23 March, 1999

Robert Benzon
Senior Air Safety Investigator, IIC
National Transportation Safety Board
490 L'Enfant Plaza East, S.W.
Washington, D.C. 20594

RE: DCA97MA055, Fedex Pilots Association Submission

Dear Mr. Benzon,

This report is respectfully submitted by the Fedex Pilots Association, under the provisions of Title 49 CFR, Part 831.14. The primary purpose of this Submission is to assist the Safety Board to develop Safety Recommendations to prevent future accidents. The body of this submittal contains both implicit and explicit observations and recommendations. Explicit recommendations are also compiled at the end of the report.

The aircraft involved in this particular accident was involved in two previous accidents. The first accident was on January 4, 1994, and was apparently handled by the Atlanta NTSB field office. FPA has been unable to obtain any documentation NTSB produced during that investigation. There is extensive documentation of the repair work performed to the aircraft after that event. FPA did obtain the NTSB report for the aircraft's second accident, occurring on November 4, 1994. Oddly, compared to the first landing accident, there are only a few pages of documented repair work following the accident on November 4.

FPA is still attempting to find more documentation for both events. It is not clear that this documentation will become available at any time.

Respectfully,

[redacted]

Shem Malmquist
FPA Party Coordinator

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Federal Express Flight 14, McDonnell Douglas MD-11 N611FE
Newark International Airport, Newark, NJ
July 31, 1997, 0131 EDT
DCA97MA055

Fedex Pilots Association
Submission

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1.0 Executive Summary

On July 31, 1997, a FedEx MD-11, N611FE, operating as flight 14, crashed at the Newark International Airport, Newark, NJ. A highly qualified and competent flightcrew conducted this Title 14 CFR Part 121 flight in a completely professional manner, according to regulations and their training. All checklists and FAA Approved Airplane Flight Manual procedures were followed. Excellent flightcrew coordination was evidenced. All briefings were accomplished in a professional manner and Crew Resource Management techniques were flawless.

The final approach for landing was completely stabilized. The aircraft was well established on the electronic glide path of the ILS before 1000 feet above the terrain and maintained this guidance throughout the approach. They flew and maintained the FMS[1] computed airspeed throughout the approach, and averaged of 800 feet per minute rate of descent. At 30 feet above the ground, as trained, the pilot initiated a proper pitch up for landing.

In the next few seconds, the aircraft bounced on the runway and climbed to approximately 5 feet. When the aircraft touched down again, portions of the right wing structure fractured, followed by the fracture of the right main landing gear. The aircraft rolled to an inverted position. Through the combination of wing and landing gear failures, with a post crash fire, the aircraft was destroyed. Due to the expeditious and professional emergency procedures utilized by the flightcrew, all occupants exited the aircraft and no serious injuries resulted.

The questions of how this accident occurred, considering the facts just described, will be addressed in this Party Submission; however, not all of these questions will be answered, because not all of the facts are available at this time.

Important safety issues have been raised as a result of this accident. These include:
1. the need for improved aircraft certification standards for landing gear and wing design strength.
2. a review of MD-11 landing incidents and accidents.
3. a review of MD-11 flightcrew training procedures.
4. a review of the criteria to determine how and when to conduct hard landing inspections.
5. a review of MD-11 hard landing maintenance inspection procedures.

Research of NTSB reports makes it clear that the MD-11 aircraft has a history of landing incidents, including tail strikes and hard landings. In an effort to prevent such incidents and accidents, FedEx, in conjunction with the manufacturer, has developed specialized

[1] Flight Management System. The MD-11 FMS will calculate and actually set the target speeds for various flight modes.

tail strike avoidance/bounced landing recovery training. FPA is not aware of any other aircraft types that require such specialized training.

FPA conducted an informal inquiry of the MD-11 landing techniques used by other operators. The result of that study showed that several of the passenger carriers teach different landing techniques for the aircraft than does FedEx. The Operations Group Factual report of the NTSB did not include a discussion of these variations, although we are aware that the Operations Group Chairman made visit to Delta Airlines and possibly American Airlines. FPA was not included in these visits.

2.0 Accident Sequence

FedEx flight 14 originated in Anchorage, Alaska (ANC) as a regularly scheduled cargo flight to Newark, New Jersey (EWR). The weather at the Newark airport was good, with visual meteorological conditions and surface winds from 260 degrees at 7 knots.

The flight from Anchorage and the descent into the Newark area were uneventful. The crew had previously noted that there had been 3 write-ups on the autobrake system[2], which were signed off by maintenance as corrected. Additionally, the number 1 thrust reverser was inoperative and was so noted in the Aircraft Maintenance Log in compliance with the Minimum Equipment List (MEL)[3]. After evaluating these matters, and in consideration of the relatively short length of the assigned runway, the flightcrew elected to set the autobrakes to the Maximum setting and deploy the wing flaps to 50 degrees to provide a greater margin of safety.

The Digital Flight Data Recorder (DFDR) showed that the aircraft was hand flown on the ILS[4] glidepath after initial glideslope interception. The airspeed was maintained by the autothrottles to the FMS set target speed of approximately 158 knots according to DFDR data. The descent rate averaged 800 feet per minute, which was collaborated by the ATC ASR[5] radar plots. All parameters closely resemble what would be expected on a coupled (autopilot) approach.

The MD-11 Airplane Flight Manual (AFM) directs the pilot to maintain the vertical descent rate on an established glideslope (electronic or VASI if available). The manual further requires a stabilized constant vertical descent rate to continue until the "30" foot radar altimeter call from the Centralized Aural Warning System (CAWS). At this point the pilot should flare the aircraft by increasing the aircraft pitch 2.5 degrees. This pitch change is accomplished by applying backward pressure upon the control yoke. At 10 feet

[2] The anti-skid system also had some previous write-ups, although there is no reference to this in the NTSB Operations Group Factual or interviews. See Appendix X.
[3] See Deferred Items placard copy in Appendix X.
[4] Instrument Landing System
[5] Air Traffic Control Airport Surveillance Radar.

a relaxing of the backward pressure is required to prevent the aircraft from continuing a nose up pitch and possibly striking the aircraft tail.

The DFDR of flight 14 reflected a pitch attitude on the approach that averaged 2-3 degrees nose-up and throttle resolver angles (TRA)[6] that averaged between 55-58 degrees until the flare began at about 30 feet radio altitude (RA). Pitch attitude increased from 2.46 degrees nose up at subframe 339 and 36 feet radio altimeter altitude to 3.16 degrees nose up at subframe 340 and 25 feet. Pitch continued to increase as the aircraft descended to 15 feet.

On a MD-11 with the autothrottles engaged, thrust will be reduced to idle at a programmed rate beginning at 50 feet regardless of the aircraft's descent rate or other factors (such as gusty winds) that would require a higher or lower thrust setting than is being commanded. The rate of throttle retard is constant for all approaches. It is a common technique to add more thrust or prevent the throttles from retarding at the programmed rate to maintain a required higher or lower power setting. It is apparent from the DFDR traces that the pilot prevented the autothrottle retard to some extent initially, and that throttle resolver angle was increased prior to the initial touchdown.

The pitch decreased slightly (about ½ degree) as the aircraft passed 15 feet, then it was increased again prior to touchdown. Although a ½ degree pitch down is a very small pitch change, it appears that it resulted in enough acceleration to lead to a firm touchdown on the initial landing. It is important to note the significance of relatively small pitch changes in this aircraft. Based on the experience of FPA committee members and many other MD-11 pilots with extensive experience in many types of airline transport aircraft including the MD-11, ***the MD-11 aircraft is unforgiving of certain landing techniques that would be scarcely noticed on many other aircraft types.***

In the MD-11, throttle resolver angles in excess of 44-49% inhibit the ground spoilers. When Flight 14 touched down the throttles were at 74.45%, 68.84% and 66.38% throttle resolver angles respectively. Once the engines spooled up to attain the selected thrust, these settings certainly would serve to "smooth out" the touchdown. Unfortunately, it also had the immediate effect of inhibiting the ground spoilers. The combination of this inhibition with the higher power setting and pitch attitude at touchdown allowed the aircraft to become airborne again.

The aircraft bounced to about 5 feet.[7] The pilot responded by initially aiming for the target pitch attitude of 7.5 degrees as published in the FedEx Aircraft Flight Manual (AFM). The pitch attitude increased to approximately 8 degrees nose up and then decreased. Throttle Resolver Angle decreased following the initial touchdown.

[6] Throttle Resolver Angle (TRA) is a precise measure of throttle position/setting. Higher numbers correspond to higher selected power settings.
[7] NTSB DFDR Factual, page V-18.

Understanding the factors behind the pitch and power changes during this 2-3 second period from the first to the second touchdown is critical to understanding this accident and finding clues for preventing a similar landing accident in the future.

When the aircraft touched down the second time, the right wing rear spar web fractured. Current hypothesis of the events that followed is that the spar web failure led to the collapse of the right main landing gear and failure of the right wing. The aircraft then rolled over due to the lift on the still-attached left wing, while having lost its support structure on the right side of the airplane.

If the right wing had not separated it is very possible that there would not have been an accident resulting hull loss.

3.0 MD-11 Design

Detailed analysis of the failure sequences has shown that the most probable **first failure** occurred in the right wing rear spar web near where the right main landing gear attaches. This led to the separation of the right wing and right main landing gear. If the rear spar web had not failed, it is possible that the landing gear structure would have supported the landing.

The structural design that led to a spar web failure is suspect and requires additional scrutiny. **Placement of the right main landing gear attach fitting aft of the rear spar has the net effect of "torquing" or "twisting" the wing on every landing.** This accident scenario appears to have the same sequence of events that were the result of a Martinaire DC-10-30[8] crash in Faro Portugal.[9]

An important discovery of this accident investigation revealed there are no FAR requirements that an aircraft manufacturer consider sideloads during landing as part of landing gear certification. The only "single gear" landing gear design requirement applies to the event where one gear is stuck in the retract position. All assumptions are based solely on that event.

FAA should define the requirements for certification during dynamic crosswind landing conditions. The standard landing technique for crosswind landings requires touching down on one gear, yet there is no requirement to test the ability of the landing gear to withstand the forces associated with such a landing – particularly considering the possible gusty conditions which often accompany the strong crosswind condition. Gusts from the upwind side may increase the sink rate on the upwind landing gear due to the possibility of high rotational velocities towards that gear, as the effect of gusts is counteracted with a rolling moment to maintain desired track over the ground. Impact

[8] See discussion under Section 6.0.

[9] The landing gear and wing design of the DC-10-30 is virtually identical to the MD-11.

with the runway at this point could place extreme loads on the upwind gear that far exceed the loads expected from the overall aircraft sink rate.

Greater awareness of these certification issues in the pilot community may lead to an increased respect for what the landing gear design limitations are and may very well affect better landing techniques.

- **FPA recommends that FAA convene a Critical Design Review of not only the MD-11 design, but also all landing gear certification under FAR 25.**

3.1 LSAS

The MD-11 is equipped with a Longitudinal Stability Augmentation System, or LSAS. This system provides (among other functions) vertical dampening and high and low speed protections by inputting control force to prevent overspeed or stall. The LSAS is normally active when the autopilot is off and there is less than 1.8 pounds of force on the control column. It becomes active climbing above 50 feet and deactivates descending through 100 feet. Additionally, to prevent a stall condition, the LSAS will exert up to 50 pounds of force to lower the nose against opposing control column force.

The LSAS low speed protection becomes active to prevent a stall when the Pitch Limit Indicator (PLI) turns amber at 75-80% of stick shaker Angle of Attack (AOA).

The DFDR records two parameters for LSAS, either "FAIL" or "NO FAIL". The DFDR indicated "NO FAIL" during the accident flight.

FPA requested detailed information on possible LSAS failure modes and indications to preclude the possibility that an LSAS failure led to any undesired control inputs. Analysis showed no indications that LSAS may have malfunctioned, and there were no reports from the crew of any control anomalies.

3.2 Maintenance

A hard landing inspection is required when requested by the pilot, or when the DFDR "G" loading exceeds certain criteria. Pilot determination of what constitutes a hard landing is a highly subjective matter. There is a no quantitative measuring criteria to make this decision. This type of inspection is most often called for when the DFDR flags it. Because the DFDR does not record total loads imparted to the gear on landing, but only the G loads measured from the accelerometer, the landing gear on our accident airplane could have sustained loads in excess of design certification limits on previous landings.

FPA accident investigators experienced in MD-11 procedures have noted that some pilots will routinely reduce the pitch attitude just prior to touchdown.[10] The recorded G loads and descent rates for aircraft N611FE during the accident landing were not excessive; however, the performance investigation revealed that the actual loads the landing gear may have absorbed were higher than would be expected based on the descent rates alone. This is because part of the load to the landing gear in the accident occurred when the aircraft lift was "unloaded" prior to the second touchdown. Unfortunately, the DFDR criteria for determining a hard landing is also an imprecise measuring tool. Precision requires a full performance analysis for possible loads to the landing gear and aircraft structure.

A possible scenario for how this accident occurred is as follows: As the aircraft became airborne after the first touchdown it started from a pitch attitude of approximately +8 degrees arcing down to about 0 degrees at the time of the second touchdown. The DFDR recorded a ½ G acceleration due to the aircraft pitch change. This means the wings went from supporting all of the aircraft's weight to only supporting ½ of the aircraft's weight.[11] Under normal conditions when an airplane touches down, the wings are still supporting the weight of the airplane. The landing gear absorbs the energy of the downward motion as it contacts the ground. The wings should still be supporting the aircraft weight at this time; in fact, ideally, the wings will be developing more lift than the aircraft weight – actually slowing the descent rate to near zero just as the landing gear touches down. Current Title 14 CFR Part 25 design criteria does not consider a condition where the wings are supporting less than the aircraft weight as it touches down.

There is no device to measure the actual energy that the landing gear absorbs. The total energy can be calculated, but if the crew does not report a hard landing there would be no other "flag" to indicate the need for such a calculation. Based on this analysis, the FPA cannot rule out the possibility that a previous landing could have been in excess of the landing gear design limits, yet still appear to be within those limits as measured only by the DFDR.

Aircraft N611FE had had a history of hard landings. On 1/4/94 it had a hard landing that was followed by a bounce; the aircraft then pitched nose down with the nose landing gear touching down before the main landing gear.[12] The aircraft sustained significant damage from this event.[13]

N611FE had a second hard landing in Anchorage on 11/4/94. This landing included two bounces and a tail strike. Major repairs to the empennage and aft pressure bulkheads

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[10] See Sections 4.0 and 4.6 for an explanation of the motives for this pilot technique.

[11] This is commonly referred to as "unloading".

[12] This is commonly referred to as "porpoising".

[13] Initial inspection revealed mild to moderate buckling of the skin and attaching longerons from longeron 36 to longeron 48, left and right sides, between stations Y595 and Y625. The Engineering Authorization states that it is not necessary to drain the landing gear struts and check for metal to metal contact.[13] EA 5330-M11-21224 has no mention of a landing gear inspection, even though the aircraft had a maximum vertical acceleration of +2.85G.

were required.[14] FPA has been unable to find any explanation for the multiple landing accidents that have occurred with this particular airplane.

FedEx used the "layered inspection" method to place MD-11 aircraft back in service after experiencing over-weight or hard landings. This procedure was approved by Boeing and certified by the FAA. A complete inspection of the rear spar web as a maintenance action would have required removal of inspection plates or wing skin. FPA has not been able to verify whether the rear spar web was inspected after either of the two hard landings recorded in N611FE maintenance history.

In addition to the known hard landings, there is no way of determining the number of landings that this airframe may have previously experienced that had nominal sink rates but during which the total forces actually exceeded the landing gear and possibly wing load limits due to wing unloading.[15]

The landing gear structure attaches to the base of the fuselage through an attachment called a "pillow block," which is bolted to the trapezoidal panel that extends into the fuselage structure. Due to the design of the pillow block bolts (commonly called "packing"), they would be less likely to show evidence of fatigue. Normally these components show evidence of fatigue quickly as they are made of extremely hard 300m steel. At this time, FPA has not been able to determine the degree that these internal components were inspected during the layered inspection; however, investigation regarding the inspection history is ongoing.

The most probable initial structural failure in the FedEx EWR accident was the right wing rear spar web. The spar web is made of 7075D6 Aluminum. If there had been evidence of fatigue or overload, it would have been visible; however, those parts were not available for inspection because these sections were released by the NTSB and destroyed by the salvage company. The missing parts included the upper and lower spar caps and shear web. These components together form the rear spar.

- **It is likely that some hard landings in transport aircraft have gone unrecorded due to the limitations in the current inspection criteria. FPA recommends that additional maintenance inspection criteria should be implemented to include the possible effects of "wing unloading."**

- **Only portions of the right wing rear spar web and related components were available for inspection because many of them were prematurely released and/or destroyed. Without these components, it is not possible to make an absolute determination that there was no previous damage.**

[14] The full narrative from the NTSB accident report ANC95FA008 is included in Appendix IV.
[15] "Wing unloading" is described on page 8 of this submittal.

3.3 General Structural/Performance Issues

The NTSB Performance Report extrapolated the descent rates from the Radio Altitude traces. From these, and the DFDR recorded aircraft pitch and roll changes, the rate of descent of the right main landing gear at the time of touchdown was calculated. The aircraft accelerometer provided the G loading the aircraft experienced at touchdown. Although the descent rate and recorded G loading at the time of touchdown are important, the total force the landing gear absorbed cannot be described by only those two variables. As previously stated, a third variable in the analysis is the amount of G loading on the aircraft prior to touchdown.[16] Boeing conducted this analysis via an ADAMS[17] simulation and achieved similar results.

Although the initial indications led investigators to believe that the right main landing gear was the first failure, later analysis indicated that the actual initial failure was the right wing rear spar web. This revelation significantly changed the focus of the investigation. If the rear spar web had not failed, it is very possible that this would not have been an accident resulting in a hull loss.

FPA requests the NTSB to analyze, and determine, the amount of load on the right main landing gear with consideration to how much load might have been absorbed by the center landing gear. It should be noted that the center landing gear crush can was completely compressed.[18]

It is apparent that at some point the center landing gear must have absorbed some of the load. Using the force equations of the analysis performed by Boeing accounts for the strut extension and the potential energy absorbed during the strut compression, but does not include any additional energy absorbed by the center landing gear. FPA asserts that at some point the center landing gear did absorb more of the energy than has been considered in this investigation.

No analysis was made of the witness marks on the center landing gear tires, since they were considered unimportant at the time the tires were sent for analysis.

Additionally, no accounting in the ADAMS model was made of the energy being absorbed into the structure as a whole. The forces of the wings and fuselage bending downward, or flexure, as the aircraft movement slowed due to landing gear contact with the ground were not considered.[19] The total loads may or may not have exceeded the

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[16] This is another way of describing how much of the aircraft weight was being supported by the lift generated from the wings.

[17] Automatic Dynamic Analysis of Mechanical Systems, designed by MDI, Ann Arbor, MI. This is a general-purpose mechanical system simulation tool that provides dynamic, time domain response from highly complex and non-linear mechanical models. Based on the principles of Lagrangian Dynamics, ADAMS numerically formulates and solves the system equations as a function of time. The equations are usually both algebraic and differential as well as highly non-linear.

[18] MDC 98K1023, page 40.

[19] An aircraft structure is not rigid and will absorb significant forces through flexure.

design limits. Without significant amounts of more detailed dynamics information, determination of the actual load on any single structural component is inaccurate.

Currently there is no way to quantify the amount of force the landing gear is subjected to, without a full performance analysis. Current hard landing and inspection parameters are based only on the amount of G loading that is recorded on touchdown. Analysis of this accident has shown that these parameters are inadequate to indicate the actual need for such an inspection and also the depth such an inspection should take.

While analysis from the DFDR of N611FE of the previous 25 hours of flight time did not show any excessive force on any recent landings, it is plausible to assume that some previous hard landing may have occurred that could have produced substantial fatigue or corrosion that had gone unrecognized and unrepaired. Again, the critical components to determine if there was previous damage were released, so no inspection of these components was possible.

Finally, the fact that this was the **third** landing accident for N611FE raises questions as to whether there could have been some hidden, and as yet undiscovered, flaw in the airframe, the landing gear or flight controls.

- **FPA requests that an analysis be performed to determine if the Center Landing Gear and fuselage structure could have absorbed part of the landing loads, and what effect this would have had on the amount of force transmitted through the right main landing gear and right wing rear spar web.**

3.4 MD-11 Design and Performance Summary

1. **The first failure in the aircraft accident sequence was the right wing rear spar web. This failure causes FPA considerable concern.**

2. The amount of force on the landing gear that is usually measured does not account for any additional acceleration forces; as a result some hard landings may go unrecorded and without inspection. It is not known how many such landings occurred in this aircraft.

3. Any of the force that could have been absorbed by the center landing gear should be determined and considered. The crush can for the center landing gear was completely compressed. We do not know at when this occurred. The center landing gear tires were not analyzed.

4. Any force absorbed by the flexure of the structure should be calculated and considered.

5. Previous undetected damage may have weakened the right wing rear spar web structure to the point that it could not absorb the forces in this landing, causing failure well below expected structure yield strength.

6. It is still unknown why this airplane (N611FE) experienced several previous landing accidents. When FPA questioned the NTSB on whether it was unusual to see one particular airplane with this type of history, we were told that it had been seen with some of the cargo operators. While FPA agrees that some other types of older cargo aircraft have experienced multiple accidents, this is most probably due to the nature of those operators and the age of those aircraft. We do not believe that a possible problem with this particular airplane can be completely ignored.

7. The lack of any FAR guidance for establishing minimum side-loads on aircraft landing gear during landings should be reviewed.

4.0 Human Performance

It is important to re-emphasize that the Captain flew the approach to runway 22R at Newark International Airport in a most professional and expert manner. After uncoupling the autopilot at approximately 1200 feet, a near perfect visual approach was flown to the runway. The vertical descent portion of this approach was well within the requirements of the FedEx Flight Operations Manual, and FAA guidance for a stabilized approach in visual conditions.[20]

The MD-11 Airplane Flight Manual calls for the vertical descent rate to continue until the "30" foot call from the Radio Altimeter (RA), at which point the pilot should flare the aircraft by increasing the aircraft pitch 2.5 degrees. This pitch change is accomplished by applying back pressure on the control yoke. At 10 feet, the back pressure should be released to prevent the aircraft from continuing a nose up momentum where increased elevator authority, due to wash effect close to the ground, can lead to striking the aircraft tail. This procedure requires the pilot to immediately recognize any change in pitch, sink rate, airspeed, runway alignment, and roll and apply control forces to counter these changes.

The MD-11 is recognized, by both the manufacturer and operators to have unique landing characteristics. This fact becomes apparent when reviewing the interviews in the NTSB Operations Group Factual Report. The following quotes are from those interviews with very experienced FedEx MD-11 Flight Standards and Training pilots:

[20] Requirements for a stabilized approach are "that the aircraft be in the final landing configuration with engines spooled-up and established on the proper flight path at approach speed." (FDX FOM page 6-11, 1 February 1998).

"...the...problem is there but it is not serious if you keep it from happening – get the nose down."[21] (Leitch).

"At 10 feet just prior to touch down we are showing the student that proper technique is to release back pressure, and the nose is allowed to come down on the ground. ...the tolerance for error is not as great as in other airplanes during landing. ...the most common characteristic seen on the line is that the airplane has a tendency for severe pitchup on touchdown." (Barnwell).

" ...during training it is the rule, not the exception, that pilots have trouble landing the MD-11; the MD-11 has a narrower than usual landing envelope and it must be kept in the envelope to make a successful landing." (Nordberg).

Additionally, the following is an excerpt from a NTSB report following one of the previous landing accidents in this particular airplane (N611FE)[22]:

> The Simulator tests distinctly showed that upon main gear touchdown and spoiler deployment, the flying pilot had to physically push the yoke forward to prevent the nose from pitching up. The pilot had to **anticipate** this control input. **If the pilot waited for the nose of the airplane to begin movement in any direction, his control effect was greatly diminished.**[23]

A specialized tail strike awareness training program has been implemented by FedEx to help train crews to overcome these issues.[24] While this eases the problem, it also serves to emphasize the fact that the MD-11 requires special landing techniques. There have been quite a few MD-11 landing accidents throughout the industry. The MD-11 airplane has design characteristics that directly translate into specialized flying techniques to safely operate the aircraft.

No study was conducted by the NTSB to determine how other operators are conducting their training. What extent they use autothrottles, guidance they provide to their flightcrews with regard to the landing and handling characteristics of the airplane, including flare and bounced landing recoveries, were not addressed. This was a significant oversight in the investigation.

- **FPA requests the NTSB Operations Group to convene a study of this issue.**

[21] This was referring to landings.
[22] NTSB ID: ANC95FA008, page 1C
[23] Emphasis added.
[24] See Section 4.3 and Appendix III

4.1 Thrust Reverser Inoperative

The number 1 thrust reverser was deferred per the Minimum Equipment List (MEL) for this flight.[25] MD-11 pilots are trained to deploy thrust reversers 1 and 3 after mainwheel touchdown and prior to nosewheel touchdown[26]. After nosewheel strut compression, the number 2 engine reverser may be fully deployed. This delay is to prevent aggravated pitch up caused by the downward vector of the number 2 reverser. The deferral of a reverser would be a consideration by the crew, especially when approaching a short runway. There would be additional concern for the possible yawing tendency with the deployment of only one wing engine reverser. This is highlighted in the FedEx AFM under the topic heading, "Landing with One Engine Inoperative," which recommends that reverse should be used with discretion[27].

- **The lack of this reverser would increase concern about the available runway length, especially on a runway where landing performance margins are reduced.**

4.2 Aircraft Performance Laptop Computer and Landing Data

The crew noted that the number 1 thrust reverser was inoperative. They also noted that the auto-brake system had previous write-ups indicating the system "would not arm," meaning that it would not activate the brakes automatically. The autobrakes were written-up several times from 07/02/97 through 07/27/97. Additionally, there were write-ups of "Antiskid L Fail" on 07/06/97, and a brake pressure indication problem on 07/27/97. The systems had been signed off by maintenance as corrected.[28]

The flight enroute to Newark was routine. Approaching the Newark area, the crew discussed the airport conditions and landing. Runway 22L was reported closed. Runway 22L is the primary runway for landing to the southwest at Newark; however, most experienced pilots flying regularly into the Newark airport find it to be closed frequently with little notice and often no Notices to Airman (NOTAMs) are posted. This means that an inbound flightcrew is unable to anticipate the requirement to land on the shorter runway 22R until just prior to descent.

Runway 22R became the planned landing runway. The useable runway length beyond the glideslope is 535 feet shorter than 22L (see figure on the next page). The crew discussed the configuration and brakes required. Because the runway was shorter, they elected to use flaps 50. Additionally, the Operations Group Factual report originally stated[29]:

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[25] See Appendix X.

[26] see FDX AFM 7-101, 31 July, 1996

[27] see FDX AFM 7-103, 15 November, 1994

[28] See appendix X.

