's a concern of the Board.

All right. Thank you.

ACTING CHAIRMAN CARMODY: I certainly agree with that, yes.

MR. CLARK: Madam Chairman, one thing along that line is the last inspection that really got into this area, I believe, was July of 2001 and that's a little more than a year and a half ago.

The other issue is that historically, we kind of don't get in the FAA's business about trying to

apportion how they have to conduct their business. The real fundamental question here is, if these events and issues give us an idea that there's a problem that needs to be looked at, I think we need to make it clear and get that known and then the tough decisions have to be made how to apportion that out and make the hard decisions, but if we don't make that known, it just kind of goes away when there may be a problem there lingering. So, I think if there's an issue there, we need to outline the issue, and if the Board finds that they don't believe there's an issue, then we need to clean it off the books here for that reason.

ACTING CHAIRMAN CARMODY: No, you're right. I was going to say something along those lines, except I also agree very much with Member Goglia's over-arching concern about the industry, but I do understand the staff is raising this issue because of this accident and because of the work they've done and we value that. We'll have to make our judgment as to whether that's the way to go or not, and the resource allocation issue is a huge one, not just for us but really for the FAA, and we can't solve that today, but I take your point.

Member Black, any questions?

MEMBER BLACK: Just a couple. I would submit

that I suspect that there's at least one or two people here from the FAA and they might have even got the message that way. So, the report itself, I think, will speak for itself when it's finished with regard to what we think. It's not that I disagree or agree one way or another with it, but I definitely think that I'm a great believer in on-going oversight. Let's put it that way.

Speaking of that, something that is not in the report that would add into this history of oversight at the FAA is while this -- I could not help but observe that while this airplane, the accident airplane was going through its route through the inspections and that sort of thing, it's next-to-the-last C check, wasn't there a fairly in-depth investigation going on in 1998 at the criminal level by the FAA and the FBI of maintenance irregularities at Alaska?

MR. RODRIGUEZ: Yes, sir.

MEMBER BLACK: So, that was actually going on while this airplane was still flying before the accident occurred, and they were looking at things at that point in time in-depth.

MR. RODRIGUEZ: Yes, sir. As a matter of fact, I believe it began in and about the time it was

going through the C check.

MEMBER BLACK: Okay. That's just a point that I'm not real sure what it means. I guess you would think that some of these things, you would think that that would certainly create -- certainly when the FBI was around, it would have created a high level of tension on me if I had been there, and I can't help but wonder why that didn't have some effect on this process and that's more of an observation than it is a -- I do think it might be worthy of noting that in the report somewhere because if it's in there, I didn't see it, that there was actually on-going in-depth investigatory work during this process. Is it in there, Karen? I missed it then. I'm sorry.

MR. CLARK: 175.

MEMBER BLACK: Okay. Thank you.

ACTING CHAIRMAN CARMODY: Was that it, Member Black? Okay.

Member Hammerschmidt?

MEMBER HAMMERSCHMIDT: Mr. Rodriguez made reference to the ATOS Program, and we delved into that quite a bit in the public hearing, as I can recollect. The Air Transportation Oversight System.

What role did the ATOS System play in the rendering of effective oversight leading up to this

accident experienced by Alaska Airlines?

MR. RODRIGUEZ: The folks at the Certificate Management Office in Seattle told us that it was very disruptive, that they were trying to -- first of all, they lost control of their geographic inspectors who had been working with them at other sites, and that they had no -- while they had some training, there was an awful lot of language to learn and concepts to understand, and I think the PMI who retired, as I mentioned, in '99, made the point that there had been virtually no surveillance because of that. They were too busy developing their safety attributes and elements and that sort of thing. They were doing the administrative work and nobody was out pounding the beat, so to speak.

MEMBER HAMMERSCHMIDT: Right. Because of this transitional --

MR. RODRIGUEZ: Yes, sir.

MEMBER HAMMERSCHMIDT: -- stage --

MR. RODRIGUEZ: Yes, sir.

MEMBER HAMMERSCHMIDT: -- from the PTRS System?

MR. RODRIGUEZ: Yes, sir.

MEMBER HAMMERSCHMIDT: Program Tracking and Reporting System to the ATOS System.

MR. RODRIGUEZ: And in fact, after the accident, at Alaska, in order to facilitate inspection and surveillance, they did generate a hybrid program wherein they were using the PTRS System as well as ATOS simultaneously during this period while they spooled up the staffing of the office.

MEMBER HAMMERSCHMIDT: Well, I had seen what you had included in the factual portion of the report in this regard, even quoted, I believe, what the PMI who had recently retired, actually in November '99, what he had said at the public hearing and I highlighted just a couple of sentences out of this two-thirds of a page quotation. It would be on Page 156, but the parts I've highlighted of what he had testified to was, "None of us were -- we were too caught up doing ATOS things to actually go out and do any surveillance, do the system evaluations." And then, the last sentence that we quote in this passage has the PMI stating, "Nobody was out there looking at the carrier."

So, when you mention ATOS, I just wanted to insert that bit of information that was gleaned at the public hearing.

So, that's all I had.

ACTING CHAIRMAN CARMODY: Member Goglia, you had a question about a date, I believe.

MEMBER GOGLIA: Yes. Mr. Guzzetti or maybe it's Rod, we talked about the rudder bearing failures that came to light.

MR. RODRIGUEZ: Yes.

MEMBER GOGLIA: Do we know the date that those were last lubed? They don't fall apart overnight, it takes some time.

MR. RODRIGUEZ: I don't have the specific lube, sir. The best I got was six months previous because the initial notification we got was that they had both recently been lubed almost, you know, within the week or two weeks, and we got a letter from Alaska Airlines advising us that that was inaccurate information, that the one had been six months out of the lubrication cycle and the other was due for the lubrication cycle within a month or two. That's the closest -- I mean, there was no specific dates given.

MEMBER GOGLIA: And what was the cycle? I meant, I was trying to deduce it as you were talking. It's six months out and we lube -- are they on a six-month lube cycle for that, those bearings?

MR. RODRIGUEZ: I don't know what the lube cycle is for the rudder.

MEMBER GOGLIA: Jeff is frantically trying to read something.

MR. GUZZETTI: Yes. Okay. I think it's every C check.

MEMBER GOGLIA: So, that's not six months, that's --

MR. GUZZETTI: Well, no. I take that back.

MR. RODRIGUEZ: Well, C check would be 15 months. So, it was -- the one was at 13 months, the other was six months out of the C -- it had passed the C check six months previously.

MR. GUZZETTI: It says here, Member Goglia, on April 23rd, 2002, Alaska's Reliability Program identified a concern with the rudder trim tab hinge support bearings. The wrap work concluded that the current C check lube interval adequately addressed the lube procedures. The Board recommended that the issuance of a maintenance information letter emphasizing the proper lubrication be issued, and then in September 23rd, 2002, the VP of Maintenance and Engineering directed the issue to be reopened for additional analysis. The result is Alaska submitting a wrap control board directive reducing the rudder trim tab lube interval from the current C check, which was approximately 4,350, to the Boeing MSG-2 OAMP low-end interval of 1,200 flight hours. Alaska initiated a fleetwide campaign on all of its MD-80 series airplanes

to inspect and lube the rudder. The campaign was completed on September 25th, 2002, with no additional bearing failures noted.

And then, it also indicates that prior to September 19th, 2002, the Alaska Airlines CMO, FAA CMO had no knowledge of the lube issues surrounding the rudder trim tab hinge bearing supports. Upon notification, the FAA requested all pertinent information, and their conclusion is on September 27th, 2002, the VP directed a decrease in the lube intervals to 1,200 hours and the CMO will continue to monitor and take action, if appropriate.

MEMBER GOGLIA: Okay. Thank you.

ACTING CHAIRMAN CARMODY: I think in light of the hour, why don't we take a lunch break at this point and come back at quarter of 2 and resume?

(Whereupon, at 12:43 p.m., the meeting was recessed for lunch, to reconvene this same day, Tuesday, December 10th, 2002, at 1:45 p.m.)

A F T E R N O O N S E S S I O N

1:49 p.m.

ACTING CHAIRMAN CARMODY: Where is John? I'd like to get started because we have a lot to cover this afternoon. So, please come in if you're in the back or if not, close the door. I think people are filtering in slowly.

Yes, let's resume. Mr. Rodriguez, will you -- had you completed your presentation or you had some more to go?

MR. RODRIGUEZ: I believe we were in the question and answer session.

ACTING CHAIRMAN CARMODY: No. We had finished on that, but I wasn't quite clear if you had finished all of the section on FAA Oversight or if that was still to come.

MR. RODRIGUEZ: Okay. I have -- no, I have no other prepared statements on the FAA.

ACTING CHAIRMAN CARMODY: All right.

MR. RODRIGUEZ: It's still, as I said, questions and answers --

ACTING CHAIRMAN CARMODY: Okay.

MR. RODRIGUEZ: -- on the two subjects, either subject.

ACTING CHAIRMAN CARMODY: All right. I think we have covered those then, and we're ready to go on to the next area which is Design and Certification.

MR. RODRIGUEZ: Yes, ma'am.

ACTING CHAIRMAN CARMODY: We had started that briefly earlier.

MR. RODRIGUEZ: Mr. John Clark, Director, Office of Aviation Safety, will summarize the staff considerations on issues surrounding design and certification of the MD-80 horizontal stabilizer jackscrew assembly.

ACTING CHAIRMAN CARMODY: Please go ahead.

MR. CLARK: Madam Chairman, Members.

I briefly mentioned a little earlier about the three recommendations that we drafted to deal with the design and certification issues that we see, and the first one was to eliminate the catastrophic effects of the thread loss. The second one was to address new designs coming out so that that issue isn't on the table in new designs, and the third was to assure that the wear process was addressed in either the system structure, system safety part of the design.

So, what I wanted to make clear was that when we raised this design and certification issue and we're not trying to minimize the importance of this

maintenance inspection failure that we see going on here. That's extremely important in this accident investigation. What we're trying to do is to improve safety margins by suggesting the use of some practical design alternatives that could eliminate the catastrophic effects of the acme nut wear rather than relying solely on the inspection process to prevent the excessive wear.

There's several key reasons to consider design enhancements. The wear failure of the acme nut should be recognized as a single catastrophic-type failure. That means it should fall under the design requirements that state the probability of a single point catastrophic failure should be less than 10 to the minus 9th. Conversely, that means that you should be able to fly to 10 to the 9th hours, a billion hours, without this type of failure in a particular design of airplane.

Wear was not considered a failure mode during this design as such, and we now have about 100 million hours on this particular design. To reach this 10 to the minus 9th level, we need to fly these hours by a factor of 10 more. We're at one-tenth of this so-called 10 to the minus 9th. Some staff believe that we can achieve this safe service life, this nine times

more flying hours, through the maintenance route and some of us aren't convinced of that and that's our big concern.

To put this in perspective, I believe the entire transport fleet right now has about 500 million flight hours or about a half of this 10 to the minus 9th, and we're dealing with a subset of the entire fleet right now at a 100 million hours.

When dealing with fatigue, for example, we require highly-controllable processes in engineering, manufacturing, inspection and training. These lubrication and measurement processes right now on this jackscrew arrangement are not considered highly-controllable events, and I think that's shown by Dr. Price's study. An acceptable position in the quality discipline -- the quality discipline out there kind of accepts the position that inspection is 80-percent effective at best. We don't have control over contamination of training either, and it appears that Alaska may still be struggling with their procedures and training regarding lubrication and end-play measurements.

In addition, and this is an important one, we have no direct measure of wear right now. We have an indirect measure with this jackscrew arrangement.

We're looking inside. We're wiggling the jackscrew and that we consider an indirect measure, not a direct measure, of wear.

The other issue that we have is that we consider the mechanic and maintenance operation in the United States to be first-class, but we're also dealing with a global issue. We're worried about what goes on out in the rest of the world, and there are operations out there that aren't as fortunate as us to have the kind of skilled people we have working in the maintenance operations.

Regarding wear of the acme nut, we have not seen the data that assures us this design could meet a 10 to the minus 9th type of requirement relying on improved maintenance procedures. How do we generate these numbers that show we can rely on maintenance? I'm not sure. We've noted the issues raised in Dr. Price's study. There's concern there. Further, we don't know all the potential failure modes. We're not sure what those are. We can look at this failure mode and perhaps we can address it directly, but that doesn't assure us that there aren't other mechanisms. For example, the grit and the wear that came in on the Hawaiian Airlines was kind of unknown to us. It was out of the blue. So, that was a second type.

Further, an FAA expert testified at our hearing that wear is so complex, that we cannot conduct a statistical analysis of it for system safety. Basically, if you can't put a number to that, that almost -- that comment almost singlehandedly takes this 10 to the minus 9th issue off the table. If you can't get that kind of number, you can't really rely on the 10 to the minus 9th.

We think we have two ways to go. We can either develop a better understanding of all of the risks associated with the wear and rely on maintenance intervention or another way is to add margin on top of that and remove or mitigate the problem through a design based on the assumption that the acme nut will wear to failure. Now, when you put those designs in place, we don't want -- we never want it to wear to failure. We want everything working on the maintenance and design side, but as that last back-up on this 10 to the minus 9th issue, we want that there as a safety margin.

To solve this single failure or single point failure issue, there's -- we perceive potential types of design changes out there. There's been a number of them bandied about. There can be some design changes or modifications perhaps to capture the jackscrew in

the event that the nut fails, stabilize the situation. We believe the airplane could land if the stabilizer quit working and that's happened before or possibly having some sort of active monitoring system. There's been suggestion that if we could get back there and look at a monitoring system once every flight, once every 10 flights, that would buy us that margin of safety that we really need.

For example, airplane brakes have wear pins on them that the crews can walk around and check before every flight. You can see if a brake has worn down or is wearing excessively. When that pin disappears from sight, you know it's not supposed to take off and fix the problem.

Now, the -- we recognize this is a tough issue, and here at staff level, we've had some really spirited discussions about some of the pros and cons of it, and I know the Board's equally concerned for lots of good reasons. The one thing I want to assure you is we don't want to be excessive in our recommendations, but on the other hand, we don't want to come up short either because this -- we're at this 100 million hours and it's a long, long time before we'll see that ninefold increase in our flying hours.

So, that's kind of a good overview of a lot

of our views. With all the spirited discussions, staff certainly are welcome to jump in and offer different views, if they choose, but basically I think we can try to answer any questions the Board may have.

ACTING CHAIRMAN CARMODY: Thank you, Mr. Clark. That was an intelligent discussion of the problem that's on all of our minds.

I guess from what you said, it's safe to say that you would view this design change and modification as another arrow in the quiver really of preventive things to increase the level of safety. Certainly it's not the only solution. It's a piece of a larger --

MR. CLARK: It can be that. It can be something that just simply takes that issue off the table, and we're looking for a practicable way to achieve that. We don't -- we're not looking for major redesign of the system, you know, going out and putting two jackscrews on or anything like that. Something that's simple, effective, and, you know, appropriate for just taking that edge off the risk.

ACTING CHAIRMAN CARMODY: That was going to my next question. How simple are these modifications? Do we have a sense of if they are truly simple ones? I appreciate your saying you don't want to redesign or add another jackscrew, but do we have a sense that this

is simple to do or not?

MR. CLARK: Well, since we haven't done it, it's always easy for us to sit there and declare that it's really simple. On the other hand, we have a lot of confidence that -- I mean, there's a lot of smart engineers out there that are very clever and can find effective ways to take the edge off and that's what we're -- we have confidence in.

There's been some designs about -- talking about followers on the jackscrew. The threads wear out. The followers simply engages the jackscrew, stops it where it is, and NASA has a certain number of designs like that on some of their applications. That's just an idea, but in a sense, it seems that it could be reasonably simple, reasonably effective, but again until you really get in and start trying to do the design, you never know for sure.

I would suggest that as we have gone through these types of issues in the past, it always amazes us how clever and good the engineers are to solve problems like this.

ACTING CHAIRMAN CARMODY: I may come back, but let me move on to Member Hammerschmidt. Any questions?

MEMBER HAMMERSCHMIDT: Well, first a comment.

Just yesterday actually, I was made aware of some information about what they've been doing down at the Kennedy Space Center on their jackscrews. They have several hundred that they have been trying to increase the safety of.

Is the staff thoroughly familiar with the work that's been done down there?

MR. CLARK: I would say thoroughly familiar, I'm not, or we're aware of it. We're aware of some of the design concepts. We've read the literature. We did, Jeff and -- I think Jeff and somebody else went up to Nook Industries, who's a leading manufacturer of acme screws and nuts, and received a lot of good advice from them, but we're aware of what NASA's done. We're aware of the literature and the patents, but as far as getting into the specifics of the design, no, we did not.

MEMBER HAMMERSCHMIDT: Okay. So, you wouldn't have a sense of whether or not their concept or their approach would be possibly transferrable to the DC-9 series of aircraft?

MR. CLARK: Oh, I think the concept is -- seems to fit. Now, if there are problems or issues that we're not in business of designing jackscrews that would crop up to render that unusable, I'm not aware of

it, but the design and the concept and the purpose for which they designed it is the exact same one we have here.

MEMBER HAMMERSCHMIDT: Right, right. Well, I found this information, like I say, which I only became aware of yesterday, including, just for reference, something called a Technical Support Package, fail-safe, continued to operate concept for jackscrews, NASA Tech Briefs, KSC-12187/291/92.

MR. CLARK: I received a letter yesterday from one of the family groups or -- and we appreciate that. It had been provided to us earlier and it made a lot of sense, but in the process of us going down there to try to junior engineer the process, we didn't do that.

MEMBER HAMMERSCHMIDT: Well, of course. Right. I was just thinking as I looked at this information that it would seem almost to be useful in a report such as this Alaska Airlines report, at least in some reference or footnote or something along those lines. I don't know what staff has to say on that. We make reference to it in a generic way in the concepts, like you've already described in your presentation. But it just seemed to be just highly interesting.

MR. CLARK: Well, I believe it is. It's --

we try to be a little cautious if we really haven't done as much of a goodness check as we can before we endorse some product. I think it's perfectly appropriate and perhaps, you know, we can refer to that type of activity that NASA is very active in it, and that there may be various applications to buy ourselves a little --

MEMBER HAMMERSCHMIDT: That's what I mean.

MR. CLARK: -- qualifier. Certainly not an endorsement.

MEMBER HAMMERSCHMIDT: Yeah. Okay. Mr. Guzzetti, you've been involved in this issue for many months now. What are your thoughts on this single-point failure approach?

MR. GUZZETTI: Well, first, let me state that I fully understand and respect both sides of the issue. It's certainly a tough issue, and Mr. Clark has articulated both sides pretty well.

Notwithstanding the fact that he's my boss, I would have to agree -- disagree in certain areas of some of the recommendations and a few of the analyses that have been made.

I don't think it's a simple fix. I don't know enough yet or I don't think anyone's studied that well enough yet, but my intuition tells me it's not as

simple as it sounds, putting a follow-on nut on there or, for example, the KSC document that you referred to. That mechanism, we have reviewed it, not in-depth, but that mechanism is vertically mounted, not horizontally mounted. It involves the nut moving and translating, not the jackscrew, and I'm not so sure you can just take that concept and apply it to the DC-9 MD-80.

That being said, I would think that if I knew that none of these recommendations we've made and are proposing regarding maintenance, if I knew that none of those or some of them were not going to be incorporated, then I'd be all for a modification of the jackscrew design, but I think there's a compelling case that needs to be made regarding maintenance intervention, lubrication and inspection, that if you tighten up those intervals and prove the reliability and validity of the end-play check or go with some other type of check that does involve direct measure of the jackscrew, I think it's a tough sell to burden carriers and to burden a manufacturer with what I believe could be a very, very expensive drain of resources, both in human attention, financial considerations, time involved, and perhaps those issues could be better left to concentrate on some of the other heavy hitters of what's causing accidents today,

like runway incursions and fatigue and inerting fuel tanks.

So, it's really a tough call because I think that if we're going to ask the FAA to require the manufacturer to come up with a design modification and then require that that modification be incorporated in well over a thousand airplanes flying in the U.S. and maybe another thousand worldwide, that's a fairly significant action on the scale of the 737 rudder PCU, and if you're going to base that on the Alaska Airlines accident in which we -- at least I'm fairly confident we've nailed it in terms of the fact that it's an inadequate lubrication issue, it's a maintenance issue, it's a procedural issue, interval issue, you plug the holes, then that would get at the fact that this very robust design should never wear down given those increased frequencies.

So, those are just some of the concerns that I have. I'm just not -- after being immersed in this for three years, I've really done a lot of soul searching, and I'm just not entirely comfortable with -- I have to go pick a side of the fence I'm going to sit on and I'm going to sit on the fence that is to give maintenance a chance before you alter the design.