[29] The NTSB Operations Group Factual report was amended to state "The Airport Performance Laptop Computer (APLC) showed that by using MED brakes the stopping distance required would be 6080 feet of the 7760 feet displayed available runway length." The "after the glideslope" distance is published on the Jeppesen chart. The original text was used here to highlight a common misinterpretation.

The Airport Performance Laptop Computer (APLC) showed that by using the MED auto brakes the stopping distance required would be 6000 feet of the 6800 available after glide slope touchdown. The crew discussed the option of using MAX auto brakes; this would require a stopping distance of 5100 feet. The decision was made to use MAX auto brakes. Air speed reference bugs were set at 162 kts. For the landing weight, Vref plus 5 kts.[30]

It is important to interpret these statements. The APLC Inflight Landing Performance Output page has a column for runway lengths, and a section that displays the approximate landing distances for the conditions and configurations entered. The FedEx MD-11 Aircraft Flight Manual provides an explanation of the data.[31] It states:

APPROXIMATE LANDING DISTANCE
The approximate landing distance based on auto-brakes is provided for Minimum, Medium and Maximum braking.

Landing distance is predicated on crossing the threshold at 50 feet at Vref+5 and touching down at 1500 feet at Vref-3 KIAS, and deploying ground spoilers immediately after touchdown.

RUNWAY LENGTH
The shorter of the three lengths which may be presented in the Jeppesen Airways Manual: the actual runway length, the landing beyond threshold length and the landing beyond glideslope length (+1000 feet).

ADDITIONAL RUNWAY INFORMATION								
				USABLE LENGTHS				
				LANDING BEYOND				
RWY				Threshold	Glide Slope	Threshold to Intersecting Runway	WIDTH
4R	HIRL CL ALSF-II TDZ	grooved	RVR	8110' 2472m	7050' 2149m		150' 46m
22L	HIRL CL MALSR LDIN TDZ	grooved	RVR	8210' 2502m	7395' 2254m		
4L	HIRL CL MALSR TDZ	grooved	RVR	7460' 2274m	6400' 1951m		150' 46m
22R	HIRL CL REIL VASI (3 bar)-L	grooved	RVR	7760' 2365m	6860' 2091m		
11	HIRL CL REIL VASI-L (angle 3.00°)	grooved			5616' 1712m	4L/22R 4550'	150' 46m
29	HIRL CL REIL VASI (3 bar)-L	grooved		6502' 1982m			

Jeppesen Chart Excerpt for EWR

It is an incorrect procedure to compare the landing distance provided by the APLC directly with the "distance after the glideslope" as presented on the Jeppesen chart. The APLC distance *includes* 1500 of air-run distance. By subtracting 1500 from the displayed distance, the approximate actual ground roll is determined. In this case that

[30] NTSB Operations Group Factual DCA97MA055, page 5, original version.
[31] FedEx Aircraft Flight Manual (AFM) page 5-0-24.

value was 4500 feet, providing a 2300 foot margin under the "after the glideslope" distance.

FPA polled a random sample FedEx pilots to determine how they were interpreting the landing distance required verses runway available. It was determined that more than 80% of the pilots questioned held a similar misconception of runway data from the APLC. Pilots found the explanation of the data confusing. The FedEx Aircraft Flight Manual explanation of this topic was amended on the day of the accident.[32]

It is probable that this confusion stemmed from a general misunderstanding of the data presented by old style landing distance charts. The data presented by the APLC is actually easier to understand, and clearer, than that of most of the charts that many pilots used in the past. Previous misconceptions in understanding those paper charts could have been carried over to the newer APLC. Clearly more effective training would solve this issue. We have been informed that FedEx has already started implementation of such training.

4.3 Aircraft and Ground Lighting

The left inboard landing light was inoperative when turned to the extend/on position during the arrival phase. Airline pilots consider runway 22R at Newark Airport a "Black Hole" approach; this is because the lights of the cities of Newark and Elizabeth surround it. Additionally, the New Jersey Turnpike and marine terminal lie to the east and the airport terminal buildings to the west. The runway is made of especially dark black top, and is without approach lights or touchdown zone lights, which are very important to a pilot in estimating the aircraft height above the runway at night. Judging the height above touchdown is especially difficult for a pilot of a wide-body aircraft, because of the size of the airplane and greater nominal heights. Additionally, pilots find the approach to runway 22R disconcerting due to the proximity of elevated roads, aircraft parked on the "West Parking Area," and the buildings on the approach. All of these factors contribute to the visual illusion of the aircraft appearing to be higher above the ground than it actually is.

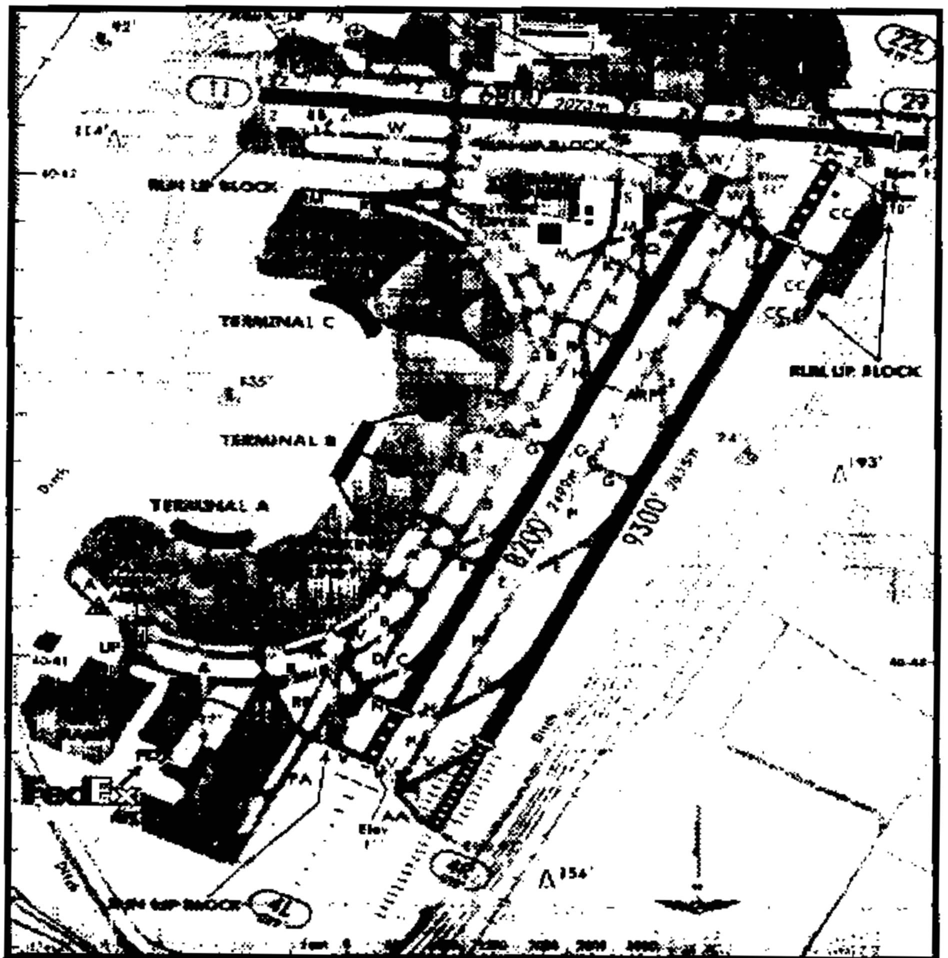
Flight 14 was landing on 22R with the left landing light inoperative, causing only the right side of the runway to be illuminated. Additionally there were no contrast lights on the left side of the runway. All of the background lights were on the right side. The left side was totally black – the pilot flying from the left side of the aircraft had even more of a "black hole effect" than the pilot on the right side. This combination of factors likely effected the depth perception of the pilot flying the approach to this runway.

The FPA Safety Committee believes that this issue cannot simply be eliminated considering the final outcome.

[32] FedEx AFM page 5-0-24, 31 July 1997. Additionally, FedEx has provided a more detailed explanation in the June, 1998 issue of the company flight operations publication "Straight In Approach".

Due to the proximity of the terminal buildings, the winds in the vicinity of 22R are highly variable, particularly with a right quartering crosswind. FPA investigators have experienced this under 50 feet RA while landing on this runway (see airport chart on page 17). While the winds during this accident may seem insignificant, they were enough to increase the workload for the pilot flying.

Many of these factors could be mitigated or eliminated entirely if the MD-11 aircraft was equipped with a Heads-Up Guidance System (HUGS or HUDS) to provide pilots with a more thorough awareness of all the variables during the landing sequence.



Jeppesen Chart Excerpt for EWR

4.4 Autothrottles

The use of the autothrottles, if available, was a FedEx mandatory procedure for all phases of flight in the MD-11.[33] In 1993, the manufacturer recommended that the autothrottles be used for all landings.[34] The autothrottles retard power at a pre-programmed rate passing 50 feet RA.[35] This retard rate is ideal only if the aircraft follows a descent and flare path similar to the autoflite system.

The autothrottle system will retard the throttles to the idle position below 50 feet. The pilot must determine if more thrust is required than the programmed autothrust setting.[36] If more thrust is required, the pilot must apply pressure not only to move the throttles to that required thrust setting, but he also will need to maintain that pressure to prevent the throttles from moving to or towards the idle position. The pilot will need to apply constant pressure to the throttles during the flare until additional thrust is no longer required.

Although this is generally not a problem, the above technique does diminish the normal tactile feel of the throttle position. The pilot will not be looking at the throttle quadrant during the flare, so the reliance of the feel of where the throttles are, relative to where they were before they were moved, becomes the major indicator of throttle position. As a result, a problem could be encountered if a pilot is attempting to add just a bit of power following a bounce recovery. Due to the autothrottle force trying to pull back the throttles and the jolt of the bounce itself, it would be very easy for a pilot to lose the feel of exactly where the throttles are, and he might believe he had increased the power to a setting higher than pre-touchdown when in reality that setting could be somewhat less.

- **The DFDR recorded a reduction in TRA immediately following the first touchdown. It does not appear to FPA that the pilot flying intended this. The pilot increased TRA just prior to the first touchdown. The combination of the factual DFDR data and crew interview statements appear to confirm the FPA position.**

[33] FedEx modified the Aircraft Flight Manual in 1998 to allow flightcrews the option of turning off the autothrottles if desired.
[34] Flight Operations Customer Service Douglas Aircraft Company. Know Your MD-11. McDonnell Douglas, April 14, 1993.
[35] Radar Altitude.
[36] Autothrottle retard rates during the flare are not adjusted for variable sink, speed or closure rates, but are a constant rate for all landings.

4.5 Aircraft Ground Spoilers

The MD-11 is equipped with a ground spoiler system. Once armed, the ground spoilers deploy to the 2/3 mid position upon main wheel spin up. Full ground spoiler deployment occurs upon nose wheel strut compression. Ground spoilers are inhibited when the throttles are advanced forward of 44-49% of the throttle travel.[37]

The information that Ground Spoilers are inhibited is not available to the line pilot either in the FedEx MD-11 Flight Operations Manual or in the Honeywell Pilots Guide, both of which are distributed to pilots during training as primary information on aircraft systems. Most line pilots are unaware that arresting an undesired sink rate by applying thrust forward of 44-49% TRA will inhibit the ground spoilers during the landing. The FedEx Tail Strike and Bounce Recovery Training program uses thrust to aid in arresting the sink rate or stabilizing the aircraft after a bounce. If power is advanced forward of the 44-49% TRA, the ground spoilers will be inhibited and allow a bounce to continue to develop.

- **FPA recommends that the FAA and manufacturer re-evaluate the TRA used for inhibiting the ground spoilers with consideration to increasing the TRA that will inhibit the spoilers.**

4.6 Tail Strike Awareness Training

The MD-11 has a history of tail strikes during both takeoff and landing, with a majority occurring during landing. After several tail strikes and one nose gear first landing within the industry, FedEx and McDonnell Douglas created a training program to make MD-11 pilots more aware of the different characteristics of landing this aircraft. All FedEx MD-11 pilots receive this training either during initial training or during recurrent training. McDonnell Douglas has produced a training/information video detailing the unusual characteristics of this aircraft during initial rotation, approach, flare, and landing. This video is shown during tail strike avoidance training.

When landing the MD-11, pilots have been conditioned to quickly arrest any pitch up with forward elevator.[38] The FedEx AFM stated, "Be prepared to counter any pitch-up tendency as spoilers extend."[39] The landing technique taught by FedEx and the manufacturer at the time of the accident was for the pilot to hold a constant pitch attitude below 10 feet or to slightly reduce pitch attitude just prior to touchdown.

[37] Throttle Resolver Angle (TRA).
[38] See also section 4.0 of this submittal.
[39] FedEx MD-11 flight manual (AFM), July 1996, page 7-101.

> Below 10 feet with the aircraft fully flared (sink rate approximately 2-4 feet per second), the basic technique is to maintain attitude by applying the required control wheel pressures. A more advanced technique is to relax the back pressure to lower the nose (approximately 1°) prior to main gear touchdown.[40]

The FedEx MD-11 "Flight Instructor Guide" portion of the "Tail Strike Awareness Training" handout dated June, 1996, stated:

> At 30 feet a smooth 2.5 degree flare should be initiated so as to arrive below 10 feet in the landing attitude. **Back pressure should then be relaxed until touchdown.**[41]

The MD-11 has had a pronounced pitch-up tendency during spoiler deployment after landing.[42] The net result is that when under 10 feet during landing, MD-11 pilots have become much more concerned with any pitch up, as opposed to any pitch down.

While the published FedEx AFM tail strike and bounce recovery techniques may not lead to problems, some pilots on the line have made it a habit to lower the pitch attitude by a few degrees prior to touchdown to insure no tail strike. The danger of decreasing pitch attitude prior to touchdown has never been highlighted by any instruction.[43]

The differences between the FedEx AFM and the guidance contained from the Tail Strike Avoidance Training publication as well as that of some of the MD-11 instructors is conflicting and confusing. The statement, "back pressure should be relaxed until touchdown," can be especially misleading.

With the exception of those pilots that may have engineering backgrounds, most pilots are not aware of, nor have they been trained to understand, what forces develop when an aircraft is pitched forward prior to touchdown. MD-11 pilots have been trained to:

1. Hold the pitch attitude constant or reduce the pitch attitude just prior to touchdown (less than 10 feet).
2. Be very concerned about and anticipate possible pitch-up just after touchdown.
3. Use power to arrest any sink rate – allowing the thrust to accelerate the aircraft "out of" any sink rate that is higher than desired rather than modify the pitch attitude.

Note that the critical time is when the aircraft is under 10 feet and that during the accident the aircraft only bounced to 5 feet. The primary guidance for crews when

[40] FedEx MD-11 flight manual (AFM), July 1996, page 7-46. Similar text can be found also on page 7-100.
[41] Emphasis added.
[42] This pitch-up tendency was virtually eliminated by re-programming Flight Control Computer (FCC) in 1994. Although this software change was made prior to July 1997, the potential for pitch-up was and is still a concern among most MD-11 pilots. Those pilots who have received initial MD-11 training after this software change still inherit a deep respect of the "pitch-up" from other pilots.
[43] See explanation in Maintenance, Section 3.2 of this submittal.

under 10 feet is to be very concerned about a pitch-up or high pitch attitude with no guidance that they should also be concerned with a pitch-down at this low altitude.

FedEx flight training is currently developing a more in depth training course to address these principles, along with other aspects of aerodynamics that have generally received little or no attention in the airlines. Unfortunately, many pilots have never received formal training in these subject areas so they have a gap in their understanding of the flight characteristics of the aircraft they operate.

- **FPA asserts such training should be a mandatory part of pilot training.**

- **FPA asserts that the addition of a Heads-Up Display/Guidance system would reduce or eliminate the potential for this type of accident by increasing pilot situational awareness.**

- **Pilots develop flying techniques over many years. The MD-11 requires aircraft-specific handling techniques to recover from an unusual situation (such as a bounced landing). FedEx and the manufacturer developed specialized training for the MD-11 to compensate for this. Even with such training, it is probable that when an unusual situation is encountered, the pilot will revert to the techniques developed over many years rather than those aircraft specific techniques that are only applicable to this one aircraft type. There is a need to determine how much training is necessary to ensure that eight or ten months after training the newly learned techniques will be those which the pilot relies upon in extremis, rather than reverting to the older, "normal" techniques. How much training will it take to wash out (somewhat permanently) 20 or more years of reliance on a different technique?**

4.7 Other Operators Procedures

FPA conducted an independent inquiry of the landing techniques taught at several other carriers operating the MD-11. The result of this study showed **significant** differences in training. While the NTSB Operations Group Chairman did visit some other carriers to compare the training, there were no records of these visits included in the NTSB Operations Group Factual Report. The Operations Group was not convened for these visits. As a result there were no Operations Group members with actual MD-11 experience in attendance at these meetings.

It is of significance that some of the other MD-11 operators have had few, if any, problems with the MD-11 yet no comparison of their training and procedures and those of FedEx has been made by the Operations Group.

- **FPA requests a detailed study be conducted of all MD-11 operators worldwide for differences in training and handling procedures for the aircraft and their history of landing accidents/incidents.**

4.8 Human Performance Summary

1. Several items contributed to the concern over the available landing distance. These include the inoperative thrust reverser on the number 1 engine and the apparent confusion over the landing distances by including air run as part of the total distance.

2. Training should be implemented so that pilots have a better understanding of the limitations and requirements pertaining to landing distances and performance.

3. The affects of the airport and surrounding city lights, combined with an inoperative aircraft left landing light contributed to optical illusions and made perception of the actual aircraft flight path difficult.

4. The absence of runway approach lights and touchdown zone lights, combined with a dark runway surface, contribute to a "black hole" effect on this runway.

5. The use of autothrottles through the landing phase on a hand-flown approach may reduce the tactile awareness of throttle position, particularly in a bounce scenario.

6. The auto-ground spoilers are inhibited at a fairly low throttle resolver angle. Consideration should be given to increasing this setting.

7. Pilots operating aircraft that have a history of tail strikes may be more likely to err on the side of "unloading" and intentionally landing in a relatively flat attitude. There is no consideration given to this factor. Tail strike awareness training should include instruction regarding the problems of pitch over prior to touchdown.

5.0 Survival Factors

When the aircraft rolled inverted, the upper fuselage was damaged in a manner that rendered the main cabin doors unusable (unable to be opened).[44]

The right sliding cockpit window appeared to be damaged due to the aircraft sliding on it for a portion of the event. The left (Captain's) DV sliding window was the only avenue available to the crew and jumpseat passengers to escape the airplane after the accident. This has obvious implications if this had been a passenger aircraft.

[44] The main cabin doors move upward into the fuselage when opened. Due to the deformation of the upward fuselage it was impossible for the doors to move to the open position.

6.0 Related accidents

Alitalia experienced a landing accident in Chicago on August 8, 1994. This was a porpoising type event. It is significant that the aircraft was stabilized prior to touchdown and that the aircraft pitched forward after the initial touchdown – as did FedEx 14.

Delta Airlines had a landing accident in 1993 that also had some striking similarities to the FedEx 14 accident, including a bounce and pitch forward after the initial landing. The second touchdown on that accident was on all three wheels – had it been on one main landing gear, the end result might have been very similar to FedEx 14.[45]

Similarly, the first of the two previous FedEx landing accidents for N611FE, occurring on 01/04/94, had an initial bounce, followed by a pitch forward onto the nose gear.[46]

Martinair did have an accident involving a DC-10-30[47] in Faro Portugal several years ago. The failure sequence was very similar; the wing was found in a similar location after the aircraft touched down, as was the inboard flap. This investigation was not conducted by NTSB; therefore, access to more detailed analysis is not available.

7.0 Accident Investigation

The field investigation portion of the investigation lasted only 5 days. At the time of the field investigation most of the emphasis was on the right main landing gear. FPA did not learn until very recently that the first failure was probably the right wing rear spar web; therefore, the NTSB and the parties placed very little emphasis on the study of those components. **More importantly, these components were released prematurely. The NTSB gave permission to move many these parts in order to allow the Newark Airport Port Authority to clean up the runway. This resulted in several critical missing items that needed to be recovered later in trash dumpsters, and others that were never recovered. Still later it was discovered that some of the released components were parts needed to find failure modes or to provide physical evidence for suspected failure paths.[48]**

Any conclusions based on assuming that those missing components had no previous damage can only be considered speculative.

The net result was that much of this missing data had to be reviewed through photographic or written records and investigator recollection. Obviously this was far from ideal.

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[45] See Appendix XII for the summary of these accidents.

[46] FPA has not been able to obtain any NTSB reports or other more detailed information for this accident, except for that which is included in Appendix IV.

[47] The DC-10-30 in this accident has a landing gear design virtually identical to the MD-11.

[48] Specifically, these components are the upper and lower spar caps and spar web.

Additionally, FPA believes that in hindsight the NTSB Operations Group should have conducted increased research in the areas of landing techniques, training and the study of other MD-11 operator's procedures. For example, FPA asks, what are American Airline's procedures in the use of autothrottles? If they are turned off prior to flare, does that explain American's unusually good safety record in landings for the MD-11 as compared to some of the other operators with similarly sized fleets? This, along with American's pitch technique during flare, must be evaluated.

8.0 Statement on Probable Cause

The normal assumption for probable cause in this type of accident would be to direct a share of the blame to the pilot because he was flying the aircraft at the time of the accident. However, to assess any probable cause to the pilot because DFDR data reveals an unorthodox second landing after the first bounce, raises the following unanswered question:

How can any investigative body list the pilot as a contributor to the accident when this airplane was not equipped with a DFDR parameter recording the position of the control yoke? Without factual data reflecting pilot input to the flight controls via the control yoke, it is impossible to conclude whether or not the pilot actually manipulated the controls that resulted in the final aircraft attitude immediately prior to the second touchdown.

9.0 Conclusions

1. Criteria for Hard Landing Inspections may not be adequate to provide complete inspections of all critical parts of the aircraft.
2. The accident aircraft had two previous hard landing events, which required repair of the aircraft. Any common factors for these accidents that may have been related to this particular airframe (N611FE) are unknown.
3. Critical parts of the accident aircraft wreckage were released and destroyed and not available to complete the investigation.
4. The FARs for the certification of landing gear testing for air carrier aircraft do not take into consideration side load during landing.
5. Although the amount of force the main landing gear strut absorbed was considered in the analysis, it is not clear that the analysis gave any consideration for loads absorbed by other aircraft components, including the center landing gear and general flexing of the aircraft structure. No analysis was performed on the center landing gear tires.
6. The number 1 Thrust Reverser was inoperative and was secured according to the Minimum Equipment List (MEL).
7. The left inboard landing light was inoperative during the landing approach.

8. The combination of the absence of approach lights and touchdown zone lights, with a dark runway surface, creates a "black hole" effect when landing on runway 22R at Newark.
9. The autobrakes system had been written-up as intermittent on several flights prior to the accident flight.
10. The flightcrew was properly certificated and qualified to conduct the flight.
11. The flightcrew did not fully understand the APLC information and perceived that the runway required was 1500 feet more than that which was computed by the APLC.
12. The runway assigned for landing has an environment conducive to visual illusions.
13. The MD-11 aircraft has a history of tail strikes and hard landings. FedEx has initialized a special pilot training program, "Tail Strike Awareness Training," to prevent inadvertent tail impacts.
14. The MD-11 Ground Spoilers are inhibited after touchdown when the throttles are advanced beyond 44-49% of TRA. FedEx pilots were generally not aware of this fact.
15. Landing techniques for the MD-11 were conflicting and confusing, both by the manufacturer and the operator.
16. No analysis was performed by the Operations Group on the training conducted at other MD-11 operators, with a related study of their accident/incident records.
17. FedEx pilots were required to use the autothrottle during all landings, even when controlling the aircraft manually. It is possible that the use of the autothrottle reduces the tactile feel of the throttle position during a bounced landing event. If the power had been increased, as the Captain intended, the aircraft would have accelerated much more and the vertical acceleration may have been negligible.
18. The accidents discussed in section 6.0 for Delta, Alitalia and FedEx, may have occurred under similar circumstances as FedEx 14. These should be further analyzed.

10.0 The FPA Position:

After presenting our analysis of the facts and circumstances related to this accident, we restate the original question: **How could this accident have occurred in an aircraft flown by a well qualified, experienced flightcrew, following a perfectly flown approach?**

Since there was no DFDR parameter to record the control yoke position, only assumptions can be made about the actual manipulations of the controls by the pilot. The FPA urges the Board to resist an easy answer of "pilot technique." This was not the cause of the accident.

In our opinion, some significant questions remain unanswered; however, based on the facts developed, we offer the following conclusions and Probable Cause(s):

11.0 Proposed Probable Cause (s):

The Probable Cause (s) of this accident were:

1. The design of the MD-11 aircraft that required specialized flightcrew training to prevent tail strikes during the landing phase.
2. The inadequate and conflicting flightcrew training for landing the MD-11 aircraft, which resulted in a bounced landing, and the subsequent hard touchdown and failure of the right wing.
3. The failure of the manufacturer and the airline to adequately address these landing problems and provide flightcrews with satisfactory training solutions.
4. The failure of the right wing rear spar web.

11.1 Contributing Factors

1. The inhibiting of the aircraft ground spoilers at a relatively low throttle resolver angle.
2. Visual illusions in the vicinity of runway 22R at EWR, aggravated by the inoperative landing light.
3. Concern over landing distance, due to misunderstanding of the APLC, leading to efforts to minimize runway use and float during the initial landing and bounce recovery.
4. Company procedures requiring the use of autothrottles at all times (if available).
5. The MD-11 design that allowed the right wing structure to fail prior to the failure of the right main landing gear.
6. Concern of the pilot over the landing distance because of the inoperative thrust reverser and previous autobrake malfunctions.

12.0 Recommendations

It is recommended that:

1. the FAA conduct a Critical Design Review of the certification of the MD-11, including the strength of the wings and landing gear.
2. the FAA and the manufacturer review the Hard Landing Inspection criteria.
3. the FAA conduct an examination of FAR 25 and related documents to determine if current regulation is adequate to ensure safe structural design. Particular attention should be given to landing gear and related structure design load limits with an emphasis of anticipated loads during landing in strong and gusty crosswinds and variable pilot technique.
4. the FAA and operators of the aircraft review the landing techniques for the MD-11 aircraft. An Aerospace Industries Association Steering Committee consisting of representatives from the pilot unions, the manufacturer, ATA, and IATA operating the MD-11 aircraft should review and develop landing procedures to prevent future landing accidents in this model aircraft.
5. the FAA and other industry groups conduct research to determine what level of initial and continuing training should be required for aircraft with type-specific landing/flying techniques to ensure that pilots operating such aircraft do not revert to techniques applicable to more "generic" aircraft.
6. The FAA consider the use of a Heads-Up Display/Guidance system to increase pilot situational awareness during landing.
7. airlines should re-emphasize training in landing performance and raise awareness of the forces that can result from various landing techniques.
8. FedEx continue a more aggressive training regime in the areas of landing performance data, aerodynamic effects during landing and landing gear design load limitations.
9. FAA mandate Flight Data Recorders that will record control yoke position.