That being said, I don't think this jackscrew

would meet a 10 to the minus 9 criteria. I agree with that. I can't argue with that. However, it's been a work horse for going on 40 years now, and the 10 to the minus 9 criteria wasn't in place back then, and I think we need to give some credit to this design that has served the airplane well, except for this one accident, in which there were some pretty clear failures of processes that occurred to get there. So, that's my take on it.

MEMBER HAMMERSCHMIDT: Okay. Well, that's a very good answer. Very complete. Of course, we're talking about not only civilian aircraft but military aircraft as well.

MR. GUZZETTI: That's correct. The Navy and the Air Force operates these airplanes.

MEMBER HAMMERSCHMIDT: Hm-hmm. And I've heard your thoughts echoed by others in our Office of Aviation Safety as well, just for reference.

Well, thank you. That's all I have for right now.

ACTING CHAIRMAN CARMODY: Member Goglia?

MEMBER GOGLIA: I have a few questions.

Mr. Clark, I'm trying to figure out which order to put these in. Let's do this. At what point as a design -- aircraft design engineer, which you were

one once, at what point does the designer have a right to rely upon the maintenance program to provide him the necessary support for his design so it can maintain its service life, design life?

MR. CLARK: Well, my prior life at the manufacturer, I really wasn't a design engineer and never got into that end of it. The issue, when should they -- where should they draw the line and say the maintenance is going to take care of everything? I think that that -- let me back up a little bit.

Jeff commented that this 10 the minus 9th issue wasn't a concept back when this airplane was designed, but it's not unfair to go back and look at it in that light and that's what we're doing. We're second-guessing a lot of people.

I think that what we try to look at is that if something is going to be catastrophic, can we buy margin or mitigate the effects, just simply make the assumption that something's going to be catastrophic and mitigate it or put the infrastructure in place where it makes it very, very difficult for that thing to occur?

The problems we have are like with high-rotating -- high-energy rotating parts out of engines. Very high energies. If the fan disk or the high-

pressure turbines on these jet engines let go, they're coming through whatever is in the way. They'll cut a wing off. They'll take the -- do serious damage, like we had up at Sioux City. We don't know of any way as a designer to contain it once it lets go. So, there's a huge amount of infrastructure in place to -- we go through the design. We go through double melts, triple melts on the titanium, very extensive inspection techniques. I know you've talked to me about what ones work out there and which ones don't.

We need that kind of infrastructure in place on something that can be catastrophic. So, where does the design come in? I would look at it as if you can size it up, if that thing -- if you assume that that failure occurs and it can be catastrophic, then we need to apply the 10 to the minus 9th. Now, is it fair to go back retroactively? I think it is in a sense. Not to criticize the design in and of itself, but what can we -- let's look at it, and if we can't get to that 10 to the minus 9th, then we can see what we can do.

Right now, to add on, retrofit, look at the design, mitigate it the best we can, and if we're not going to do that, if we can't do that, then we need to put a very extensive infrastructure in place on these critical items just to make sure, a hundred percent

sure that they're very, very carefully controlled.

What I might point out, one of the options, you know, for the amount of -- let's talk about the amount of infrastructure that it takes to keep a fan disk running, the design, maintenance, very complicated stuff, costs a lot of money. If there with an inexpensive way to contain that, you may not have to put as much attention to doing that. So, we have a balance there, also, in this particular thing with this jackscrew, is do we want to have very rigorous, very repeatable low-hour-type maintenance, 2,000, 1,000 hours, or 600 hour lubes, just repetitive, and with much more stringent training in process, or can we -- a lot of ADs that go out have -- you have to do repetitive inspections until there's some terminating action. When you take the terminating action, some sort of design change or you switch part or piece or something like that, then it takes away the burden of doing very extensive maintenance issues. So, that's a consideration, also, here.

MEMBER GOGLIA: Okay. Mr. Guzzetti, you mentioned just before lunch about American Airlines and the wear rates and their grease cycles. What did you say was their grease program?

MR. GUZZETTI: I believe they were

lubricating their jackscrews every 940 flight hours, was, I think, the second smallest, lowest interval in the industry.

MEMBER GOGLIA: And that's roughly three times the initial DC-9 interval, 300 --

MR. GUZZETTI: No, it was -- yes. On the specification.

MEMBER GOGLIA: Right.

MR. GUZZETTI: But when --

MEMBER GOGLIA: And then it went to 400 which would be double.

MR. GUZZETTI: It went to 600 to 900 when it rolled out the door, the DC-9, and these are -- and then when American started getting MD-80s, they were still lubing at the 940-hour interval, even though the MSG MRB Program escalated it up to 3,600.

MEMBER GOGLIA: Okay. And you mentioned that there was virtually no wear in their jackscrews because of that?

MR. GUZZETTI: That's correct.

MEMBER GOGLIA: All right. I guess I would go back to Mr. Clark since you're the 10th to the minus 9th guru there. If we have virtually no wear on a jackscrew because we lubricate it, would that then make the 10th to the minus 9th?

MR. CLARK: I don't think we know. The -- will it always make that? Can we go out there for that period of time and never have a maintenance failure that allows lubrication? Can we get -- we know we had a contaminant get in on the Hawaiian Air and give us a 13 time. Is that the worse contaminant we can get in there that can give us problems between these 2,000-hour maintenance cycles? Those are things that concern us and it's the thing that we don't know that we're -- that kind of keeps that open. I don't know how to answer that.

What I said earlier was that for this specific issue and this specific lubrication, would it appear that we've solved the problem by more lubrication rates? In a sense. But there's things, also, we don't know. For example, if I did miss one of those lubrications and for whatever mechanism I got into a high wear rate, what we don't know that if we relube that jackscrew or we -- will that self-heal itself and go back to a normal wear rate? Those are the kind of things we don't know.

If we want to look at how this thing got to 40,000ths, could it be that back at 10,000 hours, the lubrication was missed and we had a small section of a high wear rate and then it went away? It's the unknown

that's worrisome, and if you can just simply take the argument off the table, you don't have to worry about the unknown, but I also recognize we do rely on standard practices, but most of those don't lead us to this type of catastrophic failure and that's -- so, I think that puts this thing in a class that there are very few parts and pieces that really fall right in that area.

MEMBER GOGLIA: As I listened to you explain that, I got thinking about Aloha and the accident, and why didn't we recommend double hulls like we do on tankers?

MR. CLARK: I don't think that would be practicable. I don't -- I wouldn't know how to do that. I wouldn't know how to contain a fan disk. Those, we have to handle other ways.

MEMBER GOGLIA: And what about bi-planes? Do you think we should go back to bi-planes, so we can have redundant wings?

MR. CLARK: No.

MEMBER GOGLIA: That's what comes to mind. It's a no-win situation.

MR. CLARK: It's a tough situation.

MEMBER GOGLIA: Okay. I will pass it on to Member Black.

MEMBER BLACK: Thank you.

A couple of questions. John, you shared with me a systems safety analysis fault tree which I can't find right now, by the way.

MR. CLARK: Okay.

MEMBER BLACK: That's okay. I didn't understand it anyway. But the -- something that comes to mind and one of the things that we're talking about with Dr. Price earlier about certainties here. We're putting an awful lot of confidence in this number of 10 to the minus 9, and I often wonder what the error band is for the 10 to the minus 9. I mean, somebody selected somewhere along the line. It's my understanding from ValuJet or some other accident that we found that that was a pretty arbitrary selection when the FAA was asked to define extremely improbable, somehow they came up with 10 to the minus 9.

I'm just saying that I think we're dealing in things here that are not well-established numbers. Are we going to have 10 to the minus 9?

MR. CLARK: Ms. Schultz is our expert on that.

MEMBER BLACK: Okay.

MR. CLARK: Ms. Schultz is our expert on that 10 to the minus 9th. She has -- comes with a systems

safety background.

MEMBER BLACK: Okay.

MR. CLARK: But I'd just make one comment. There's -- we worked a number of accidents where some of those parts and pieces should have made it to 10 to the minus 9th and they don't, and, I mean, there's some, I can't recall off the top of my head, but we dealt with it in prior accidents. But for the origin of 10 to the minus 9th.

MEMBER BLACK: Okay.

MS. SCHULTZ: Good afternoon, Member Black.

Just to answer your question, it is a somewhat arbitrary number, and it's currently a number that presides in the Federal Aviation Regulations, and it's a number that's used to assess systems and their ability to comply with the safety standards during certification, and the real issue here that we were looking at was the single-point failure nature, that this nut itself could be considered a single item whose failure surely in almost every circumstances, we believe we see it, would result in a catastrophic event, and we as a group looked at current aircraft and we failed to really see many situations where one single component fails.

Member Goglia mentioned the wings and that's

a very astute difficult discussion, but even in those circumstances from my understanding, and I don't have a lot of background in structures, but that the load-bearing capability, which is the function that the wing provides, is redundant. There are dual load paths through the wing, and so it's a difficult question, how far do you go?

MEMBER BLACK: Okay. Thank you. The best explanation I've heard. I still think they guess but okay.

There's also the issue here that we haven't addressed. Thank you. There's also the issue again here that we haven't directly addressed that we worried about in the USAir 427 accident in Pittsburgh, is first do no harm. In other words, you have a system that has performed perfectly, I guess, for lack of a better word for nearly a hundred million fleet hours at the time of the accident. You don't want to mess with it and create something by some other device design to make it fail-safe which will cause another problem, and of course, that's up to the manufacturers, if we make a recommendation and the FAA chooses to implement that recommendation, but I -- what I'm saying is we're sort of in the pseudoscience here about saying very large numbers.

If we were talking about an airplane that only had a few hundred thousand fleet hours, this would be a very different discussion, but in this particular one with a very large number of airplanes in the fleet and no previous failures, it becomes a different issue, and I think that's what the board members are struggling here with and what Jeff Guzzetti is trying to say, also, and I'm inclined to agree with him, that this process is before you go changing a system which has performed well, as we did in the 737s, we want to make sure that we have some issue, and of course, in the 737s, we had three or four incidents that led us down that path, and we don't have that here, and we certainly don't want that to happen.

There are other -- are there -- John, can you think of systems in the airplane that single-failure catastrophic systems, if a maintenance technician failed a certain operation?

MR. CLARK: There's a -- I assume there's a number in the sense that anything that's going to give you loss of control on approach or it was suggested to me that, you know, losing a flap on approach, put the flaps out and somewhere close to the ground, you lose a flap, you're going to be in a very oximetric lift condition, that can happen. We talked about the --

even right now in the 737 rudder hard-over situation, that there's a certain altitude below which, if we do have a hard-over, the pressure has to come up to handle the engine thrust. If we have a hard-over in those conditions, we're still going to lose an airplane, and again those are some of the decisions that are made and evaluated at -- it's cutting the risk in the sense that we -- at least we haven't eliminated it until they possibly go to the new design with redundancy built in, but it has a -- it's at least cut it down to for every flight to the first thousand feet up and the last thousand feet getting down and getting down below some sort of controllable speed.

MEMBER BLACK: Well, I can't help but think when I was reading this for the first time, I thought about the Aloha accident, also, which is, for those who don't know what it is, it's the airplane that lost its crown skin most of the way back, a 737, in Hawaii a number of years ago, and the pilot somewhat miraculously got it on the ground with only one fatality, and I guess I would -- and I don't know what the inspections are on 737s, but I guess I'd argue that someone was supposed to look at that seam probably the last time it was inspected and they didn't catch it, and it was almost a catastrophic incident. So, that in

essence by your definition, it almost sounds like a single-point failure.

MR. CLARK: From what I know about that, in the sense that once the cracks lined up, it certainly did become a single event, unzipped the top. It wasn't catastrophic. Of course, we're dealing with one that's very potentially that case over in Taiwan right now in China Air 611 that came apart in flight and lost everybody on board.

MEMBER BLACK: And there's some maintenance management. They don't have a cause for that accident yet, but there's some suspicions of maintenance management and maintenance practices on that airplane.

MR. CLARK: Yeah. We have to defer to Dr. Young over at Taiwan right now. He's the guy that's going to make the call on what it was, --

MEMBER BLACK: I understand.

MR. CLARK: -- but we did find some maintenance -- poorly-performed maintenance 20 years ago that there were some big cracks there. Now, whether those are the right cracks that got this airplane down.

MEMBER BLACK: We don't need to get into that. I'm just saying that there -- any time anyone touches an airplane, and I used to be an aircraft

maintenance officer and I was aware of this, any time anyone touches an airplane, there's the possibility that they can do some harm, and I think what the Board is saying here and Mr. Guzzetti is saying we have a maintenance system that works the vast majority of the time. Obviously it's worked on DC-9 series before this because it hadn't before, and I don't know whether I'm ready to abandon that system yet.

MR. CLARK: No, I don't think -- we're in no way, shape or form abandoning that system at all. That's not the case at all. When we have a demonstrated issue and this catastrophic loss, if we can do something reasonable and take that issue away and buy some margins for the mechanics, we want to do that.

I'll point out that we try to buy margin for the pilots. You know, many places that we put margins in every time to try to mitigate and cut the risk. We do it. The engineers try to do it in all of the designs they work on, and there's no reason not to try to buy margins when we can in a reasonable manner on these airplane designs to buy margins for mechanics making errors, and so that's -- I mean, that's the whole concept behind all this. It shouldn't be -- it turns out to be a killer operation, hugely expensive,

extremely complicated, then I don't -- I think money's better spent trying to take care of it on the maintenance side.

MEMBER BLACK: This might be the logical place to interpose the question about what about jackscrew or stab trim control assemblies on other types of airplanes?

MR. CLARK: Okay. What Member Black's referring to, other airplanes have different arrangements. Probably the most prominent out there are the -- it's called the ball screw arrangement. It looks -- the shaft looks kind of like a jackscrew and instead of having -- engaging threads from a nut, there's a series of balls that cycle around and create kind of a set of nut threads only using recirculating balls, and Mr. Guzzetti had done an extensive amount of work on that. We have a lot of concern about that, and in the process of trying to put the report together, I talked him into putting that in abeyance until we got the report together and then if we had time go back and more fully develop -- we had a number of questions about the issue of ball screws and where we were at and potential failure modes and things we didn't know, and in the process, it absorbed all of his time and even though he and I are kind of on opposite sides of the

fence, we still respect him very much and in fact, we promoted him to be Deputy Director for our Regional Operations.

So, I think that's a testament to what we think of his opinions. So, I don't want to be shooting myself in the foot bragging on him right now, but the --

MEMBER BLACK: You're making his case.

MR. CLARK: I know it. I know it. But that -- but we try to be very fair about what the issues are out on the table, but the -- we had decided to put that in abeyance and what we anticipated -- you know, get this report done and out and almost immediately, and we were looking at within two-three-four weeks trying to bring that second recommendation to the Board about how we really wanted to deal with those other actuating mechanisms on transport category airplanes because there are many out there that have similar features that have the potential to get into single-point failure modes. A lot of them have dual-load path structure like this thing did, but we really haven't addressed the loss of threads or the loss of the balls out of the actuator. So, that's coming, but I also -- Member Black's been very active out there doing a lot of that research that we would like to have been

working on while we were moving this report forward.

So, we're doing right now, Mr. Guzzetti had a fairly comprehensive factual analysis and a recommendation, and it was right on the edge of incorporating and we believe there is an issue out there for the rest of the fleet.

MEMBER BLACK: Well, ever how we choose to do with it, I just think we're centering on one airplane because it had -- one type of airplane because it had the accident, but we certainly don't want to overlook others and ever how we choose to get our recommendation, perhaps some sort of a recommendation that this just be a general consideration, somewhat like we did in 427, is look at this, look at this issue in the fleet, all of the fleets, and if there's a problem with it, we need to do something about it.

MR. CLARK: Yeah. We talked to staff about that. You know, we can do the more extensive work and hand that off to the FAA or I think in a sense, Jeff has really outlined the issue for other airplanes. That could be incorporated into this report, and then our Systems people would have to assign a person to kind of keep track of that to make sure we keep on the focus over at FAA and so either way, we're prepared to go either way, whatever the Board chooses.

ACTING CHAIRMAN CARMODY: Member Goglia?

MEMBER GOGLIA: You know, I've seen a list, and I think George, you may have a copy of it, on these jackscrews, and it's the ones that use the acme nut, not necessarily the reciprocating ball. It's extensive, including some of the most recently-designed airplanes, which there are virtually hundreds and hundreds on order and that's the regional jets. It is -- I think that we're -- we need to address the entire issue, the entire fleet, everywhere in our recommendations. We keep saying DC-9 MD-80s, 717, but, you know, the regional jets, I think there's something like 7 or 800 of them on order, and when you look at the jackscrew that's used on them, it looks like somebody put it in -- took the drawings, put it in the xerox machine and said reduce it by 50 percent and printed it.

MR. CLARK: Oh, yeah. Yes. I fully agree with you.

MEMBER GOGLIA: It's extensive. Extensive. Now, I have a couple more questions.

MR. CLARK: Your microphone, Member Black.

MEMBER BLACK: I've received information from two regional jet manufacturers that were kind enough to send it to me just recently and I haven't had a chance

to analyze it, but it is -- they're selling rapidly, and we need to find out if there is an issue here, it needs to be addressed because it's a very active issue, and as you can see from the list, there are everywhere from 707s and DC-8s all the way up through the RJs that have some sort of an assembly similar to this.

Thank you. I'm sorry, John.

MEMBER GOGLIA: John, let's talk a minute about the dual path, the single-point failure, and just a minute ago, our Systems Analysis person here mentioned the nut is a single failure in this design.

How do you feel about the screw and the fact that it has the torque tube on the inside which gives us an alternate path?

MR. CLARK: Well, I think that was clearly meant to be a dual structural load path, and for everything we know about it, it does fulfill that on the screw side. Yeah.

MEMBER GOGLIA: And would you agree with the assessment that the nut in this particular installation is 300-percent overload? It's robust enough?

MR. CLARK: Strength-wise? The threads are in place?

MEMBER GOGLIA: Yeah.

MR. CLARK: I think it's even much more than

that. I think it's -- I think you can wear it to the replacement limit 10 times. Strength-wise, if the threads are in place, it's much, much more than that. In fact, I'd point out that you saw the remnant and much of that remnant had been pushed out of the way and we were down to the last 100th of an inch of that remaining thread and that was sufficient to operate and maintain strength with the thinness of that thread element still reasonably in place. So, structurally, it's the thread. The brass nut first meets any standard we could dream up. Yeah.

MEMBER GOGLIA: I asked and had a jackscrew nut cut to give us a dual path, and it's not sound engineering. I actually have it here. I don't know if I want to bring it out, but with a hacksaw, with a simple hacksaw, I can make that one nut into two nuts and provide us with the redundancy that you're talking about.

MR. CLARK: Works for me. The -- what you want to -- the object there is, for -- there's a dual concentric path and what that means is you have one spiral of threads and then a second one that's interleaved within that. So, in theory, from the structural side, you could break off one set of threads and you would have the other thread, even though

they're interwoven.

What defeated this design was the wear, that you really can't wear out one set of threads without wearing out the other set. So, wear is the problem that got us to the issue. So, structurally, the threads in the dual concentric make sense. From wear standpoint, that was the failure point.

MEMBER GOGLIA: Just by cutting the nut in half on an angle, it satisfies the verbiage of the FAR.

MR. CLARK: Yeah. The issue right there, John, is if you can wear out one side without wearing out the other and that's the concern. I don't know that that would do that in that case.

MEMBER GOGLIA: But that's not in the certification requirement.

MR. CLARK: No, it isn't, but what we do -- we certainly don't limit ourselves to what the FAA rules were in place then or even what is in place now. What we want to do is make sure we solve the problem.

MEMBER GOGLIA: Okay. I have one question, and it goes back to Jeff, and I think it's going to end up over at -- how quick we forget. No, not Ron Battocchi. You can rest at ease.

The training for the mechanics back in '97 when they did the end-play check and Mr. Leontine is

the one who wrote it up at 40,000ths, did we get the training records and experience level of Leontine and the others who subsequently said that this -- redid the wear check and said it was

MR. CLARK: I did not, but Mr. McGill would probably be better to answer that question. He's the one that checked into some of that.

MR. McGILL: We looked at all the training records. I had probably 50 of them sent to my office, but as you know, training in a 121 environment because of the lack of definement that is such as flight attendants, dispatchers, pilots, so forth, it doesn't really tell you a lot. It just says, yes, they were given some courses here and they would document them whenever they got them. Mr. Leontine had courses documented that he had took, given by Alaska Airlines, so did many other mechanics that we looked at, but there is no structure to that and that's just -- that's in the industry itself, not specifically Alaska Airlines. They were kind of following suit.

So, what you can get from this is they went to some four hours or eight hours and did some sort of training. I don't know what happened because it's not recorded properly. So, we can never determine exactly the degree of sophistication nor can we figure out or

articulate in any manner what the training accomplished on these individual mechanics.