Appendix I

FedEx MD-11 Aircraft Flight Manual Excerpts

Special Output Considerations

FLASHING VAPP
A flashing V_{APP} signifies that winds for at least one runway exceed either crosswind or tailwind operational limits. Out-of-Wind-Limits runways are designated by a "+" next to the Out-of-Limits wind component for that runway. Wind components shown are the maximum allowable and calculated landing distances use the wind component limits shown on the screen.

APPROXIMATE LANDING DISTANCE
The approximate landing distance based on autobrakes is provided for Minimum, Medium and Maximum braking .

Landing distance is predicated on crossing threshold at 50 feet at V_{REF} + 5 and touching down at 1500 feet at V_{REF} - 3 KIAS, and deploying ground spoilers immediately after touchdown.

RUNWAY LENGTH
The shorter of three lengths which may be presented in the Jeppesen Airways Manual: the actual runway length, the landing beyond threshold length and the landing beyond glideslope length (+1000 feet).

MIN BRKG
Minimum Braking assumes a constant deceleration rate. If this rate is achieved through aerodynamic braking and reverse thrust, little or no braking occurs. If thrust reversers are not used, more braking is required to achieve this rate.

MED BRKG
Medium braking on a dry runway assumes a constant deceleration rate and the same deceleration components as minimum braking apply. Medium braking distances on a wet runway assume no reverse thrust.

MAX BRKG
Maximum braking assumes a constant deceleration level achieved with full anti-skid braking without the use of thrust reversers.

BRAKING ACTION REQUIREMENT
When a runway is other than dry and the crosswind for that runway exceeds 10 Kts., a note will appear in the bottom right portion of the screen stating "Reqd Braking Action: FAIR" meaning that reported braking should be fair or better.

MINIMUM QUICK TURNAROUND TIME
When a specific combination of OAT, Pressure Altitiude, Winds and Runway Slope is encountered for a given runway, the MD-11 is required to remain in the blocks for at least 45 minutes. When these conditions are experienced, a "B" is shown next to the affected runway and a note appears in the lower portion of the screen stating "B-Reqd Block Time (Min): 45."

Function Menu

The function menu for this screen contains

I Input Screen
- Returns the user to the Inflight Landing Performance Input screen.

Q Quit
- Quits the current module and returns to the Module Menu.

X Exit
- Terminates the program and returns to the Configuration Menu.

GENERAL PROCEDURES (3.0.0)

DESCRIPTION (3.1.0)

General procedures are applicable to all phases of flight.

PROCEDURE (3.2.0)

Altimeter Procedures (3.2.1)

Refer to Chapter 2 of the Flight Operations Manual for altimeter procedures.

Altitude Verification (3.2.2)

Autopilot engaged:

> The PF sets the new altitude in the FCP. The PNF verifies that the correct altitude is set in the FCP and states the new altitude clearance (i.e. "350"). If verbal verification is not received from the PNF, the PF points to the FCP. If verbal verification is still not received, the PF commands "Confirm Altitude."

Autopilot not engaged:

> The PNF sets the new altitude in the FCP. The PF verifies that the correct altitude is set in the FCP and states the new altitude clearance (i.e. "310"). If verbal verification is not received from the PF, the PNF points to the FCP. If verbal verification is still not received, the PNF commands "Confirm Altitude."

Autobrakes (3.2.3)

Autobrakes, if available, will be armed for takeoff.

Autopilot (3.2.4)

WARNING

> Applying force to the control wheel or column while the autopilot is still engaged has resulted in autopilot disconnects and subsequent abrupt aircraft maneuvers. Pilots have over-controlled the aircraft while trying to return to stabilized level flight. The pilot should never apply force to the control wheel or column while the autopilot is engaged. If the pilot is not satisfied with the autopilot performance, or is unsure that it is operating correctly, it should be immediately disconnected by using one of the autopilot disconnect switches.
>
> If the autopilot disengages while a force is applied to the control wheel or column, there will be a rapid, commanded change in some of the control surface positions. This will result in an abrupt and unpredictable aircraft response. Additionally, the pilot should not attempt to disconnect the autopilot while applying a control force. If an inadvertent autopilot disconnect occurs, the pilot must smoothly stabilize the aircraft attitude, releasing the flight controls, if necessary, until the aircraft motion dampens out.

Autospoilers (3.2.5)

Autospoilers, if available, will be armed for takeoff and full stop landing.

Autothrottles (3.2.6)

Autothrottles, if available, are recommended for all phases of flight. However, at the discretion of the captain, manual manipulation of the throttles is authorized.

NOTE

> Unlike the autopilot, autothrottles may be overridden while engaged.

FCP Operation (3.2.7)

All FCP system inputs must be visually verified on the FMA and/or ND.

Autopilot engaged:

> All FCP inputs should be made by the PF.

Autopilot not engaged:

> All FCP inputs should be made by the PNF with the exception of the AUTOFLIGHT tile.

LANDING (1.0.0)

DESCRIPTION (1.1.0)

The objective of this section is to provide procedures and techniques used to accomplish a normal landing.

The best landings are a result of well executed approaches. Flaps 35° or 50° are the normal landing configurations. Flaps 35° is recommended for crosswinds greater than 15 knots (when the landing distance is not critical), potential windshear, and noise abatement considerations. Flaps 50 may be appropriate with tailwinds, contaminated runways, low visibility approaches, and marginal APLC landing distances. Landing with 50° flaps will decrease the approach deck angle by one degree and landing distance by up to 500'. A lower deck angle aids pilot acquisition of visual landing cues in low visibility. The aircraft must be flown in a controlled, stabilized manner through touchdown and rollout. Pitch attitude and thrust are keys to a good landing.

PROCEDURE (1.2.0)

Normal Landing (1.2.1)

Aim to touch down 1500 from the runway threshold. The runway threshold should disappear under the nose at about the same time CAWS announces "100'." Maintain a stabilized flight path through the 50 and 40 foot CAWS callouts (unless sink rate is high). At 30' a smooth 2.5 degree flare should be initiated so as to arrive below 10' in the landing attitude. Do not trim in the flare. Elevator back pressure should be relaxed, and a constant pitch attitude should be maintained from 10' radio altitude to touchdown.

The autothrottles switch to the retard mode at 50' RA. In the retard mode, the throttles move to idle at a preprogrammed rate without regard to airspeed, vertical velocity, or RA. The PF must maintain the appropriate glide path to touchdown. If a deviation occurs from that glide path, the PF must override the autothrottles to prevent retard.

NOTES

During a visual approach the main landing gear should cross the runway threshold at approximately 50' above the TCH. Do not deviate from the visual glidepath in an attempt to touchdown shorter than normal.

Excessive sink rates, and subsequent tailstrikes, have occurred as the result of an early flare and "feeling" for the runway.

If the airplane is flared early and the autothrottles are allowed to retard, the airspeed will decay, elevator effectiveness will be reduced, and a higher pitch attitude will be required making the pitch up tendency after touchdown more pronounced and more difficult to counteract.

At main wheel touchdown the autospoilers partially deploy. Counter any pitch-up tendency associated with spoiler extension. Fly the nose wheel smoothly to the runway. Avoid full elevator down input. If selected, autobraking will begin shortly after spoiler deployment. When the nosewheel is lowered to the runway, the spoilers will fully deploy. After main gear touchdown reverse all three engines as soon as possible. A momentary pause will be encountered at the interlock stop. Engine #2 will provide only idle thrust until nosewheel strut compression. At 80 knots, smoothly move the reverse thrust levers toward the reverse idle detent, so as to be at idle forward thrust by 60 knots. Do not delay lowering the nosewheel to the runway.

NOTE

Fast movement out of reverse will produce a sudden surge of forward thrust that will negate some of the airplane's stopping ability.

The PNF monitors spoiler deployment and manually deploys the spoilers if necessary. During landing and reversing the PNF monitors the engine instruments and calls out "80/60 knots." When applicable, the captain normally initiates transfer of control from the F/O after the "60 knots" callout.

WARNING

After reverse thrust is initiated, a full stop landing must be made. Do not attempt a go-around.

High Sink Rate/Bounce Recovery (1.2.2)

If a high sink rate or low bounce occurs, the PF should establish a 7 1/2° pitch attitude and increase thrust until the sink rate has been arrested and/or a normal landing is accomplished.

If a high bounce occurs, a low-level go-around should be initiated. Low-level go-arounds are dramatically different than normal go-arounds. During low-level go-arounds, main wheel touchdown may be unavoidable. The PF must not exceed 10° of pitch or retract the landing gear until the aircraft is safely airborne with a positive rate of climb.

Crosswind Landing (1.2.3)

Crosswind landings are accomplished by flying the final approach in a wings level attitude with a crab into the wind. At approximately 200' agl, align the fuselage with the runway by smoothly applying rudder and maintain runway centerline by lowering the upwind wing. In high crosswinds, consideration should be given to commencing the align maneuver prior to 200'. The align maneuver shall be established by 100' agl.

NOTES

> Excessive sink rates and subsequent tailstrikes have occurred as the result of a late or abrupt align maneuver. The align maneuver has an associated increase in drag, and if unchecked with power, will result in an increased sink rate.

Aft Fuselage Ground Clearance (Landing) (1.2.4)

Tailstrikes are not caused by landing with a high sink rate. Tailstrikes occur as the result of attempting to arrest a sink rate or bounce by quickly adding significant up elevator below 10' RA. Up elevator inputs will load the horizontal stab increasing the effective weight of the aircraft and initially increasing the vertical velocity. Increasing the pitch attitude drives the main wheels into the ground and compresses the main gear struts.**The MD11's aft fuselage will contact the runway at approximately 10 degrees pitch attitude with the struts compressed.** Additionally, there is a direct correlation between an increasing pitch attitude rate at touchdown and an increased pitch up tendency after touchdown. One degree per second of increasing pitch attitude rate at touchdown generates as much pitch up tendency as full spoiler deployment. Therefore, elevator back pressure should be relaxed and a constant pitch attitude should be maintained from 10' RA to touchdown.

TECHNIQUE (1.3.0)

Consider using max autobrakes for landing, if available, for adverse conditions.

Example: wet/slippery runways, high crosswinds etc.

For landing it is recommended that the PF have the ACT F-PLN displayed and the PNF have the TO/APPR page displayed on the MCDU.

ACCEPTABLE PERFORMANCE GUIDELINES (1.4.0)

- Airspeed - ±5 knots of the target speed on final.
- Touchdown to occur in the touchdown zone.
- Touchdown close to or on the centerline.

PROCEDURE TURN

DESCRIPTION

A procedure turn is specified where it is necessary to reverse direction to establish the airplane inbound on an intermediate or final approach course. The approach plate will specify the outbound and inbound course, the distance within which the procedure turn shall be completed, the side of the inbound course on which the turn should be made and a minimum altitude to be maintained.

Unless specified on the approach plate, the point at which the procedure turn is started is left to the discretion of the pilot. It is recommended that the turn to the outbound heading be commenced 1 minute past the final approach fix on a non-precision approach and 30 seconds past the final approach fix on an ILS approach. Timing of the outbound leg should be a minimum of 30 seconds and a maximum of 1 minute depending on wind conditions. Normally the procedure turn will be accomplished with 28°/Ext and at minimum maneuvering airspeed.

When established on the inbound course of the procedure turn and cleared for the approach, the Before Landing Checklist should be accomplished. One MCDU should be set to APPR page with the appropriate flap setting selected. One ND should be selected to the APP/VOR display and one ND selected to MAP display (10 mile range recommended).

ACCEPTABLE PERFORMANCE GUIDELINES - PROCEDURE TURN

- Altitude: ± 100 ft during the procedure turn.
- Airspeed: +10 kts of target airspeed, but not less than minimum maneuvering speed.
- Proper planning of altitude, airspeed and configuration prior to the FAF.
- Compliance with ATC instructions.

COMMON ERRORS - PROCEDURE TURN

- Improper airspeed.
- Early/late configuration.
- Failure to maintain visual watch while maintaining VMC.

VISUAL APPROACH

DESCRIPTION

Complete the descent and approach procedures prior to entering the airport traffic area so the flight crew may devote their full attention to airplane control and traffic avoidance. The FMS and all radio aids shall be used to identify the proper runway. Electronic and visual glideslopes will be used when available.

Aircraft should be stabilized in final landing configuration, on descent flightpath and on speed with appropriate wind and gust corrections applied to VREF by 1000 feet AGL. If the aircraft is not stabilized by 500 feet AGL, a missed approach should be executed. Rate of descent should not exceed 1000 feet per minute below 1000 feet AGL. Visual aimpoint, to provide a threshold clearance height of 47 feet on a 3.0 degree glideslope, should be approximately 1700 feet past the threshold. This will provide a no-flare touchdown point approximately 900 feet from threshold. Aircraft should not deviate from visual glidepath in an attempt to touch down early.

CAUTION

The normal two bar VASI must not be used below 500 ft AGL for establishing the approach flight path in the MD-11. Following a two bar VASI on the lower edge of on glideslope, may cause the main gear to touch down short of the runway.

NOTE

The three bar VASI establishes a 3° glideslope and a visual aim point about 1,600 ft from the threshold. The two sets of bars farthest from the threshold are used in the same manner as the two bar VASI. Since the glideslope angle and the visual aim point generated by this system are compatible with the MD-11, the system may be used for guidance during a visual approach, keeping in mind the general limitations of the VASI (i.e., large tolerances, large vertical dimension for on glideslope indication, etc.).

Adjust thrust smoothly in small increments. Large sudden thrust changes are indicative of an unstable approach. The use of autothrottles is mandatory, if available.

CAUTION

When hand flying in Idle Clamp mode and descending, the Flight Director Pitch bar is commanding speed based on pitch (Speed on Pitch will appear in the Autothrottle window). If the Pilot Flying ignores the Pitch Bar commands and slows the airplane with a higher attitude position than the Pitch Bar is commanding, airspeed will decay below the selected speed (white bow tie). Lo-speed protection will engage as the airspeed enters the amber Foot. Two ways to prevent this action are: 1; Follow Pitch Bar guidance commands if descending in Idle Clamp (Speed on Pitch) or 2; Descend in Vertical Speed. A Vertical Speed descent engages the Autothrottles in a Speed on Thrust mode of operation.

The flight profile represents the ideal approach situation. Flap and landing gear extension points were selected to minimize thrust changes and crew work load during final approach. The airplane must be stabilized on final approach at least 500 ft above field elevation.
Multiple approaches and landings will develop the pilot's ability to discern a 2.5° to 3° glidepath. An up slope in either the runway or approach zone creates an "above glidepath" illusion and your actual height is lower than it appears. Under conditions of haze, smoke, dust, glare or darkness, expect to appear higher than you actually are. Bright runway lights appear closer, while dim runway lights appear further away. Wider than normal runways create an illusion of being lower than you actually are. Be alert for depth perception problems on snow covered runways or when the color blends with that of the surrounding terrain. The effects of illusions can be minimized by verifying the approach glidepath with cockpit instrumentation, crosschecks with other crewmembers and, most important, knowledge and awareness of the special problems associated with these approaches. Abnormal or emergency conditions requiring landings at other than flaps 35°/50° will result in other than normal pitch attitudes for a given glideslope angle.

Airplane deck angle, rate of descent and thrust required can be used along with exterior visual cues to establish or verify a correct final approach visual glidepath. A typical rate of descent for a 3° visual glidepath is about 700 ft per minute (no wind). Remember that rate of descent is a function of ground speed and glidepath angle. Multiplying the ground speed by five will result in the required rate of descent for a 3° glidepath. Multiplying each mile from the end of the runway by 300 feet will result in the required attitude above the TDZE.
A flat approach (below 2.5° visual glidepath angle) is indicated by an increase in thrust required, lower rate of descent than normal and a higher deck angle. A steep approach (above 3.5° visual glidepath angle) is indicated by a lower thrust setting, higher than normal rate of descent and a lower deck angle. These cues are only true for stable conditions (thrust, body attitude and airspeed steady).

FLARE

Autothrottles should be used for landings and will begin to retard after passing 50 feet AGL. A slight flare should be initiated between 30 and 40 feet (approximately 2°). Do not trim stabilizer during flare. Aircraft should touch down in touchdown zone. This technique will result in a touchdown slightly below VREF. Do not hold aircraft off in an attempt to achieve a smooth landing. Holding aircraft off to achieve a smooth landing may result in a long touchdown, unusually heavy braking, a higher pitch attitude and reduced tail clearance.

NOTE

Below 10 feet with the aircraft fully flared (sink rate approximately 2-4 feet per second), the basic technique is to maintain attitude by applying the required control wheel pressures. A more advanced technique is to relax the back pressure to lower the nose (approximately 1°) prior to main gear touchdown.

The aft fuselage will contact runway at approximately 10° pitch attitude with struts compressed.

TOUCHDOWN

After touchdown , The PNF will monitor ground spoiler deployment and be prepared to manually deploy the spoilers if necessary. The PF should be prepared to counter any pitch-up tendency as spoilers extend. Fly nosewheel to runway, and if ground spoilers do not fully deploy upon nosewheel touchdown, manually deploy spoilers. Pitch-up tendency is more pronounced at aft CG. Use of autobrakes will help counter any pitch-up tendency.

ROLLOUT

As nosewheel is lowered to the runway, deploy reversers on all three engines simultaneously. A momentary pause will be encountered at interlock stop on engines 1 and 3, and the reverse thrust may be selected to desired level. Engine 2 will provide only idle reverse thrust until nosewheel strut compression. For normal landing, at 80 KIAS, smoothly move reverse thrust levers toward reverse idle detent, so as to be at reverse idle by 60 KIAS.

LANDING PROCEDURES

LANDING FLAP SETTING

Normal landing flap settings may be flaps 35° or 50° depending upon conditions.

One or more of the following conditions might cause flaps 50° to become the preferred landing flap setting.

- Short runway.
- Tailwind.
- Contaminated runway.
- Early turn off or shortening landing roll.
- High landing gross weight associated with any of the above items.

SELECTION OF FLAPS 50°

Precision	Normally after 35° and below flaps 50° limit speed.
Non-Precision	Prior to FAF except if distance from fix to runway is unusually long, maintain flaps 35° until visual contact with the runway and in a position to intercept a normal descent profile. In any case, the airplane, should be in the final configuration prior to descent below MDA.
Visual	No later than 1000 ft. above TDZE.

FINAL APPROACH CONDITION AND TOUCHDOWN

The desired visual final approach condition consists of a 3° glide path and the airspeed at V_{APP}. Autothrottles should be used for all landings. The autothrottles will begin to retard after passing 50 feet AFL and will retard at a linear rate for a 3 degree glide path without airspeed, vertical speed or radio altitude bias. Consideration should be given to holding power on if a normal flare is not established.

V_{APP} is adjusted for wind effects. Target approach speed is V_{APP} for landing in reported winds up to 10 kts steady state. When landing in higher wind conditions, add 1/2 the steady headwind component plus the full value of the gust to V_{REF}. The total additive should not exceed 20 kts.

Early stabilization of airspeed, power and descent rate are essential to a good landing. For normal landing configurations, the descent rate will be 650 to 800 ft per minute. The pitch attitude is 5° for the MD-11 with the flaps set at 35°, mid CG, on a 2.5° glideslope at V_{APP}. In the hypothetical case, if the airplane is flared to the zero rate of descent with idle thrust and a speed of 1.25 V_S at touchdown, the pitch attitude will be 10°. However, with a typical low rate of descent at touchdown, the pitch attitude will normally be 8° to 9°. Landing with a 50° flap setting will decrease the pitch attitude approximately 1° in all cases. This body angle creates a relatively high eye level position in relation to the landing gear. For the transitioning pilot this frequently makes him want to lower the airplane's nose (duck under) when going VFR from an instrument approach or when approaching the threshold. The aiming point is 1,500 ft to 1,800 ft down the runway (40 to 60 ft threshold clearance) in contrast to the 1,000 ft point used on smaller airplanes. The radio altimeter is a good guide to assist in determining the correct position for crossing the threshold. The radio altimeter is biased to accurately indicate the height of the lowest part of the main wheels above the terrain. Radio altimeter calls are very valuable as an aid in determining wheel height to touchdown. When seated in the proper seat position the threshold should disappear under the nose at 75 ft radio altitude. At any time the radio altitude is observed to be 75 ft or less, and the approach end of the runway is still in sight, the airplane is dangerously low and corrective action should be immediately taken. One of the most important factors which may lead to ground contact with the tail is holding off in the flare which allows the airplane to float prior to touchdown. Do not try to arrest high sink rates with pitch alone. A slight flare (approximately 2 degrees) should be initiated between 30 and 40 feet radio altitude to reduce the sink rate. Trimming the stabilizer or leaving the power on throughout the flare will contribute to flaring too late. Flaring too early or abruptly will cause floating in ground effect which rapidly uses the runway. If speed is excessive, it is still better to set the airplane onto the runway as near the 1,500 ft point as possible rather than allowing it to float in order to bleed off airspeed. Deceleration on the runway is about 3 times greater than in the air. At 10 feet radio altitude relax the back pressure on the yoke to lower the nose (approximately 1 degree) prior to main gear touchdown. On touchdown, it is important to lower the nosewheel to the runway and hold a positive forward pressure to counteract nose up pitching tendencies. When this is done, the wing angle of attack is decreased, resulting in minimum lift, which places more weight on the main gear sooner. This not only increases rolling friction but increases braking effectiveness as well. This procedure is five times more effective in decelerating the airplane than that achieved from holding the nosewheel off. Do not use aerodynamic braking.

Be prepared to counter any pitch-up tendency as spoilers extend. Pitch-up tendency is more pronounced at aft CG and/or airspeeds below V_{REF} minus three knots. Auto brakes and maximum reverse thrust (without delay as soon as interlocks release and prior to nosewheel touchdown) will help counter any pitch-up tendency. The aft fuselage will contact the runway at approximately 10 degrees pitch attitude with struts compressed. Excessive pitch angles combined with slow airspeeds (in excess of three knots below V_{REF} at touchdown) while attempting to obtain a smooth touchdown by holding the airplane off the runway increases the risk of a tail strike. If the airplane should bounce, establish a 71/2 degree pitch attitude and add thrust as necessary to counter the rate of descent. Do not increase pitch attitude to hold the airplane off the runway. If a high bounce occurs, initiate a go-around.

REVERSE THRUST

Reverse thrust is most effective at higher roll out speeds and becomes less effective as the speed is reduced. Upon main gear touch down, the PF should immediately position all three reversers to idle reverse. The PNF will observe the Reverser Unlock lights (3 amber) illuminate followed by the Reverse Thrust lights (3 green).

While flying the nose gear to the ground, the PF should maintain a constant pressure on No. 1 and No. 3 reverse levers so that reverse thrust on these engines can be smoothly applied when the interlock releases. Do not cycle the levers. As the nose gear touches down and the squat switch is depressed, the pilot should then reach forward and bring the No. 2 reverser back to match No. 1 and No. 3 if required.

After reaching 80 kts, the pilot should slowly move the reversers to the idle position. Remember that fast movement out of reverse will produce a sudden surge of forward thrust that will negate some of the airplane stopping ability. Finally all lights (green and amber EAD reverse indicators) should be out upon reaching 60 kts to prevent reingestion, FOD damage and compressor stalls.

CAUTION

Excessive forward thrust will result when a fan reverser is inoperative if the thrust lever is actuated. To prevent this occurrence, maintenance procedures dictate a positive locking of the cockpit reverse lever.

CAUTION

Reduce reverse thrust slowly so as to be at reverse idle when the reverse levers are stowed.

The PNF will call out: "80/60 knots"

During landing and reversing the PNF will monitor reverse and call out by engines number:

- Any engine that does not display "REV" on the EAD.
- Engines that fail to spool.
- N_1 RPM in excess of G/A limit.
- Excessive EGT rise.

ADVERSE BRAKING OPERATION

There are two ways that a perfectly functioning anti-skid system can be defeated on a wet or icy runway resulting in locked wheels and a loss of directional control.

The first is due to the requirement for the wheels to spin-up on touchdown before the anti-skid is activated. If this spin-up does not occur, when the pilot applies brake pressure the anti-skid logic will let the brakes be set as if at the gate.

The second is similar but occurs during the landing roll. If, during the release phase of the anti-skid cycle, the friction is not enough to accelerate the wheel there will come a point when the wheel speed is slow enough to allow the anti-skid logic to set the brakes as if at the gate, even though the airplane is still traveling at a medium speed.

This can be felt as a feeling of acceleration when applying the brakes. To overcome this condition the brakes should be completely released momentarily in order to allow the wheels to spin-up to the proper speed.

CROSSWIND LANDING, DRY RUNWAY

The recommended method for a crosswind landing is to fly the final approach in a wings level attitude with a crab into the wind. When approximately 200 ft above the runway, align the fuselage with the runway using the rudder and lowering the upwind wing. Use only enough cross control to stop the drift. Avoid holding the airplane off during landing; low angles of attack during landing provide positive lateral control. The MD-11 has ample bank angle clearance during the crosswind landing maneuver. However, excessive banking of the airplane in close proximity to the ground, depending on flap setting, bank angle and pitch attitude, can result in wing tip contact.

The forward slip maneuver recommended would require (worst example) a maximum bank angle of 6°. This provides a comfortable margin for maneuvering and gust protection. After touchdown, maintain directional control with rudder and keep the wings level with ailerons. The landing gear/tail area geometry of the MD-11 causes a marked tendency for the airplane to weathercock in a cross wind (takeoff or landing). This weather cocking tendency should be anticipated and corrected immediately with the rudder while decelerating to taxi speed or until the nose wheel steering and wheel braking become effective.

NOTE

For crosswinds components in excess of 15 knots, flaps 35 is recommended unless runway surface conditions or length dictate the use of flaps 50.

SPOILERS

Observe the spoiler handle moves aft upon main gear spin-up.

If armed, auto-spoilers will deploy on landing or rejected takeoff to decrease lift. Activate auto-brakes and allow optimum braking efficiency. During a rejected takeoff, if the reject is initiated below 100 knots, the spoilers will deploy upon application of reverse thrust. If the takeoff is rejected above 100 knots, retarding any two throttles to idle will deploy the spoilers. During landing with flaps in the landing range, the spoilers will deploy to about 2/3 ground spoilers and then deploy fully at nose touchdown. During landings with less than landing flaps the spoilers will deploy at nose gear touchdown.

NOTE

If the spoiler handle does not move to the full aft position (ground spoiler), the PNF will lift the handle up and pull it aft to the Ground Spoiler position. If the handle does not latch in the full aft position, the PNF will hold it aft.

REJECTED LANDING

The rejected landing procedure is identical to the go-around procedure. Rotate to go-around attitude (approximately 20° initially, then adjust attitude to maintain V_{APP} + 5 kts). Apply go-around thrust and select flaps 28°. Gear retraction will not be initiated until such time as a positive rate of climb has been verified and called by either pilot. Follow standard missed approach procedures.