MEMBER GOGLIA: Okay. Thank you. I have no further questions.

ACTING CHAIRMAN CARMODY: All right. I think we're finished with this section then, and we can move on to Flight Crew Decisionmaking.

MR. IVEY: Good afternoon, Madam Chairman, Members of the Board.

I have a very brief presentation highlighting the findings in the staff report concerning flight crew decisionmaking. The Operations Group spent a great deal of time evaluating the flight crew's actions and their decisionmaking on the accident flight.

The report concludes that the crew's decision not to return to Puerto Vallarta immediately after recognizing the trim system malfunction was understandable. The decision to divert to Los Angeles rather than continue to San Francisco as originally planned was prudent and appropriate. The use of the autopilot when the horizontal stabilizer was jammed was not appropriate. The captain should have kept the slats and flaps extended when the airplane was found to be controllable in that configuration after the initial dive. His retraction of the flaps and slats was not

appropriate.

The report also includes a recommendation for clearer guidance to flight crews who encounter flight control system failures. In particular, we believe that they should complete only checklist procedures and if not effective land at nearest suitable airports. Pilots should not attempt any additional corrective actions.

This concludes my brief presentation.

ACTING CHAIRMAN CARMODY: Thank you, Captain Ivey.

Any questions? Member Hammerschmidt?

MEMBER HAMMERSCHMIDT: Could someone go into the communications between the flight crew and the Dispatch and maintenance people on the ground that were -- that took place and whether or not the flight crew was being helped by their ground support during the flight?

MR. IVEY: Actually, the beginning of attempted communications started over Mexico as the flight was proceeding towards the border with the United States. There are repeater stations down there in which it's like a dial telephone, if you will, in which they're able to dial in for assistance, and the Operations Group interviewed the flight crew who was

paralleling the accident flight and actually reported that they had heard a couple of attempts to dial up, but that was not successful.

Once they reached the area of Tijuana, Mexico, the accident crew did contact Maintenance Control in Seattle and also the Los Angeles Operations was listening on the conversation. So, the three were actually on the same line at that point.

When the attempt was made to contact Maintenance Control in Seattle, we were able to get a written log more or less of the conversation. However, as you know, the cockpit voice recorder began in the middle of that conversation when the flight crew was talking to Maintenance Control in Seattle.

I don't know if there's any specifics that you're interested in regarding that conversation I may be able to answer.

MEMBER HAMMERSCHMIDT: Well, I was just wondering if the ground support should have given the flight crew just better information in terms of getting the plane on the ground rather than suggesting all these optional things to look for in the cockpit.

MR. IVEY: I think the flight crew believed that they had a jammed stabilizer. Obviously they had been hand-flying the airplane and quite well at 31,000

feet for the duration of the flight from when the trim actually ceased operation. But the crew had no way of knowing what had transpired in the back of the airplane. Similarly, when talking to Maintenance Control, they, too, would have had no idea of the nature of the problem that the crew was experiencing, other than to establish a dialogue to try to understand and through the limits of their knowledge offer suggestions.

In the case of the mechanic who was also monitoring the conversation in the Los Angeles Maintenance Facility, he was trying to volunteer his help as well, but I don't think anyone, anyone on the ground or in the air, really understood the nature of the problem.

MEMBER HAMMERSCHMIDT: Thank you. That's all I have.

ACTING CHAIRMAN CARMODY: Member Goglia?

MEMBER GOGLIA: Yes, I have a few questions.

I agree with you, Mr. Ivey. I don't think anybody knew. This airplane after the first event was clearly flying in uncharted territory, and having said that, I'm still very troubled by the role of Dispatch and Maintenance Control in Seattle, you know, and as you were talking, I recalled one or two sentences in

the -- it's actually in the report, where the captain asked for the numbers for Los Angeles because of his intention to return to -- to divert to Los Angeles, and the dispatcher gives him the numbers for San Francisco. Now, there's no doubt in my mind, having been on the one end of those microphones more than once, that that's pressure being put on the captain to take the airplane to its original landing site and this guy, this crew finds themselves in a very difficult situation and at least part of the time when they're on the radio asking for help essentially from others in the organization, it wasn't there. It was adding to the problem and not adding to the solution, and I'm really bothered by the fact, and I was going to raise this a little further one, that we really need to have recommendations in this report that deal with that and how the flight crews interface with Maintenance Control.

I know from my experience in the industry, that the FAA has struggled with this as well, and it's about time that we brought this out into the open and started to address it.

MR. IVEY: I certainly agree that there was not a lot of assistance provided and to cite two examples, Number 1, when the flight crew asked to talk

to an instructor, someone up on the second floor of the building, that was never acknowledged nor was that request fulfilled. Similarly, that Maintenance Control actually passed off the idea of helping the crew obtain the center of gravity and the information needed for landing and passed that off to -- asked L.A. to calculate these numbers for them, and in fact, the L.A. Operations agent on duty at the time actually was unable to do so, even though they had had that training early on as working in Operations.

So, that was not the assistance that they could have used. I totally agree.

MEMBER GOGLIA: Okay. I'm going to make a request that we modify this as a motion at one point. Do you want -- Madam Chairman, do you want to do that now or you want to wait until --

ACTING CHAIRMAN CARMODY: What is it you're referring to? The recommendations? Because we haven't gotten --

MEMBER GOGLIA: Yes. I want to add an additional recommendation which I do not have language for.

ACTING CHAIRMAN CARMODY: Well, I think we'd have to see the language before we consider it.

MEMBER GOGLIA: Well, I have another way of

dealing with it.

ACTING CHAIRMAN CARMODY: Well, you may want to at the break circulate the language and then we can talk about it with the recommendations.

MEMBER GOGLIA: Well, we may at the break ask staff to prepare something and present it to us.

ACTING CHAIRMAN CARMODY: Does staff know what you want because I don't?

MEMBER GOGLIA: We'll talk about it.

ACTING CHAIRMAN CARMODY: We can talk.

MEMBER GOGLIA: We'll try to --

MS. WEINSTEIN: Chairman Carmody, what we can do from safety recommendations is go and do a run on prior recommendations on dispatch and that might help Member Goglia with some language. We'll do that now.

ACTING CHAIRMAN CARMODY: Okay. That's a good idea.

All right. Are you through with questions for now?

MEMBER GOGLIA: Yes.

ACTING CHAIRMAN CARMODY: Member Black?

MEMBER BLACK: Thank you.

Dave, could we have up the slide again where you list the conclusions? Could you put all of them up? This is so fuzzy on my screen, that even with my

glasses, I have trouble with it.

I certainly agree with the first two, and I have some -- really, the third one, also, and I tried to find in my records a copy of the checklist. I'm sure you know what I'm talking about, but there actually is a checklist item that you run for a stab problem or a jam that has a line in it that says do not engage the autopilot, is that not --

MR. IVEY: That's correct. In fact, if you'll look into the staff report behind Page 151, that is the stabilizer inoperative procedure.

MEMBER BLACK: Okay. I read that one and knew that one. The difficulty that we were talking about a minute ago about this incident and with the crew's response to it, I do have some difficulty with the retraction of the flaps and slats, and I guess one of the fortunate or maybe unfortunate things is one of the things a board member does is get to listen to the actual taperecordings and it's often quite distressing to do this.

But there isn't any guidance about what happened basically after the first event. They were on their own. Would you agree with that?

MR. IVEY: I think the guidance after the first event changed significantly because the only two

procedures that are in the Quick Reference Handbook, the QRH as it's called, related to stabilizer is a run-away stabilizer and the stabilizer inoperative. In both those cases, prior to the first dive, these are abnormal procedures.

I as a pilot, if I'd taken a 7,000-foot dive without the ability to get this airplane back to a stable and level position, I've now gone from an abnormal situation --

MEMBER BLACK: Sure.

MR. IVEY: -- into an emergency situation.

MEMBER BLACK: Emergency, yes. Absolutely. And there are lots of others that agree with you on that.

I just feel like and what John was saying a minute ago, sort of summed up, is this has never happened before. There's no documentation that this has ever occurred before, and the pilots gave some indication of understanding vaguely what was back in the tail of the airplane, but they didn't -- they probably couldn't have drawn a picture of it to be very accurate, and I for one think that to have the fourth finding there is -- I suspect that if they had a chance to do it over again, they would agree with that position, but given the situation they were in at that

time, they had no prior guidance and so we can -- I don't expect you to agree or disagree with that. I just -- I have some difficulty with that one.

I also have some comments on what John said. I think that it is especially distressing to find that pilots had asked for some help from Training and I can't help but wonder if some people, some instructor pilots had come down to talk, that they might have changed some of the actions that occurred before the first event, but we'll never know the answer to that because that didn't occur.

There also was another bit that John talked about that distressed me, is that clearly the dispatcher to me from listening to the part of the recording that we have was very interested in having the crew go to San Francisco. There was some discussion of flow control or air traffic control procedures that might be restrictive. There was some discussion about immigration and naturalization because they had people -- it was an international flight, and all of this seemed inappropriate to me to be talking about with an airplane that has mechanical problem with 88 souls on board is somewhat distressing to me, and I don't know whether there's some kind of a recommendation or something.

It would seem to me that this -- even though they hadn't declared an emergency at that point, that they certainly deserved expedited handling and certainly deserved all the help that could be provided to them and hopefully we learned something from that.

Thank you, Madam Chairman.

ACTING CHAIRMAN CARMODY: Anything else on this section?

(No response)

ACTING CHAIRMAN CARMODY: Thank you, Captain Ivey.

Then we can go on to the last --

MEMBER BLACK: Madam Chairman?

ACTING CHAIRMAN CARMODY: Yes?

MEMBER BLACK: Let me add one more thing, too. Something that might have gone unnoticed here when I was reading the transcript again. This crew kept this airplane out over the water. We don't know what would have happened had they turned, had they not -- had they kept the flaps out and turned immediately for LAX. There are varying opinions on whether the airplane would have been able to maneuver successfully to the -- to LAX and land. It could very well be there's some people in Burbank who owe their lives to these two guys and I don't know whether that's been

appreciated by people enough or not, but I think it should be.

ACTING CHAIRMAN CARMODY: All right. Mr. Guzzetti?

MR. GUZZETTI: Thank you, Madam Chairman.

This is -- this presentation is actually very brief. I don't even have any slides, other than the cover slide, and it addresses the issue involving jackscrew assembly overhaul procedures.

Although the accident jackscrew assembly was never overhauled, the Systems Group investigation evaluated overhaul procedures and practices and identified several deficiencies in the DC-9 Overhaul Maintenance Manual and the practices of several maintenance facilities that were visited during the course of this investigation.

The most significant of these findings was that there is currently no requirement for overhaul facilities to record or inform customers of the end-play measurement of the assemblies that are being returned to the airlines after they've been overhauled. Because overhaul does not necessarily involve restoring the end play to manufacturing specifications, the absence of such a requirement could result in an airline unknowingly returning an assembly to service

with a higher-than-expected end-play measurement.

There's several other issues related to overhauls, but that's the most significant. The draft report includes several recommendations to address these issues as well as other shortcomings in the overhaul process.

That's it. That concludes my presentation.

ACTING CHAIRMAN CARMODY: All right. Thank you.

Member Hammerschmidt, any questions?

MEMBER HAMMERSCHMIDT: No questions.

ACTING CHAIRMAN CARMODY: Member Goglia?

MEMBER GOGLIA: Mr. Guzzetti, I share your concerns on the overhaul, so-called overhaul facilities, other than the manufacturer's facility, which I found to be on multiple visits truly a first-class operation.

I'm concerned because of the -- with the others that do the work because of the data that's available or lack of data. You know, Boeing calls this design proprietary, and the repair information that's available to facilities to accomplish these tasks is not very robust, and this is not the only place that -- I'll have to turn it off. The only that that -- that we have that. We have it in other areas of other

airplanes, and I'm surprised that we didn't have any verbiage in the report to address that. There is a little bit, but I'm surprised that we didn't have more on point, and can you enlighten me why?

MR. GUZZETTI: Yes, Member Goglia. I think it's simply because the Systems Group at the request of the investigator-in-charge was out chasing jackscrews all over the place. We must have visited over two dozen cities in a two-year time span, and we could only go so far in depth into the overhaul process, and so what we decided to do in terms of prioritizing and triaging our efforts, we decided to just really solely focus on the jackscrew assembly. That was it. We didn't want to start to get into more global issues related to overhaul facilities which I'm sure there are plenty of global issues out there.

Several of the overhaul facilities that we visited gave us an earful about some of the issues that you've addressed. So, in the context of this particular investigation, we really just focused our efforts on the jackscrew assembly and the essence of utilizing our resources as best as we could.

That being said, you mentioned lack of data and the data not being robust. I would certainly agree with you. In fact, again as it only relates to the

jackscrew, the staff feels that the DC-9 Overhaul Manual instructions for the jackscrew assembly are lacking, is the best word I guess I could -- is a kind word I could use for it, and I've documented that to great detail in my factual group chairman's report and we've highlighted some of that in the draft factual that you have before you. But we just didn't have the resources to tackle the global issues.

MEMBER GOGLIA: Well, Mr. Clark, can I interrupt your reading there for a second? Just earlier, you made -- you talked about what we should do, what we can do.

MR. CLARK: Right.

MEMBER GOGLIA: All right. And since long before I came to the Board and after I've come to the Board, I have felt that we don't do what we should do in the maintenance arena, and this report just continues my feelings in that area.

MR. CLARK: What's that?

MEMBER GOGLIA: Well, here's an example of manual instructions, instructions for continued airworthiness, the keystone of the operation, safe operation of airplanes, and they're lacking, and we do identify it in the text of the report. We don't identify it in any of the conclusions, and we have no

recommendation. Why not?

MR. CLARK: I don't know.

MEMBER GOGLIA: Well, I guess you can say I don't know, but, you know, that's your job. You're supposed to know. So, we'll deal with that as we go on further with the report, but that's just a concern, and it goes on and on and on. We need to start dealing with this stuff.

MR. CLARK: You commented about the specific issue of maintenance, but I think trying to put the control, I think we do have recommendations that do try to deal with the control and get the proper -- not necessarily the documentation but to try to get proper control of these critical parts.

MEMBER GOGLIA: But we don't get proper control of the people who are dealing with them, and we haven't made recommendations to it. Mr. McGill testified or commented moments ago about the training. Where's the training recommendation? Where's the qualifications for the people? It's missing.

MR. CLARK: Yeah.

MEMBER GOGLIA: It's missing.

MR. CLARK: I believe we do have recommendations specifically to this issue, to properly train the mechanics to deal with this critical safety

item. We put those out before, and we have others, also.

ACTING CHAIRMAN CARMODY: We made them to the FAA and they've not acted on them yet, the ones we made last year.

MEMBER GOGLIA: No further questions.

ACTING CHAIRMAN CARMODY: Member Black, any questions?

MEMBER BLACK: I, too, am somewhat distressed to find the -- it might even be a tribute to the jackscrew assembly that it could survive that process and we not have had other accidents because some of the things that are described in Jeff's factual and the addendums are very frightening and these things get -- a jackscrew could actually get back to the audience, a jackscrew could actually get back on an airplane with, let's say, a 038 wear level and there would be no notification to the airline. Unless they measured it, they wouldn't know that it was very nearly worn out because there was no requirement for it. So, it's just atrocious, some of the things that could have happened and probably did happen and somehow they survived it.

ACTING CHAIRMAN CARMODY: Is that it, Member Black?

MEMBER BLACK: Yes, ma'am.

ACTING CHAIRMAN CARMODY: Okay. Member Hammerschmidt, anything from you?

MEMBER HAMMERSCHMIDT: No.

ACTING CHAIRMAN CARMODY: I propose we take a 15-minute break and come back and we'll start on the Conclusions then.

Thank you.

(Whereupon, a recess was taken.)

ACTING CHAIRMAN CARMODY: All right. Let's resume.

Mr. Clark, I believe you had something else you wanted to add.

MR. CLARK: Just a little bit. With the conversation going on between the members and Captain Ivey, this -- we have this Finding Number 17 that -- where we -- and it goes with the last bullet on Captain Ivey's presentation, where we talk about this crew should not have retracted the flaps and slats after they had extended it.

In one sense, we fully recognize this is 20/20 hindsight and that they were in uncharted territory, but what we were after with that is not to criticize the crew in this situation but to try to take a lessons learned into the -- out into the future, and in a number of accidents and incidents, we've seen that

the crew end up doing things that either cost more time or take them further away from a good landing condition.

Let me just step through a couple here, if I may. In this case, this crew had just gone through a very serious upset and they were in a very critical emergency-type situation, and as they needed to get headed for the airport and they were doing that, and part of the thing you have to do is you have to start getting the airplane configured, getting it slowed down and still keep progressing towards the airport, and some of the, I guess, adages in aviation, you know, if you do something that isn't working, undo it fast, but -- or go back to the last thing that was working for you, but in this case, they had to progress toward some sort of landing configuration or that was not unreasonable to do so. So, the fact that the slats got extended and we started getting slowed down is perfectly reasonable.

It's not clear to us that there was any reason to retract the flaps and slats, but we weren't there. The captain was. So, he made his decision for whatever reason he chose to. But if there's not a good reason for the crew, keep what you've got and keep that progression going to get that airplane safely down on

the end of the runway. So, that was the intent out of this, to go after a lessons learned in the future, not to take an unfair hit because we weren't in that cockpit to know what this guy was doing or why he did what he did. So.

ACTING CHAIRMAN CARMODY: No, I understand. I think that's --

MR. CLARK: Part of that stemmed out of the thing like on the ValuJet where there was a fire on board and we didn't make recommendations in that, but there's a lot of discussions at staff level that the crew took several minutes and then took a radar vector kind of still going outbound and there was a lot of discussion on that one to try to get people thinking about making the turn, get headed -- get to the airport, get to safe haven, as fast as you can, regardless of what air traffic's telling you or whatever.

ACTING CHAIRMAN CARMODY: Hm-hmm.

MR. CLARK: We saw elements of that in the Swiss Air 111, and I don't want to comment too much because the Canadians are still having issues with their report. But we also saw a positive benefit not too long ago. We had a maintenance issue on an AirTran airplane, had a heck of a fire cooking on board, and

that crew beat heat to the airport just as fast as they could, and had they not done that, we fully expect we could have lost another airplane due to a fire on board.

So, that's the purpose of this, is go after the lessons learned.

ACTING CHAIRMAN CARMODY: Yeah. No, I understand. Thank you. Excuse me one second.

(Discussion off the record.)

ACTING CHAIRMAN CARMODY: All right. I think what we'll do now is proceed with reading the Conclusions. There are quite a few of them, and I think there are going to be some changes as I go along. So, why don't I start and -- one at a time. There may be many that don't need changing, but I think there will be some that will. So, let me begin with the Findings.

Number 1. The flight crew on Alaska Airlines Flight 261 were properly certificated and qualified and had received the training and off-duty time prescribed by the Federal Air Regulations. No evidence indicated any pre-existing medical or other condition that might have adversely affected the flight crew's performance during the accident flight.

2. The airplane was dispatched in accordance

with FAA regulations and approved Alaska Air procedures. The weight and balance of the airplane were in limits for dispatch, take-off, climb, and cruise.

3. Weather was not a factor in the accident.

4. There was no evidence of a fire or an impact with birds or any other foreign object.

5. No evidence indicated that the airplane experienced any pre-impact structural or system failures, other than those associated with the longitudinal trim control system, the horizontal stabilizer and its surrounding structure.

6. Both engines were operating normally before the final dive.

7. Air Traffic Control personnel involved with the accident flight were properly certificated and qualified for their assigned duty stations.

8. The longitudinal trim control system on the accident airplane was functioning normally during the initial phase of the accident flight.

9. The horizontal stabilizer stopped responding to autopilot and pilot commands after the airplane passed through 23,400 feet. The pilots recognized that the longitudinal trim control system was jammed, but neither they nor the Alaska Airlines

maintenance personnel could determine the cause of the jam.

10. The worn threads inside the horizontal stabilizer acme nut were incrementally sheared off by the acme screw and were completely sheared off during the accident flight. As the airplane passed through 23,400 feet, the acme screw and nut jammed, preventing further movement of the horizontal stabilizer until the initial dive.

11. The accident airplane's initial dive from 31,050 feet began when the jam between the acme screw and nut was overcome as a result of operation of the primary trim motor. Release of the jam allowed the acme screw to pull up through the acme nut, causing the horizontal stabilizer leading edge to move upward, thus causing the airplane to pitch rapidly downward.

12. The acme screw did not completely separate from the acme nut during the initial dive because the screw's lower mechanical stop was restrained by the lower surface of the acme nut until just before the second and final dive about 10 minutes later.

13. The cause of the final dive was the low-cycle fatigue failure of the torque tube, followed by the failure of the vertical stabilizer tip fairing

brackets which allowed the horizontal stabilizer leading edge to move upwards significantly beyond what is permitted by a normally-operating jackscrew assembly.

The resulting upward movement of the horizontal stabilizer leading edge created an excessive upward aerodynamic tail load which caused an uncontrollable downward pitching of the airplane from which recovery was not possible.

14. In light of the absence of a checklist requirement to land as soon as possible and the circumstances confronting the flight crew, the flight crew's decision not to return to Lic Gustavo Diaz Ordaz International Airport, Puerto Vallarta, immediately after recognizing the horizontal stabilizer trim system malfunction was understandable.

15. The flight crew's decision to divert the flight to Los Angeles International Airport, Los Angeles, California, rather than continuing to San Francisco as originally planned, was prudent and appropriate.

16. The flight crew's use of the autopilot while the horizontal stabilizer was jammed was not appropriate.

Member Goglia?

MEMBER GOGLIA: Captain Ivey or Mr. Rodriguez, on this recommendation, do we have any indication that possibly the flight crew may have switched off the stabilizer system, pulled the circuit breakers, or --

MR. IVEY: With regard to the stabilizer inoperative system, --

MEMBER GOGLIA: Right.

MR. IVEY: -- there is a reset allowed for the circuit breakers if tripped, and under general circuit breaker procedures, you're allowed a reset once of a circuit breaker. If it popped again, of course, then you would leave it to pop. You wouldn't reset it.

MEMBER GOGLIA: Isn't there a trim switch shut-off?

MR. IVEY: There is. The system -- it depends on whether you've got a run-away stabilizer. In that case, there's a red guarded switch that would stop the high-speed trim from operation and that's a switch down by the pilot, the captain's right-hand side, and then that stops high-speed trim. Then you assess the situation in the case of run-away.

In the case of the stabilizer inoperative, there are circuit breakers that are also mentioned that you can check to see if that could be part of the

problem.

MEMBER GOGLIA: But in an effort to lighten their load, could they not pull the circuit breakers to remove electrical power from the motors and then engage the autopilot to fly?

MR. IVEY: No, not by procedure, because the autopilot uses the low-speed trim system as part of its controls. So, you would be, as they were, you'd be masking the situation by engaging the autopilot because it would not be using low-speed trim to trim out any undue loads that the autopilot would be experiencing, and in the case where the flight crew engaged the autopilot, again upon the disconnect which was just preceding the dive, the first dive, apparently the captain was using some other than the normal means of disconnect of the autopilot while the co-pilot was the flying pilot. So, here he is holding the control yoke and more than likely we believe that he either attempted to use the high-speed trim which will disconnect the autopilot on the control yoke or the high-speed longitudinal suitcase handles which is an alternative measure. That also would disconnect the autopilot.

But the autopilot would not have been able to use the alternate trim because of the jam as we know,

and so it still would have masked the condition as to what flight controls were being held in, and once the autopilot released, then the elevator would go more than likely to an entrail position or at least until the pilot flying was able to grasp whatever control inputs were different than what he expected and to correct the elevator.

MEMBER GOGLIA: We said that it took about a hundred pounds of force for them to hand-fly this airplane? Or was it 50 pounds for the cruise and then it was a hundred pounds?

MR. RODRIGUEZ: Initially, it was 50 pounds in the climb-out, sir, and in the recovery, it was a 130 to a 140.

MEMBER GOGLIA: Okay. Gotcha. All right. Thank you.

MR. IVEY: Yes. The crew did a very nice job at 31,000 feet flying. In fact, when you look at that FDR trace, they held altitude very close and they had actually increased speed. That does two things. That actually increases your fuel burn which gets the weight down which is certainly a necessary consideration for landing. Your air speeds are going to be based upon your gross weight for landing, and they found what I believe to be an optimum speed at that altitude that

really did release a lot of those control pressures that they initially encountered. So, they found a good harmony, if you will, hand-flying the airplane at 31,000 feet.

MEMBER GOGLIA: Okay. Thank you.

ACTING CHAIRMAN CARMODY: 17. The captain should have kept the slats and flaps extended when the airplane --

MR. CLARK: We need your microphone.

ACTING CHAIRMAN CARMODY: I'm sorry. Thank you.

17. The captain should have kept the slats and flaps extended when the airplane was found to be controllable in that configuration after the initial dive.

MEMBER GOGLIA: Okay. Go ahead, George, you can start.

MEMBER BLACK: I'll just repeat what I said a minute ago. I understand what you're saying, John, and I think there's nothing wrong with having it in the text. I don't necessarily think that there's any purpose in having it in the Findings, and I would hold that we just leave this one out as a Finding because it certainly is in hindsight a great idea, but with everything going on, the way I read this, we're -- when

they say "should", we're holding them responsible for it, and I'll bet they would have liked to have done it, too, although it probably wouldn't have made any difference.

ACTING CHAIRMAN CARMODY: Is there another way we could say it that -- other than should? I think it's worth preserving the idea just for future lessons, but I take your point that it's not intended to be a criticism of the crew.

MEMBER BLACK: Well, --

ACTING CHAIRMAN CARMODY: Is there nothing thing we could say or any other --

MEMBER BLACK: -- I suppose we could say in retrospect.

ACTING CHAIRMAN CARMODY: Well, I mean, that -- this is all in retrospect.

MEMBER BLACK: That's what I'm saying.

MEMBER GOGLIA: Well, I agree with that, but, you know, I don't think we need to use these words. You said it very well without using any of these words after you restated it. So, maybe we should just agree to lift this verbiage out of here and circulate before the next few days some new language that clearly says what you articulated to us here because I think what you said was right. What's written here, I can't

support.

ACTING CHAIRMAN CARMODY: Captain Ivey?

MR. IVEY: The fact that the crew had selected the slats and flaps to 11, as Mr. Clark stated, ultimately you're going to have to slow the airplane and configure the airplane for landing. They took those steps. In fact, the captain initially did what I think was a very proper approach, took a proper approach in that he asked for the slats first, a methodical and slow approach to attempting to reduce this airplane down to a target air speed of a 180 knots.

Once he got slats, he was satisfied. I will say this, that there was no remarks on the CVR indicating to the contrary because if in fact this airplane had at any point started to generate an increased control pressure or something that he was not able to maintain, then you would go back to, as you say, a happy position or somewhere where you were in controllable flight. So, Flaps 11 was the next selection.

It's my understanding that you can actually -- this is from the manufacturer. It's my understanding that you can take that flap handle and you could very gently move this thing back towards from

zero flaps towards 11 degrees of flaps in increments, and that would have been my approach to the flap selection.

Nevertheless, 11 degrees of flaps was selected and the co-pilot actually asked the captain, "How does it feel?" He says, "It feels pretty good." And so, they were at a configuration that would enable the airplane to slow and the next critical factor in trying to land this airplane at some point in time is going to be trying to drop the landing gear, and I believe that there would have been a case of preparation, saying that as I drop this landing gear, if I lose control of this airplane, then bring that landing gear right back up. We're just -- if it doesn't work, it doesn't work.

So, ultimately based upon the configuration that they were able to achieve, they're either going to have to land with gear down, land with gear up, and not to belabor this point, but both of these gentlemen were military pilots, were very familiar with all the military fields around there, and their choice of Los Angeles was excellent because they had 12,000 feet of runway. March Air Force Base. There are numerous bases around there that have got lots of runway, but most importantly, in any military pilot that had flown

in California as these two gentlemen had, would be very much aware of Edwards Air Force Base which is the best airport we got in the country. There's over 5,000 feet -- five miles of paved runway at Edwards Air Force Base, and I think even I could make a decent landing out there on five miles.

But furthermore, the dry lake bed is -- it just goes on forever. The space shuttle lands on that. So, if in fact you were not able to get the landing gear down and you were traveling at very high rates of speeds, there were a lot of options. Unfortunately, the crew was not able to move through all those steps in decisionmaking. So, I do believe that once you had achieved slats and flaps 11, that it should have remained there.

ACTING CHAIRMAN CARMODY: Mr. Clark, I noticed you had a piece of paper. Have you got a redraft of this, by any change, or some suggestions?

MR. CLARK: No. We're working on the one Member Goglia suggested in an earlier conversation.

ACTING CHAIRMAN CARMODY: All right. Member Black?

MEMBER BLACK: How about leaving the flaps and slats extended at Time 16:18:00 might have allowed better control of the aircraft?

MR. CLARK: I believe that's true. It's the -- I think it's somewhat a little indirect from the concern of the issue of undoing or taking a step back. So, I --

MR. RODRIGUEZ: Madam Chairman, could I throw my oar in?

ACTING CHAIRMAN CARMODY: Yes, please do.

MR. RODRIGUEZ: I feel that in this case just the opposite of what a lot of people have been expressing. I believe that the safety message here is if people don't already know it, and I would have thought they would, as you progress toward a landing in any kind of an emergency situation, each step in the progression, barring loss of -- further loss of control or something, is an irreversible step, and so once the flaps were extended and the slats were out, I feel they should have been left out. I feel that as a finding, for those who may not be aware of that kind of a philosophy, I think it's an important safety message for it to be highlighted in the Findings, and perhaps if you want to -- I would offer some alternate language which I haven't written down, but if you come at it from a different direction and say that something to the effect that we were unable to understand the benefit to be derived by raising the flaps and then say

that there was a possible benefit to have left them down or something of that nature, the safety message comes out without perhaps any sense of condemnation of the crew specifically.

ACTING CHAIRMAN CARMODY: Well, why don't we do this? Perhaps you could -- staff could continue to work on this and we could circulate language later, if necessary, for the board members. I think we kind of have a sense we'd like something in here, but we want it worded differently.

MEMBER BLACK: Yes. Something like Rod's talking about, if better worded, of course, would --

(Laughter)

ACTING CHAIRMAN CARMODY: Well, just to convey the safety message. So, let's --

MR. CLARK: We'll give Captain Ivey a shot at it.

MEMBER BLACK: Why don't we let Karen write it?

MR. CLARK: Okay. We'll do that. We understand what your concerns are and we'll try to make sure we address them.

ACTING CHAIRMAN CARMODY: Okay. Let's kind of put a little question mark on that one.

All right. 18. Without clearer guidance to

flight crews regarding which actions are appropriate and which are inappropriate, in the event of an inoperative or malfunctioning flight control system, pilots may experiment with improvised troubleshooting measures that could inadvertently worsen the condition of a controllable airplane.

19. The acme nut threads on the accident airplane's horizontal stabilizer jackscrew assembly wore at an excessive rate.

20. Alaska Airlines use of Aeroshell 33 for lubrication of the jackscrew assembly, acme screw thread surface finish, foreign debris, and abnormal loading of the acme nut threads were not factors in the excessive wear of the accident acme nut threads.

21. There was no effective lubrication on the acme screw and nut interface at the time of the Alaska Airlines Flight 261 accident.

MEMBER BLACK: Just an editorial. Karen, Ms. Bury, should that be lubricant rather than lubrication? In other words, grease? Don't worry about it. It can't be of any consequence. Lubricant. We're really saying that there was no material on it which would be the lubricant.

ACTING CHAIRMAN CARMODY: Well, yeah.

MEMBER BLACK: Just leave it then. No

problem.

ACTING CHAIRMAN CARMODY: Okay. 22. The excessive and accelerated wear of the accident jackscrew assembly acme nut threads, was the result of insufficient lubrication which was directly causal to the Alaska Airlines Flight 261 accident.

23. Alaska Airlines extension of its lubrication interval for its McDonnell-Douglas MD-80 horizontal stabilizer components, the last of which was based on Boeing's extension of the recommended lubrication interval, increased the likelihood that a missed or inadequate lubrication would result in excessive wear of jackscrew assembly acme nut threads and therefore was a direct cause of the excessive wear that led to Alaska Airlines Flight 261 accident.

The Federal Aviation Administration's acceptance of those extensions was a contributing factor.

I'd like to propose a change to this language to say Alaska Airlines extension of the lubrication interval, etc., and the FAA's acceptance of those extensions increased the likelihood and therefore was a direct cause of the excessive wear that led to the accident. In other words, I'm saying the FAA was more than a contributing factor.

Do I take by your silence you're agreeing or do members have comments on this?

MEMBER GOGLIA: I'm trying to digest it.

ACTING CHAIRMAN CARMODY: Okay. All I'm doing is moving the last sentence up and put it after the first comma, so it's both Alaska Airlines extension and FAA's acceptance which resulted in excessive wear, was a direct cause of the excessive wear that led to the accident.

John?

MEMBER HAMMERSCHMIDT: Well, from a meeting process standpoint, we're going to be edging into the probable cause determination in a few of these conclusions.

ACTING CHAIRMAN CARMODY: Right.

MEMBER HAMMERSCHMIDT: And I haven't quite digested the different options we have before us at this point.

ACTING CHAIRMAN CARMODY: All right. Good point. Well, why don't we -- I'm going to put a mark on this one and hold it, and after we discuss probable cause, we may need to return to this one. Is that reasonable? Okay. 23.

24. When lubricating the jackscrew assembly, removal of used grease from the acme screw before

application of fresh grease will increase the effectiveness of the lubrication.

25.

MEMBER GOGLIA: We didn't talk about that at all during -- I think Joe Kolly, I think that's your area. You know, what are we basing that on?

MR. GUZZETTI: Member Goglia, we -- you're right. We didn't talk about it, but it is addressed in the report, and you're right. Dr. Kolly is kind of tag-teaming with me as far as this issue's concerned, but used grease contains contaminants or the wear debris, if you will, and that wear debris takes up the space that you would normally have the oils that are needed to emulsify the grease.

So, if you remove the used grease from the acme screw and then put fresh grease on it, there's basically more room for that fresh grease to go, and you don't have a lot of space taken up with grease that has more wear debris than it does the characteristics of the lube. You need to get the -- Mr. Epperson also reminds me that in the case of Hawaiian Airlines where we found a grit-lasting medium in there, it sure would be good to get that old grease out which may contain abrasive contaminants, so you can put fresh grease on it. So, we think that's a good thing to do.

We have been told that Boeing is very much strongly considering that in their revised lubrication procedure, and when we talked to other jackscrew assembly or acme screw manufacturers, they also felt that that was prudent.

Oh, the -- well, as a matter of fact, Boeing, when they came here to provide a briefing on their revised end-play check, they also showed us a comb, a device that they're trying to field where it's got -- you clamp it right on to the acme screw and the teeth of the comb fit right into the threads and then you rotate the -- you move the comb around and it just scrapes out all that old grease and then you put fresh grease on it. So, they're going to be adopting a procedure like that.

MEMBER GOGLIA: Okay. Now, you mentioned everybody that had this feeling that this was better, but there's no testing done that we know of?

MR. GUZZETTI: Testing in regard to?

MEMBER GOGLIA: Making a determination whether or not, because it's a pretty strong statement here, it'll increase the effectiveness of the lubrication. I happen to agree with that. I'm just challenging you to the -- how did we get there?

MR. KOLLY: Yes. We received that guidance

from jackscrew manufacturers who said one of the most important features of relubrication is in fact removing the wear debris from inside the screw threads to allow this fresh grease to now take up the space and provide a reservoir for continuing lubrication during the course of the lubrication interval. So, that's from manufacturers of jackscrews and also in some -- it has to do with purging. Essentially, it's a purging operation. We got into a lot of discussion with grease manufacturers and maintenance groups about how you -- we know that when you purge a system that has a grease fitting, you introduce new grease until the old grease is taken out. That's a standard.

On a screw, on an external screw surface, you don't have a classic purging technique and that's why you would want to use something like this comb and manually remove it, but it's accepted across the industry that when you introduce new lubricant, it's best to remove the most -- as much as you can of the old lubricant.

MEMBER GOGLIA: Okay. Thank you.

ACTING CHAIRMAN CARMODY: That was 24.

25. A larger access panel would facilitate the proper accomplishment of the jackscrew assembly lubrication task.

26. If the jackscrew assembly lubrication procedure was a required inspection item for which an inspector's sign-off is needed, the potential for missed or improperly-performed lubrications would be reduced.

MEMBER GOGLIA: Question on the word "missed". I read that to mean the card wasn't issued, the task wasn't issued during a maintenance visit. What do you mean by missed? Maybe I should ask you what you mean by it.

MR. CLARK: Well, I think the -- what we mean by missed is that somebody tried to lube that and perhaps we would not see the lubrication extruding out of the acme nut or that the screw had not been properly slathered with grease or it had not been done at all.

ACTING CHAIRMAN CARMODY: So, you'd say unperformed or improperly performed? Is that what you meant?

MR. CLARK: Yes.

MEMBER GOGLIA: The role of the inspector at this level, if the card, the task document, was not issued, the inspector has no way of knowing when it's a time-controlled card, like 650 hours. He wouldn't know. So, if it was missed by planning, the inspector wouldn't pick that up.

MR. CLARK: No, I understand that.

MEMBER GOGLIA: So, that's why the word "missed" --

MR. CLARK: Okay. That's fair.

MEMBER GOGLIA: -- raised my attention. We need either another word or actually if we drop the word, then it really addresses the role of the inspector. It doesn't address the whole role of the maintenance program.

MR. CLARK: Yeah. I think we're good with either way. Unperformed or --

ACTING CHAIRMAN CARMODY: Unperformed or improperly performed. All right.

MR. CLARK: Okay.

ACTING CHAIRMAN CARMODY: Okay.

MR. CLARK: Super.

ACTING CHAIRMAN CARMODY: Okay. 27. Alaska Airlines extension of the end-play check interval allowed the accident acme nut threads to wear to failure without the opportunity for detection and therefore was the direct cause of the excessive wear that led to Alaska Airlines Flight 261 accident. The FAA's approval of that extension was a contributing factor.

This is one that I'll come back to after we

discuss probable cause.

MEMBER GOGLIA: I have a couple of words on that, too.

ACTING CHAIRMAN CARMODY: Okay.

MEMBER GOGLIA: So, bring it back.

ACTING CHAIRMAN CARMODY: Okay. All right.

28. Alaska Airlines end-play check interval extension should have been but was not supported by adequate technical data to demonstrate that the extension would not present a potential hazard.

29. The existing process by which manufacturers revise recommended maintenance task intervals and by which airlines establish and revise these intervals does not include task-by-task engineering analysis and justification and therefore allows for the possibility of inappropriate interval extensions for potentially-critical maintenance items.

30. Because of the possibility that higher-than-expected wear could cause excessive wear in less than 2,000 flight hours and the additional possibility that an end-play check could be missed or improperly performed, the current 2,000 flight-hour end-play check interval specified in Airworthiness Directive 2000-15-15 may be inadequate to ensure the safety of the Douglas DC-9, McDonnell-Douglas MD-80/90 and Boeing 717

fleet.

Do you have the same concerns about "missed" in this paragraph?

MEMBER GOGLIA: I have concerns about "missed", but I have concerns about the whole paragraph as well.

ACTING CHAIRMAN CARMODY: All right.

MEMBER GOGLIA: Because, you know, the 2,000 flight hours and the 650-hour lubrication intervals with an inspection that's hauled out looking for the debris, looking for shavings in the grease and so on, I think really does increase the probability that any defects will be found, and I can't support this one simply.

I think that the work that was done by the industry and the FAA in this area is adequate, and I think that we need to defer to their judgment until such time as we can show that three additional lubrication visits between a shortened end-play check isn't going to produce satisfactory results. I think it is.

DR. ELLINGSTAD: Excuse me, Mr. Goglia. This particular finding addresses the inspection interval and not lubrication by itself, and what I would remind you is what was shown with respect to the failure to

demonstrate reliability and validity for the end-play procedures calls into question the capacity of the available measuring procedures to reliably detect this condition. So, that is coupled with these possibilities of not performing an inspection on those intervals, so which gives rise to the concern about missing significant wear.

MEMBER GOGLIA: And I would counter that with the AD note which I might note that I requested from staff and took a rather unusual length of time for something that's referenced in the report so many times to be able to put their hands on to give it to me. But in the AD note that the FAA issued in this area, it calls for an intensive visual examination at the grease job which did not exist up until this AD note was issued and they actually give you the detail and what you have to accomplish this inspection. Those are all additional requirements that did not exist at the time that this airplane was lubricated and that's the reason why I say that coupled. The two of them are not in a vacuum separately. They're together. You add those together and additionally add the Boeing tool, the new tool, into the mix, and I think that there is the 2,000-hour cycle for end-play checks is a substantial improvement, and we don't need this recommendation.

DR. ELLINGSTAD: Well, one additional point that I'd like to make is that in addition to the changes in the end-play procedures that Boeing has developed, there was also, as a focus of our earlier recommendation, a request that that procedure be validated and that the reliability be demonstrated.

Now, we understand that Boeing is in fact engaged in the study to accomplish that, but we have not yet seen the results.