CAUTION

Do not attempt a go-around after reverse thrust has been initiated. Failure of a thrust reverser to return to the forward thrust position may prevent a successful go-around.

ONE ENGINE INOPERATIVE APPROACH

If making a one engine inoperative approach, it is essential that the airspeed and profile be stabilized early in the approach to minimize thrust changes. "Flaps 28°", "Gear Down", "Before Landing Checklist", "Flaps 35°" should be called 5nm prior to the FAF. As the flaps are lowered, the airspeed should be decreased so that the proper approach speed is reached at or soon after glideslope interception. If a wing engine is inoperative, thrust/speed changes will require rudder/rudder trim changes and should be anticipated to obtain best airplane and AFS performance. If the center engine is inoperative, thrust changes will require elevator inputs and/or stabilizer trim changes.

Landing with one engine inoperative is the same as a normal landing, except that V_{APP} + 5 (V_{REF}+10) is maintained after extension of flaps to 35°. Reverse the operative engines with discretion.

ACCEPTABLE PERFORMANCE GUIDELINES - LANDING

- Airspeed: ± 5 KIAS of target speed on final.
- Touchdown to occur in the touchdown zone.
- Touchdown close to or on the centerline.

COMMON ERRORS - LANDING

- Early/late flare.
- Poor throttle control.
- Poor brake usage.
- Improper use of reverse thrust (excessive, not enough or none at all).
- Failure to fly the nose gear to the ground smoothly.
- Airplane not in trim.

The ATS controls to speed targets during approach, altitude hold, vertical speed, flight path angle, and profile modes of the AFS/FMS system.

Flight Level change operation transfers the ATS to thrust control. Speed will then be controlled by the pitch attitude. The speed and thrust control functions are annunciated on the FMA.

The ATS provides for automatic speed reference transitions (IAS/Mach) during climbs and descents as follows:

- If climbing and under IAS control, auto-transition occurs when the existing MACH number equals the preselected Mach number (or 26,000 feet if the Mach number was not preselected).
- If descending and under control of Mach number, auto-transition occurs when the existing IAS equals the preselected IAS (or 26,000 feet if IAS was not preselected).

Auto-transition is annunciated on the FMA speed widow by a change in the control target.

SPEED ENVELOPE LIMITING

GENERAL

The AFS provides full flight regime speed protection using the following:

- ATS self engagement.
- ATS speed control.
- LSAS speed limiting and stall protection.
- AP/FD automatic pitch mode transitions.

AUTOMATIC ENGAGEMENT AND SPEED CONTROL

The ATS (if available but not engaged) will auto engage and transition to a speed on thrust mode when the V_{MAX} or V_{MIN} limit is about to be (or has been) exceeded. The AP/FD (if engaged) reverts to a compatible pitch mode. ATS engagement is annunciated by a flashing white A/T OFF on the PFD and HI SPEED (or LO SPEED) PROTECTION flashing above the FMA speed window as appropriate.

LSAS SPEED LIMITING AND STALL PROTECTION

If the AP is not engaged and the ATS is not available, or *unable to maintain a safe speed*, LSAS speed limiting will engage automatically to provide overspeed or stall protection. LSAS overspeed limiting is accomplished by changing pitch. The target speed that the LSAS chooses in high speed protection is variable between Vmo/Mmo, for throttles at idle, and V_{MO}/M_{MO} plus 6 knots for throttles at full power. LSAS will not auto trim in the nose down direction in a high speed encounter.

LSAS does not provide flap, slat or gear overspeed protection.

LSAS stall protection engages at stickshaker warning angle-of-attack (PLI on the PFD turns amber). Stickshaker warning is 75 to 85 percent actual stickshaker angle-of-attack depending on flap setting.

If windshear command guidance is on, LSAS stall protection is delayed until actual stickshaker angle-of-attack.

After the angle-of-attack is reduced below stickshaker warning, LSAS stall protection is discontinued and ATS speed control to FMS V_{MIN} is resumed.

The pilot may counteract the LSAS overspeed or stall protection by pushing on the control column with force to defeat the LSAS elevator inputs. This force is approximately 50 pounds. If the pilot releases the control column force rapidly, LSAS will dampen the resulting elevator instability. For further information refer to the Flight Controls chapter.

AP/FD SPEED MODE REVERSIONS

Detection of speed limit violations in FMS SPD or PROF modes disengages the FMS and the AFS will resume control (if engaged).

If the FCP level change/speed on pitch mode is engaged, the ATS is off or available, and a V_{Max} or FMS V_{Min} speed limit violation occurs the following will happen:

At 5 knots over or underspeed:

- The AP/FD pitch control mode reverts to V/S-FPA at existing vertical speed/flight path angle.
- ATS engages in speed-on-thrust speed protection with a V_{Min} or V_{Max} speed target.
- The FMA flashes THRUST and V/S or FPA five times before becoming steady.
- The FMA flashes HI SPEED PROTECTION or LO SPEED PROTECTION.

At 10 knots over or underspeed:

- The AP/FD pitch control mode reverts to pitch speed protection with a V_{Min} or V_{Max} speed target.
- The throttles are clamped at their existing positions.
- The FMA flashes PITCH five times before becoming steady.
- The FMA flashes HI SPEED PROTECTION or LO SPEED PROTECTION.

LONGITUDINAL TRIM

GENERAL

Longitudinal trim is provided by a two-speed, hydraulically powered, adjustable stabilizer.

The stabilizer is actuated by two hydraulic motors powered independently by hydraulic systems 1 and 3. Hydraulic system 2 will provide backup hydraulic power to the stabilizer through the 2-1 NRMP.

The stabilizer operates automatically at two different trim rates as a function of airspeed and/or altitude to provide optimum performance. The rate is also dependent upon which stabilizer control input is in use.

A compensator with a low fluid level switch will automatically shut off hydraulic flow from hydraulic system 2 to the 2-1 NRMP if fluid level is low in the compensator.

Four modes of operation are available as follows:
- Autotrim (longitudinal stability augmentation system (LSAS)).
- Autotrim (autopilot).
- Manual trim (switches).
- Manual trim (LONG TRIM handles).

To accomplish smooth and appropriate longitudinal trim rates for all flight conditions, two trim rates are provided for each mode of operation. The rate change occurs at 250 knots airspeed or 33,000 feet.

LSAS AUTOTRIM

When LSAS is engaged in pitch attitude hold (force on column less than 2 pounds), the automatic pitch trim will move the horizontal stabilizer to trim out steady state elevator commands. The FCC operates one trim motor in this mode. Rate (high or low) is based on altitude and airspeed.

AUTOPILOT AUTOTRIM

When the autopilot is engaged, the autotrim function will control the stabilizer based on average elevator position offsets, rather than using elevator commands as in LSAS. When the AFS OVRD switch on the FCP is pushed to OFF, AP automatic pitch trim turns off.

MANUAL TRIM (SWITCHES)

Full-time actuation of both trim motors is available to the pilot through use of the manual trim switches on both control wheels. These switches will move the stabilizer in the commanded direction and disengage the autopilot from any engaged mode (except DUAL or SINGLE LAND).

MANUAL TRIM (HANDLES)

Override of the electrical trim systems is accomplished with a pair of LONG TRIM suitcase style handles on the Captain's side of the forward pedestal.

The LONG TRIM handles remain stationary when the control wheel switches operate trim. Use of these handles will disconnect the autopilot from any engaged mode (except DUAL or SINGLE LAND).

LONGITUDINAL STABILITY AUGMENTATION SYSTEM (LSAS)

The LSAS enhances longitudinal stability and provides:
- Pitch attitude hold.
- Pitch attitude limiting.
- Pitch rate dampening.
- Automatic pitch trim.
- LSAS speed protection.
- LSAS stall protection

LSAS is off when autopilot is engaged or below 100 feet AGL.

With no force on the control column and bank angle of less than 30 degrees, the LSAS holds the current pitch attitude. If the pilot manually changes pitch attitude and then removes control column input, the aircraft will hold the new pitch attitude.

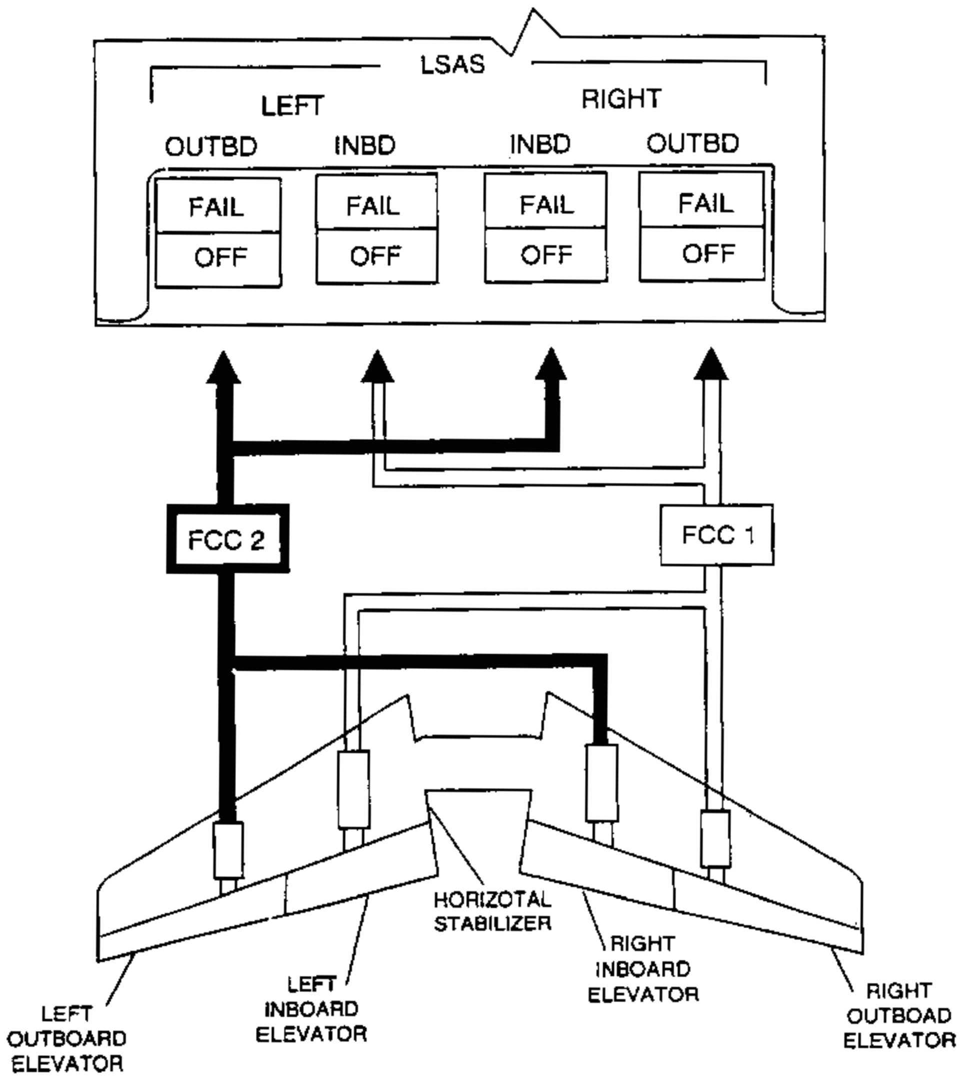
The LSAS holds pitch attitude by deflecting the elevators up to 5 degrees. The stabilizer is automatically adjusted to relieve sustained elevator deflection and maintain a full 5 degrees of elevator authority. The LSAS also maintains pitch attitude to less than 10 degrees of dive or less than 30 degrees of climb. Whenever there is more than approximately 2 pounds of force on the control column, LSAS is inoperative. Once the pilot applies about 4 pounds of control column force, the elevators respond to the pilot's commands.

Stabilizer position will appear on the system display (SD) when the configuration page is selected with the CONFIG cue switch.

LSAS also provides speed and stall protection.

Each of the two FCCs contains two redundant LSAS control channels. Each of the separate LSAS channels controls one of the four hydraulic actuators at the elevators. If fewer than four of the LSAS channels are

LSAS DIAGRAM



AFS CONTROL PANEL

FLAP LIMIT SELECTOR and FLAP LIMIT MANUAL LIGHT - amber
The FLAP LIMIT selector is used to manually override the auto mode of the flap limiter. In the AUTO position, the flap limiter will automatically retract the flaps if the airspeed exceeds limits for flap settings between 22 and 50 degrees.

In the OVRD 1 or 2 position, automatic flap limiting is by-passed.

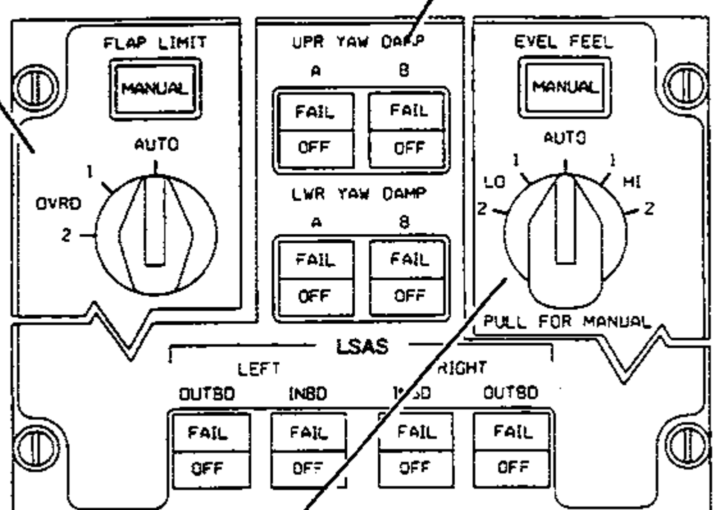
The FLAP LIMIT MANUAL light will illuminate amber when both flap limiter channels fail or when the FLAP LIMIT selector is in OVRD 1 or 2.

The FLAP LIM DISAG alert may be displayed after selecting OVRD 1 or OVRD 2. If the alert remains displayed after after selecting OVRD 2, flap extension may be limited.

LSAS SWITCHES AND YAW DAMP SWITCHES - amber
When an LSAS or YAW DAMP switch is pushed the respective control channel will shut off and OFF will illuminate amber.

Pushing an LSAS or YAW DAMP switch when OFF is illuminated will engage the respective control channel if it is not failed.

Failure of an LSAS or yaw damper control channel will automatically illuminate the respective FAIL light amber and shut off the failed control channel.



ELEV FEEL SELECTOR/MANUAL LIGHT - amber
The ELEV FEEL selector allows manual slewing of the elevator load feel (ELF) when airspeed is between 120 and 300 knots.

With the selector in AUTO, the ELF is varied automatically to correspond with airspeed.

The MANUAL HI or LO positions allow slewing of the ELF to a higher or lower airspeed. The airspeed will be displayed on the configuration page of the SD.

The ELEV FEEL MANUAL light will illuminate amber when both ELF control channels fail or when the ELEV FEEL selector is in MANUAL.

FM-1-2-466A

Appendix II

<u>Selected Excerpts from FedEx "Straight in Approach" publication</u>

Flight Standards & Technical News

GENERAL

Please, let us hear from YOU!! To provide an easy way to receive your comments, requests for specific information/articles, you may send an e-mail to: SIA

If you are missing any pages or revisions for your publications, e-mail requests to PUBLICATION SUPPORT CENTER/CUSTOMER REQUEST using Bulletin Board "MANUAL/ORDERS," or call the PSC at (901) 224-6006.

(Editor's Note: Performance Engineering has been asked to contribute a monthly article on items of general interest. This month's offering describes landing distances. Comments and suggestions for future articles may be e-mailed to SIA.)

Landing Distance and the APLC

The analysis of landing data can be thought of in two distinct parts. As with everything we do in this technical world, first we need to plan it, then do it. The same can be said for landing. First we look at the planning data, using the Dispatch Landing Module; then we look at the actual landing data, which is the Inflight Landing Module.

In planning for landing using the Dispatch Landing Module, the landing data is calculated using very specific guidelines detailed in the Federal Aviation Regulations - the FARs. For planning the landing, the FAR's tell us that

- for a given airplane gross weight;
- at a particular altitude and temperature;
- using a touchdown point 1000' from the threshold, max effort braking, autospeed brakes, and no thrust reverser;

if the runway is dry, the amount of runway that the airplane will need to make the landing can be no more than 60% of the available landing length.
If the runway is wet, the amount of runway that the airplane will need can be no more than 52% of the available runway. Obviously, since runways cannot be lengthened to accommodate any airplane weight, the airplane weight must be adjusted during the flight planning stage to insure that the expected landing weight is allowable on the destination runway.

The plan is done and once the airplane is dispatched, the plan, as they say, is history. It insured we were legal to start the flight, but has no bearing on the actual landing that will take place. So, the flight takes place and the airplane is approaching the destination airport. Due to all kinds of various circumstances we could find that we are close to our anticipated landing weight, somewhat lighter, or somewhat heavier. Now comes part two of the landing, doing it.

The Inflight Landing Module in the APLC was created to provide the crewmembers realistic, meaningful data for the upcoming landing they are about to perform. Providing inputs of temperature, wind (and gusts, if any), altimeter, and estimated actual landing gross weight, the APLC will provide a whole page of useful information.

For each runway listed, a Runway Length is listed also. The Runway Length is obtained by using the lesser of three separate runway lengths found in the Jepps. Those three are:

1) the length as found on the airport diagram page;
2) the threshold length, listed on the runway data page;
3) the glide slope length +1000 ft, also listed on the runway data page.

The +1000 ft added to the glide slope length accounts for the length of pavement prior to the glide slope beacon based on coming over the threshold at 50 ft on a 3 degree glide slope.
For example: if we look at Newark (KEWR), runway 04L we see 8200' on the diagram, threshold distance of 7460' and glideslope distance of 6400' (+1000') = 7400' on the data page. The lesser of these three is 7400'. This is the number listed in the APLC.

Answers for JUN - (1)C (2)B (3)C (4)C (5)C

The Approximate Landing Distance values are calcu-lated using actual stopping distance plus 1500'. The 1500' accounts for runway surface between the 50' height at threshold and the touchdown point plus some conservatism. The MIN, MED, and MAX BRKG values are based upon a fixed deceleration rate according to the Brake Switch setting - MIN, MED, or MAX. Fixed deceleration means that if you feed in more thrust reverser, the braking system will back off a bit on brake pedal force; less reverser - more brake pedal force.

For example, a 130,000 lb 727 using MED braking at EWR may see that it needs a runway length of 4590'. This means that it needs 3090' to stop after it touches down 1500' from the threshold.

So, as we see from above, the data presented from the Dispatch Landing and the Inflight Landing modules are completely separate. One being used for planning purposes, the other being used by the pilot for actual landing.

MEL Tips & Suggestions

A large amount of effort is expended within AOD reviewing and arbitrating delays associated with the MEL. Often, many delays could be minimized or even avoided, if all parties involved would read the ENTIRE MEL entry. From the crew perspective, this would mean reading not only the (O) procedure statements, but also the Remarks or Exceptions, and the (M) procedures. Practicing this approach will help to capture the entire picture.... understanding the nature of the failure, and how the MEL ensures continued airworthiness. Per MMEL definitions, a (M) procedure is normally accomplished by Maintenance, and an (O) procedure is normally accomplished by the Flight crew; however, either party may be qualified and authorized to perform certain functions. Thus, by reading all (O) and (M) procedures one can then ensure all necessary actions are accomplished in a timely and safe manner.

The following is a review of the basic philosophy associated with the MEL, and is intended to aid your understanding of how to apply the MEL:

1. **Components of an MEL Item (Read them all!)**
   - Description – Note if the description is referring to a specific item, an entire system or a subfunction of a component or system.
   - Category
   - Minimum Required for Flight
   - Remarks or Exceptions – Cannot overstate the importance of reading and comprehending this section. It is equally applicable as the (O) procedures section. Every person who uses the MEL must read this in its ENTIRETY because it states specific guidelines and restrictions that must be complied with when deferring an item. These guidelines may specifically be directed to GOC, MOCC, Maintenance, the Crew or **ALL** parties, and may **not** be repeated in an (O) or (M) procedure.

2. **Interrelationships of Multiple Inoperative MEL Items/Systems**
   - When operating with multiple inoperative items, the interrelationship between those items and the affect on aircraft operation and crew work-load should be considered. Review of an MEL Item in its entirety ensures compliance of applicability and continued airworthiness.

Remember, Two Sets of Eyes are Better than One!

3. **FLAG ITEMS**
   - This symbol is often misapplied or misinterpreted. A flag on an MEL item generally points to a (M) Placard indicating required maintenance and is applied ONLY to that specific item of relief. Consider that a MEL item may have more than one set of conditions for relief of a deferral. One set of relief/conditions may have a FLAG and the other may NOT. Do not automatically assume that since a set of conditions for relief has a flag that each subsequent set of relief would be flagged as well. A FLAG will be applied to each specific set of relief that directs Maintenance to be performed that can not be safety accomplished by crew or delayed until arrival at next station.

JUNE QUESTIONS

1. Windshear is defined as a rapid change in wind direction resulting in an airspeed change of more than ______ knots.

A. 2
B. 8
C. 10
D. 12

2. Each crew member is required to maintain a current flight log book to document flight time qualifications:

A. True
B. False

Flight Standards &Technical News

MD-11 NEWSLETTER

MD-11 Flight Manual

Revision 28 .... 30 June 1998
Bulletins 97-01
Temporary Revisions .... None

Flight Standards

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Flight Standards

Tail Strike Avoidance

Following is a reprint of an article Boeing printed in their publication AERO Magazine. The writer of the article was Pete Benardin, Chief Pilot Boeing. You may access the full article with figures on the Boeing home page, www.boeing.com. The article is a generic one that covers all Boeing aircraft types, but the issues raised do apply directly to the MD-11 in most cases.

Tail strike, which occurs when an airplane tail contacts the runway during takeoff or landing, is an event that can be encountered by virtually all transport airplane designs. Some models in the Boeing commercial airplane fleet experience tail strike more often than others and, almost without exception, the cause is elusive to the flight crew. In order to better understand this occurrence, Douglas Products Division (DPD) examined a number of recent tail strike events.

In an effort to help operators avoid tail strike and the resulting damage, DPD conducted an evaluation of the circumstances surrounding this event, including weather, wind, weight, speed, and control input. DPD also conducted flight crew interviews and reviewed flight recorder data during its examination of recent tail strike events.

The results provided the following conclusions:

- The frequency of tail strike is higher for some models on takeoff, and for other models on landing (Editor's note: The MD-11 has experienced both.). The overall incident rate varies from one model to another as well as over time. For example, one model experienced a high incident rate upon entry into service, followed by a reduced rate and then an increased rate about six years after initial entry into service......
- Though tail strike occurs in both daylight and darkness, and in both good and bad weather, the amount of flight crew experience with the model of airplane flown is a more significant factor. While tail strike may occur to pilots with abundant flight time in a model, most occur to pilots who are transitioning from one airplane model to another and have fewer than 100 hours of flight time in the new model. Incidents are greatest among pilots during their first heavy-weight operations in the new model, especially when the weather is marginal.

The DPD examination revealed eight risk factors, one or more of which precede a tail strike: mistrimmed stabilizer; unstabilized approach; holding off in the flare; mishandling of crosswinds; and over-rotation during go-around. Additional factors may exist that were not revealed by the DPD examination, but each of the eight was shown to play a significant role in tail strike. Most importantly, the examination showed that each is under the direct control of the flight crew, and therefore can be avoided with proper understanding and training. The risk factors were found to occur in two categories:

1. Takeoff risk factors.
2. Landing risk factors.

Takeoff Risk Factors

Any one of these four takeoff risk factors may precede a tail strike:

- Mistrimmed stabilizer.
- Rotation at improper speed.
- Excessive rotation rate.
- Improper use of the flight director.

MISTRIMMED STABILIZER

A mistrimmed stabilizer occurring during takeoff is not common but is an experience shared at least once by almost every flight crew. It usually results from using erroneous data, the wrong weights, or an incorrect center of gravity (CG). Sometimes the information presented to the flight crew is accurate, but is entered incorrectly either to the flight management system (FMS) or to the stabilizer itself. In any case, the stabilizer is set in the wrong position. The flight crew can become aware of the error and correct the condition by challenging the reasonableness of the load sheet numbers. A flight crew that has made a few takeoffs in a given weight range knows roughly where the CG usually resides and approximately where the trim should be set. Boeing suggests testing the load sheet numbers against past experience to be sure that the numbers are reasonable.

A stabilizer mistrimmed nosedown can present several problems, but tail strike usually is not one of them. However, a stabilizer mistrimmed noseup can place the tail at risk. This is because the yoke requires less pull force to initiate airplane rotation during takeoff, and the pilot flying (PF) may be surprised at how rapidly the nose comes up. With the Boeing-recommended rotation rate (of 2.5) degrees per second (dps), ... and a normal liftoff attitude, liftoff usually occurs about four seconds after the nose starts to rise. ... However, with the stabilizer mistrimmed noseup, the airplane can rotate 5 dps or more. With the nose rising very rapidly, the airplane does not have enough time to change its flight path before exceeding the critical attitude. Tail strike can then occur within two or three seconds of the time rotation is initiated.

If the stabilizer is substantially mistrimmed noseup, the airplane may even try to fly from the runway without control input from the PF. Before reaching Vr and possibly as early as approaching V1, the nose begins to ride light on the runway. Two or three light bounces may occur before the nose suddenly goes into the air. A faster-than-normal rotation usually follows and, when the airplane passes through the normal liftoff attitude, it lacks sufficient speed to fly and so stays on the runway. Unless the PF actively intercedes, the nose keeps coming up until the tail strike occurs, either immediately before or after liftoff.

ROTATION AT IMPROPER SPEED

This situation can result in a tail strike and is usually caused by one of two reasons: rotation is begun early because of some unusual situation, or the airplane is rotated at a Vr that has been computed incorrectly and is too low for the weight and flap setting.....

An error in Vr speed recently resulted in a trijet tail strike. The load sheet numbers were accurate, but somehow the takeoff weight was entered into the FMS 100,000 lb lower than it should have been. The resulting Vr was 12 knots indicated air speed (kias) slow. When the airplane passed through a nominal 8-deg liftoff attitude, a lack of sufficient speed prevented takeoff. Rotation was allowed to continue, with takeoff and tail strike occurring at about 11degrees. Verification that the load sheet numbers were correctly entered may have prevented this incident.

EXCESSIVE ROTATION RATE

Flight crews operating an airplane model that is new to them, ... are most vulnerable to using excessive rotation rate. The amount of control input required to achieve the proper rotation rate varies from one model to another. When transitioning to a new model, flight crews may not consciously realize that it will not respond to pitch input in exactly the same way.