MR. CLARK: In addition, examining the grease is again not one of those things we would consider a highly-controllable process since that's the kind of thing we think is required for such a critical item, and again this goes back to trying to control fatigue and prevent fatigue or catch it before it reaches critical mass requires that highly-controllable environment, and we do recognize cutting the inspection intervals down to 2,000 hours is a big bite at that and also doing things like examining the grease.

If you find the flakes in there or find something extremely unusual, certainly grounds to pull it off. What we're not convinced of is that are you always going to find something right there when you're doing that or is it always going to get done properly or to a certain level, and can those things get missed,

and I think that goes back to the comment I made earlier that for the system safety-type work or maintainability-type work, I think it's been well established, the number I've been told, I'm not an expert in that area, that maintenance items should be considered an 80-percent reliability level, and so again, this is part of the out of the ordinary is we're dealing with this highly-critical system where I think in many other situations we've dealt with in parts failures and that lead to accidents and stuff, that that may be appropriate, but again it's still, we think, better to be cautious, and we haven't asked them to change it, but we want to see the numbers to see that it fully supports this, and if the reliability and the accuracy of these measurements and processes don't get us there, then we may need a shorter number.

For example, again we don't know that this 13 times wear rate from the grit that showed up in Hawaii Airlines is the worst we can get. It's a number. We know we can get that because we had that at Hawaii. How much worse can it get? So, then if we go back and start looking at we still want to try to have the opportunity for a blown inspection and at least get two shots at it before it fails, that's where our concern is. You can get into some high wear rates up in this

Hawaiian number, maybe a little bit greater, and you blow one of those 2,000-hour cycles, you can be in a critical state before you get to the next 2,000-hour cycle. That's a concern we have.

MEMBER BLACK: Madam Chairman, we're always saying maybe in here. Maybe we could handle this at the recommendation stage and have them to monitor the performance of the new end-play check and lubrication process and report back or something. It might be a way out of this. We're saying it might be. We don't know. And then, if we -- and this is just a finding. Then at the recommendation stage, ask them to monitor it and report back or something of that nature.

We keep talking about Hawaii. How long have they been flying DC-9s out there? This is the first time that happened. How long have they been using that grit stuff?

MR. CLARK: As far as we know, they used it one or two times on a couple airplanes back in the tail cone.

MEMBER BLACK: That's all we know.

MR. CLARK: That's the difficulty when we're dealing with one of these out of 80 million flight hours, it's not just going to show up in the normal course of business. It's --

MEMBER BLACK: Well, but Hawaii had had DC-9s a long time.

MR. CLARK: Oh, absolutely. Yeah.

MEMBER BLACK: And I assume that it had corrosion for a long time. So, you know.

MR. CLARK: I assume there's a good reason to use the grit back there, that's for sure.

MEMBER BLACK: Yeah.

ACTING CHAIRMAN CARMODY: As I understand it, Member Black has proposed that we strike the Finding and perhaps incorporate another recommendation that would suggest that --

MEMBER BLACK: I don't even know that we need to strike it. It says may be.

ACTING CHAIRMAN CARMODY: Well, I would leave it in, but, I mean, I'm trying to --

MEMBER BLACK: Then --

ACTING CHAIRMAN CARMODY: And then, craft a recommendation that would say --

MEMBER BLACK: I think there is a recommendation that says something about it and just handle the recommendation when we get to it.

ACTING CHAIRMAN CARMODY: Hm-hmm.

MEMBER BLACK: Is that okay, John?

MEMBER GOGLIA: I think so.

ACTING CHAIRMAN CARMODY: All right. I'll put a note on 30 as well.

MEMBER GOGLIA: Before we move on, Mr. Clark, when this AD note was issued, did we comment on this? I don't remember.

MR. CLARK: I don't remember.

MEMBER GOGLIA: Because one of the things that --

MR. CLARK: I think Jeff just said it was a telegraphic AD and I don't remember. Was it telegraphic?

MR. GUZZETTI: The first one was a telegraphic AD that was issued two-three days after the accident and then they simply revised it four or five months later. I don't think -- it was already a final rule. I don't think it was an MPRM. I could be wrong about that, though.

MR. CLARK: And I think for what we saw at that time, it made sense to us, and it was appropriate. I think we had no objections to it in that sense, whether we commented on it or not.

MEMBER GOGLIA: Well, I agree with you. I think it was appropriate, but one of the things that you said that had my ears perk up was about the -- in the grease inspections, somebody not identifying what's

in it, and if that's the case, I wanted to know if we were -- if we had responded to this AD, to have chemical analysis done on the grease when we take it, which is routine on oil samples.

MR. CLARK: Sure. We didn't do that. I think the way I would kind of go back and what was on everybody's mind back then, I probably can't reconstruct that, certainly can't from my own memory, but the issue is that that is a good thing to do. It's one way to get at the problem. It's one way to, you know, take an edge off or to have mechanics out there looking. We don't know that that's in one sense reliable enough to get away from escalating from 2,000 hours or extending from 2,000 hours what it is now or is it enough not to back off of that 2,000 hours even now. It's still a good thing to do. It's still good practice having the mechanics out there taking every shot they can to take the edge off the risk.

MEMBER GOGLIA: Knowledgeable mechanics.

MR. CLARK: That's true, too.

MEMBER GOGLIA: Okay.

ACTING CHAIRMAN CARMODY: All right. Member Hammerschmidt?

MEMBER HAMMERSCHMIDT: Are we agreeing to leave it in for the moment?

MEMBER GOGLIA: I think for the time being, until we get the recommendations.

MR. CLARK: Okay.

ACTING CHAIRMAN CARMODY: I have it circled. I have a couple of things we'll come back to.

MEMBER HAMMERSCHMIDT: Well, I might mention that this was really the first conclusion that I put a question mark by, but the two words "may be" softened it, made it enough uncertain --

ACTING CHAIRMAN CARMODY: May be inadequate.

MEMBER HAMMERSCHMIDT: So, I mean, we could say may be adequate. It may be inadequate, it may be adequate. I believe that's what Mr. Clark was getting at in your -- whenever I asked you about this earlier on this morning, I believe, that it's just an uncertainty.

MR. CLARK: Well, it is right now and part of it is, is that, in where we're at right now, we haven't set down and tried to develop very specific -- take a rigorous approach and develop those numbers. That's kind of not the business we're in. Sometimes we sure take a try at it to push people the wrong -- force them to take a try, but we haven't done that in this case.

ACTING CHAIRMAN CARMODY: Okay. 31. The continued collection and analysis of end-play data are

critical to monitoring acme nut thread wear and identifying excessive or unexpected wear rates, trends or anomalies.

32. Until August 2000, Alaska Airlines used a fabricating restraining fixture that did not meet Boeing specifications. However, the Safety Board could not determine whether the use of this non-compliant fixture generated an inaccurate end-play measurement during the last end-play check or whether the use of this fixture contributed to the accident.

33. The on-wing end-play check procedure, as currently practiced, has not been validated and has low reliability.

34. Deficiencies in the overall process increase the likelihood that jackscrew assemblies may be improperly overhauled.

35. The absence of a requirement to record or inform customers of the end-play measurement of an overhauled jackscrew assembly could result in an operator unknowingly returning a jackscrew assembly to service with the higher-than-expected end-play measurement.

36. Operators will maximize the usefulness of end-play measurements and wear rate calculations by recording on-wing end-play measurements whenever a

jackscrew assembly is replaced on an airplane.

37. Because the jackscrew assembly is an integral and essential part of the horizontal stabilizer trim system, a critical flight system, it is important to ensure that maintenance facilities authorized to overhaul these assemblies possess the proper qualifications and equipment.

38.

MEMBER GOGLIA: Mr. Clark, what about adding manuals here?

MR. CLARK: I put documentation. I just penciled in documentation, manuals.

MEMBER GOGLIA: Documentation is fine.

MR. CLARK: Okay.

MEMBER GOGLIA: Instructions for continued airworthiness. Use the FAA's terms.

ACTING CHAIRMAN CARMODY: What are we saying? Possess the proper qualifications, equipment and?

MEMBER GOGLIA: Instructions for continued airworthiness.

ACTING CHAIRMAN CARMODY: Okay.

MR. CLARK: Okay. Usually -- I don't like to get into their term of art because that forces us to kind of weave our way through their terms and regulations. If we just get back and say

documentation, then we can --

ACTING CHAIRMAN CARMODY: Okay.

MR. CLARK: Is that all right?

MEMBER GOGLIA: That's fine.

MR. CLARK: Okay.

ACTING CHAIRMAN CARMODY: Okay. We're adding and documentation to Number 37. All right.

38. The dual-thread design of the acme screw and nut does not provide redundancy with regard to wear.

39. The design of the Douglas DC-9, McDonnell-Douglas MD-80/90, and Boeing 717 horizontal stabilizer jackscrew assembly did not account for the loss of the acme nut threads as a catastrophic single-point failure mode. The absence of a fail-safe mechanism to prevent the catastrophic effects of total acme nut thread loss contributed to the Alaska Airlines Flight 261 accident.

Now, this is another one that relates to the probable cause. Do we want to go back to this after we go to probable cause? All right.

40.

MEMBER BLACK: Well, if we were going to interject, John, a finding with regard to Jeff's other aircraft systems, probably somewhere in this vicinity

would be the place to do it.

MR. CLARK: Yeah. The findings, we usually take in the words that were developed in the analysis and wherever we would put that would fall out. I assume it would fall right here, but --

MEMBER BLACK: Okay. Wherever. Let's just not forget it.

MR. CLARK: Okay. But I agree with you. It most likely will fall somewhere close here.

MEMBER BLACK: Okay. Good.

MR. CLARK: The only other problem it could be is that it may be easier to put it in a separate section right at the very end and address that issue in its entirety by itself, so then it would fall later.

MEMBER BLACK: Okay.

ACTING CHAIRMAN CARMODY: So, do we have a proposal for a new finding or what?

MEMBER BLACK: Not yet.

ACTING CHAIRMAN CARMODY: Not yet. All right.

40. When a failure could have catastrophic results, it is not appropriate to rely on maintenance and inspection intervention to prevent the failure from occurring if a practicable design alternative could eliminate the catastrophic effects of the failure mode.

MEMBER GOGLIA: Don't -- go on. Do I count to 10?

MEMBER BLACK: Well.

ACTING CHAIRMAN CARMODY: Well, what is the --

MEMBER GOGLIA: We have to rely upon the entire system. It's the design, it's the operation, and it's the maintenance and inspection process. That statement is -- the word "inappropriate" and the words on either side of it, they are not appropriate. That whole aviation system as well as other modes of transportation, even the elevators that we rode up and down in today in this building, they all rely upon maintenance. If you don't maintain it, the outcome is certain. So, I mean, I just --

MR. CLARK: Well, the -- you're seeing something different in this than I am because we're not -- maintenance is absolutely critical out there and they need to perform well, and I think you just made a comment a moment ago about properly-trained and properly-qualified mechanics. They aren't out there. There are those that aren't properly trained or properly qualified and we have our overseas operations where they don't have the opportunity to reach the skills that our United States mechanics do perhaps, and

so this in no way means to take away from the critical responsibility that maintenance has, but when there is -- I would offer a slight analogy that we expect pilots out there to be professional and do their jobs, but CFIT is one of the worse situations going. So, we put other instruments in there to help them evaluate the situation better and to help them use the instruments that they have better to try to mitigate those kinds of risks.

I see what we're doing here is that maintenance needs to be doing their job, first and foremost, every time. What we're saying here is that in those areas that are so critical, if we can go in there and buy that safety margin, then we ought to do it, and if it's something like a fan disk where we cannot contain it if it ruptures, then we better take other actions, but we're looking for a practical solution here to buy that margin for the maintenance side and that's all we're saying.

ACTING CHAIRMAN CARMODY: Maybe I could suggest something where we eliminate some of the language that disturbs Member Goglia. Maybe we could say when a failure could have catastrophic results, it may be appropriate to consider a practicable design alternative to eliminate the catastrophic effects of

the failure mode.

MEMBER GOGLIA: That's fine with me.

ACTING CHAIRMAN CARMODY: Would that be all right?

MR. CLARK: Well, I would consider for that one, it's almost mandatory to consider. It's not maybe. It is mandatory to consider and if we can --

ACTING CHAIRMAN CARMODY: So it doesn't get us anything.

MR. CLARK: Well, no. I think to say that it is mandatory to consider and that's all we're doing here. What can we do in a practical way to buy that margin for that mechanic and that's no different than what we try to do in a practical way in buying margins for the pilots in all different phases of their flight operations.

MEMBER GOGLIA: You're talking about a systemic approach but that's not how it's worded here. Can we -- I don't want to bog us down here. Can we take this one, Number 40, and put it in the same place that we put Number 17 where we work on some additional language and circulate it?

ACTING CHAIRMAN CARMODY: Sure.

MR. CLARK: When we start that, somebody offered up that right at that first line, it says it's

not appropriate to rely solely upon, and I think that doesn't quite fix everything I know you're after, but that is the issue. It's not just maintenance. Why stick it all to them if we can find other ways to get us off the --

ACTING CHAIRMAN CARMODY: Okay.

MR. CLARK: -- same --

MEMBER BLACK: Would solely work, John? I mean, it sounds okay to me.

MEMBER GOGLIA: It does sound -- let's just move it. We can deal with this later.

ACTING CHAIRMAN CARMODY: All right. Well, let's perfect some language on that one, if you will.

41. Douglas DC-9, McDonnell-Douglas MD-80/90, and Boeing 717 series airplanes should be modified to ensure that loss of the horizontal stabilizer trim system jackscrew assembly acme nut threads does not preclude continued safe flight and landing.

MEMBER GOGLIA: This one begs the question, what about the rest of the fleet?

MR. CLARK: We agree, and that's what we talked about, that we hadn't progressed far enough in developing Jeff's whole factual analysis and he had a proposed recommendation on ball screws, and I think

that we talked to Member Black a little bit about kind of detuning that a little bit, just basically going to get a study going of all of those systems out there and make sure we don't have a lingering or a potential failure mode like we saw here due to wear specifically and any other thing they may find while they're looking at it.

So, I think that's something that Member Black had put together perhaps for a follow-on.

ACTING CHAIRMAN CARMODY: Do we want to take up your suggestions at this point, George?

MEMBER BLACK: I don't know. This is the thing John and I have been talking about, when to put in, for quite some time, and --

ACTING CHAIRMAN CARMODY: Well, maybe we should finish -- go down through 45 and then return to these because I know you had some amendments to these conclusions and it might be a good time to take them up. Would that be reasonable? Let's do that.

MEMBER BLACK: Yeah. I think this one's going to be difficult, though.

ACTING CHAIRMAN CARMODY: All right. Well, we're circling 41 to return to, right?

MEMBER GOGLIA: Hm-hmm.

ACTING CHAIRMAN CARMODY: Okay. I hope

somebody's keeping track of all these. Good.

42. Catastrophic single-point failure modes should be prohibited in the design of all future airplanes with horizontal stabilizer trim systems, regardless of whether any element of that system is considered structure rather than system or is otherwise considered exempt from certification standards for systems.

43. The certification requirements applicable to transport category airplanes should fully consider and address the consequences of failures resulting from wear.

44. At the time of the Flight 261 accident, Alaska Airlines Maintenance Program had widespread systemic deficiencies, some of which apparently still have not been corrected.

45. The FAA did not fulfill its responsibility to properly oversee the maintenance operations at Alaska Airlines, and at the time of the Alaska Airlines Flight 261 accident, FAA surveillance of Alaska Airlines had been deficient for several years.

So, that completes the draft of the Conclusions.

Now, do we want to move on to the Probable

Cause and then return to Conclusions later? Would that make sense or do you want to take up your Conclusions?

MEMBER BLACK: From a logical sense, it doesn't make sense.

ACTING CHAIRMAN CARMODY: Well, we're split here. I mean, we have some conclusions that kind of hinge on the probable cause. We have others that do not.

MEMBER BLACK: It's all right to discuss it. It doesn't -- I mean, we already have a framework we're working on. So, I suppose it makes sense.

ACTING CHAIRMAN CARMODY: The Probable Cause?

MEMBER BLACK: Right.

ACTING CHAIRMAN CARMODY: Well, I will read the Draft Probable Cause and then I have a proposed revision, and I'm sure others do as well. So, let me read the draft first.

The National Transportation Safety Board determines the probable cause of this accident was a loss of airplane pitch control resulting from in-flight failure of the horizontal stabilizer trim system jackscrew assembly acme nut threads. The thread failure was caused by excessive wear resulting from (1) Alaska Airlines insufficient lubrication of the jackscrew assembly, (2) Alaska Airlines extended

lubrication interval which increased the likelihood that a missed or inadequate lubrication would result in excessive wear of the acme nut threats, and (3) Alaska Airlines extended end-play check interval which allowed the excessive wear of the acme nut threads to progress to failure without the opportunity for detection.

Contributing to the accident was (1) the FAA's acceptance of Alaska Airlines extended lubrication interval and the FAA's approval of Alaska Airlines extended end-play check interval, and (2) the absence on the MD-80 of a fail-safe mechanism to prevent the catastrophic effects of total acme nut thread loss.

Now, I will take the liberty of reading my proposal and then I know Member Black has one and we'll see.

Probable Cause. The National Transportation Safety Board determines that the probable cause of this accident was the loss of airplane pitch control resulting from the in-flight failure of the horizontal stabilizer trim system jackscrew assembly acme nut threads. That's the same as the original one.

The thread failure was caused by excessive wear resulting from (1) Alaska Airlines insufficient lubrication of the jackscrew assembly, (2) Alaska

Airlines extended lubrication interval which increased the likelihood that a missed or inadequate lubrication would result in excessive wear of the acme nut threads and the FAA's approval of Alaska Airlines extended lubrication interval, and (3) Alaska Airlines extended end-play check interval which allowed the excessive wear of the acme nut threads to progress to failure without the opportunity for detection and the FAA's approval of Alaska Airlines extended end-play check interval.

Contributing to the accident was the absence on the MD-80 of a fail-safe mechanism to prevent the catastrophic effects of total acme nut thread loss.

What my proposal does, it retains the same language as the draft, but it essentially moves the FAA up to make them one of the -- along with Alaska Airlines the cause of the accident as opposed to contributing, and the reason I think this is important is that the FAA is the government and I think the public trusts the government to assure the safety of flight. The public pays the FAA. The public has faith in the FAA to do this, and I feel in this instance, the FAA failed miserably in the oversight of Alaska Airlines.

So, while certainly Alaska Airlines is --

(Applause)

ACTING CHAIRMAN CARMODY: While I think Alaska Airlines has a heavy responsibility, a primary responsibility to enforce the regulations, I don't think that the FAA's role is any less crucial nor do I think they should be seen as contributing. I think they were causal. That's my view, and I wanted to say that.

Member Black?

MEMBER BLACK: Well, as you know, I've had this written both ways. I had it written almost identically to that and then I have another option here, and I guess that is the -- you well stated the fundamental question. We in government, and I used to be in the local government where I had inspectors working for me on the roadway system and the people who paid my salary and their salary expected those people to produce a safe roadway system, and if we didn't, we were certainly held accountable for it, and it -- I mentioned during the meeting they were -- actually had intensive scrutiny of this airline going on as this airplane, the accident airplane, was proceeding through its course to its ultimate destiny, and it was not caught, and I don't know why. I don't think anybody will ever know really why, but it's just a question of

how you weigh this out, and I see that it can be argued either way.

There's also another one that is around that basically, I guess I could read that I wrote once that says, the National Transportation Safety Board determines the probable cause of this accident to be a loss of airplane pitch control resulting from the in-flight failure of the horizontal stabilizer trim system jackscrew assembly acme nut threads. The thread failure was caused by excessive wear resulting from Alaska Airlines insufficient lubrication of the jackscrew assembly.

This particular addition then moves to contributing. Contributing to the accident were (1) Alaska Airlines extended lubrication interval and the FAA's approval and/or acceptance, whatever the proper word is, of that extension which increased the likelihood that a missed or inadequate lubrication would result in excessive wear of the acme nut threads, and (2) Alaska Airlines extension of the end-play check interval and the FAA's approval or acceptance of that extension which allowed the excessive wear of the acme nut threads to progress to failure without proper opportunity for detection, and I also had as a separate paragraph, contributing also to it was the absence of

the MD-80 -- on the MD-80 of a fail-safe mechanism to prevent catastrophic effects of total acme nut thread loss.

That one was similar to an earlier staff draft, I believe, was it not, John?

MR. CLARK: Yeah. We had one similar around the director's review similar to that.

ACTING CHAIRMAN CARMODY: Are there other views? Member Goglia, you were expressing something to me just now.

MEMBER GOGLIA: I actually like what Member Black has proposed, and if we merge some of what you said and dropped "contributing" in the second paragraph of what you were reading and just listed all as part of the probable cause, and --

ACTING CHAIRMAN CARMODY: Okay. Would you make -- yeah. Has the same practical effect of mine.

MEMBER GOGLIA: Right.

ACTING CHAIRMAN CARMODY: Hm-hmm.

MEMBER GOGLIA: It flows better.

ACTING CHAIRMAN CARMODY: It's just different language.

MEMBER BLACK: Okay. I'm certainly -- engineers are notoriously illiterate.

MEMBER GOGLIA: No, good.

ACTING CHAIRMAN CARMODY: No, no.

MR. CLARK: John, one thing. The -- as we've tried to develop this, the one that -- when we put it up, we were trying to put, even though it's a factor on this -- on the design, that we were trying to separate it to some extent from the others, and I commented about that earlier, that it's -- so, anyway, that was one part of what we were trying to do, is get a little separation in there, that it's an issue. It's something we need to deal with or, you now, we think people need to be aware of, but it didn't measure up in a sense to the others. So, there's -- that's one reason we ended up the way we did.

MEMBER GOGLIA: John, we talk here and we've talked a lot today about the fail-safe mechanisms for these screws, but we haven't even mentioned at all whether or not this technology was available at the time the airplane was certified, and one of the things that we do very well is hold airplanes that have been designed a long time ago to today's standards.

Do we know anything in that area? What was available?

MR. CLARK: No, I really don't. What we know is there's nothing available for this jackscrew right now, but I think the -- starting off with the clean

sheet of paper, that if one of the design goals is to accept that that thing would wear out, wear completely through and then what would be the consequences, we may have seen a different design. We don't know what we would have seen, but the concept could have been on the table at that time to think of it in that terms.

Now, whether it would -- I don't know. It seems to me that jackscrews have probably been around a heck of a lot longer than airplanes, and so is there something out there, something that could have been added, it would surprise me if there wasn't, but it still could have -- the same engineering effort could have been put in then that we would like to see as an attempt right now. It may have been easier then. I mean, what we're trying to do now is go back and accommodate an existing design and enhance it where, when you start off with a clean sheet of paper with that design goal in mind, it's a lot easier to incorporate whatever needed to be incorporated.

MEMBER GOGLIA: I tend to think, given the work that NASA's done, that maybe there wasn't anything out there.

MR. CLARK: That would surprise me if there wasn't. I would -- but it could be.

ACTING CHAIRMAN CARMODY: Member

Hammerschmidt, did you have a comment?

MEMBER HAMMERSCHMIDT: Well, I was just going to say that I think we're achieving a consensus here. I mentioned to Member Black prior to the meeting even that I thought he had come up with a good alternate probable cause statement. The only improvement I would offer is concerning the last sentence, the one that we've been stating, contributing also to the cause was the absence of the MD-80, on the MD-80, of the fail-safe mechanism to prevent the catastrophic effects of total acme nut thread loss, and we've discussed that at length today.

I'm not sure that that's really part of the cause of this accident as a causal element.

MEMBER BLACK: It's an interesting point. It certainly is true if there had been something there, the accident wouldn't have happened, but it was not -- I don't know whether -- are we saying yes or no at the time this airplane was certified, that it should have been there in our reading of the -- that was the Civil Aviation Regulations then. Should it have had the -- the DC-9 have had a fail-safe device?

ACTING CHAIRMAN CARMODY: I don't know if it makes sense to go back and say what it should have had when it was certified.

MEMBER BLACK: Well, it certainly --

ACTING CHAIRMAN CARMODY: I think it makes sense -- it makes sense to observe that it was a causal factor or a contributing factor. It was.

MR. CLARK: I don't -- like I said, that had been the design thought or design requirement to take that on at that time and consider that --

MEMBER BLACK: Well, --

MR. CLARK: Well, what I would say is that they did put dual redundancy in there in many places in that. They put the torque tube inside of the jackscrew. So, they put the dual threads on. So, they were absolutely thinking about putting in dual-load paths for structure and which is good, I mean, and we believe that was there. It was the wear thing that slipped through. So, should it have been considered then? I don't know, but the fact -- we're dealing more now with what is right now.

MEMBER BLACK: Well, of course, certainly it was a hard time item when it was first designed, a life item it's called here. In other words, they were going to change it out. They said its life was X, whatever it was, 30,000 hours.

MR. CLARK: 30,000. It wouldn't make that. So, they backed off and, of course, this one made it no

where near 30,000 hours.

ACTING CHAIRMAN CARMODY: Well, let me just clarify what we agree on. It seems to me this formulation -- we agreed to strike the first "contributing to the accident" which is the top of that second paragraph.

MEMBER GOGLIA: And roll it together.

ACTING CHAIRMAN CARMODY: And roll it together. Shall I read it? Maybe I should read it so we know what we have.

The NTSB determines that the probable cause of this accident was the loss -- yes? Slowly. Was the loss of airplane pitch control resulting from the in-flight failure of the horizontal stabilizer trim system jackscrew assembly acme nut threads. The thread failure was caused by excessive wear resulting from Alaska Airlines insufficient lubrication of the jackscrew assembly.

MEMBER GOGLIA: 2.

ACTING CHAIRMAN CARMODY: I'm sorry.

MEMBER GOGLIA: That was 1.

ACTING CHAIRMAN CARMODY: That was 1. Yeah. You're right.

MEMBER GOGLIA: And jump on to 2.

ACTING CHAIRMAN CARMODY: 2. Thank you,

John. Alaska Airlines extended lubrication interval and the FAA's approval of that extension which increased the likelihood that a missed or inadequate lubrication would result in excessive wear of the acme nut threads, and 3. I guess this is, Alaska Airlines extended end-play check interval and the FAA's approval of that extension which allowed the excessive wear of the acme nut threads to progress to failure without the opportunity for detection.

Now, the remaining paragraph is the one contributing about the fail-safe mechanism, and I still don't have a clear idea of where we are on that.

MEMBER GOGLIA: I'd like to drop that.

ACTING CHAIRMAN CARMODY: I think it's a statement of what occurred in this accident. Now, I think we can look at recommendations and modify those in some way, if that's an issue, but I think to say that this wasn't even a factor in the accident is denying what seems to be the case.

I'm sorry. We're going to have just the people on the stage talking.

Any other thoughts, Member Black, Member Hammerschmidt?

MR. CLARK: Microphone.

MEMBER BLACK: Well, it's certainly a true

statement, but I guess there was a reason I asked about history because whether it's contributing was whether it was required in the first place. If it wasn't required to be in the series, it's sort of a moot point.

ACTING CHAIRMAN CARMODY: No, it's not.

MR. CLARK: What was required, they did go to the effort to put the redundancy in many areas and this one -- we heard at the hearing was that, you know, there was debate whether it was a system or a structure and certain parts were considered systems, certain parts were considered structure, and wear in and of itself wasn't considered at all in the failure mode. So, was it specifically required? Perhaps not because that's why we're making some specific recommendations in that area, but should it have been? We think so.

MEMBER BLACK: That's fair enough. Thank you.

MEMBER GOGLIA: Mr. Guzzetti?

MR. GUZZETTI: I just wanted to offer an unsolicited comment, but even though I express my uncomfortableness regarding the recommendation, Recommendation 13, I'm not uncomfortable at all with placing this as a contributing factor in this report.

As long as I've been writing proposed probable causes, in my mind, a contributing factor is something that if it was there, the accident wouldn't have occurred, and if this jackscrew assembly would have had some sort of mitigating device that would have handled the catastrophic effects of total acme nut thread loss, this accident wouldn't have happened.

So, I think that's a pretty compelling case to at least make it -- well, to make it a contributing factor, certainly not causal but contributing, and that's coming from a person that is uncomfortable with making a recommendation in that regard. So, I just wanted to offer that.

ACTING CHAIRMAN CARMODY: That goes to my point, Mr. Guzzetti, that I think the recommendations we can discuss, but I think this really needs to be in because it is what happened and it reflects this accident and that's what we're addressing here today.

MEMBER GOGLIA: Let me -- thinking out loud here. What's missing was a requirement to have a fail-safe mechanism and that requirement transcends MD-80s, although we're focused here on the MD-80.

MR. GUZZETTI: Actually, Member Goglia, there was a requirement, it wasn't this 1309 10 to the minus 9th, but there was a CAR 4b, I think it was. Back

then, it was -- just one moment here. 4b.606, Equipment Systems and Installations, and basically it said all equipment systems and installations shall be designed to safeguard against hazards to the airplane in the event of their malfunctioning or failure, and I think it even went on to state something regarding single-point failures. I'm trying to find it right now, but there was a requirement back then. It just wasn't as embellished and as detailed as the replacement requirement which was FAR Part 25-1309. So, I just wanted to make that clear. It just made reference to a probable -- any probable single-point failure.

The interpretation, Boeing interpreted -- they didn't feel it was probable to have a complete wear-out of the entire acme nut threads. They felt that the system was so robust, that you didn't even have to go there and be concerned about wear because even if you wore down 90 percent of the threads, you were still well above the safety margin, the structural safety margin.

What they did not consider was some mechanism where you could actually wear them all out.

MEMBER GOGLIA: Somebody totally disregarding the instruction for continued airworthiness and not

performing maintenance in any meaningful way over an extended period of time that led to the failure.

(Applause)

MEMBER GOGLIA: And I don't know how you could design any mechanical system to take that into effect.

MEMBER HAMMERSCHMIDT: Mr. Guzzetti, where is the information in the report that you just referenced?

MR. GUZZETTI: Page 41 of the factual report.

MEMBER HAMMERSCHMIDT: 41. Okay. This is a 315-page tome. So, it's hard to --

MEMBER GOGLIA: Don't forget all the submissions.

MEMBER HAMMERSCHMIDT: Yes.

(Pause)

MR. GUZZETTI: Actually, if I could just point out on the bottom of Page 39 is what I was trying to grapple for. It's CAR Section 4b.320(d), and it says, "Control Systems. Each adjustable stabilizer must have a means to allow any adjustment necessary for continued safety of flight after the occurrence of any reasonably-probable single-failure of the actuating system."

Now, this kind of goes into the whole argument about system versus structure. The FAA

testified that they didn't consider the acme nut as a system, they considered it structure which falls under this other regulation. Well, of course, staff vehemently disagreed with that and we felt that this control systems should have been considered, but the regulations were such that they were interpreted that it wasn't very clear. So, I just wanted to point that out.

MEMBER HAMMERSCHMIDT: Well, the reason I had asked is because I actually had highlighted something on this page, and I forgot what page it was in the factual part of the report. So, that answers that question.

ACTING CHAIRMAN CARMODY: Are there other comments on this?

(No response)

ACTING CHAIRMAN CARMODY: Are we ready to come to a decision about this? Do we need to have a break and a little more time?

MEMBER GOGLIA: Take a break.

ACTING CHAIRMAN CARMODY: Let's take a break. Come back in 10 minutes, please.

(Whereupon, a recess was taken.)

ACTING CHAIRMAN CARMODY: Let's take our seats, please. I'd like to get started again.

I think there have been a number of formulations suggested. I think Member Black has one more. So, let's ask you to read that, please.

MEMBER BLACK: Okay. If I can read through my strike-throughs, and I would like to ask counsel or someone first, is it approval or acceptance is the proper word?

MR. BATTOCCHI: If you look at the original draft, it makes a distinction between approval and acceptance. For purposes of FAA's rules, there is a distinction. I don't know that the Board needs to feel bound by that, but the FAA does differentiate between acceptance and approval. They use approval when they're looking for formal written blessing to something as opposed to acceptance which may be silent acquiescence. So, there is a distinction within the regulatory framework for approval and acceptance, and again, I don't think the Board needs to feel bound by it if it's using approval in a broader sense, but there is a distinction.

MEMBER BLACK: I guess I don't know which one to read now. I've got both.

MEMBER GOGLIA: We probably should read it acceptance.

MR. BATTOCCHI: On the way the original was

drafted, the end-play check is approval, and the --

ACTING CHAIRMAN CARMODY: Lubrication is acceptance.

MR. BATTOCCHI: -- extended lubrication was approval rather, and the end-play -- I'm sorry. The acceptance was the lubrication interval, and the end-play check was approval.

MEMBER BLACK: Okay.

MR. BATTOCCHI: Okay.

MR. CLARK: But we've gone through that a lot. That's the way it was originally written, but there is the global sense of approval, and I'm going to talk until I get in trouble, then Frank's going to be helping me out here.

On the escalation of the lubrication interval, there are specific requirements in there that are maintenance tasks, if they extend 10 percent, requires an approval. It can be accepted if it's less than 10 percent, but if it's greater than the manufacturing recommended interval, and it exceeds 10 percent, it requires approval.

Now, in this case, the manufacturing recommended value was 3,600 hours which was greater than 2,700. So, in that sense, it wouldn't require an acceptance, but that 3,600 came from an MSG-3 program,

and they were operating on the MSG-2 program. Somebody had to allow them to use the MSG-3. So, I think with all of that going on, they -- somewhere, there had to have been approval to work their way into that situation, but that whole situation, each step, I'm not clear.

ACTING CHAIRMAN CARMODY: Does it matter a lot?

MEMBER BLACK: Does it matter?

ACTING CHAIRMAN CARMODY: I think it's a distinction with no difference.

MEMBER BLACK: Okay. Let's make them both --

MR. CLARK: You're certainly free to use approval for both.

ACTING CHAIRMAN CARMODY: All right.

MEMBER BLACK: Thank you.

If I might, Madam Chairman? The National Transportation Safety Board determines that the probable cause of this accident was a loss of airplane pitch control resulting from the in-flight failure of the horizontal stabilizer trim system. I probably have a typo here. Horizontal stabilizer trim system jackscrew assembly acme nut threads. The thread failure was caused by an excessive wear resulting from Alaska Airlines insufficient lubrication of the

jackscrew assembly.

Contributing to the accident were: (1) Alaska Airlines extended lubrication interval and the FAA's approval of that extension which increased the likelihood that a missed or inadequate lubrication would result in excessive wear of the acme nut threads, (2) Alaska Airlines extension of the end-play check interval and the FAA's approval of that extension which allowed the excessive wear rate of the acme nut threads to progress to failure without opportunity for detection.

Contributing also was the absence on the MD-80 of a fail-safe mechanism to prevent the catastrophic effects of total acme nut thread loss.

ACTING CHAIRMAN CARMODY: Thank you, Member Black.

May I have a motion to adopt?

MEMBER BLACK: So moved.

ACTING CHAIRMAN CARMODY: And a second?

MEMBER HAMMERSCHMIDT: Second.

ACTING CHAIRMAN CARMODY: All in favor, say aye.

(Chorus of ayes)

ACTING CHAIRMAN CARMODY: Opposed?

(No response)

ACTING CHAIRMAN CARMODY: Unanimously carried.

Thank you for your cooperation on that.

(Applause)

ACTING CHAIRMAN CARMODY: Thank you. I know you all are interested. I'm going to have to ask you to hold your applause and let us have quiet because we have to proceed with our work.

Shall we go now to the Recommendations? Yes, Member Goglia? Good idea. Why don't we go clean up the Conclusions first since there were a number of those that were dependent on our action on the Probable Cause? All right.

MEMBER GOGLIA: 23.

ACTING CHAIRMAN CARMODY: 23.

MEMBER BLACK: Well, someone is supposed to be getting us wording on 17.

ACTING CHAIRMAN CARMODY: That's true. Well, 17 may not be complete yet. So, 23 can stay as it is, I guess.

MEMBER GOGLIA: 17 and 40 were -- we held for redraft.

ACTING CHAIRMAN CARMODY: Hm-hmm.

MEMBER GOGLIA: 23 was the first we turned to.

ACTING CHAIRMAN CARMODY: Yeah. But that was -- that's moot. So, we don't need -- and 27 was -- can stay as it is. I have 30.

Yes, Dan?

MR. CAMPBELL: Madam Chairman, 23, when you say stays as it is, I believe that you had suggested a modification as the last sentence there was FAA's contributing. So, you mean stay as it is modified as earlier suggested.

ACTING CHAIRMAN CARMODY: No. Stays as it is here because of what we did in Probable Cause.

MR. CAMPBELL: Well, microphone.

ACTING CHAIRMAN CARMODY: Sorry. Stay as it is written because of how we handled the Probable Cause.

MR. CAMPBELL: As written, it has the Federal Aviation Administration as a contributing factor.

ACTING CHAIRMAN CARMODY: I know. That's what we just did with the Probable Cause, and the same with 27, and I have 30. Was there going to be -- there was going to be some redrafting on 30 as well, wasn't there?

MEMBER GOGLIA: Yes.

ACTING CHAIRMAN CARMODY: If it's not ready yet, that's fine, but is by chance the redrafting on 30

available? No? Okay. Well, we'll catch that later then. Then I have 39.

MEMBER GOGLIA: That one's okay, too.

ACTING CHAIRMAN CARMODY: That one's okay. All right. Well, I guess we didn't have as much cleaning up as we thought. We still have two outstanding for redrafting.

MEMBER GOGLIA: Wait a minute. There's one I would like to --

DR. ELLINGSTAD: Excuse me, Madam Chairman. I believe both 23 and 27 are stated the way that they are written with Alaska as direct cause, and I believe that the Probable Cause that the Board just voted on has Alaska as contributing for both of those rather than as cause.

ACTING CHAIRMAN CARMODY: Well, let's look at the -- well, no. We said the insufficient lubrication, Alaska Airlines insufficient lubrication was the primary. So, that's not inconsistent with what's written on 23.

MEMBER BLACK: 27.

ACTING CHAIRMAN CARMODY: I think 23's fine.

MEMBER BLACK: 27, no.

ACTING CHAIRMAN CARMODY: I'm sorry? Yes?

MR. CLARK: The intent of putting in -- it

says the -- it says, "Therefore, was a direct cause of the excessive wear". That was going to a causal statement rather than --

ACTING CHAIRMAN CARMODY: Is there a suggestion for change? I'm kind of lost here.

MEMBER GOGLIA: We've got to slow down. We've got too much going on.

ACTING CHAIRMAN CARMODY: I know.

MR. CLARK: I think it'll stay.

ACTING CHAIRMAN CARMODY: I thought so.

MR. CAMPBELL: Madam Chairman, that conclusion is the extension of the lubrication interval which was then changed to contributing, and in this instance, it is listed as direct. So, to match the Probable, that would be a contributing factor.

ACTING CHAIRMAN CARMODY: Okay, okay. Could someone reformulate that for us, please? I take your point. And 27, the same, so it matches the Probable Cause. Okay.

MR. CLARK: I think one thing we're talking with our writers is that this comment about direct cause of excessive wear is in and of itself accurate and doesn't necessarily go to saying that entire thing is causal to the accident. It's a direct cause of the excessive wear which can be contributing.

MEMBER GOGLIA: Which one are we talking about?

MR. CLARK: We're on 23, Line 19, right now, but 27 is the same.

MEMBER GOGLIA: One at a time.

ACTING CHAIRMAN CARMODY: Okay.

MEMBER GOGLIA: We got too much.

ACTING CHAIRMAN CARMODY: Let me suggest something. Since we've agreed on the Probable Cause and we know what that language is, could we ask staff to make recommendations, 23 and 27, consistent with the Probable Cause rather than us doing it here? I think we all know what we intended, but rather than craft it in public, it might be easier if you would redraft those two consistent with the Probable Cause.

MR. CLARK: We're working on it now.

ACTING CHAIRMAN CARMODY: Since you're smarter than we are at this point. Okay. So, that's 23 and 27. Now, --

MEMBER GOGLIA: 39 and 41.

ACTING CHAIRMAN CARMODY: -- 39. Hmm. Well, that's consistent with the Probable Cause. Okay. So, that's okay. All right. And you mentioned 41.

MEMBER GOGLIA: And they were going to reword that.

ACTING CHAIRMAN CARMODY: 41 was going to be reworded, is that it? Oh, 40 was going to be reworded.

MEMBER GOGLIA: 40. You're right. Reading the wrong one.

ACTING CHAIRMAN CARMODY: 40. Okay. So, reword 40.

MEMBER BLACK: 41 is an independent decision.

ACTING CHAIRMAN CARMODY: 41's --

MEMBER BLACK: Probable Cause.

ACTING CHAIRMAN CARMODY: Okay.

MEMBER GOGLIA: We're going to fold that into Recommendations.

ACTING CHAIRMAN CARMODY: I think you're right. All right. So, no.

MEMBER GOGLIA: So, 41, we hold.

ACTING CHAIRMAN CARMODY: 41, we hold. 23, 27, 39, and 41.

MEMBER HAMMERSCHMIDT: My memory may be a little short here, but I was thinking that on 41, we had considered maybe substituting all transport category aircraft instead of those models that are listed. I think, wasn't that the option that we were debating over?

MEMBER GOGLIA: That's one.