As simulators reproduce airplane responses with remarkable fidelity, simulator training can help flight crews learn the appropriate response. A concentrated period of takeoff practice allows students to develop a sure sense of how the new airplane feels and responds to pitch inputs. On some models, this is particularly important when the CG is loaded toward its aft limits, because an airplane in this condition is more sensitive in pitch, especially during takeoff. A normal amount of noseup elevator in aft CG condition is likely to cause the nose to lift off the runway more rapidly and put the tail at risk.

IMPROPER USE OF THE FLIGHT DIRECTOR

..., the flight director (FD) is designed to provide accurate pitch guidance only after the airplane is airborne, nominally passing through 35 ft (10.7 m). With the proper rotation rate, the airplane reaches 35 ft with the desired pitch attitude of about 15 deg and a speed of V2 + 10... However, an aggressive rotation into the pitch bar at takeoff is not appropriate and may rotate the tail onto the ground.

Landing Risk Factors

Any one of these four landing risk factors may precede a tail strike:

- Unstabilized approach.
- Holding off in the flare.
- Mishandling of crosswinds.
- Over-rotation during go-around.

A tail strike on landing tends to cause more serious damage than the same event during takeoff and is more expensive and time consuming to repair. In the worst case, the tail can strike the runway before the landing gear touches down, thus absorbing large amounts of energy for which it is not designed. The aft pressure bulkhead is often damaged as a result.

UNSTABILIZED APPROACH
An unstabilized approach ... appears in one form or another in virtually every landing tail strike event. When an airplane turns on to final approach with excessive airspeed, excessive altitude, or both, the situation may not be under the control of the flight crew. The most common cause of this scenario is the sequencing of traffic in the terminal area as determined by air traffic control.

Digital flight recorder data show that flight crews who continue through an unstabilized condition below 500 ft will likely never get the approach stabilized. When the airplane arrives in the flare, it invariably has either excessive or insufficient airspeed, and quite often is also long on the runway. The result is a tendency toward large power and pitch corrections in the flare, often culminating in a vigorous noseup pull at touchdown and tail strike shortly thereafter. If the nose is coming up rapidly when touchdown occurs and the ground spoilers deploy, the spoilers themselves add an additional noseup pitching force. Also, if the airplane is slow, pulling up the nose in the flare does not materially reduce the sink rate and in fact may increase it. A firm touchdown on the main gear is often preferable to a soft touchdown with the nose rising rapidly.

HOLDING OFF IN THE FLARE
The second most common cause of a landing tail strike is a long flare to a drop-in touchdown, a condition often precipitated by a desire to achieve an extremely smooth landing. A very soft touchdown is not essential, nor even desired, particularly if the runway is wet.

Trimming the stabilizer in the flare may contribute to a tail strike. The PF may easily lose the feel of the elevator while the trim is running; too much trim can raise the nose, even when this reaction is not desired. The pitchup can cause a balloon, followed either by dropping in or pitching over and landing flat. Flight crews should trim the airplane in the approach, but not in the flare itself, and avoid "squeakers," as they waste runway and may predispose the airplane to a tail strike.

MISHANDLING OF CROSSWINDS
A crosswind approach and landing contains many elements that may increase the risk of tail strike, particularly in the presence of gusty conditions. Wind directions near 90 deg to the runway heading are often strong at pattern altitude, and with little headwind component, the airplane flies the final approach with a rapid rate of closure on the runway. To stay on the glidepath at that high groundspeed, descent rates of 700 to 900 ft (214 to 274 m) per minute may be required. Engine power is likely to be well back, approaching idle in some cases, to avoid accelerating the airplane. If the airplane is placed in a forward slip attitude to compensate for wind effects, this cross-control maneuver reduces lift, increases drag, and may increase the rate of descent. If the airplane then descends into a turbulent surface layer, particularly if the wind is shifting toward the tail, the stage is set for tail strike.

The combined effects of high closure rate, shifting winds with the potential for a quartering tail wind, the sudden drop in wind velocity commonly found below 100 ft (31 m), and turbulence can make the timing of the flare very difficult. The PF can best handle the situation by exercising active control of the sink rate and making sure that additional thrust is available if needed. Flight crews should clearly understand the criteria for initiating a go-around and plan to use this time-honored avoidance maneuver when needed.

OVER-ROTATION DURING GO-AROUND
Go-arounds initiated very late in the approach, such as during flare or after a bounce, are a common cause of tail strike. When the go-around mode is initiated, the FD immediately commands a go-around pitch attitude. If the PF abruptly rotates into the command bars, tail strike can occur before a change to the flight path is possible. Both pitch attitude and thrust are required for go-around, so if the engines are just spooling up when the PF vigorously pulls the nose up, the thrust may not yet be adequate to support the effort. The nose comes up, and the tail goes down. A contributing factor may be a strong desire of the flight crew to avoid wheel contact after initiating a late go-around, when the airplane is still over the runway. In general, the concern is not warranted because a brief contact with the tires during a late go-around does not produce adverse consequences. Airframe manufacturers have executed literally hundreds of late go-arounds during autoland certification programs with dozens of runway contacts, and no problem has ever resulted. The airplane simply flies away from the touchdown.

Summary

An examination of recent tail strike events, which included consideration of weather conditions, flight recorder information, and interviews with flight crews, showed that eight factors contribute to tail strike. A significant factor that appears to be common is the lack of flight crew experience with the model being flown. The examination concluded that flight crews can take a variety of steps to prevent tail strike, including challenging the reasonableness and accuracy of takeoff numbers, being very aware of pitch attitude when flying on or just above the runway, and obtaining flight simulator training to become more familiar with how various airplane models respond to pitch inputs.

down input sufficient to disconnect the autopilot. The aircraft nose down input was quickly corrected, and the airplane returned to stabilized flight. The initial pitch down generated a negative "G" condition which resulted in injury to some unrestrained passengers. One flight attendant working in the aft galley was also seriously injured during the pitch maneuver.

Obviously, this didn't happen on one of our aircraft, but it could. This is one of those occurrences that just sort of sneaked up on the crew. One crewmember made a change without informing the other person what he was doing. Just be aware of what's going on and don't be afraid to communicate.

BULLETIN MD-11-94-03

Be on the lookout for Bulletin MD-11-94-03. This will be on the street within the next few weeks. This bulletin will replace the emergency bulletin MD-11-94-02. Both of these bulletins make the same statements but because the first one had to be completed by a certain date we did not have time to review some of the other bulletins that we wanted to remove from the AFM.

Anyway, this bulletin was issued because of an AD issued by the FAA. Once again, it deals with calculations of erroneous V speeds by the FMC. One noticeable difference from this bulletin compared with MD-11-94-01 was the use of FLEX temperatures and anti-ice. Another difference is that this AD does not allow for any difference between FMC computed speeds and APLC computed speeds. If any difference exists, the APLC speed must be used.

HYDRAULIC TEST FAILURES

Within the past few weeks, there have been several reports of Hydraulic test failures occurring. This is the test that occurs during engine start.

It seems that some crewmembers have been trimming the aircraft during the engine start. This has been placing a load on the hydraulic system and causing the test failure. We should be waiting until the start sequence has been completed and all tests are complete before setting the trim.

HARD LANDINGS

By now most people are aware that a very hard landing was made by an MD-11 operator causing extensive damage to the airplane.

It seems that a not so unusual set of circumstances caused this accident to happen. The crew was hand flying the aircraft with the autothrottles disconnected. On touch down, the spoilers did not deploy. They didn't deploy because the throttles were not at idle. The throttles had not been reduced all the way and were left in a position just beyond the spoiler extend point.
In anticipation of pitch up at touch down, the crew applied forward pressure and forced the nose down rather firmly. This was exacerbated by the fact that the spoilers did not extend. The aircraft bounced and caused the crew to make more than one control wheel movement causing some oscillations to occur.

We can all think of times that we have disconnected the autothrottles and been in what could have been a very similar situation. We must remember that anything done out of the ordinary requires a lot of thought and planning. Hopefully, we can learn from all of these situations and keep a safe operation.

A-300 Fumes in the Cockpit - The passenger carrying jet had flown approximately one hour from SJU to JFK when the Head Flight Attendant reported fumes in the cabin. The Captain requested an emergency divert to BDA (Bermuda). The Flight Attendant asked the passengers in the vicinity of the odor if they knew what the cause could be. A male passenger indicated that he was carrying some dental office chemicals in his carry-on baggage. A check of his carry-on bag revealed two 10 ounce bottles of methyl methacrylate monomer (a flammable liquid) which were leaking. The immediate area was cleared of passengers and the odor became so strong that the passenger emergency oxygen was deployed and the cockpit crew donned their oxygen masks. Several passengers and a Flight Attendant complained of dizziness, nausea and headaches.

Following an uneventful landing, emergency crews met the aircraft, removed the liquid, and took five passengers and one Flight Attendant to a local hospital. The passengers were released and the Flight Attendant remained there over night.

An investigation determined that the passenger who had the offending luggage had arrived at the airport with 9 boxes, one of them weighing 119 pounds, to check in for the flight. The agent checking the baggage requested that 20 pounds be removed from the box to comply with limitations. While the passenger was removing some of the items the agent noticed a 16 ounce propane fuel tank. The agent advised the passenger that the propane was restricted from carriage and began an inspection of the remainder of the checked items for other restricted articles. That inspection found another propane tank, two 11 ounce spray paint cans, and the two glass bottles which were returned to the passenger for carriage in his carry on bag. The inspection after the emergency landing discovered 9 bottles of the flammable chemical in the passenger's baggage.

B-727 Collision with Pick-Up Truck - The passenger carrying jet was powered back from the gate and a departure "salute" was given by the ramp employee to the crew. The ramp employee then gave the crew an unacknowledged (and unseen) hold signal for a pick-up truck which had sped to the gate with late baggage. While the cockpit crew was awaiting taxi clearance the unseen truck was positioned at the forward cargo door in front of the right wing to transfer the baggage. Once taxi clearance was received, the Captain added power and began a right turn. His progress was halted by the grossly deformed remains of the truck. Employees on the ground were able to escape without injury.

SIGNIFICANT OCCURRENCES (FEDEX)

MD-11 Hard Landing - On January 3, 1994, N611FE experienced a hard landing on runway 36R at MEM. The flight and approach were unremarkable until just prior to touchdown. A coupled approach was flown to approximately 250 feet AGL. The autopilot was disconnected and the auto throttles remained engaged. At less than 45 feet AGL, the aircraft rolled approximately 2 to 3 degrees right then left. The aircraft touched down on the left main gear then skipped/bounced. The aircraft then touched down on the nose gear simultaneously with or slightly before the right main gear. The maximum G loading was +2.85. Damage was limited to an area immediately aft of the nose gear wheel well and included approximately 20 inches of skin buckling and associated stringer deformation. The aircraft was cleared by the McDonnell Douglas Corporation and Federal Express Engineering for continued service until the next Phase C Check. All aspects of the mishap are being investigated.

Appendix III

FedEx MD-11 Tail Strike Awareness Training

MD-11 FLIGHT INSTRUCTOR GUIDE

TAIL STRIKE AWARENESS TRAINING

CONTENTS

MD-11 Tail Strike Awareness Information

Introduction

FedEx flight standards and flight training have developed an MD-11 tail strike awareness training program. The primary objective of this program is to improve awareness of the pilot controlled factors that affect pitching tendency after touchdown and to reinforce proper sink rate and bounce recovery technique. The program consists of a 30 minute briefing followed by 1 hour of simulator training. Tail strike awareness training has been incorporated into recurrent, initial, and transition training. All FedEx pilots currently qualified on the MD-11 will receive the training during their next recurrent event, i.e. warm up, pt, or loft.

The purpose of this document is to provide FedEx MD-11 pilots immediate access to the information gathered during the development of the tail strike awareness training program.

The airline industry has logged approximately 350,000 MD-11 landings to date. MD-11 tail strike incidents/accidents have occurred at a fairly constant rate (tail strikes/total landings). Approximately 25% of the industries MD-11 tail strikes occurred on takeoff and 75% on landing.

Takeoff

The recommended rotation technique is a 3 degree per second rotation to an initial pitch attitude of approximately 15 degrees. The pilot flying (PF) should then transition to the flight director pitch bar for guidance. The flight director pitch bar is not usable until approximately five seconds after nose gear strut extension. A two step rotation is not appropriate. Two step or segmented rotations will significantly impact takeoff performance, i.e. required runway, second segment climb gradients, and obstacle clearance. It is, however, the PF's responsibility to ensure that the aircraft is accelerating properly and has become airborne passing 10 degrees of pitch attitude. If the aircraft has not become airborne, possibly due to an inaccurate flap setting, stab setting, gross weight entry, or contaminated wing, the rotation should be stopped.

Some tail strikes on takeoff have occurred as a result of early or quick rotations. One tail strike occurred as a result of the pilot initiating a rotation at V1 vs. VR. Another tail strike occurred as a result of an inaccurate gross weight entry into the FMS which resulted in inaccurate V speeds.

LANDING

- **Some of the factors that affect pitching tendency after touchdown are:**

Flap setting	**Strut servicing**	**Sink rate**
Center of gravity	**Ground spoilers**	**Pitch Attitude**
Gross weight	**Autobrakes**	**Pitch Attitude rate**
		Airspeed

- **Landing tail strikes have occurred with the following:**

  Flaps 35 and flaps 50
  Forward and aft center of gravity
  Light and heavy gross weight
  Over serviced and correctly serviced struts

One consistent factor in every landing tail strike to date has been an excessive descent rate with an increasing pitch attitude rate prior to the initial touchdown. Sink rates, pitch attitude, pitch attitude rate, and airspeed are pilot controlled factors that affect pitching tendency after touchdown and are the focus of the tail strike awareness training program.

- **The following pilot actions may result in high sink rates prior to touchdown:**

  Unstable approach
  Late or abrupt align maneuver
  Early flare

- **Stabilized approach**

  The aircraft should be fully configured, on speed (including appropriate wind and gust corrections applied to Vref) and on flight path by 1000 feet AGL. If the aircraft is not stabilized by 500 feet or if a sink rate of more than 1000 FPM develops, a missed approach should be executed.

  Several tail strikes have occurred on visual approaches without the use of an electronic glideslope. Increased crew awareness and crew coordination during these types of approaches is critical.

TAIL STRIKE AWARENESS TRAINING
INSTRUCTOR NOTES

BRIEFING 30 MINUTES
TRAINING DEVICE 1 HOUR
DEBRIEF 30 MINUTES

OBJECTIVE

The primary objective of tail strike awareness training is to improve awareness of the pilot controlled factors that affect pitching tendency after touchdown and to reinforce proper sink rate and bounce recovery technique.

This training may be accomplished as part of recurrent, initial, or transition training.

REQUIRED SIGN OFF

Note completion by a remark "Tail Strike Awareness Training Accomplished" in the remarks section of the 007 or 007A.

High Sink Rate And Bounce Recovery Technique

The recommended high sink rate and bounce recovery technique is to establish a 7 1/2 degree pitch attitude and arrest the sink rate with thrust. If a high bounce occurs, a go-around should be initiated. Low level go-arounds, i.e. less than 20 feet RA, are dramatically different than higher altitude go-arounds. High altitude go-arounds are initiated with pitch, while low level go-arounds must be initiated with thrust. During low level go-arounds main wheel touchdown may be unavoidable. The PF must not exceed 10 degrees of pitch or retract the landing gear until passing 20 feet RA with a positive rate of climb.

Some tail strikes have occurred as a result of the pilot attempting to arrest a high sink rate or bounce by quickly adding up elevator. This technique immediately increases both the effective weight of the aircraft and the aircraft's vertical velocity. The resulting increased attitude rate will aggravate the pitching tendency after touchdown and drive the main wheels into the ground, thus compressing the main wheel struts. The aft fuselage will contact the runway at approximately 10 degrees pitch attitude with the struts compressed.

It is imperative that pilots fully understand the correlation between an increasing attitude rate at touchdown and an increased pitch up tendency after touchdown. One degree per second of increasing attitude rate at touchdown generates as much pitch up tendency as full spoiler deployment. Elevator back pressure should be relaxed, and a constant pitch attitude should be maintained from 10 feet radio altitude to touchdown.

[redacted]

Captain Jim Ward
Manager MD-11 Flight Standards

[redacted]

Captain Warren Travis
Manager MD-11 Flight Training

TAIL STRIKE AWARENESS BRIEFING

INTRODUCTION

- **MD-11 tail strike incidents/accidents have occurred at a fairly constant rate (tail strikes/total landings).**
- **25% of MD-11 tail strikes to date have occurred on takeoff and 75% on landing.**

TAKEOFF

The recommended rotation technique is a 3 degree per second rotation to an initial pitch attitude of approximately 15 degrees. The PF should then transition to the flight director pitch bar for guidance. The flight director pitch bar is not usable until approximately five seconds after nose gear strut extension. A two step rotation is not appropriate. Two step or segmented rotations will significantly impact takeoff performance i.e. required runway, second segment climb gradients, and obstacle clearance. It is, however, the PF's responsibility to ensure that the aircraft is accelerating properly and has become airborne passing 10 degrees of pitch attitude. If the aircraft has not become airborne, possibly due to an inaccurate flap setting, stab setting, gross weight entry, or contaminated wing, the rotation should be stopped.

Some tail strikes on takeoff have occurred as a result of early or quick rotations. One tail strike occurred as a result of the pilot initiating a rotation at V1 vs. VR. Another tail strike occurred as a result of an inaccurate gross weight entry into the FMS which resulted in inaccurate V speeds.

- **Late or abrupt forward slip maneuver**

  The recommended method for a crosswind landing is to fly the final approach in a wing's level attitude with a crab into the wind. At approximately 200 feet AGL, align the fuselage with the runway by smoothly applying rudder pressure and lower the upwind wing to prevent drifting off runway centerline. In high crosswinds, consideration should be given to commencing the forward slip maneuver prior to 200 feet, and in all cases, the forward slip should be fully established by 100 feet AGL.

  Some tail strikes have occurred as a result of the pilot initiating a late or abrupt align maneuver. The align maneuver, commonly referred to as a forward slip, will reduce lift and if unchecked, will result in an increased sink rate. This will be demonstrated in the simulator.

- **Early flare**

  The recommended flare technique is to maintain a stabilized flight path through the 50 and 40 foot CAWS callout (unless sink rate is high). At 30 feet a smooth 2.5 degree flare should be initiated so as to arrive below 10 feet in the landing attitude. Back pressure should then be relaxed until touchdown.

  Some tail strikes have occurred as a result of the pilot initiating an early flare and "feeling for the runway." It is critical that pilots understand the dynamics involved in this situation. The autothrottles switch to the retard mode at 50 feet radio altitude. In the retard mode, the throttles are retarded to idle at a pre-programmed rate without airspeed, vertical speed, or radio altitude bias. The pilot flying or the autopilot, if selected, must maintain the appropriate glide path to touchdown. If the aircraft is flared early, the airspeed will decay, elevator effectiveness will be reduced, and a higher pitch attitude will be required making the pitch up tendency after touchdown more pronounced and more difficult to counteract. This will be demonstrated in the simulator.

TAIL STRIKE AWARENESS TRAINING
TRAINING DEVICE

- **Instructor note.**

  In order to make maximum utilization of simulator time, tail strike awareness simulator periods have no preflight/cockpit setup. The instructor will have the simulator fully configured for takeoff prior to the students arrival, i.e. on the active runway, all engines started, fms loaded (KMEM to KDFW) and the before takeoff checklist complete to the line.

  Tail strike awareness simulator training is comprised of three individual scenarios. Each scenario is designed to demonstrate a specific pilot controlled factor that affects pitching tendency after touchdown.

BEFORE TAKEOFF
- **Review before takeoff checklist below the line.**
- **Save flight plan if able.**

TAKEOFF
- **Review normal takeoff procedures.**
- **Reinforce proper rotation technique.**

  The recommended rotation technique is a 3 degree per second rotation to an initial pitch attitude of approximately 15 degrees. The PF should then transition to the flight director pitch bar for guidance. The flight director pitch bar is not usable until approximately five seconds after nose gear strut extension. A two step rotation is not appropriate. Two step or segmented rotations will significantly impact takeoff performance i.e. required runway, second segment climb gradients, and obstacle clearance. It is, however, the PF's responsibility to ensure that the aircraft is accelerating properly and has become airborne passing 10 degrees of pitch attitude. If the aircraft has not become airborne, possibly due to an inaccurate flap setting, stab setting, gross weight entry, or contaminated wing, the rotation should be stopped.

AFTER TAKEOFF
- **Review normal after takeoff procedures.**

APPROACH AND LANDING
- **Vector the aircraft for an ILS to 36L.**

  Multiple resets to the 6 NM final to runway 36L will be used as a time management tool. To eliminate the need for time consuming FMS programming, the runway 36L ILS (IOHN/358) should be hard tuned, and both NDs should display raw data.

EARLY FLARE SCENARIO

- **Instructor note.**

The primary objective of this scenario is to demonstrate the dynamics of an early flare. The autothrottles switch to the retard mode at 50 feet radio altitude. In the retard mode, the throttles are retarded to idle at a pre-programmed rate without airspeed, vertical speed, or radio altitude bias. The pilot flying or the autopilot, if selected, must maintain the appropriate glide path to touchdown. If the aircraft is flared early, the airspeed will decay, elevator effectiveness will be reduced, and a higher pitch attitude will be required making the pitch up tendency after touchdown more pronounced and more difficult to counteract. Ideally this demonstration will increase the pilots understanding of the correlation between a high pitch attitude at touchdown and an increased pitch up tendency after touchdown. Additionally, ATS retard logic will be stressed to encourage overriding the autothrottles when needed.

The setup for this demonstration is as follows:

Position	6 NM final
Init runway	36L
Visual	Day
Ceiling	Clear
Visibility	48NM
Wind	Calm
AP and ATS	Engaged

The AP and ATS should be engaged and the FGS programed to fly the ILS. At 1000 feet AGL the AP should be disconnected. The PF should take their hands off the throttles for the remainder of this demonstration. The PF should be directed to make a normal descent until 40 feet RA, where an early flare should be commenced. The PNF should be directed to call out RA and pitch attitude. The PF should make every effort to remain at or above 20 feet RA until the PNF calls 10 degrees of pitch attitude. The PF should then allow a sink rate to develop. At touchdown the instructor will move the spoiler handle to the GROUND SPOILER position. The pitch up tendency will be pronounced and difficult to counteract.

Reposition the simulator to the 6 NM point.

The second part of this demonstration is set up identical to the first except this time the PF should make a normal descent with only a slight flare prior to touchdown. The landing attitude should be less than 5 degrees resulting in little or no pitch up tendency after touchdown.

Repeat this demonstration with the other pilot flying.

TRAININGOBJECTIVES

AST 6

REVIEW

PRE-BRIEF

As required to adequately address the training events to be covered during the period.

DISCUSSION

- **PAR**
- **Single FMC Operations**
- **Tail Strike Awarness during Takeoff**
  - If #2 engine fails, a conscious effort is required to prevent over rotation. Two engine rotation is 3 - 4° less than normal rotation (16° is initial climb attitude to maintain V2). A failure of #2 engine will result in a pitch-up, an increased probability of tail strike, and an airspeed decaying below V2. Fly pitch attitude do not chase the command bar.
- **Dual Hydraulic Failure**
  - Autoflight Impact
  - Configuration
- **Power Plant Failure Second Segment**
- **Fuel Dump**
- **Two Engine Go-Around**
- **Two Engine INOP Approach and Landing**
- **Air System in Manual**

PROCEDURES AND MANEUVERS

_____ Normal and Abnormal Engine Starts
_____ Normal Takeoff (Night)
Crosswind
Anti-ice
_____ V1 Cut
_____ Tail Strike Awarness (#2 Engine Failure on Takeoff)
_____ Engine Failure @ 100' AGL (Second Segment)
_____ Area Departure - (Memphis Four)
_____ FMS Procedures- Single FMC Operations
Hdg to Intercept - RAD/CRS/AIRWAY
_____ Area Descent and Arrival - (Gilmore Arrival)
_____ Instrument Approaches
PAR
ILS Hand Flown to 100' AGL
_____ Missed Approaches
_____ Landings
No Autoland
One and two Engines INOP

TRAINING OBJECTIVES

AST 3

REVIEW

PRE-BRIEF
As required to adequately address the training events to be covered during the period.

TRAINING OBJECTIVE
Build pilot confidence in the basic capabilities of the MD-11 through hand flying exercises (no autoflight) and the use of only basic instrumentation (no FMS).

DISCUSSION

- **Basic Instrument Procedures**
  - Non Precision Approaches
  - Procedure Turns
  - VDP Computation
  - Flap/Slat Schedule and Approach Configuration
- **Pitch Attitude References**
- **Autopilot Disconnect / High Altitude Handling Characteristics**
- **Stalls**
  - Clean Configuration
  - Takeoff Configuration
  - Landing Configuration
- **Tail Strike Awareness in the Takeoff/Landing phase** - Discuss techniques to be avoided to prevent tailstrikes
  - A pitch angle >12° on the PFD may cause a tail strike
  - Nominal pitch angle at touchdown (1.25Vs) with zero rate of descent and idle thrust will be at about 10°
  - A normal approach with flaps at 35° yields a 6° pitch reference on the PFD - with flaps 50° the pitch is 5°
  - At 1.3Vs the pitch angle will increase approximately 1°.
  - Tailstrikes can also occur in approaches with high rates of descent on short final with an early flare, increasing pitch attitudes, and floating in an attempt at a smooth touchdown.
  - High descent rates on final with late, abrupt flares can cause tailstrikes due to high rotational inertia forces
  - The nose-up pitching forces generated by automatic ground spoiler deployment at main gear spin-up can also contribute to tail strikes
  - Nose-up pitching forces are magnified if the automatic spoiler deflection feature malfunctions and goes to full deflection on main gear spin-up rather than delaying until the nose gear is on the ground. The nose-up pitching moment generated in this scenario will be exaggerated and must be aggressively countered if a tail strike is to be avoided.
- **Steep Turns**

TRAININGOBJECTIVES

AST 9

REVIEW

PRE-BRIEF
As required to adequately address the training events to be covered during the period.

OBJECTIVE:
Practice key maneuvers and procedures critical to safe operation of the aircraft. At the end of this period the student should have satisfactory commanded of the maneuvers and procedures identified below and be ready for the Progress Check.

DISCUSSION

- **Abnormal traffic pattern operations caused by single or multiple engine failures**
- **Two engine inop approach and landing.**
- **Landings with forward or aft CGs.**

An aircraft with forward CG is more stable than an aircraft with aft CG! With forward CG (a common revenue configuration) column travel required for flare will be greater than normal, and if the necessary travel is not applied, a harder than anticipated landing may result. Note: elevator force remains essentially unchanged because the elevator load feel system is designed to compensate for the CG influence on elevator control forces.

PROCEDURES AND MANEUVERS

_____ Flight Deck Preparation and Flows
_____ Normal Checklist and Procedures
_____ Normal Engine Start and Taxi
_____ Takeoff - Night (No Autoflight)
_____ V1 Cut
_____ Area Departure
_____ Steep Turns
_____ Takeoff Configuration Stall
_____ Area Descent and Arrival
_____ ILS Approach - One Engine Inoperative to 100 ' DH
_____ Missed Approach - One Engine Inoperative
_____ Landings at CG limits
_____ PAR Approach
_____ Two Engine INOP Approach and Landing
_____ Normal After Landing / Shutdown / Termination
_____ Load Panang arcing approach (explain the MCDU line entry for the arc maneuver)

Appendix IV

NTSB reports from previous accidents involving the accident airplane

FORM APPROVED FOR USE THROUGH 11/30/90 BY OMB NO. 3147-0001

NATIONAL TRANSPORTATION SAFETY BOARD
PILOT/OPERATOR AIRCRAFT INCIDENT REPORT
This Form To Be Used For Reporting Civil Aircraft Accidents Involving Commercial and General Aviation Aircraft

Location

Nearest City/Place, State, Zip Code	Date of Accident	Local Time (24 HOUR CLOCK)	Zone	Elevation At Accident Site
Memphis TN 38194	Jan. 03, 1994	2355		____ Feet MSL / 332 Feet MSL

If The Accident Occurred On Approach, Takeoff Or Within 3 Miles Of An Airport, Complete The Following Information

Proximity To Airport:

1. [X] On Airport
2. [ ] Within 1/4 Mile
3. [ ] Within 1/2 Mile
4. [ ] Within 3/4 Mile
5. [ ] Within 1 Mile
6. [ ] Within 2 Miles
7. [ ] Within 3 Miles
8. [ ] Beyond 3 Miles

Airport Name	Airport Ident	Runway/Landing Surface And Conditions
Memphis Intl.	KMEM	1. Direction: 358 2. Length 8400 3. Width: 150' 4. Surface: concrete 5. Condition: good/dry

Phase Of Operation:

1. [ ] Standing
2. [ ] Taxi
3. [ ] Takeoff
4. [ ] Climb
5. [ ] Cruise
6. [ ] Descent
7. [ ] Approach
8. [XX] Landing
9. [ ] Hover/Maneuver
10. [ ] Altitude Of In-Flight Occurrence ____ Feet MSL

Aircraft Information

Registration Mark	Aircraft Manufacturer	Aircraft Type/Model	Serial Number	Cert Max Gross WT
N611FE	McDonnell Douglas	MD11/F	48604	625,000

Type Of Aircraft: 1. [XX] Airplane 2. [ ] Helicopter 3. [ ] Glider 4. [ ] Balloon 5. [ ] Blimp/Dirigible 6. [ ] Ultralight 7. [ ] Gyroplane 8. Specify ____

Type Of Airworthiness Certificate: 1. [ ] Normal 2. [ ] Utility 3. [ ] Acrobatic 4. [X] Transport 5. [ ] Restricted 6. [ ] Limited 7. [ ] Experimental 8. Specify ____

Amateur Built: 1. [ ] Yes 2. [X] No

Landing Gear: 1. [ ] Tricycle—Fixed 2. [X] Tricycle—Retractable 3. [ ] Tailwheel—Fixed 4. [ ] Tailwheel—Retractable 5. [ ] Tailwheel—Retractable Mains 6. [ ] Amphibian 7. [ ] Skid 8. [ ] Ski/Wheel 9. Specify ____

No. Of Seats: Flight/Cabin Crew 6 Pax ____

Stall Warning System Installed: 1. [X] Yes 2. [ ] No

IFR Equipped: 1. [XX] Yes 2. [ ] No

Engine Type: 1. [ ] Reciprocating—Carburetor 2. [ ] Reciprocating—Fuel Injected 3. [ ] Turbo Prop 4. [ ] Turbo Jet 5. [XX] Turbo Fan 6. [ ] Turbo Shaft

Engine Manufacturer	Engine Model/Series	Engine Rated Power	Type Of Fire Extinguishing System Used
General Electric	CF6-80C2D1F	1. ____ Horsepower / 60,240 Lbs. Thrust	1. [XX] None 2. Specify ____

Engine(s) NEW	Date of Mfg.	Mfg. Serial No.	Total Time	Time Since Inspection	Time Since Overhaul
Engine No. 1	7-93	702 916	952 Hours	Hours	Hours
Engine No. 2	7-93	702 919	952 Hours	Hours	Hours
Engine No. 3	7-93	702 918	952 Hours	Hours	Hours
Engine No. 4			Hours	Hours	Hours

Type Of Maintenance Program: 1. [ ] Annual 2. [ ] Manufacturer's Inspection Program 3. [ ] Other Approved Inspection Program (AAIP) 4. [X] Continuous Airworthiness 5. Specify ____

Type Of Last Inspection: 1. [ ] Annual 2. [ ] 100 Hour 3. [ ] AAIP 4. [XX] Continuous Airworthiness

Date Last Inspection Performed: 01/01/94 (M/D/Y)

Time Since Last Inspection: 34 Hours

Airframe Total Time: 952 Hours

Emergency Locator Transmitter (ELT)	ELT Manufacturer	Model/Series	Serial Number	Battery Date (M/D/Y)
	DME Corporation	RLB-93		

Switch: 1. [ ] On 2. [ ] Off 3. [X] Armed — Operated: 1. [ ] Yes 2. [X] No — Aided In Accident Location: 1. [ ] Yes 2. [X] No

Registered Aircraft Owner: Wilmington Trust Co. Trustee

Address: 1100 N. Market St. Rodney Square N. Wilmington, DE 19890

Operator Of Aircraft: 1. [ ] Same As Registered Owner 2. Name Federal Express Corp. 3. DBS:

Address: 1. [ ] Same As Registered Owner 2. ~~3101 Tchulahoma Rd Memphis, TN 38118~~

Owner/Operator Information

Operator (Certificate Number)	Operator Designator (4 Letter Designator)
[redacted]	FDEA

Purpose Of Flight And Type Of Operation

Regulation Flight Conducted Under
1. ☐ FAR 91 (only)
2. ☐ FAR 91D
3. ☐ FAR 103
4. ☒ FAR 121
5. ☐ FAR 125
6. ☐ FAR 129
7. ☐ FAR 133
8. ☐ FAR 135
9. ☐ FAR 137

Purpose Of Flight
1. ☐ Personal
2. ☒ Business
3. ☐ Instructional
4. ☐ Executive/Corporate
5. ☐ Aerial Application
6. ☐ Aerial Observation
7. ☐ Other Work Use
8. ☐ Public Use
9. ☐ Ferry
10. ☐ Positioning

Operator Authority
FAR 121
1. ☐ Domestic
2. ☐ Flag
3. ☒ Supplemental

FAR 135
4. ☐ On Demand
5. ☐ Commuter

FAR 133
6. ☐ Rotorcraft External Load

FAR 125
7. ☐ Large Aircraft

FAR 129
8. ☐ Foreign

FAR 121, 125, 127, 129, 135 Revenue Operations
1. ☒ Scheduled
2. ☐ Non Scheduled
3. ☐ Domestic
4. ☐ International
5. ☐ Passenger
6. ☒ Cargo
7. Specify ______

Pilot Information

Pilot Name	Pilot Certificate No.	Address	Nationality
Vartanian/Eric A.	[redacted]	[redacted] Annapolis MD 21401	US

Certificate(s)
1. ☐ Student
2. ☐ Private
3. ☐ Commercial
4. ☒ Airline Transport
5. ☐ Flight Instructor
6. ☐ Flight Engineer
7. ☐ Military
8. ☐ Foreign
9. ☐ None
10. Specify ______

Rating(s)
1. ☐ None
2. ☐ Single Engine Land
3. ☐ Single Engine Sea
4. ☒ Multiengine Land
5. ☐ Multiengine Sea
6. ☐ Helicopter
7. ☐ Glider
8. ☐ Free Balloon
9. ☐ Airship
10. ☐ Gyroplane

Instrument Rating(s)
1. ☐ None
2. ☐ Airplane
3. ☐ Helicopter

Instructor Rating(s)
1. ☐ None
2. ☐ Airplane S.E.
3. ☐ Airplane M.E.
4. ☐ Helicopter
5. ☐ Glider
6. ☐ Instrument Airplane
7. ☐ Instrument Helicopter
8. ☐ Ground Instructor
9. Specify ______

Type Ratings/Student Endorsements: B737 DA20 DC10 MD-11 B727

Date Of Biennial Flight Review Or Equivalent (M/D/Y):

BFR Aircraft
1. Make ______
2. Model ______

Medical Certificate
1. ☐ None
2. ☒ Class 1
3. ☐ Class 2
4. ☐ Class 3

Date Of Last Medical (M/D/Y): 1-4-94

Limitations:

Waivers:

Date Of Birth (M/D/Y): [redacted]47

Degree Of Injury
1. ☒ None
2. ☐ Minor
3. ☐ Serious
4. ☐ Fatal

Seat Occupied
1. ☒ Left
2. ☐ Right
3. ☐ Center
4. ☐ Front
5. ☐ Rear

Person At Controls At Time Of Accident
1. ☐ Pilot In Command
2. ☒ Second Pilot
3. ☐ Both Pilots
4. ☐ Non-Pilot
5. ☐ No One

Seat Belt Available
1. ☒ Yes
2. ☐ No

Seat Belt Used
1. ☒ Yes
2. ☐ No

Shoulder Harness Available
1. ☒ Yes
2. ☐ No

Shoulder Harness Used
1. ☒ Yes
2. ☐ No

Source Of Pilot Flight Time Information
1. ☐ Pilot Logbook
2. ☐ Operators Estimate
3. ☐ FAA Records
4. ☒ Company
5. Specify ______

Flight Time	All A/C	This Make & Model	Airplane Single Engine	Airplane Multiengine	Night	Instrument Actual	Instrument Simulated	Rotorcraft	Glider	Lighter Than Air
Total Time		472								
Pilot In Command (PIC)										
Instructor										
This Make/Model										
Last 90 Days		113								
Last 30 Days										
Last 24 Hours		7								

Second Pilot Information

Second Pilot Responsibilities At The Time Of Accident
1. ☒ Co-Pilot
2. ☐ Dual Student
3. ☐ Safety Pilot
4. ☐ Check Pilot
5. ☐ None (Pilot-Rated Passenger)

Pilot Name	Pilot Certificate No.	Address	Nationality
Rick M. Sowers	[redacted]	[redacted] Incline Village, NV 89450	

Certificate(s)
1. ☐ Student
2. ☐ Private
3. ☐ Commercial
4. ☒ Airline Transport
5. ☐ Flight Instructor
6. ☐ Flight Engineer
7. ☐ Military
8. ☐ Foreign
9. None ______
10. Specify ______

SECOND PILOT INFORMATION

Rating(s)
1. ☐ None
2. ☐ Single Engine Land
3. ☐ Single Engine Sea
4. ☒ Multiengine Land
5. ☐ Multiengine Sea
6. ☐ Helicopter
7. ☐ Glider
8. ☐ Free Balloon
9. ☐ Airship
10. ☐ Gyroplane

Instrument Rating(s)
1. ☐ None
2. ☐ Airplane
3. ☐ Helicopter

Instructor Rating(s)
1. ☐ None
2. ☐ Airplane S.E.
3. ☐ Airplane M.E.
4. ☐ Helicopter
5. ☐ Glider
6. ☐ Instrument Airplane
7. ☐ Instrument Helicopter
8. ☐ Ground Instructor
9. Specify ______

Type Ratings/Student Endorsements
MD-11

Date Of Biennial Flight Review Or Equivalent (M/D/Y)

BFR Aircraft
1. Make ______
2. Model ______

Medical Certificate
1. ☐ None
2. ☒ Class 1
3. ☐ Class 2
4. ☐ Class 3

Date Of Last Medical (M/D/Y) 3/24/93

Limitations

Waivers

Date Of Birth [redacted]53

Degree Of Injury
1. ☒ None
2. ☐ Minor
3. ☐ Serious
4. ☐ Fatal

Seat Occupied
1. ☐ Left
2. ☒ Right
3. ☐ Center
4. ☐ Front
5. ☐ Rear

Seat Belt Available
1. ☒ Yes
2. ☐ No

Seat Belt Used
1. ☒ Yes
2. ☐ No

Shoulder Harness Available
1. ☒ Yes
2. ☐ No

Shoulder Harness Used
1. ☒ Yes
2. ☐ No

Source Of Pilot Flight Time Information
1. ☐ Pilot Logbook
2. ☐ Operators Estimate
3. ☐ FAA Records
4. ☒ Company
5. Specify ______

Flight Time	All A/C	This Make & Model	Airplane Single Engine	Airplane Multiengine	Night	Instrument Actual	Instrument Simulated	Rotorcraft	Glider	Lighter Than Air
Total Time		886								
Pilot In Command (PIC)										
Instructor										
This Make/Model										
Last 90 Days		93								
Last 30 Days										
Last 24 Hours		7								

Other Personnel

Name	Seat	Address (City & State)	Crew	Passenger Non-Revenue	Passenger Revenue	Non-Occupant	FAA	Degree Of Injury (Fatal Serious Minor None)
1. Robert Steiner		on file FEDEX		X				none
2. Richard Gattis		"		X				none
3. Linda Agar		"		X				none
4.								
5.								
6.								

FLIGHT INFORMATION

Last Departure Point
1. Airport ID KANC
2. City/Place Anchorage
3. State Alaska

Time Of Departure
1. Time 0023z
2. Time Zone ______

Destination
1. Airport ID KMEM
2. City/Place Memphis
3. State TN

Flight Plan Filed
1. ☐ None
2. ☐ VFR
3. ☒ IFR
4. ☐ VFR/IFR
5. ☐ Company (VFR)
6. ☐ Military (VFR)

If Weather Was Involved, State If Weather Briefing Was Obtained Or If Weather Reports Were Checked And How It Was Accomplished

Fuel On Board At Last Takeoff
______ Gallons or
135,000 Pounds

Fuel Type
1. ☐ 80/87
2. ☐ 100 Low Lead
3. ☐ 100/130
4. ☐ 115/145
5. ☒ Jet A
6. ☐ Automotive
7. Specify ______

Other Services, If Any, Prior To Departure

WEATHER INFORMATION AT THE ACCIDENT SITE

Source Of Weather Information (Pilot/Operator, Weather Observation)
MEM Tower

Light Condition
1. ☐ Dawn
2. ☐ Daylight
3. ☐ Dusk
4. ☐ Bright Night
5. ☒ Dark Night

Visibility 7 Miles

Temp (°F) 37

Dew Point	Altimeter Setting	Sky/Lowest Cloud Condition	
33 (°F)	2986 "Hg	1. ☐ Clear 2. ☐ Scattered ____ Feet AGL 3. ☐ Broken ____ Feet AGL	4. ☒ Overcast 900 Feet AGL 5. ☐ Partial Obscuration 6. ☐ Obscurred

Wind Information	Restriction To Visibility	Type Precipitation	Intensity Of Precipitation
1. Direction 310 2. Velocity 12 KTS 3. Gusts ____ KTS		snow	1. ☒ Light 2. ☐ Moderate 3. ☐ Heavy 4. Specify ____

Turbulence (Multiple entry)
1. ☒ None 2. ☐ Light 3. ☐ Moderate 4. ☐ Severe 5. ☐ Extreme 6. ☐ Clear Air 7. ☐ In Clouds

Degree Of Aircraft Damage
1. ☐ None 2. ☒ Minor 3. ☐ Substantial 4. ☐ Destroyed

Fire
1. ☐ Yes 2. ☒ No 3. ☐ In-Flight 4. ☐ On Ground

Description Of Damage To Aircraft And Other Property

Approximately 20 inches of skin buckling on left and right fuselage just aft of the nose gear box.

1. ☒ No
2. ☐ Yes List The Name Of The Part, Manufacturer, Part No., Serial No. And Describe The Failure

Total Time	
On Part	At Overhaul
____ Hours	____ Hours

Collision Accident

If Collison Accident Occurred, Complete The Information For Other Aircraft

Registration mark	Aircraft Manufacturer	Aircraft Type/Model	Degree Of Aircraft Damage
			1. ☐ Destroyed 2. ☐ Substantial 3. ☐ Minor 4. ☐ None

Registered Aircraft Owner	Address

Pilot Name	Address	Pilot Certificate No.

Assistance Received
1. ☐ Outside Person(s) 3. ☐ Slide 5. ☐ Ladder
2. ☐ Auxiliary Lighting 4. ☐ Rope 6. ☐ Specify ____

Method Of Exit (State Approximate Number Of Persons Using Each Of The Following)
1. Main Door XX 6 2. Auxiliary Door ____ 3. Emergency Exit ____ No emergency

Operator/Owner Safety Recommendation (Optional Entry)

[illegible]

Describe What Occurred In Chronological Order, The Circumstances Leading To The Accident And The Nature Of The Accident. Describe The Terrain And Include A Sketch Of Wreckage Distribution If Pertinent. Attach Extra Sheets If More Space Is Needed. State Point Of Departure, Time Of Departure, Intended Destination And Services Obtained.

I Certify That The Above Information Is Complete And Accurate To The Best Of My Knowledge

Date Of This Report	Signature Of Pilot/Operator
2/21/94	

Signature Of Person Filing Report Other Than Pilot/Operator

1. Signature [redacted]
2. Type Or Print Name Kenneth C. Enslin
3. Title Senior Manager Flight Safety

For NTSB Use Only

Accident No.	Reviewed By NTSB Office Located At	Name Of Investigator	Date Report Received

TOTAL P.06

NTSB Identification: **ANC95FA008**. The docket is stored in the (offline) NTSB Imaging System.

Nonscheduled 14 CFR 121 operation of FEDERAL EXPRESS, INC
Accident occurred NOV-04-94 at ANCHORAGE, AK
Aircraft: MCDONNELL DOUGLAS MD-11/F, registration: N611FE
Injuries: 2 Uninjured.

ACCORDING TO THE FLIGHT DATA RECORDER, WHEN 50 DEGREES OF FLAPS WERE SELECTED AT 985 FEET AGL, THE FIRST OFFICER, WHO WAS FLYING THE AIRPLANE, DID NOT STABILIZE THE APPROACH. THE PITCH ATTITUDE OF THE AIRPLANE VARIED APPROXIMATELY 2 DEGREES WITH CORRESPONDING ELEVATOR POSITION CHANGES. AT 40 TO 50 FEET THE PITCH ATTITUDE OF THE AIRPLANE WAS DECREASING. THE CAPTAIN STATED HE FELT A HIGHER THAN NORMAL RATE OF DESCENT AT 20 FEET SO HE GRABBED THE YOKE AND PULLED BACK. THE AIRPLANE LANDED HARD, BOUNCED, AND OSCILLATED AT LEAST THREE TIMES, REACHING A MAXIMUM PITCH UP ATTITUDE OF 12.3 DEGREES. THE TAIL STRUCK THE RUNWAY DURING THE OSCILLATIONS. THE CAPTAIN DID NOT USE VERBAL INSTRUCTIONS AS REQUIRED BY THE FLIGHT MANUAL AND COMPANY PROCEDURES, WHEN TAKING CONTROL OF THE AIRPLANE. BOTH PILOTS WERE MANIPULATING THE CONTROLS DURING THE BOUNCED LANDING RECOVERY.

Probable Cause

THE FLIGHT CREW'S IMPROPER RECOVERY FROM A BOUNCED LANDING. FACTORS ASSOCIATED WITH THE ACCIDENT ARE THE FIRST OFFICER'S LACK OF FAMILIARITY WITH THE AIRPLANE, HIS FAILURE TO STABILIZE THE APPROACH, AND THE CAPTAIN'S DELAYED REMEDIAL ACTION.

Full narrative available

Index for Nov 1994 | Index of Months

ANC95FA008

HISTORY OF FLIGHT

On November 4, 1994 at 1125 Alaska standard time, a McDonnell Douglas, MD-11 airplane, N611FE, operating as Federal Express flight number 016, experienced a hard landing at Anchorage International Airport while landing on runway 6R, Anchorage, Alaska. The airplane landed hard and bounced. The tail struck the runway's surface. The airplane was substantially damaged. The all cargo flight, operating under 14 CFR Part 121, departed Kansai, Japan, on an instrument flight rules flight plan. The destination was Anchorage. Visual meteorological conditions prevailed. The Captain and the First Officer, the only occupants, were not injured.

According to the crew, they were following a Japan Air Lines Boeing 747, which preceded them by an estimated 3 miles. The Federal Express crew was cleared for a visual approach to runway 6R and they used the ILS course for guidance. The Captain stated that the airplane flew through a little bit of turbulence when crossing the shoreline but it was nothing unusual. At 50 feet above the ground everything looked normal, but at 20 feet the Captain stated he perceived an increase in the airplane's sink rate. He and the first officer (the flying pilot) both pulled the yoke back. The airplane hit the runway and bounced upward. The nose of the airplane began to pitch up and the crew pushed the yoke forward. The tail then struck the ground. The nose began to respond, and they landed normally.

DAMAGE TO AIRCRAFT

The airplane received substantial damage. Approximately 32 feet of lower fuselage skin on the underside of the tail section was scraped and dented. There were small puncture/scrape holes in the skin. The aft pressure bulkhead and supporting steel structures were crushed and bent. The VHF antenna, located on the underside of the tail section, was sheared off.

PERSONNEL INFORMATION

According to Federal Express flight crew records log, the Captain was hired and received his basic indoctrination into Federal Express on September 1, 1967. He has functioned as a Captain on the Boeing 727 and 747 airplanes. On August 25, 1992, he received transition/upgrade training to the MD-11 airplane. On October 28, 1992 he completed his Initial Operating Experience (IOE) as Captain on the MD-11. According to Federal Express records, the Captain had 1216 hours in the MD-11 airplane.

According to Federal Express flight crew records log, the First officer was hired and received his basic indoctrination to Federal Express on February 12, 1988. He was assigned to the Boeing 727 as a second officer on March 3, 1988. On February 8, 1989 he was assigned to the DC-10 as a second officer. On August 31, 1994, he received transition/upgrade training on the MD-11 airplane and completed his IOE on October 13, 1994. According to Federal Express records, the First Officer had 56 hours in the MD-11 airplane. The first Officer stated, this was his third landing after his IOE.

FLIGHT RECORDERS

The cockpit voice recorder and flight data recorder were retrieved and sent to NTSB Headquarters, Washington, D.C. for readout. The cockpit voice recorder did not contain any pertinent information.

The flight data recorder was deciphered and analyzed. The vertical rate of descent information (VSPD) was not valid on the main readout and was computed by the NTSB HQs flight data recorder analyst by using the altitude and time readouts. This information was portrayed on a chart (included) and at 100 feet above ground level (agl), the rate of descent increased to just over 1000 feet per minute with a nose pitch up attitude of 2.46 degrees. The rate of descent then decreased to 850 feet per minute and again increased to 900 feet per minute when the airplane was 50 feet above the ground. At this point the airplane's pitch attitude was 2.11 degrees up.

A review of the pitch attitude during the approach showed that the airplane's pitch attitude was approximately 3.87 degrees while flaps were selected and set at 35 degrees. The flight data recorder readout frame count number 115 shows that flaps were at 39.731 degrees which shows a transitory position. The pitch attitude of the airplane reached 4.57 degrees. At 785 feet agl, the flaps reached the selected 50 degree position and the airplanes's pitch attitude reduced to 2.11 degrees. From frame count 115 to frame count 127, the airplane's pitch attitude varied from a low of 1.41 degrees to a high of 4.57 degrees. There were two cycles of variation and at frame count number 127; the pitch attitude was decreasing through 2.46 degrees to reach a low of 2.11 degrees.

The flight data recorder elevator positions were examined and were found to fluctuate with the pitch attitude changes. The airplane's pitch attitude would reach its maximum deflection approximately 1 second after the maximum elevator input.

The flight data recorder readout shows that between 55 and 40 feet agl, the airplane's pitch attitude was increasing from 2.11 degrees to 2.81 degrees. The elevator position information shows a positive increase in elevator position. The pitch attitude of the airplane continued to increase to 8.44 degrees until ground contact. Upon ground contact, the elevator position began decreasing from its positive deflection. The flight data recorder readout shows elevator deflection varying to positive pitch up two more times before going to a negative position for the completion of landing.

According to McDonnell Douglas Aircraft, and Federal Express, Inc., the MD-11 has a tendency to pitch up when the spoilers deploy. The spoilers were designed to deploy only to the half position at main wheel spin up and if the throttles were retarded to less than 46 degrees of throttle travel. This was designed to reduce the pitch up effect. According to the flight data recorder readout information, the spoilers did not deploy upon initial ground contact. Throttle position travel was approximately 37 degrees. The spoilers did deploy to the half position upon the second touch down of the main wheels. The following information is excerpted from the flight data recorder readout and shows the relationship between the frame count, average elevator position between left and right and inboard and outboard elevators, spoiler position, and airplane pitch attitude.

frame count avg elev pitch spoiler grnd contact no. position attitude position

129 - 7.316 3.16 8.004 - 11.797 4.22 -- - 8.239 7.03 9.147 - 2.198 8.44 -- initial 130 - -0.6367 5.27 7.828 - 15.159 3.16 -- - 5.031 7.73 27.090 second - -7.66 12.30 -- 131 - -10.282 9.84 26.387 third + final

- 11.6875 4.22 -- - 15.15 -0.35 26.739 - -7.294 0.70 -- 132 - -14.613 0.00 58.667

This information shows that the airplane's pitch attitude responded to the control inputs selected by the flight crew.

WRECKAGE AND IMPACT INFORMATION

There was no wreckage or debris on the runway after landing.

The damage to the airplane was discovered during the maintenance crews post flight examination of the airplane.

TESTS AND RESEARCH

Flight simulator tests conducted at the Federal Express Training facility, Memphis, Tennessee, showed that the airplane had a pronounced tendency for the nose to pitch up upon main gear touchdown. The nose pitch up tendency was exaggerated by the deployment of the spoilers which occurred upon main landing wheel spin up. Upon main landing wheel spin up, the spoilers deployed to the half deployed position.

The simulator tests distinctly showed that upon main gear touchdown and spoiler deployment, the flying pilot had to physically push the yoke forward to prevent the nose from pitching up. The pilot had to anticipate this control input. If the pilot waited for the nose of the airplane to begin movement in any direction, his control input effect was greatly diminished. The control input effectiveness was also affected by the position of the airplane's center of gravity. If the center of gravity was near the forward position, the control input took a longer time to effect a change in the momentum of the nose pitching rate. Conversely, when the center of gravity was near the rear limit, the control input more quickly effected a change.

The nominal center of gravity range for the MD-11 airplane during landing is 25 to 27 percent of MAC (mean aerodynamic chord). According to the Captain, the airplane's landing center of gravity was 23 percent of MAC.

A demonstration by the company MD-11 instructor pilot showed that if a stabilized approach was flown and the touchdown was normal, the nose of the airplane pitched up and stabilized at approximately 10 degrees nose up. He demonstrated this by removing his hands from the flight controls upon touchdown.