ACTING CHAIRMAN CARMODY: I don't know if we

were agreeing they all should be modified. Maybe they should be --

MEMBER GOGLIA: Well, if you say one shipment, --

MR. CLARK: I think where we were at on our discussions on that was that we need the -- usually what we do is we identify the model that's particularly a problem and then follow on almost immediately with the second recommendation to do the any and all, check the rest of the fleet, and so this finding would be that -- should be modified and then the second -- the next one should be, if that's the appropriate place it falls out, would be some way -- there'd be a finding to address that we have concern about the rest of the fleet or something, and I think Jeff is pretty close to that. Either Jeff or George have the set-up of language for that, for the more --

ACTING CHAIRMAN CARMODY: You have some expansive language, Member Black, I do believe.

MEMBER BLACK: I do, but I got it from you, John.

ACTING CHAIRMAN CARMODY: All right. Well, whoever has it, let's --

MR. CLARK: I don't have a copy right now.

ACTING CHAIRMAN CARMODY: I've got it in

front of me. 39. Why don't you -- 40? Here we are. Sorry.

MR. CLARK: We did have that in the language on the page changes that came up December 6th. It's the very last page. It says, "Possible new recommendation." It says to add it between 13 and 14, and the text would be, "The Safety Board also believes that the FAA should evaluate the horizontal trim system of all transport category airplanes that employ a single-actuating assembly to identify any designs that have a catastrophic single-point failure mode and for any such systems identify means to eliminate that catastrophic effect of that single-point failure mode and require that such fail-safe mechanisms be incorporated into the design of all existing and future airplanes that are equipped with such horizontal trim systems."

ACTING CHAIRMAN CARMODY: Now, you're reading a recommendation.

MR. CLARK: Yeah. But the finding could be --

ACTING CHAIRMAN CARMODY: Could be the same. Okay.

MR. CLARK: -- very similar.

ACTING CHAIRMAN CARMODY: Do we have --

MEMBER HAMMERSCHMIDT: I have Member Black's suggestion on Finding 41 that supports the recommendation. I mean, that would be corresponding to the recommendation you were -- do you have this?

ACTING CHAIRMAN CARMODY: I don't see that that supports what he just said.

MEMBER HAMMERSCHMIDT: Okay.

MEMBER GOGLIA: In this package?

MR. CLARK: What page are we on?

MEMBER HAMMERSCHMIDT: 8.

MR. CLARK: The -- his 41 is okay in the sense of going global, but it says if found necessary, and of course, we believe that it is necessary for the DC-9 series. So, if that were broken up into two separate ones and leave 41 the way it was and then start in and say -- I would say the if found necessary on other transport category airplanes -- if found necessary, other transport category airplanes should be modified to ensure. So, basically break it up into two and keep them separate.

MEMBER GOGLIA: I like George's version.

ACTING CHAIRMAN CARMODY: I think Mr. Clark's point about the if found necessary is important. We should strike that, I think.

MR. CLARK: Or the other way to do that is do

the DC-9 and other transport category aircraft, if necessary. Isolate the if necessary to the other transport categories.

ACTING CHAIRMAN CARMODY: Okay. All right. So, Douglas DC-9, McDonnell-Douglas and Boeing 717 series airplanes and other transport category aircraft, if necessary. Would that be what you -- or as necessary?

MR. CLARK: In a sense, that doesn't explicitly isolate the two, but --

ACTING CHAIRMAN CARMODY: Hm-hmm.

MR. CLARK: -- it still -- the language would still incorporate both.

ACTING CHAIRMAN CARMODY: Okay.

MR. CLARK: Now, you can move the if necessary to the front of that and talk about the DC-9 series airplane and, if necessary, other transport category, that would isolate it.

ACTING CHAIRMAN CARMODY: Okay. Okay. So, we have one revised 41.

MEMBER GOGLIA: We have three versions that he just proposed.

ACTING CHAIRMAN CARMODY: Okay. Mr. Clark, would you read your latest proposal and let's see if we can agree on that? 41 as revised, starting with

Douglas DC-9, etc.

MR. CLARK: 41, I believe we have now, is just a slight modification from the one from Member Black. It says, "Douglas DC-9, McDonnell-Douglas MD-80/90 and Boeing 717 series airplanes and, if found necessary, other transport category aircraft should be modified to ensure that the loss of the horizontal stabilizer trim system jackscrew assembly acme nut threads or other control assembly does not preclude continued safe flight and landing."

MEMBER BLACK: You might want to work on the language there because the others don't have acme nuts. Some of them don't.

MR. CLARK: Well, okay. We said horizontal trim system acme nut threads or other control assembly. You had that in there.

MEMBER BLACK: I put it in, but does that cover it? I mean, is that adequate wording, John?

MR. CLARK: Well, we always think so. Now, when we get our responses back from FAA, we're surprised sometimes that we weren't careful enough.

ACTING CHAIRMAN CARMODY: Let's assume it does.

MR. CLARK: But it makes sense to us right now.

ACTING CHAIRMAN CARMODY: It makes sense to me.

May I have a motion on -- well, wait a minute. We ought to adopt all of them. So, that's revised 41. I think that's the last of the Findings, other than 23, 27 and 40, which are being reworked right now.

MR. CLARK: Okay. If we can take on 23 and 27, --

ACTING CHAIRMAN CARMODY: All right.

MR. CLARK: Let's see. I've lost my place.

ACTING CHAIRMAN CARMODY: Okay.

MEMBER GOGLIA: 17.

ACTING CHAIRMAN CARMODY: You're right.

MEMBER GOGLIA: 17, 40 --

ACTING CHAIRMAN CARMODY: You're right, you're right.

MEMBER GOGLIA: -- are being circulated for rewrite.

MEMBER BLACK: Circulating? Okay.

ACTING CHAIRMAN CARMODY: Yeah. They were going to do it after --

MR. CLARK: We have a little more concern on 17, but first, on 23, I think we can essentially on the top of 23 put in that -- and we talk about Alaska

Airlines extension of the lubrication and the FAA's acceptance. Then everything stays the same. Even the word, was a direct cause of the excessive wear that led to the accident, and what we can say was a direct cause of the excessive wear and contributed to the accident and that could -- puts the connotation of contributing into --

ACTING CHAIRMAN CARMODY: All right.

MR. CLARK: Is the direct cause of the excessive wear and just simply contributed to the --

ACTING CHAIRMAN CARMODY: All right.

MR. CLARK: And then everything else would stay the same, and then basically we have quite a similar situation --

MEMBER GOGLIA: Wait, wait, wait. Don't go on. Read that one to me one time.

MR. CLARK: I was going to try to bluff my way through it. All right. The -- okay. Let me see if I have it. Okay.

"Alaska Airlines extension of the lubrication interval and FAA's acceptance of the interval extension for its McDonnell-Douglas MD-80 horizontal stabilizer components, the last of which was based on Boeing's extension of the recommended lubrication interval, increased the likelihood that a missed or inadequate

lubrication would result in excessive wear of jackscrew assembly acme nut threads and therefore was a direct cause of the excessive wear and contributed to the Alaska Airlines Flight 261 accident.

The Federal Aviation Administration's acceptance of those extensions was a contributing factor."

ACTING CHAIRMAN CARMODY: Why would you need the last sentence if you have it in the first part?

MR. CLARK: I'm sorry.

ACTING CHAIRMAN CARMODY: Strike it.

MR. CLARK: You're right.

ACTING CHAIRMAN CARMODY: Okay. All right.

MR. CLARK: Yep.

ACTING CHAIRMAN CARMODY: Okay. Because that squares with the Probable Cause, and I think with 27, we can do the same thing.

MR. CLARK: Right.

ACTING CHAIRMAN CARMODY: Alaska Airlines extension and FAA's approval of that extension allowed the accident, etc., etc. Strike the last sentence.

MR. CLARK: I said acceptance in 23. I lost track. Are we going to go with approval in both or --

ACTING CHAIRMAN CARMODY: Whatever we do, let's just make a decision and go with it.

MR. CLARK: Approval, we believe, is the appropriate word.

ACTING CHAIRMAN CARMODY: Okay. Well, I'm really not of a strong mind on that. All right.

MEMBER GOGLIA: Wait a minute. How is the extension of the time a cause of excessive wear? Extension of the end-play check interval was a direct cause of the excessive wear.

MR. CLARK: Well, you need both a high wear rate and time and the extension of the time allowed the excessive wear to occur.

MEMBER GOGLIA: Read it, John. Let's hear it. Let's hear it. Read it aloud and see if you -- 27.

ACTING CHAIRMAN CARMODY: I can read it, if you'd -- okay.

MR. CLARK: No. I just wanted to add in a few notes here.

ACTING CHAIRMAN CARMODY: Okay.

MR. CLARK: And okay. "Alaska Airlines extension of the end-play check interval and FAA's approval of the extension allowed the accident acme nut threads to wear to failure without the opportunity for detection and therefore was a direct cause of the excessive wear that led to -- was a direct cause of the

excessive wear and contributed to the Alaska Airlines Flight 261 accident."

MEMBER GOGLIA: Do we really need anything after detection?

MR. CLARK: Well, we usually in the Findings identify those particular findings that go to cause or go to contributing.

MEMBER GOGLIA: I'll defer to everybody else on that.

ACTING CHAIRMAN CARMODY: Okay. Let me suggest that we -- oh, John has one. Yes. You go ahead and then we'll --

MEMBER GOGLIA: I have one at the end and it's Number 44. "At the time of the Flight 261 accident, Alaska Airlines Maintenance Program had widespread systemic deficiencies, some of which have apparently not been corrected."

I'm not particularly comfortable with some of which have not been corrected in there. Is that --

ACTING CHAIRMAN CARMODY: Just strike it.

MEMBER GOGLIA: Just strike it there. Right after the deficiencies, put a period instead of a comma.

ACTING CHAIRMAN CARMODY: Let me suggest on the Conclusions that we vote on them with the

understanding that 17 and 40, we agreed to in principle and they're being drafted, and we will see the language, but -- and with the corrections we have noted as we've gone through today.

So, if I could have a motion on the Conclusions? Yes, Member Hammerschmidt?

MEMBER HAMMERSCHMIDT: I just wanted to make sure we're clear on Finding 44.

MEMBER GOGLIA: Period after deficiencies.

MEMBER HAMMERSCHMIDT: Okay.

MEMBER BLACK: Okay. We'll take care of it in the Recommendations.

MEMBER GOGLIA: All right. 41, we were holding 41 until we --

ACTING CHAIRMAN CARMODY: 41 was redrafted with George's formulation, I thought.

MEMBER BLACK: Yes.

ACTING CHAIRMAN CARMODY: Yeah. We agreed to that.

MEMBER GOGLIA: Okay. That's right.

ACTING CHAIRMAN CARMODY: Yeah. Okay? All right. May I have a motion?

MEMBER GOGLIA: I make a motion that we accept the Conclusions as modified with the understanding that Number 17 and Number 40 in the draft

report are to be rewritten by staff and circulated for members' concurrence.

ACTING CHAIRMAN CARMODY: Right.

MEMBER GOGLIA: Did I miss anything?

ACTING CHAIRMAN CARMODY: No. You said as modified and you mentioned those two. Second?

MEMBER HAMMERSCHMIDT: Second.

ACTING CHAIRMAN CARMODY: All in favor?

(Chorus of ayes)

ACTING CHAIRMAN CARMODY: Opposed?

(No response)

ACTING CHAIRMAN CARMODY: Conclusions are carried.

Now for the Recommendations. There are quite a few of these and I want to propose a new one. This is John's. Okay. I'll let John do this one when we get to it. This is yours. Yeah.

Okay. I am going to read it. There are 13 of these. They are all for the FAA. I will read them and I'm sure my colleagues will stop me as we go through with modifications or corrections.

Number 1. Issue of Flight Standards Information Bulletin directing air carriers to instruct pilots that in the end of an inoperative or malfunctioning flight control system, if the airplane

is controllable, they should complete only the applicable checklist procedures and should not attempt any corrective actions beyond those specified.

In particular, in the event of an inoperative or malfunctioning horizontal stabilizer trim control system, after final determination has been made in accordance with the applicable checklist that both the primary and alternate trim systems are inoperative, neither the primary nor the alternate trim motors should be activated, either by engaging the autopilot or using any other trim control switch or handle. Pilots should further be instructed that if checklist procedures are not effective, they should land at the nearest suitable airport.

MEMBER BLACK: I assume we're talking about DC-9 series here?

ACTING CHAIRMAN CARMODY: Well, it's not specific in the recommendation, but I would assume. Do we need to specify?

MEMBER BLACK: Maybe we should say that. Shouldn't we, John?

ACTING CHAIRMAN CARMODY: Although --

MEMBER BLACK: This is talking about DC-9 MD-80 series, is it not?

MR. CLARK: Well, I don't see that it is

exclusive of any airplane out there.

MEMBER BLACK: Okay. All right.

ACTING CHAIRMAN CARMODY: All right. I think it's a generic caveat.

MEMBER BLACK: Is that okay, David? Captain Ivey?

MR. IVEY: I think that would apply to all aircraft.

MEMBER BLACK: Okay.

ACTING CHAIRMAN CARMODY: Okay. 2. As part of the response to Safety Recommendation A0141, those were one of the ones we made earlier to the FAA, as part of that recommendation, require operators of Douglas DC-9, McDonnell-Douglas MD-80/90, and Boeing 717 series airplanes to remove used grease from the jackscrew assembly acme screw and flush degraded grease and particulates from the acme nut before applying fresh grease.

Number 3.

MEMBER BLACK: Madam --

ACTING CHAIRMAN CARMODY: Yes?

MEMBER BLACK: Madam Chairman?

ACTING CHAIRMAN CARMODY: Hm-hmm?

MEMBER BLACK: Dr. Kolly, isn't the correct word "worn grease" and not used grease?

MR. KOLLY: I believe both of those -- we're talking about grease that needs now renewal. So, however you want to call it, whether you want to call it worn or used, degraded.

MEMBER BLACK: Degraded might actually be better. Let's use degraded because that's really what it is. It's lost its capabilities and it's contaminated with particles, right?

MR. KOLLY: That's right.

MEMBER BLACK: If you don't mind, let's use degraded.

ACTING CHAIRMAN CARMODY: Degraded. Okay.

3. As part of the response to Safety Recommendation A0141, require operators of Douglas DC-9, McDonnell-Douglas MD-80/90, and Boeing 717 series airplanes in coordination with Boeing to increase the size of the access panels that are used to accomplish the jackscrew assembly lubrication procedure.

Number 4.

DR. DOWNS: If feasible, I think we should put in there. I mean, this is a monumental task. Doors and access panels on airplanes are not easy. It's not just a simple case of hacking the hole a little larger and putting a bigger piece of aluminum over it.

MR. GUZZETTI: Actually in this case, you know, and we have some communication with Boeing that they're already doing this, that one panel where the banana fairing is, it just has a hinged -- it's a fiberglass. It has a hinge on it and they'll just be able to cut out a larger panel and put a hinge on it. So, they telegraphed to us that they're going to be doing it anyway.

ACTING CHAIRMAN CARMODY: I would think we could go ahead and make the recommendation. If it turns out the FAA finds it obsessive or excessive, they can let us know. Okay.

4. Establish the jackscrew assembly lubrication procedure as a required inspection item that must have an inspector sign-off before the task can be considered complete.

Number 5. Review all existing maintenance intervals for tasks that could affect critical aircraft components and identify those that have been extended without adequate engineering justification in the form of technical data and analysis demonstrating that the extended interval will not present any increased risk and require modifications of those intervals to ensure that they (1) take into account assumptions made by the original designers, (2) are supported by adequate

technical data and analysis, and (3) include an appropriate safety margin that takes into account the possibility of missed or inadequate accomplishment of the maintenance task.

In conducting this review, the FAA should also consider original intervals recommended or established for new aircraft models that are derivatives of earlier models, and if the aircraft component and the task are substantially the same and the recommended interval for the new model is greater than that recommended for the earlier, treat such original intervals for the derivative model as extended intervals.

That is a complicated one.

6. Conduct a systematic industry-wide evaluation and issue a report on the process by which manufacturers recommend and airlines establish and revise maintenance task intervals and make changes to the process to ensure that in the future, intervals for each task (1) take into account assumptions made by the original designers, (2) are supported by adequate technical data and analysis, and (3) include an appropriate safety margin that takes into account the possibility of missed or inadequate accomplishment of the maintenance task.

7. Require operators to supply the FAA before the implementation of any changes in maintenance task intervals that could affect critical aircraft components, technical data and analysis for each task demonstrating that none of the proposed changes will present any potential hazards, and obtain written approval of the proposed changes from the principal maintenance inspector and written concurrence from the appropriate FAA aircraft certification office.

8. Pending the incorporation of a fail-safe mechanism in the design of the Douglas DC-9, McDonnell-Douglas MD-80/90, and the Boeing 717 horizontal stabilizer jackscrew assembly, as recommended in Recommendation 13, (a) establish an end-play check interval that (1) accounts for the possibility of higher-than-expected wear rates and measurement error in estimating acme nut thread wear, and (2) provides for at least two opportunities to detect excessive wear before a potentially catastrophic wear condition becomes possible, and (b) until such a scientifically-based interval is determined, immediately establish an end-play check interval that is appropriately more conservative than the 2,000 flight hours.

MEMBER GOGLIA: Don't go on.

ACTING CHAIRMAN CARMODY: I'm not. I was

waiting for your intervention.

MEMBER GOGLIA: Yes. Again, I need to digest the changes that were given to us.

ACTING CHAIRMAN CARMODY: Yes. Pending the incorporation of a fail-safe -- establish an interval -- I have the change page.

MEMBER GOGLIA: Well, I guess I would say here that I disagree with more conservative than 2,000. I think 2,000 hours in conjunction with the 650-hour grease cycle and the inspections that go with that 650-hour cycle, at least in the interim until we do (a) in this, certainly would provide us with enough safety margin.

ACTING CHAIRMAN CARMODY: I'm sorry. We're trying to figure out what page that was. What -- did you make a suggestion, John, that I didn't hear?

MEMBER GOGLIA: I just said I don't agree with (b).

ACTING CHAIRMAN CARMODY: And that's (b) being until such time as an interval is determined, immediately establish an end-play check interval appropriately more conservative. Would you suggest what?

MEMBER GOGLIA: I think we have to defer to the FAA's folks and what they did with the 650-hour

grease job with the inspection, the AD Notice essentially, until they can --

ACTING CHAIRMAN CARMODY: Well, are we saying --

MEMBER GOGLIA: -- accomplish a --

DR. ELLINGSTAD: Excuse me. Again, Member Goglia, this relates to the fact that there is considerable uncertainty about the reliability and validity of the end-play measure. We're awaiting the results of validity studies and reliability studies that Boeing has underway. So, again staff feels that this approach to condition this recommendation on the conclusion of that scientific research is a conservative and a cautious method to make sure that there is an opportunity to catch excessive wear if it does in fact happen and if there is an inspection that is improperly performed or not performed at all.

So, it's conditional on the completion of that work that we know is in progress and we're expecting to see some results from.

MEMBER GOGLIA: And you started that conversation with the considerable concern or -- I mean, we're basing this, unless I missed something that was said, we're basing this on the wear of one or two jackscrews.

DR. ELLINGSTAD: No, sir. We're basing this on the results of all of the data that we have seen from repeated end-play measurements that have come in in response to the AD and all of the data that we have looked at has produced highly-variable results and a relatively low correlation between successive intervals and also a very low correlation between on-wing and bench end-play measures and no results from any other kind of a direct measure of wear.

MEMBER GOGLIA: I still don't -- we're cutting it essentially in half, the time between end-play checks. The FAA has done that already and essentially we're saying that's not adequate and I disagree. So -- well, how do you want to handle this?

I will make a motion that we strike (b) and now we can have a discussion on the motion and move forward and deal with it.

ACTING CHAIRMAN CARMODY: Is there a second to the motion?

MEMBER BLACK: Second.

ACTING CHAIRMAN CARMODY: All in favor?

(Chorus of ayes)

ACTING CHAIRMAN CARMODY: Okay. All right. The ayes have it.

MEMBER GOGLIA: Okay.

ACTING CHAIRMAN CARMODY: Okay. Moving on to Number 9, and I seem to have the latest package you sent, John. I'm reading from it, and the others don't seem to have it. The changes are not large. I'll read what I have.

Number 9. Require operators to permanently (1) track end-play measures according to airplane registration number and jackscrew assembly serial number, (2) calculate and record average wear rates for each airplane based on end-play measurements and flight times, and (3) develop and implement a program to analyze these data, to identify and determine the cause of excessive or unexpected wear rates, trends or anomalies.

The FAA should also require operators to report this information to the FAA for use in determining and evaluating an appropriate end-play check interval.

MEMBER GOGLIA: That's fine.

ACTING CHAIRMAN CARMODY: Okay. 10. Require that maintenance facilities that overhaul jackscrew assemblies record and inform customers of an overhaul jackscrew assembly end-play measurement.

11. Require operators to measure and record the on-wing end-play measurement whenever a jackscrew

assembly is replaced.