A pilot not rated in the MD-11 airplane flew an unstabilized approach and upon touchdown did not anticipate the pitch up tendency. The nose of the airplane pitched up at touchdown and full forward control input was applied before the pitch up movement was arrested. At this point the nose of the airplane began to drop rapidly toward the runway. The pilot entered a maneuver commonly termed as a pilot induced oscillation. The tail did not strike the runway during this maneuver. After three to four pitch oscillations, the main landing gear touched the runway and the pilot applied immediate full forward yoke and the airplane landed normally and stayed on the runway.

Examination of the company's training program showed that tail strike awareness is discussed. The Captain and the First Officer both stated during their interviews that they received information during training referencing tail strikes.

Examination of the MD-11 Flight Manual, page 7-113, under the section titled "Tail and Wing Clearance," subsection "Landing," revealed the following statement, "Attempting to make the smoothest landing possible can result in decreased clearances which in turn could result in a tail strike." The section further states that high descent rates on short final could lead to late or early flares which could also lead to a tail strike. The Flight Manual recommends against aerodynamic braking due to the increased possibility of a tail strike. The Manual states "Another contributor to tail strikes during landing is the nose- up pitching force generated by the automatic ground spoiler deployment at main gear spin-up. This is quickly noted and pilots are taught to compensate for it during initial transition training. It then becomes part of the MD-11 pilot's reflexes. Spoiler pitch-up is still present during every landing, and must be counteracted. If touchdown does occur with higher than normal pitch attitude, the nose should be lowered promptly to prevent spoiler deployment from further increasing the pitch attitude...." "In short there is not a substitute for a well- executed, stabilized approach to position the airplane for proper flare, touchdown at the proper spot and stopping while there is runway remaining."

The Flight Manual further states that a normal landing configuration would give the airplane a vertical rate of descent between 650 and 800 feet per minute. The pitch attitude should be 5 degrees with the flaps set at 35 degrees, a mid center of gravity, while on a 2.5 degree glide slope descent angle. The use of 50 degrees of flaps will reduce the pitch attitude by 1 degree. The manual also states that the pitch attitude necessary to attain a near zero rate of descent under the described conditions would normally be 8 to 9 degrees.

According to the flight data recorder information, the airplane had a pitch attitude of 4 to 5 degrees while the flaps were extended to 35 degrees. Approximately 850' above the ground, 50 degrees of flap were selected and the pitch attitude of the airplane reduced to approximately 1 degree and continued to vary throughout the approach. The variation was between 2 and 4.5 degrees until the event.

According to the instrument approach plate for Anchorage International Airport, ILS runway 6R, the descent angle for the glide slope is 3.0 degrees. The Captain and First Officer both stated that the airplane was on course and on glide slope. The average rate of descent for the airplane during the approach, up until the time of the event was 856.73 feet per minute. However, the rates of descent varied from 2000 feet per minute to a climb of 350 feet per minute. These rate of descent points were taken from the point were 50 degrees of flaps were applied.

Examination of the training program showed that tail strike awareness is taught and the training objectives coincided with the information in the airplane flight manual. However, the training objective stated that with 35 degrees of flaps extended the pitch attitude during approach should be 6 degrees; at flaps set to 50 degrees, the pitch attitude should be 5 degrees. There is no reference to descent angle.

According to a representative of McDonnell Douglas Aircraft, those are nominal numbers for the flight crews to show an example of the approach sight picture. It was stated that a stabilized approach is very important and that a 2 degree variation of the pitch attitude during the final phases of the approach is not a very stabilized approach, "considering the size of this airplane."

The training program also listed a section dealing with transfer of airplane control. The training program did not list any specific method for performing the transfer of airplane control. However, on page 7-7 of the MD-11 flight manual, a specific procedure for the transfer of airplane control is listed. According to the Federal Express Flight Operations Manual, page 2-10, there is a discussion about airplane control. It states in part, "At any time, during ground or flight operations, if the First Officer is controlling the airplane and the Captain becomes concerned about the airplane's flight path or ground track, the Captain must take physical control of the airplane and state 'I have the airplane.' The First Officer must then completely relinquish control of the airplane." The Captain did not use any verbal commands in this accident to acquire control of the airplane.

Discussions conducted with the Federal Express Training Department and the Standardization Department revealed that the standardization department was responsible for the information taught by the training department. The Training Department stated that they had trouble getting the most current information through their company distribution system. The training department indicated that they would like to implement training procedures based upon information given in the various McDonnell Douglas publications, such as "All Operator Letters" and "Know your MD-11" letters. Individual instructors in the Training Department stated they receive the update information faster by getting the publications directly from

McDonnell Douglas Aircraft.

The distribution of these publications, within Federal Express, is handled by the Standardization Department. One individual in the Standardization Department is responsible for reviewing the documents/publications and routing the documents to their destinations such as maintenance, operations, or training.

According to the Standardization Department Manager, the company separated standardization and training as a method to check the quality of training. However, the Standardization Department is responsible for the curriculum information sent to the Training Department. The manager stated, "they teach only what we tell them to teach."

There was no written procedure for training program development or distribution of publications.

ADDITIONAL INFORMATION

The MD-11 airplane is equipped with a dual chamber, main landing gear, shock strut. If this strut is not serviced correctly, it may cause the airplane to rebound more than usual during landing. The landing gear struts on the accident airplane were examined and found to be over serviced with both fluid and nitrogen. According to McDonnell Douglas Aircraft, this strut is very difficult to service and there is no simple way for the flight crew to determine whether the strut has been correctly serviced. The traditional method of strut extension examination, as used by most flight crews, is not a valid method for determining correct servicing. The amount of strut extension is dependent on many factors, such as airplane gross weight, terrain/ramp slope, or fuel load distribution. These elements may lead to uneven strut extension. McDonnell Douglas Aircraft stated that if the strut is not leaking oil, and it was serviced correctly during maintenance, it should operate properly.

According to McDonnell Douglas Aircraft, they do not feel that the landing gear strut over service problem has been attributed to the cause of any tail strike in the MD-11 airplane.

They do believe that the rebound potential created by the over servicing could assist in aggravating a pilot induced oscillation during an unstabilized touchdown. According to Federal Express, the main landing gear struts are checked only when the airplane gets a "B" maintenance check. There is no way for the flight crew or line maintenance crew to determine if the struts have been properly serviced. Federal Express did not have a written procedure in place, for flight crews or line maintenance crews, to determine the servicing level of the main landing gear struts.

National Transportation Safety Board Supplements C, D, and I, were not completed or submitted with this report.

Return to synopsis

NTSB Identification: **ANC96FA072**. The docket is stored in the (offline) NTSB Imaging System.

Nonscheduled 14 CFR 121 operation of FEDERAL EXPRESS
Accident occurred MAY-16-96 at ANCHORAGE, AK
Aircraft: McDonnell Douglas MD-11-F, registration: N614FE
Injuries: 1 Minor, 1 Uninjured.

MD-11 was cleared visual approach (apch) to runway (rwy) 24R, 3 mi (1 min) behind Boeing 747 (landing on rwy 24L). Rwys were 550 ft apart with rwy 24L threshold staggered 4300 ft beyond that of rwy 24R. MD-11 captain (capt) used VASI, which had 3.25 deg glide path. On final apch, 21 kt left crosswind diminished to about 5 kts. From 100 ft agl, MD-11 exhibited left, then right roll & slight yawing. About 50 ft agl, MD-11 entered high sink rate. Capt began go-around & raised nose. Lower aft fuselage hit rwy & MD-11 bounced. Capt discontinued go-around; MD-11 bounced two more times; sustained damage to aft pressure bulkhead. Last 20 sec of flight, MD-11 averaged 1380 ft/min rate of descent, 152 kts, 5.12 deg apch angle. MD-11 flight manual discussed visual apchs, go-around procedure, & tail/wing clearance issues, but operator did not have formal tailstrike awareness training for MD-11 pilots. After accident, operator developed tail strike awareness training program that included bounced landing recovery & simulator training, & limited pitch attitude to 7-1/2 deg for recovery from bounced landing. AIM recommended that for landing behind larger acft on parallel rwy, closer than 2500 ft, stay above larger acft's flight path. Tower controller did not issue precaution for wake turbulence.
Probable Cause
the pilot's improper in-flight planning/decision, which allowed the airplane (MD-11) to encounter wake turbulence from a larger/heavy jet airplane (Boeing 747), while on a short final approach for landing on a close-by/parallel runway with a staggered threshold. Factors relating to the accident were the staggered/off-set runway thresholds, which positioned the normal approach path of runway 24R below that of runway 24L; the steeper than normal final approach path; and the left crosswind, which resulted in wake turbulence drifting from the Boeing 747's approach path to the MD-11's approach path.

Full narrative available

Index for May 1996 | Index of Months

ANC96FA072

History of the Flight

On May 16, 1996, about 0633 Alaska daylight time (ADT), a McDonnell Douglas MD-11-F, N614FE, sustained substantial damage when its tail struck the runway during landing at the Anchorage International Airport, Anchorage, Alaska. The airplane, operated by Federal Express Corporation, Memphis, Tennessee, as Federal Express flight 71 (FDX71), was being operated on an instrument flight rules (IFR) cross-country cargo flight under Title 14 CFR Part 121 when the accident occurred. The captain, a certificated airline transport pilot, reported minor injuries. The first officer, also a certificated airline transport pilot, was not injured. Visual meteorological conditions prevailed. The flight originated from Newark, New Jersey, about 2328 ADT, May 15, 1996.

A Japanese Airlines Boeing 747 (JAL flight 49), contacted the Anchorage Air Route Traffic Control Center (ARTCC) at 0621:25 and reported passing 10,000 feet during its descent into the Anchorage terminal area from the northeast. The accident airplane (FDX71), also arrived in the terminal area from the northeast and advised the ARTCC of passing 10,000 feet at 0622:35. Each airplane was vectored for a visual approach to runway 24L. At 0622:50, FDX71 advised they would take runway 24R if it was available. At 0624:48, FDX71 requested a right base entry to the airport but the request was denied due to sequencing. At 0628:13, FDX71 advised the ARTCC that JAL49 was in sight. The ARTCC advised FDX71 to maintain visual separation from JAL49 and was cleared for a visual approach to runway 24R at 0628:31.

At 0630:17, JAL49 received clearance to land on runway 24L from the Anchorage Air Traffic Control Tower (ATCT) local controller. At 0630:32, FDX71 was cleared by ATCT for a visual approach to runway 24R. At 0631:42 the local controller requested on-board inertial navigational system (INS) wind information from FDX71 and was told 180 degrees (true, 156 degrees magnetic) at 21 knots. At that time, the controller reported observing FDX71, 4 nautical miles southeast of the approach end of runway 24R. JAL 49 was observed approximately 1 mile from the approach end of runway 24L.

The captain of FDX71 reported he was flying the airplane and turned onto the final approach at 1,000 feet mean sea level (msl). The captain was visually aligning the airplane with the visual approach slope indicator (VASI) for the runway. He indicated he was observing a "pink over white" visual angle indication from the VASI. The autopilot was disengaged and the autothrottle was engaged. About 50 feet above the ground, the captain noticed some instability of the airplane and then the airplane developed a high rate of descent. The captain initiated a wind shear "escape" procedure by applying go-around power and began pitching the nose of the airplane upward but the airplane continued to descend. The tail of the airplane scraped the runway and bounced into the air. The captain decided to discontinue the go-around maneuver and closed the throttles. The airplane descended and bounced a second time. The airplane touched down a third time and then rolled out.

The pilot was concerned about the hazard of wind shear activity to other arriving aircraft and reported a 40 knot low level wind shear on short final.

The airplane was inspected externally by airport fire department personnel and then was taxied to parking. During the completion of the after landing checklist, the flight crew noticed the spoiler handle was retracted. The crew also noticed a "FADEC ALTN" (full authority digital electronic control - alternate) alert message from each engine on the engine activity display (EAD).

Crew Information

The captain holds an airline transport pilot certificate with airplane single and multi-engine land ratings. He also holds a flight engineer certificate with a turbojet powered rating and type ratings in Douglas DC-8, Boeing 727 and 747, and McDonnell Douglas MD-11 aircraft. The captain received his basic indoctrination with Federal Express Corp., on April 4, 1977. Since that time the captain has functioned as captain of Boeing 727 and Douglas DC-8 aircraft and first officer of Boeing 747 aircraft. On July 20, 1994, he completed his initial operating experience (IOE) in McDonnell Douglas MD-11 aircraft. At the time of the accident, the captain had accrued 1,470 hours in the MD-11. The captain's most recent simulator training was provided on June 25, 1995.

The first officer holds an airline transport pilot certificate with an airplane multi-engine land rating. He also holds a flight engineer certificate with a turbojet powered rating and a type rating in McDonnell Douglas MD-11 aircraft. The first officer received his basic indoctrination with Federal Express Corp., on May 9, 1986. Since that time, the first officer has functioned as the second officer and first officer on Boeing 727 aircraft. On April 26, 1992, he completed his IOE in MD-11 aircraft. At the time of the accident, the first officer had accrued 2,107 hours in the MD-11. The first officer's most recent simulator training was provided on April 23, 1995.

Aircraft Information

The airplane had accumulated a total time in service of 12,392.54 flight hours. The most recent continuous airworthiness inspection was accomplished on April 29, 1996, 204.76 flight hours before the accident.

Following the accident, the operator measured the right main landing gear strut extension as 5 3/8 inches at 1,475 PSI. The left main landing gear strut extension was 4 3/4 inches at 1,500 PSI. The status of the fluid level of the main landing gear struts was not evaluated by the operator at the Anchorage base prior to the airplane being ferried to their maintenance facility in Los Angeles, California, for repair. During the repair to the airframe, the operator planned to conduct a check of the strut fluid level. On July 10, 1996, the operator informed the National Transportation Safety Board (NTSB) investigator-in-charge (IIC) of an internal miscommunication that resulted in the landing gear struts being deflated on May 27, 1996 while being prepared for the tail strike repair.

On the accident date, the airplane transmitted an automated Arinc Communications Addressing and Reporting System (ACARS) message to a Federal Express Inc., ground station at 0632:18. The message noted "turbulence". A second ACARS report obtained from the airplane's computer noted an "on report" at 0632:03. The accuracy of the transmittal time could not be correlated with the time reference contained on the flight data recorder. The operator indicated that the airplane could have generated the ACARS report as a result of the hard landing.

The airplane utilizes an auto ground spoiler system (AGS) that will automatically deploy the spoilers about 30 degrees when the main landing gear tires spin up at touchdown. The spoilers will fully deploy to 60 degrees upon nose wheel compression. The AGS also has an auto-retract feature for use in go-arounds. The spoilers will retract automatically when the number 2 throttle is advanced more than 1 inch from the idle stop.

The airplane utilizes several systems to provide the crew with alert messages concerning the operational limits of the airplane. The previously noted FADEC ALTN alert message on the EAD is recorded when the throttles are advanced beyond the FADEC bar. At this point the FADEC systems reverts to the alternate mode for maximum manual selection of engine thrust.

The airplane is equipped with a wind shear alert and guidance system (WAGS) that provides a visual and aural warning and pitch guidance commands to the crew. The system is enabled from 1,500 feet down to 50 feet above ground level (AGL). The WAGS did not activate.

The airplane is also equipped with a ground proximity warning system (GPWS) that provides a visual and aural warning to the crew. The GPWS had several modes of operation which include excessive descent rate (Mode 1). Mode 1 can produce a warning of "sink rate" and "whoop-whoop pull-up" based on the profile of the airplane. The GPWS did not activate.

Meteorological Information

At 0555, a surface observation at the Anchorage airport was reporting, in part: Sky condition and ceiling, measured ceiling 10,000 feet broken, 20,000 feet broken; visibility, 60 miles; temperature, 46 degrees F; dew point, 30 degrees F; wind, 170 degrees at 9 knots; altimeter, 29.43 inHg.

At 0638, a special observation was reporting, in part: Sky condition and ceiling, measured ceiling 10,000 feet broken, 20,000 feet broken; visibility, 60 miles; wind, 150 degrees at 5 knots; altimeter, 29.42 inHg.

The FAA did not include any reports of wind shear (other than the accident airplane) in their report of this accident. JAL49 did not report any wind shear during their approach.

Communications

Examination of voice recordings from the airplane's cockpit voice recorder was conducted by the Safety Board. At 0632:36 the voice recording indicated a comment from the first officer, "got about twenty knots of left cross right here." At 0632:37, the airplane's central aural warning system (CAWS) provided an audible altitude warning of 500 (feet). Between 0632:46 and 0632:52, the first officer reported a decreasing cross wind with a last report of 12 knots. At 0632:54, the first officer reported the airplane's sink rate was 1,000 feet per minute and at 0632:55, the CAWS provided an altitude warning of 100 feet. At 0632:57, the CAWS indicated 50 feet and less than 1 second later, the first officer voiced an exclamation of "whoa".

The airplane touched down at 0633:00.

After touchdown, the crew voiced concern both in the cockpit and to the Anchorage ATCT that they had experienced wind shear. The crew indicated, "and ah tower, Fedex ah 71, we had about a forty knot wind shear on final. It could have been ah due to that seven four that was ahead of us." JAL49 touched down on runway 24L at 0632, as reported by JAL operations.

The Anchorage International Airport does not routinely record low level radar data in the terminal area. Anchorage Center Radar records radar track information on a continuous data recording (CDR). The coverage for center radar usually begins above 2,000 feet msl in the terminal area. Radar data was reviewed by the NTSB IIC to determine the profile of both arriving airplanes. The radar data indicated that both airplanes made left turns from the downwind pattern southeast of the airport onto the final approach. JAL49 turned onto the final approach for runway 24L east (outside of) the flight profile of FDX71. Radar data from JAL49 revealed at 0629:52, the last recording with altitude information, the JAL flight was at 1,400 feet msl at 181 knots ground speed. At the same time, FDX71 was at 3,200 feet at 229 knots.

A transcript of communications with Anchorage Center and Anchorage ATCT, the cockpit voice recorder, and radar data is included in this report.

Aerodrome and Ground Facilities

The airport is within Class C airspace and Federal Aviation Regulation (FAR) Part 93 applies to the terminal area. The air traffic control tower is equipped with a D-BRITE radar repeater display. The Brite system is designed to display primary and secondary (transponder) radar returns of aircraft and alphanumeric target symbology generated by the Automated Radar Terminal System (ARTS) to positions in the tower. The equipment is specifically intended to present usable visual display in the tower of the traffic inbound/outbound to the respective runways during both day and night conditions. The radar display augments visual observations by tower personnel of arrival, departure, and overflight aircraft. The tower is an ARTS IIA facility.

The airport is equipped with two parallel hard-surfaced runways on a 247/067 degree magnetic orientation. A single hard surface runway is oriented on a 321/141 degree heading. Runway 24R is 10,601 feet long by 150 feet wide. The southern edge of runway 24R is separated from the northern edge of runway 24L by 550 feet. The approach end of 24R is situated 4,300 feet east of the approach end of runway 24L. Runway 24R is equipped with a two bar visual approach slope indicator (VASI). The airport is not equipped with a low level wind shear advisory system (LLWAS).

According to the Alaska Supplement, airport/facility directory, the VASI light system for runway 24R consists of a 3 bar system. The upper glide slope is reported as 3.25 degrees and the lower glide slope is reported as 3 degrees. According to FAA Airways Facilities personnel and Anchorage International Airport personnel, the VASI system installed at runway 24R consists of 4 light boxes. The downwind boxes consist of two light boxes, parallel to each other, positioned on either side of the runway threshold. The upwind boxes are positioned 700 feet further along and on either side of the runway.

On June 28, 1996, the VASI was examined by FAA Airways Facilities personnel. They reported that the upwind boxes were in close tolerances and set to 3.0 degrees. The downwind boxes were set to 2.5 degrees. The proper visual approach angle is maintained by the pilot observing a white light bar in the downwind box and a red light bar in the upwind box (red over white). Deviation above the established visual glidepath will produce a change in the upwind light bar from red through pink, to white. Deviation below the glidepath will produce a change in the downwind light bar from white through pink, to red. The total change in color, both above and below the glidepath occurs within 1/4 to 1/2 degree.

Flight Data Recorder

The airplane's flight data recorder was sent to the Safety Board for examination. The recorded parameters are listed by subframe numbers. One subframe is equivalent to one second of time. Downloading the airplane's recorded parameters revealed the following, in part:

At subframe number 2970, the airplane was configured with the autopilot off, flaps were set at 35 degrees, the airplane was near wings level at an indicated airspeed of 155.5 knots. The Vref speed was 147 knots. The heading of the airplane was 241.61 degrees and was slowly increasing.

At subframe 2975, the airplane began a slight roll to the left reaching 3.52 degrees. The roll rate decreased and the airplane then began a roll toward the right.

At subframe 2976, the vertical acceleration decreased to 0.84 g's and returned to 1.11 g's in subframe 2977. It then began decreasing once again. The airspeed began increasing from 151 knots.

At subframe 2978, the thrust resolver angles began decreasing in response to the autothrottle commands. The lower rudder began moving toward 7.47 degrees trailing edge left and then began moving toward the right. The airplane experienced a lateral acceleration to the left of 0.09 g's. The airspeed reached 158.5 knots and then began decreasing. In subframe 2978 and 2979, the number 1 and number 2 angle of attack indicators displayed about a 3 degree difference in their respective values.

At subframe 2979, the right roll reached 8.09 degrees right wing down. The vertical acceleration moved upward from a low of 0.65 g's. The thrust resolver angle for engine number 2 and 3 increased in subframe 2980 to 85.80 degrees. The elevators began to deflect toward 22.85 degrees trailing edge up.

At subframe 2981, the pitch angle of the airplane reached 11.6 degrees nose up. A vertical acceleration spike of 2.6 g's occurred. The thrust resolver angle decreased to previous settings. The lower rudder reached 23.38 degrees trailing edge to the right. The airplane was near wings level and on a 249.7 degree heading.

From subframe 2982 to 2984, the elevators were deflected to 15.47 degrees trailing edge down and then toward 22.59 degrees trailing edge up. The pitch angle of the airplane decreased to 2.11. From subframe 2282 to 2985, the left wing spoilers reached 34.13 degrees. The right wing spoilers reached 28.41 degrees. Both wing spoilers then began to retract.

At subframe 2984, a second vertical acceleration spike of 3.03 g's occurred

From subframe 2985 through 2988, the elevators were deflected in a similar manner as subframe 2982 through 2984 but to a lesser degree.

At subframe 2987, a third vertical acceleration spike of 1.77 g's occurred.

At subframe 2990, the nose gear compressed.

Examination of flight data revealed an average descent rate of approximately 1,380 feet per minute during the last 20 seconds of the landing approach. The average airspeed was 152 knots. Calculation of the descent angle of the airplane, based on the above averages, indicated a flight path angle of 5.12 degrees.

Wreckage and Impact Information

The NTSB's IIC examined the accident airplane on May 16, 1996, as it was parked at the Anchorage International Airport. The underside of the fuselage about fuselage station number 1821 to station number 2047, received scraping and buckling damage. A blade type antenna was destroyed. Examination of the aft fuselage pressure bulkhead revealed wrinkling and cracking of the bulkhead. Several adjacent lateral formers were also cracked and broken.

Measurement of the main landing gear strut extension by the IIC revealed that the right main gear strut extension was 6 30/32 inches. The left main gear strut was extended 6 21/32 inches. The strut pressures were not recorded.

Additional Information

Prior to the accident, the operator provided wind shear recovery procedures that recommended applying firewall power and increasing the pitch of the airplane to 15 degrees nose up. Following the accident, the operator added additional language that recommended a 7 1/2 degree pitch attitude for a bounced landing recovery.

Following the accident, the operator published a notice concerning landing procedures and techniques. The notice emphasized early stabilization of thrust, airspeed, pitch and descent rate to provide a good landing. The notice stated, in part: "The desired final approach conditions consists of a 3 degree glide path and the airspeed a Vapp plus wind additives as required. For normal landing configuration, the descent rate will be 650 to 800 feet per minute. Autothrottles should be used for all landings and will begin to retard after passing 50 feet AFL. The autothrottles will retard at a linear rate for a 3 degree glide path..."

Before the accident, the operator did not have a formal tailstrike awareness training program for the MD-11. Neither pilot reported receiving training in bounce recovery or tail strike prevention techniques during their ground school, simulator, or flight training. Information was provided in the MD-11 flight manual that discussed visual approaches, go-around procedures, and tail and wing clearance issues. Following the accident, the operator developed and implemented a tail strike awareness training program that included bounced landing recovery and a simulator training profile.

Wreckage Release

The cockpit voice recorder was released to the operator on August 7, 1996. The flight data recorder was released to the operator on June 10, 1996.

Return to synopsis

NTSB Identification: **FTW94IA321**. The docket is stored in the (offline) NTSB Imaging System.

Scheduled 14 CFR 121 operation of FEDERAL EXPRESS
Incident occurred SEP-28-94 at ANCHORAGE, AK
Aircraft: MCDONNELL DOUGLAS MD-11-F, registration: N603FE
Injuries: 2 Uninjured.

THE RIGHT HAND INBOARD FLAP VANE DEPARTED THE AIRFRAME WHEN THE AIRPLANE WAS 500 FEET ABOVE THE GROUND ON FINAL APPROACH TO THE RUNWAY. THE VANE TO TRACK SUPPORT, AFT ADJUSTMENT ECCENTRIC, AND THE SPRING CARTRIDGE STOP ASSEMBLY SEPARATED DUE TO TENSILE OVERLOAD; HOWEVER, THE TENSILE PROPERTIES DID NOT APPEAR TO INFLUENCE THE FAILURE OF THE VANE. THE SUPPORT TRACK, THE ROLLER SUPPORT BOLT, AND THE FLAP SUPPORT BUSHING SEPARATED DUE TO SHEAR OVERLOAD. TESTING FAILED TO DETERMINE THE CAUSE FOR THE FAILURE.

Probable Cause

RIGHT INBOARD FLAP VANE COMPONENT SEPARATION DUE TO UNDETERMINED REASONS.

Full narrative available

Index for Sep 1994 | Index of Months

FTW94IA321

On September 28, 1994, at 2050 Alaska standard time, a McDonnell Douglas MD-11-F, N603FE, received minor damage during approach near Anchorage, Alaska. The crew of two were not injured. Visual meteorological conditions prevailed for Federal Express Flight 81, scheduled Title 14 CFR Part 121 cargo flight to Anchorage, Alaska.

Company personnel and Federal Aviation Administration inspectors reported that the right hand inboard wing flap vane departed the airframe when the airplane was 500 feet above the ground on final approach. The airplane landed without further incident and taxied to the gate.

The Federal Aviation Administration (FAA) inspector and the airplane manufacturer examined the components and found the right inboard flap vane components: #2 vane to track support (P/N ARC7481-1), aft adjustment eccentric (P/N 2941-503), and the spring cartridge stop assembly (P/N ARC2948- 2), separated due to tensile overload. The tensile properties "did not appear to influence the failure of the vane" (enclosed report). The support track (P/N ARC2700-501), the roller support bolt (P/N ARC3154-1), and the flap support bushing (P/N ARC7495-1) separated due to shear overload.