12. Require that maintenance facilities that overhaul jackscrew assemblies obtain specific authorization beyond a Class 1 accessory rating to perform such overhauls, predicated on demonstrating that they possess the necessary capability, documentation, and equipment for the task, and that they have procedures in place to (1) perform and document the detailed steps that must be followed to properly accomplish the end-play check procedure and lubrication of the jackscrew assembly, including specification of appropriate tools and grease types, (2) perform and document the appropriate steps for verifying that the proper acme screw thread surface finish has been applied, and (3) ensure that appropriate packing procedures are followed for all returned overhauled jackscrew assemblies, regardless of whether the assembly has been designated for storage or for shipping.

MEMBER BLACK: Question on that one.

ACTING CHAIRMAN CARMODY: Yes.

MEMBER BLACK: Are we talking about ball jack screws or just acme jackscrews?

MR. GUZZETTI: When the Systems Group did their evaluation to come up with this rec, in my mind,

it just addressed acme screws because there, you have an issue involving surface finish and we --

MEMBER BLACK: I think you're right. It just doesn't say that and we found in looking at this information that a lot of people use the word jackscrew and ball jackscrew interchangeably. So, it might not -- we might ought to say acme jackscrew if that's what we're talking about.

MR. GUZZETTI: Or we could just specify the airplane model.

MEMBER BLACK: Or the DC-9 series. Yeah.

MR. GUZZETTI: In my mind, we meant it to be for the DC-9, MD-80/90 and 717 series only.

MR. CLARK: Which is to say, that overhauled DC-9 series or DC-9 type?

MEMBER BLACK: Whatever the right terminology is.

MR. CLARK: DC-9 series and that should include the MD-80s, the 717s.

ACTING CHAIRMAN CARMODY: Okay. So, what -- let's -- require -- how does that read now?

MR. CLARK: Just in the first line, it says require that maintenance facilities that overhaul DC-9 series jackscrew assemblies and the implication there, I suppose we could add MD-80 and 717 like we have

elsewhere, but --

MEMBER BLACK: Aren't they all theoretically DC-9s and MD-80 is a -80?

MR. CLARK: I would think so.

ACTING CHAIRMAN CARMODY: All right.

MEMBER GOGLIA: There's a -50 in there, too. DC-910, 15, 20, 30, 50, 80, 90, and I don't think it changed until we went to the 717.

MR. CLARK: We can easily add the DC-9, MD-80 and 717 series and just -- we have other language down below that's quite similar in 13. We'll just carry that.

ACTING CHAIRMAN CARMODY: Okay.

MR. CLARK: Sure.

MEMBER GOGLIA: And before we move on, Mr. Guzzetti, --

MR. GUZZETTI: Yes, sir?

MEMBER GOGLIA: -- Class 1 accessory rating. I'm going by memory here. There is nothing today that's beyond that, is there?

MR. GUZZETTI: No, there isn't. You're correct.

MEMBER GOGLIA: And then, that would require a rule change which, by the time that's done, this fleet type will be beer cans.

MR. GUZZETTI: I would hope that you wouldn't have to do a rule change. Maybe it could simply be -- well, if you're going to require maintenance facilities obtain specific authorization, it could be -- I don't know the answer to that, Member Goglia. It could be some sort of inspector's handbook guideline or something.

MEMBER GOGLIA: Not binding. We need to look at that.

MR. CLARK: What's -- what we've asked for is to require and we always run into this with FAA that when they see require, that requires an AD and we've repeatedly told them we're using the more generic require and however they can make that happen, we'd be perfectly happy with, and so --

MEMBER GOGLIA: Well, we're saying the stuff in paren, the verbiage in paren is what's going to get us in trouble.

ACTING CHAIRMAN CARMODY: Should we strike it? Strike the paren?

MEMBER GOGLIA: At least we need to strike the paren.

ACTING CHAIRMAN CARMODY: Strike the paren.

MR. GUZZETTI: Yeah. Striking the parens would probably be the best bet for that.

ACTING CHAIRMAN CARMODY: Okay. Let's fix that one.

MR. GUZZETTI: Ms. Weinstein suggested that, also.

ACTING CHAIRMAN CARMODY: Good. Great minds. Okay.

13. Conduct a systematic engineering review of the Douglas DC-9, McDonnell-Douglas MD-80/90, and Boeing 717 series airplanes to identify means to eliminate the catastrophic effects of total acme nut thread failure in the horizontal stabilizer trim system jackscrew assembly and require that such fail-safe mechanisms be incorporated in the design of all existing and future DC-9, MD-80 and 717 series airplanes and their derivatives.

MEMBER GOGLIA: Again, we go back to all the airplanes that have the same acme nut and there are a considerable number. We've excluded those. I think that we should not mention the airplane type in this recommendation but mention the jackscrew type since it's to the FAA, we'd like them to look at all of the airplanes that have this system or similar system, and maybe we should talk about the recirculating ball, but at the very least, we need to talk about all the airplanes that have the acme nut installed on the

airplane, not single out these group.

ACTING CHAIRMAN CARMODY: I do have a recommendation, a new recommendation that I guess came from Mr. Clark.

MR. CLARK: It grew out of Member Black's concern of how we broaden this and part of this for 13 still is -- usually we issue the recommendations for the things that we really have a handle on and then issue the more global recommendations to study here.

MEMBER GOGLIA: I have so much paper now.

ACTING CHAIRMAN CARMODY: I know. This is John's paper. Do we want to talk about this proposal?

MEMBER BLACK: We could leave this one and then put in the other one.

ACTING CHAIRMAN CARMODY: Well, that was what I thought we were doing.

MEMBER HAMMERSCHMIDT: Well, I'm thinking like Member Goglia here. I had looked over Member Black's revisions yesterday and he had quite a revision on this one, and then I tweaked it some more from an editorial standpoint and came up with this for another option, and it would read: conduct a systematic engineering review of all transport category airplanes to identify means to reduce the maximum extent possible the catastrophic effects of a system or associated

structure failure in the horizontal stabilizer trim control system and, if necessary, require that such fail-safe mechanisms be incorporated in the design of all existing and future transport category airplanes.

MEMBER BLACK: I like it.

MEMBER GOGLIA: I like it as well.

ACTING CHAIRMAN CARMODY: That's good.

MEMBER HAMMERSCHMIDT: Okay.

ACTING CHAIRMAN CARMODY: Any comments?

MEMBER GOGLIA: Second.

ACTING CHAIRMAN CARMODY: Are there any comments from staff we should be aware of? This sounds good to us.

MEMBER HAMMERSCHMIDT: That would be to replace 13. It's a double modification of 13. It's Member Black's substitution and then my editing of his substitution.

ACTING CHAIRMAN CARMODY: Hammerschmidt.

MEMBER HAMMERSCHMIDT: Amend the amendment.

MR. CLARK: I think the -- what it does leave open is that what we want out of 13 -- wanted out of 13 is specific efforts in the MD-80 because we have had the failure there, and the one thing I saw in 13 was that we had left out -- we say require and for existing, we should have the practicable in there, but

what I see that -- and I'm not sure I heard everything in what you read, is that, it leaves it really open for any and all airplanes out there, and I guess our preference was to -- of course, that's certainly, you know, the Board's prerogative, but our preference was to directly deal with the MD-80 airplane and then, if those design deficiencies were found on other airplanes, to include those. So, and again, I may have misheard or not totally absorbed.

MEMBER HAMMERSCHMIDT: Well, I was trying to incorporate all transport category airplanes, which is essentially what Member Black had done, other than the fact that I tweaked his language a bit. Let me read it again just for --

MR. CLARK: Okay.

MEMBER HAMMERSCHMIDT: -- the sake of repeat here. Conduct a systematic engineering review of all transport category airplanes to identify means to reduce to the maximum extent possible the catastrophic effects of a system or associated structure failure in the horizontal stabilizer trim control system and, if necessary, require that such fail-safe mechanisms be incorporated in the design of all existing and future transport category airplanes.

MR. CAMPBELL: If I might try and explain the

difficulty we're having at the table with that formulation? It's the term "if necessary" which we think would be appropriate for all category of aircraft, except that which we're looking at here. For the group that we've actually identified in this accident, we think that the "if necessary" has already been determined and that we would like to proceed to the fail-safe mechanism, and so by lumping them all together, that if necessary seems to put back into play whether or not this particular category of aircraft needs that fail-safe mechanism.

MEMBER HAMMERSCHMIDT: I thought I heard Mr. Clark just say that he would insert "if practical" at some point in there.

MR. CLARK: Well, that's different than if necessary and again that still directs to DC-9 MD-80 series airplanes.

MEMBER HAMMERSCHMIDT: Okay. Well, if practical is all right with me. I was just using the language that Member Black had utilized. So, if practical works.

MR. CLARK: Okay. Then the only other issue or the one thing I saw in there is that I still think the language where we had originally had it eliminate the catastrophic effects because in a sense, how do you

reduce to the maximum extent possible a catastrophic? It's kind of either catastrophic or you've eliminated the catastrophic effect. You can't have probably half a catastrophic --

MEMBER HAMMERSCHMIDT: I was satisfied with that word "eliminate", but I was talking to someone in the Office of Aviation Safety who said, "Well, how can you actually eliminate something conclusively?" So, I was -- it wasn't the people at this front table, but I was taking a lead on that alternate language from someone from your office.

ACTING CHAIRMAN CARMODY: Why don't we return to "eliminate"?

MEMBER HAMMERSCHMIDT: Okay. I know it's a subtle point, I think.

MR. CLARK: No. It's a fair point to say we're never certain in the sense to eliminate that. That's the goal. That's what we strive for, is to eliminate it, get it -- take it off the table, and I think that language is clear.

MEMBER HAMMERSCHMIDT: It's certainly more concise.

MR. CLARK: I think so, also.

MEMBER HAMMERSCHMIDT: That's fine.

MR. CLARK: Okay. Let me -- okay. I think

the -- I guess we'd have to just take a quick look. The -- what I was going -- in the way this is, I think what you -- you've added other language about jackscrews and other control structure which I think is appropriate if we're going to expand it.

What I think is that it's -- for existing designs, if practical, and of course, we want it for future designs. It's a little hard without seeing it written. You have to really sit down, but -- well, I think the -- okay. It's still easier to us to separate them, but if we're going to combine them, I guess we need to see it written out, but the gist of what we're after seems --

ACTING CHAIRMAN CARMODY: Let this be one that we kind of agree in principle but you will redraft it and circulate it to us. How does that sound?

MR. CLARK: Okay. All right.

ACTING CHAIRMAN CARMODY: And we'll take another look at it because I think there are some subtleties here we might need to consider.

MR. CLARK: Okay. On the whole of it, I think it's pretty good. It seems to get to where we want to go, but, you know, I can't -- it's hard to sort out the loopholes in it that we don't intend to be in there.

MEMBER BLACK: Well, I was trying to catch some of that business between system and structure, you'll notice, which is --

MR. CLARK: Yeah.

MEMBER BLACK: Just so that we wouldn't have that problem happen again. It is clumsy-sounding.

MR. CLARK: Yeah. It's a fair observation.

MEMBER GOGLIA: I think the sense of the Board is that we want to combine all the airplanes that have this system in it. We want to ask the FAA to take a look at all of them. I don't think it makes sense to ask them to look at them one-by-one-by-one. I think in the broad sense, that they should bring all the parties together and they should look at this issue globally, as you said, and not pick the one fleet type today and defer any work on the rest of it for -- as we often see months or years. I'd like the FAA to sit and address this in a timely way, all the airplanes, because I don't want to ever sit here looking at people like this again for another airplane that has a similar design that we didn't get to or they didn't get to yet.

ACTING CHAIRMAN CARMODY: But, of course, as a practical matter, the FAA's going to have to start with something and they're not going to be able to do them all simultaneously. So, in any event.

Okay. 14. Modify the certification regulations, policies or procedures to ensure that new horizontal stabilizer trim control system designs are not certified if they have a single-point catastrophic failure mode, regardless of whether any element of that system is considered structure rather than system or is otherwise considered exempt from certification standards for systems.

15. Review and revise aircraft certification regulations and associated guidance applicable to the certification of transport category airplanes to ensure that wear-related failures are fully considered and addressed, so that to the maximum extent possible, they will not be catastrophic.

16. Convene a Headquarters-led team to conduct another in-depth on-site follow-up inspection of Alaska Airlines to evaluate whether adequate corrective measures have been fully implemented to address the deficiencies identified in the FAA's April 2000 Special Inspection Report.

MEMBER GOGLIA: Madam Chairman, we talked about this at length this morning, and I would like to propose that we just eliminate this recommendation.

ACTING CHAIRMAN CARMODY: Is there a second?

MEMBER HAMMERSCHMIDT: We're talking about --

ACTING CHAIRMAN CARMODY: 16, John. Sorry.

MEMBER HAMMERSCHMIDT: Second.

ACTING CHAIRMAN CARMODY: Okay. All in favor?

(Chorus of ayes)

ACTING CHAIRMAN CARMODY: Opposed?

(No response)

ACTING CHAIRMAN CARMODY: Okay. All right. Now, John, you had one more you wanted to propose and you'll have to work on the language but why don't you do that?

MEMBER GOGLIA: Right. We earlier talked about the role of dispatch and putting a recommendation in and given all that's going on and the fact that we're coming back with Number 17 and Number 40 as well as --

ACTING CHAIRMAN CARMODY: 13.

MEMBER GOGLIA: -- Number 13 in the Recommendations, why don't we add this dispatch recommendation to that list, make it four items that we'll circulate and deal with. Just given all that we've had, it's just too much.

ACTING CHAIRMAN CARMODY: Did you read it?

MEMBER GOGLIA: No. What we had proposed, it's simple, issue a flight safety information

bulletin. This is to the FAA, asking them to issue a flight safety information bulletin directing air carriers to advise dispatch and maintenance control personnel not to place pressure on flight crews to continue scheduled flight when they are troubleshooting emergency situations, and I think that we need a little more time to develop the language to fully vet that proposal.

MEMBER BLACK: Was this one going to cover giving them adequate assistance, also?

MEMBER GOGLIA: Yes, that's what we were struggling with earlier.

ACTING CHAIRMAN CARMODY: Okay. So, we need to work on that.

MEMBER GOGLIA: So, it needs some work to capture all that this flight crew experienced from their support on the other end of the radio.

ACTING CHAIRMAN CARMODY: So, that will probably be Recommendation 16 since we struck 16. That will be the new 16.

MEMBER GOGLIA: Yes.

ACTING CHAIRMAN CARMODY: Okay. So, 13 and 16 are going to be reworked.

MEMBER GOGLIA: And 17 and 40 on the Conclusions.

ACTING CHAIRMAN CARMODY: On the Conclusions. Yeah. We've already agreed to that.

MEMBER GOGLIA: Hm-hmm.

ACTING CHAIRMAN CARMODY: Now we're looking at a motion for the --

MR. CLARK: Which recommendation?

ACTING CHAIRMAN CARMODY: I'm sorry? Yes?

MR. CLARK: Which recommendation?

ACTING CHAIRMAN CARMODY: Recommendation 13, which is being redrafted, and then this new Recommendation 16 from Member Goglia on the dispatch.

MEMBER GOGLIA: Okay. I make a motion that we accept the recommendations as modified.

MR. CLARK: Okay. And that's the Findings we -- we have 17 --

ACTING CHAIRMAN CARMODY: We've already done that, but 17 and 40 were the --

MR. KOLLY: 17 and 40.

ACTING CHAIRMAN CARMODY: -- two Findings that needed to be perfected.

MR. CLARK: And then a Finding of Dispatch that goes along with the Rec 16.

ACTING CHAIRMAN CARMODY: That's a good idea, yes.

MR. CLARK: Okay.

ACTING CHAIRMAN CARMODY: Okay. Member Goglia's made a motion. Is there a second?

MEMBER HAMMERSCHMIDT: Yes, second.

ACTING CHAIRMAN CARMODY: All in favor?

(Chorus of ayes)

ACTING CHAIRMAN CARMODY: Opposed?

(No response)

ACTING CHAIRMAN CARMODY: The Recommendations are adopted.

Now, we need to adopt the whole report.

MEMBER GOGLIA: I make a motion.

ACTING CHAIRMAN CARMODY: Yes. Member Hammerschmidt?

MEMBER HAMMERSCHMIDT: Well, your motion is to approve?

MEMBER GOGLIA: Yes.

MEMBER HAMMERSCHMIDT: I would suggest that -- I will second that motion, that we approve it as modified and as modified per the changes that have been made in the Findings, Safety Recommendations essentially, that those changes be taken into consideration in the text of the report itself, and so that the report will be modified accordingly, to be consistent with the changes that were made in the Recommendations and Findings.

MR. CLARK: What we normally do is for the Recs, we back up and have a finding and then appropriate text. For those that are eliminated, those need to be adjusted. For those that are added, we need to add text to fit. But other than that, those that aren't touched by that, the report is okay.

MEMBER HAMMERSCHMIDT: Right. So, so seconded.

ACTING CHAIRMAN CARMODY: Okay. All in favor?

(Chorus of ayes)

ACTING CHAIRMAN CARMODY: Opposed?

(No response)

ACTING CHAIRMAN CARMODY: The report is adopted then.

Well, this has been a long and, I hope, productive day. I congratulate all the staff for their hard work and their patience. I think you've all done an outstanding job, not only today but in the last three years, on this accident, and I'm very grateful to you.

MR. CLARK: Madam Chairman, if I may, the -- I'd like to especially acknowledge people and I probably lost a little bit of a list here, so I'm really going to goof it up. But this whole report

always comes together with our writers and editors and Karen Bury and Kristen Sears are really the ones that pull it together, make it readable, and I think we've had an opportunity to see a number of people up here that worked actively on it, but basically we ended up with probably at least 25 investigators that each one contributed.

I'm not going to go down through their whole name, but there's some other people that -- like Gina John and Kevin Renze that worked on the graphics, Carolyn Dargan that set up the room and took care of all of this, and Antoine Downs who certainly helped churn all of that. So, we kind of get our names out here on the factuals and stuff, but Chris Annibale is a student intern working with us, and so he's been running all the graphics, always does. So, we got a lot of key players, but out of that, we have about 50 investigators at Headquarters and Vern has probably 20 and so out of that 70, at least 25 people were actively involved in this investigation.

I really want to express my appreciation to each and every one of them.

MEMBER BLACK: Madam Chairman?

ACTING CHAIRMAN CARMODY: Yes?

MEMBER BLACK: As the engineer in the group

here, I feel obligated to say that this is in many respects one of the best reports that I've seen because there is really basic science done in several areas. So, we haven't talked much about it, but aircraft performance and trying to deal with airplanes that are not exactly like they left the factory and trying to figure out what the loads were and the materials area and the grease area and Mr. Guzzetti and we haven't talked about structures, but the documentation of all of the structures that Lorenda did was just first-rate engineering work, and I'd like to thank them for that.

ACTING CHAIRMAN CARMODY: Are there comments from any other board members? Member Hammerschmidt?

MEMBER HAMMERSCHMIDT: Let me just say very briefly that I thought the staff did an outstanding job on this accident investigation and report. I was very close to this investigation being the board member on scene and then having the opportunity to chair the public hearing in this room, and I believe that the way that the staff has operated in a very dedicated purposeful way to come up with solutions so that this accident, Alaska Air Flight 261, will not happen again is certainly evident and to be commended, the staff's dedication and purpose.

George has already mentioned that it's a very

intelligent report and I was commenting to a few people at the front table here, staff table, after the first coffee break that I thought that the animation that Mr. Guzzetti showed this morning and narrated was one of the most impressive ones that I've seen since I've been here at the Board and that's pushing quite a few years, and I just want to commend the staff for very hard work, difficult work, and good work, and to the families, I certainly want to extend again my deepest sympathy and hopefully that the fruit of all these efforts by these many dedicated investigators will be such that there'll be some good that may come out of such a tragic event.

ACTING CHAIRMAN CARMODY: Member Goglia?

MEMBER GOGLIA: I'll say ditto. It was especially in the maintenance issues not exactly easy on staff when we get maintenance issues and you guys did a very good job of investigating those issues, putting them on the table and coming up with good ways to deal with them.

So, even though it pains me to give Jeff Guzzetti any credit, he really deserves a lot of credit along with Frank McGill and, of course, the IIC deserves something. Some credit for it. I can't give you credit, Rod. You've been -- but it was really an

excellent, excellent job on this report.

ACTING CHAIRMAN CARMODY: We're going to record that and hold you to it.

But thanks to all. It was very good work and thanks to my colleagues for their patience and their cooperation, and we're very glad the families were able to be here and to observe. I hope you've felt that the process was productive. I think we've all -- I believe we've all done something to improve safety today and that's why we all are here.

Thank you all. Adjourn the meeting.

(Whereupon, at 5:56 p.m., the meeting was adjourned.)