During flight testing the flap system was instrumented using strain gauges. During the testing the manufacturer isolated vibratory loads that were being imparted in a lateral motion on the failed part. They reported that no fatigue was evidenced in the failed parts. Additional testing concluded that part of the assembly (part numbers ARC7481-1 and ARC2941-503) were not manufactured in accordance with the current engineering drawings.

A review of these components by the manufacturer's Material Review Board subsequently declared them within the safety requirements. It was also determined that these components, although non-conforming, did not contribute to the failure of the system.

Return to synopsis

National Transportation Safety Board
Washington, D.C. 20594

Brief of Accident

Adopted 08/31/1995

ANC95FA008

FILE NO. 1931 | 11/04/94 | ANCHORAGE,AK | AIRCRAFT REG. NO. N611FE | TIME (LOCAL) - 11:25 AST

MAKE/MODEL - MCDONNELL DOUGLAS MD-11/F AIRCRAFT DAMAGE - Substantial
ENGINE MAKE/MODEL - GE CF6-80C2DIF
NUMBER OF ENGINES - 3
OPERATING CERTIFICATES - Air Carrier - Supplemental
NAME OF CARRIER - FEDERAL EXPRESS, INC
TYPE OF FLIGHT OPERATION - Non-scheduled
- International
- Cargo

	FATAL	SERIOUS	MINOR/NONE
CREW	0	0	2
PASS	0	0	0

REGULATION FLIGHT CONDUCTED UNDER - 14 CFR 121

LAST DEPARTURE POINT - KANSAI,JP
DESTINATION - Same as Accident

AIRPORT PROXIMITY - On airport
AIRPORT NAME - ANCHORAGE INTERNATIONAL
RUNWAY IDENTIFICATION - 06R
RUNWAY LENGTH/WIDTH (Feet) - 10897/ 150
RUNWAY SURFACE - Asphalt
RUNWAY SURFACE CONDITION - Dry

CONDITION OF LIGHT - Daylight

WEATHER INFO SOURCE- Weather observation facility

BASIC WEATHER - Visual (VMC)
LOWEST CEILING - 11000 FT Broken
VISIBILITY - 0020.000 SM
WIND DIR/SPEED - 160 /003 KTS
TEMPERATURE (F) - 29
OBSTR TO VISION - None
PRECIPITATION - None

PILOT-IN-COMMAND AGE - 54

CERTIFICATES/RATINGS
Airline transport
Multi-engine land
INSTRUMENT RATINGS
Airplane

FLIGHT TIME (Hours)

TOTAL ALL AIRCRAFT - 12084
LAST 90 DAYS - Unk/Nr
TOTAL MAKE/MODEL - 1216
TOTAL INSTRUMENT TIME - Unk/Nr

ACCORDING TO THE FLIGHT DATA RECORDER, WHEN 50 DEGREES OF FLAPS WERE SELECTED AT 985 FEET AGL, THE FIRST OFFICER, WHO WAS FLYING THE AIRPLANE, DID NOT STABILIZE THE APPROACH. THE PITCH ATTITUDE OF THE AIRPLANE VARIED APPROXIMATELY 2 DEGREES WITH CORRESPONDING ELEVATOR POSITION CHANGES. AT 40 TO 50 FEET THE PITCH ATTITUDE OF THE AIRPLANE WAS DECREASING. THE CAPTAIN STATED HE FELT A HIGHER THAN NORMAL RATE OF DESCENT AT 20 FEET SO HE GRABBED THE YOKE AND PULLED BACK. THE AIRPLANE LANDED HARD, BOUNCED, AND OSCILLATED AT LEAST THREE TIMES, REACHING A MAXIMUM PITCH UP ATTITUDE OF 12.3 DEGREES. THE TAIL STRUCK THE RUNWAY DURING THE OSCILLATIONS. THE CAPTAIN DID NOT USE VERBAL INSTRUCTIONS AS REQUIRED BY THE FLIGHT MANUAL AND COMPANY PROCEDURES, WHEN TAKING CONTROL OF THE AIRPLANE. BOTH PILOTS WERE MANIPULATING THE CONTROLS DURING THE BOUNCED LANDING RECOVERY.

ANC95FA008
FILE NO. 1931   11/04/94   ANCHORAGE,AK   AIRCRAFT REG. NO. N611FE   TIME (LOCAL) - 11:25 AST

Occurrence# 1   HARD LANDING
Phase of Operation   LANDING - FLARE/TOUCHDOWN

Findings
1. - AIRCRAFT CONTROL - INADEQUATE - COPILOT/SECOND PILOT
2. - LACK OF FAMILIARITY WITH AIRCRAFT - COPILOT/SECOND PILOT
3. - REMEDIAL ACTION - DELAYED - PILOT IN COMMAND

Occurrence# 2   DRAGGED WING, ROTOR, POD, FLOAT OR TAIL/SKID
Phase of Operation   LANDING - FLARE/TOUCHDOWN

Findings
4. - RECOVERY FROM BOUNCED LANDING - IMPROPER - FLIGHTCREW

The National Transportation Safety Board determines that the Probable Cause(s) of this Accident was:
THE FLIGHT CREW'S IMPROPER RECOVERY FROM A BOUNCED LANDING. FACTORS ASSOCIATED WITH THE ACCIDENT ARE THE FIRST OFFICER'S LACK OF FAMILIARITY WITH THE AIRPLANE, HIS FAILURE TO STABILIZE THE APPROACH, AND THE CAPTAIN'S DELAYED REMEDIAL ACTION.

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National Transportation Safety Board **FACTUAL REPORT AVIATION**	NTSB ID: ANC95FA008	Aircraft Registration Number: N611FE
	Occurrence Date: 11/04/94	Most Critical Injury: NONE
	Occurrence Type: Accident	Investigated By: NTSB

Location/Time

Nearest City/Place	State	Zip Code	Local Time	Time Zone
ANCHORAGE	AK	99501	1125	AST

Accident Location: On Airport	Distance From Landing Facility: UNK/NA	Direction From Airport: UNK/NA

Aircraft Information Summary

Aircraft Manufacturer	Model/Series	Type of Aircraft
MCDONNELL DOUGLAS	MD-11/F	Airplane

Sightseeing Flight: No **Air Medical Transport Flight:** No

Narrative

Brief narrative statement of facts, conditions, and circumstances pertinent to the accident/incident:

HISTORY OF FLIGHT

On November 4, 1994 at 1125 Alaska standard time, a McDonnell Douglas, MD-11 airplane, N611FE, operating as Federal Express flight number 016, experienced a hard landing at Anchorage International Airport while landing on runway 6R, Anchorage, Alaska. The airplane landed hard and bounced. The tail struck the runway's surface. The airplane was substantially damaged. The all cargo flight, operating under 14 CFR Part 121, departed Kansai, Japan, on an instrument flight rules flight plan. The destination was Anchorage. Visual meteorological conditions prevailed. The Captain and the First Officer, the only occupants, were not injured.

According to the crew, they were following a Japan Air Lines Boeing 747, which preceded them by an estimated 3 miles. The Federal Express crew was cleared for a visual approach to runway 6R and they used the ILS course for guidance. The Captain stated that the airplane flew through a little bit of turbulence when crossing the shoreline but it was nothing unusual. At 50 feet above the ground everything looked normal, but at 20 feet the Captain stated he perceived an increase in the airplane's sink rate. He and the first officer (the flying pilot) both pulled the yoke back. The airplane hit the runway and bounced upward. The nose of the airplane began to pitch up and the crew pushed the yoke forward. The tail then struck the ground. The nose began to respond, and they landed normally.

DAMAGE TO AIRCRAFT

The airplane received substantial damage. Approximately 32 feet of lower fuselage skin on the underside of the tail section was scraped and dented. There were small puncture/scrape holes

(Continued on Next Page)

Narrative (Continued)

in the skin. The aft pressure bulkhead and supporting steel structures were crushed and bent. The VHF antenna, located on the underside of the tail section, was sheared off.

PERSONNEL INFORMATION

According to Federal Express flight crew records log, the Captain was hired and received his basic indoctrination into Federal Express on September 1, 1967. He has functioned as a Captain on the Boeing 727 and 747 airplanes. On August 25, 1992, he received transition/upgrade training to the MD-11 airplane. On October 28, 1992 he completed his Initial Operating Experience (IOE) as Captain on the MD-11. According to Federal Express records, the Captain had 1216 hours in the MD-11 airplane.

According to Federal Express flight crew records log, the First officer was hired and received his basic indoctrination to Federal Express on February 12, 1988. He was assigned to the Boeing 727 as a second officer on March 3, 1988. On February 8, 1989 he was assigned to the DC-10 as a second officer. On August 31, 1994, he received transition/upgrade training on the MD-11 airplane and completed his IOE on October 13, 1994. According to Federal Express records, the First Officer had 56 hours in the MD-11 airplane. The first Officer stated, this was his third landing after his IOE.

FLIGHT RECORDERS

The cockpit voice recorder and flight data recorder were retrieved and sent to NTSB Headquarters, Washington, D.C. for readout. The cockpit voice recorder did not contain any pertinent information.

The flight data recorder was deciphered and analyzed. The vertical rate of descent information (VSPD) was not valid on the main readout and was computed by the NTSB HQs flight data recorder analyst by using the altitude and time readouts. This information was portrayed on a chart (included) and at 100 feet above ground level (agl), the rate of descent increased to just over 1000 feet per minute with a nose pitch up attitude of 2.46 degrees. The rate of descent then decreased to 850 feet per minute and again increased to 900 feet per minute when the airplane was 50 feet above the ground. At this point the airplane's pitch attitude was 2.11 degrees up.

A review of the pitch attitude during the approach showed

(Continued on Next Page)

Narrative (Continued)

that the airplane's pitch attitude was approximately 3.87 degrees while flaps were selected and set at 35 degrees. The flight data recorder readout frame count number 115 shows that flaps were at 39.731 degrees which shows a transitory position. The pitch attitude of the airplane reached 4.57 degrees. At 785 feet agl, the flaps reached the selected 50 degree position and the airplanes's pitch attitude reduced to 2.11 degrees. From frame count 115 to frame count 127, the airplane's pitch attitude varied from a low of 1.41 degrees to a high of 4.57 degrees. There were two cycles of variation and at frame count number 127; the pitch attitude was decreasing through 2.46 degrees to reach a low of 2.11 degrees.

The flight data recorder elevator positions were examined and were found to fluctuate with the pitch attitude changes. The airplane's pitch attitude would reach its maximum deflection approximately 1 second after the maximum elevator input.

The flight data recorder readout shows that between 55 and 40 feet agl, the airplane's pitch attitude was increasing from 2.11 degrees to 2.81 degrees. The elevator position information shows a positive increase in elevator position. The pitch attitude of the airplane continued to increase to 8.44 degrees until ground contact. Upon ground contact, the elevator position began decreasing from its positive deflection. The flight data recorder readout shows elevator deflection varying to positive pitch up two more times before going to a negative position for the completion of landing.

According to McDonnell Douglas Aircraft, and Federal Express, Inc., the MD-11 has a tendency to pitch up when the spoilers deploy. The spoilers were designed to deploy only to the half position at main wheel spin up and if the throttles were retarded to less than 46 degrees of throttle travel. This was designed to reduce the pitch up effect. According to the flight data recorder readout information, the spoilers did not deploy upon initial ground contact. Throttle position travel was approximately 37 degrees. The spoilers did deploy to the half position upon the second touch down of the main wheels. The following information is excerpted from the flight data recorder readout and shows the relationship between the frame count, average elevator position between left and right and inboard and outboard elevators, spoiler position, and airplane pitch attitude.

(Continued on Next Page)

Narrative (Continued)

frame count no.	avg elev position	pitch attitude	spoiler position	grnd contact
129 -	7.316	3.16	8.004	
-	11.797	4.22	--	
-	8.239	7.03	9.147	
-	2.198	8.44	--	initial
130 -	-0.6367	5.27	7.828	
-	15.159	3.16	--	
-	5.031	7.73	27.090	second
-	-7.66	12.30	--	
131 -	-10.282	9.84	26.387	third + final
-	11.6875	4.22	--	
-	15.15	-0.35	26.739	
-	-7.294	0.70	--	
132 -	-14.613	0.00	58.667	

This information shows that the airplane's pitch attitude responded to the control inputs selected by the flight crew.

WRECKAGE AND IMPACT INFORMATION

There was no wreckage or debris on the runway after landing.

The damage to the airplane was discovered during the maintenance crews post flight examination of the airplane.

TESTS AND RESEARCH

Flight simulator tests conducted at the Federal Express Training facility, Memphis, Tennessee, showed that the airplane had a pronounced tendency for the nose to pitch up upon main gear touchdown. The nose pitch up tendency was exaggerated by the deployment of the spoilers which occurred upon main landing wheel spin up. Upon main landing wheel spin up, the spoilers deployed to the half deployed position.

The simulator tests distinctly showed that upon main gear touchdown and spoiler deployment, the flying pilot had to physically push the yoke forward to prevent the nose from pitching up. The pilot had to anticipate this control input. If the pilot waited for the nose of the airplane to begin movement

(Continued on Next Page)

Narrative (Continued)

in any direction, his control input effect was greatly diminished. The control input effectiveness was also affected by the position of the airplane's center of gravity. If the center of gravity was near the forward position, the control input took a longer time to effect a change in the momentum of the nose pitching rate. Conversely, when the center of gravity was near the rear limit, the control input more quickly effected a change.

The nominal center of gravity range for the MD-11 airplane during landing is 25 to 27 percent of MAC (mean aerodynamic chord). According to the Captain, the airplane's landing center of gravity was 23 percent of MAC.

A demonstration by the company MD-11 instructor pilot showed that if a stabilized approach was flown and the touchdown was normal, the nose of the airplane pitched up and stabilized at approximately 10 degrees nose up. He demonstrated this by removing his hands from the flight controls upon touchdown.

A pilot not rated in the MD-11 airplane flew an unstabilized approach and upon touchdown did not anticipate the pitch up tendency. The nose of the airplane pitched up at touchdown and full forward control input was applied before the pitch up movement was arrested. At this point the nose of the airplane began to drop rapidly toward the runway. The pilot entered a maneuver commonly termed as a pilot induced oscillation. The tail did not strike the runway during this maneuver. After three to four pitch oscillations, the main landing gear touched the runway and the pilot applied immediate full forward yoke and the airplane landed normally and stayed on the runway.

Examination of the company's training program showed that tail strike awareness is discussed. The Captain and the First Officer both stated during their interviews that they received information during training referencing tail strikes.

Examination of the MD-11 Flight Manual, page 7-113, under the section titled "Tail and Wing Clearance," subsection "Landing," revealed the following statement, "Attempting to make the smoothest landing possible can result in decreased clearances which in turn could result in a tail strike." The section further states that high descent rates on short final could lead to late or early flares which could also lead to a tail strike. The Flight Manual recommends against aerodynamic braking due to the increased possibility of a tail strike. The Manual states "Another contributor to tail strikes during landing is the nose-

(Continued on Next Page)

Narrative (Continued)

up pitching force generated by the automatic ground spoiler deployment at main gear spin-up. This is quickly noted and pilots are taught to compensate for it during initial transition training. It then becomes part of the MD-11 pilot's reflexes. Spoiler pitch-up is still present during every landing, and must be counteracted. If touchdown does occur with higher than normal pitch attitude, the nose should be lowered promptly to prevent spoiler deployment from further increasing the pitch attitude...." "In short there is not a substitute for a well-executed, stabilized approach to position the airplane for proper flare, touchdown at the proper spot and stopping while there is runway remaining."

The Flight Manual further states that a normal landing configuration would give the airplane a vertical rate of descent between 650 and 800 feet per minute. The pitch attitude should be 5 degrees with the flaps set at 35 degrees, a mid center of gravity, while on a 2.5 degree glide slope descent angle. The use of 50 degrees of flaps will reduce the pitch attitude by 1 degree. The manual also states that the pitch attitude necessary to attain a near zero rate of descent under the described conditions would normally be 8 to 9 degrees.

According to the flight data recorder information, the airplane had a pitch attitude of 4 to 5 degrees while the flaps were extended to 35 degrees. Approximately 850' above the ground, 50 degrees of flap were selected and the pitch attitude of the airplane reduced to approximately 1 degree and continued to vary throughout the approach. The variation was between 2 and 4.5 degrees until the event.

According to the instrument approach plate for Anchorage International Airport, ILS runway 6R, the descent angle for the glide slope is 3.0 degrees. The Captain and First Officer both stated that the airplane was on course and on glide slope.

The average rate of descent for the airplane during the approach, up until the time of the event was 856.73 feet per minute. However, the rates of descent varied from 2000 feet per minute to a climb of 350 feet per minute. These rate of descent points were taken from the point were 50 degrees of flaps were applied.

Examination of the training program showed that tail strike awareness is taught and the training objectives coincided with :he information in the airplane flight manual. However, the

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Narrative (Continued)

training objective stated that with 35 degrees of flaps extended the pitch attitude during approach should be 6 degrees; at flaps set to 50 degrees, the pitch attitude should be 5 degrees. There is no reference to descent angle.

According to a representative of McDonnell Douglas Aircraft, those are nominal numbers for the flight crews to show an example of the approach sight picture. It was stated that a stabilized approach is very important and that a 2 degree variation of the pitch attitude during the final phases of the approach is not a very stabilized approach, "considering the size of this airplane."

The training program also listed a section dealing with transfer of airplane control. The training program did not list any specific method for performing the transfer of airplane control. However, on page 7-7 of the MD-11 flight manual, a specific procedure for the transfer of airplane control is listed. According to the Federal Express Flight Operations Manual, page 2-10, there is a discussion about airplane control. It states in part, "At any time, during ground or flight operations, if the First Officer is controlling the airplane and the Captain becomes concerned about the airplane's flight path or ground track, the Captain must take physical control of the airplane and state 'I have the airplane.' The First Officer must then completely relinquish control of the airplane." The Captain did not use any verbal commands in this accident to acquire control of the airplane.

Discussions conducted with the Federal Express Training Department and the Standardization Department revealed that the standardization department was responsible for the information taught by the training department. The Training Department stated that they had trouble getting the most current information through their company distribution system. The training department indicated that they would like to implement training procedures based upon information given in the various McDonnell Douglas publications, such as "All Operator Letters" and "Know your MD-11" letters. Individual instructors in the Training Department stated they receive the update information faster by getting the publications directly from McDonnell Douglas Aircraft.

The distribution of these publications, within Federal Express, is handled by the Standardization Department. One individual in the Standardization Department is responsible for

(Continued on Next Page)

Narrative (Continued)

reviewing the documents/publications and routing the documents to their destinations such as maintenance, operations, or training.

According to the Standardization Department Manager, the company separated standardization and training as a method to check the quality of training. However, the Standardization Department is responsible for the curriculum information sent to the Training Department. The manager stated, "they teach only what we tell them to teach."

There was no written procedure for training program development or distribution of publications.

ADDITIONAL INFORMATION

The MD-11 airplane is equipped with a dual chamber, main landing gear, shock strut. If this strut is not serviced correctly, it may cause the airplane to rebound more than usual during landing. The landing gear struts on the accident airplane were examined and found to be over serviced with both fluid and nitrogen. According to McDonnell Douglas Aircraft, this strut is very difficult to service and there is no simple way for the flight crew to determine whether the strut has been correctly serviced. The traditional method of strut extension examination, as used by most flight crews, is not a valid method for determining correct servicing. The amount of strut extension is dependent on many factors, such as airplane gross weight, terrain/ramp slope, or fuel load distribution. These elements may lead to uneven strut extension. McDonnell Douglas Aircraft stated that if the strut is not leaking oil, and it was serviced correctly during maintenance, it should operate properly.

According to McDonnell Douglas Aircraft, they do not feel that the landing gear strut over service problem has been attributed to the cause of any tail strike in the MD-11 airplane.

They do believe that the rebound potential created by the over servicing could assist in aggravating a pilot induced oscillation during an unstabilized touchdown.

According to Federal Express, the main landing gear struts are checked only when the airplane gets a "B" maintenance check. There is no way for the flight crew or line maintenance crew to determine if the struts have been properly serviced. Federal Express did not have a written procedure in place, for flight crews or line maintenance crews, to determine the servicing level

(Continued on Next Page)

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID: ANC95FA008
	Occurrence Date: 11/04/94
	Occurrence Type: Accident

Narrative (Continued)

of the main landing gear struts.

National Transportation Safety Board Supplements C, D, and I, were not completed or submitted with this report.

National Transportation Safety Board
FACTUAL REPORT AVIATION

NTSB ID: ANC95FA008
Occurrence Date: 11/04/94
Occurrence Type: Accident

Landing Facility/Approach Information

Airport Name	Airport ID	Airport Elevation	Runway Used	Runway Length	Runway Width
ANCHORAGE INTERNATIONAL	ANC	124 Ft. MSL	06 R	10897 Ft.	150 Ft.

Runway Surface Type: Asphalt

Runway Surface Condition :	Dry			
Type Instrument Approach :	ILS-Complete	Visual		
VFR Approach/Landing :	Straight In			

Aircraft Information

Aircraft Manufacturer	Model/Series	Serial Number
MCDONNELL DOUGLAS	MD-11/F	48604

Airworthiness Certificate : Transport

Landing Gear Type : Tricycle-Retractable

Homebuilt Aircraft? No | Number of Seats: 6 | Certified Max Gross Wt. 625500 LBS | Number of Engines 3

Stall Warning System Installed? Yes

Engine Type	Engine Manufacturer	Model/Series	Rated Power
ırbojet	GE	CF6-80C2DIF	60240 Lbs

- Aircraft Inspection Information

Type of Last Inspection	Date of Last Inspection	Time Since Last Inspection	Airframe Total Time
Continuous Airworthiness	10/17/94	227 Hours	3974 Hours

- Emergency Locator Transmitter (ELT) Information

ELT Installed? Yes | ELT Operated? No | ELT Aided in Locating Accident Site? UNK/NA

Owner/Operator Information

Registered Aircraft Owner: FEDERAL EXPRESS, INC

Street Address: 2837 SPRANKEL, HANGAR 7 2ND FL

City: MEMPHIS | State: TN | Zip Code: 38118

Operator of Aircraft: Same As Reg'd Aircraft Owner

Street Address:

City: | State: | Zip Code:

Operator Does Business As: | Operator Designator Code:

- Type of Certificate(s) Held:

Air Carrier Operating Certificate : Supplemental

~~perating Certificate: | Operator Certificate:

..egulation Flight Conducted Under: 14 CFR 121

Type of Flight Operation Conducted: Non-Scheduled International Cargo

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National Transportation Safety Board FACTUAL REPORT AVIATION	
NTSB ID:	ANC95FA008
Occurrence Date:	11/04/94
Occurrence Type:	Accident

First Pilot Information

Name	City	State	Date of Birth	Age
FREDERICK FERGUSON JR.	BRIER	WA	[redacted]/40	54

Sex: M | Seat Occupied: Left | Principal Profession: Pilot-Civilian | Certificate Number: [redacted]

Certificate(s):	ATP
Airplane Rating(s):	ME Land
Rotorcraft/Glider/LTA:	None
Instrument Rating(s):	Airplane
Instructor Rating(s):	None

Type Rating Endorsement for Accident/Incident Aircraft? Yes | Current Biennial Flight Review? Yes

Months Since Last BFR	BFR Aircraft Make	BFR Aircraft Model
1	MCDONNELL-DO	MD-11

Medical Certificate: Class 1

Date of Last Medical Exam: 05/17/94

Medical Certificate Status: Valid Medical-With Waivers/Limitations

Source of Pilot Flight Time Information: Pilot Rpt

Flight Time Matrix	All A/C	This Make and Model	Airplane Single Engine	Airplane Multi-Engine	Night	Instrument Actual	Instrument Simulated	Rotorcraft	Glider	Lighter Than Air
Total Time	12084	1216								
Pilot In Command (PIC)										
Instructor										
Last 90 Days		103								
Last 30 Days										
Last 24 Hours		6								

Seatbelt Used? Yes | Shoulder Harness Used? Yes | Autopsy Performed? No | Toxicology Performed? No

Person at Controls of Aircraft at Time of Accident/Incident: Both Pilots | Second Pilot? Yes

Flight Plan/Itinerary

Type of Flight Plan Filed: IFR

Departure Point	State	Airport Identifier	Departure Time	Time Zone
KANSAI	JP	KIX	1248	GMT

Destination	State	Airport Identifier
Same as Accident/Incident Location		

Type of Clearance:	IFR
Type of Airspace:	Class D

Weather Information

Source of Briefing:	Flight Svc Sta	PATWAS	Company
Method of Briefing:	In Person	Telephone	

National Transportation Safety Board

FACTUAL REPORT AVIATION

NTSB ID: ANC95FA008

Occurrence Date: 11/04/94

Occurrence Type: Accident

Weather Information

WOF ID	Observation Time	Time Zone	WOF Elevation	WOF Distance From Accident Site	Direction From Accident Site
ANC	1050	AST	124 Ft. MSL	0 NM	000 Deg. Mag.

Sky/Lowest Cloud Condition: Scattered 8000 Ft. AGL | Condition of Light: Daylight

Lowest Ceiling: Broken 11000 Ft. AGL | Visibility: 20 SM | Altimeter: 28.78 "Hg

Temperature: 29 F | Dew Point: 17 F | Wind Direction: 160 | Density Altitude: UNK/NA Ft.

Wind Speed: 3 | Gusts: None | Weather Conditions at Accident Site: Visual Conditions

Visibility (RVR): Ft. | Visibility (RVV) SM | Intensity of Precipitation:

Restrictions to Visibility :	None			
Type of Precipitation :	None			

Accident Information

Aircraft Damage: Substantial | Aircraft Fire: None | Aircraft Explosion: None

Classification: US Registered on US Soil, Territories or Possessions, or Intl Waters

- Injury Summary Matrix	Fatal	Serious	Minor	None	TOTAL
First Pilot				1	1
Second Pilot				1	1
Dual Student					
Check Pilot					
Flight Engineer					
Cabin Attendants					
Other Crew					
Passengers					
TOTAL ABOARD				2	2
Other Aircraft					
Other Ground					
GRAND TOTAL				2	2

National Transportation Safety Board **FACTUAL REPORT AVIATION**	NTSB ID: ANC95FA008
	Occurrence Date: 11/04/94
	Occurrence Type: Accident

Administrative Information

Investigator-In-Charge (IIC)

GEORGE KOBELNYK

Additional Persons Participating in This Accident/Incident Investigation:

GEORGE MCCAMMETT
FSDO 03
ANCHORAGE AK 99502

National Transportation Safety Board
Supporting Documentation File Contents

NTSB File Number ANC95FA008

Item No.	Description of Item	No. of Pages Doc	Photo
1	Supporting Documentation File Contents, NTSB Form 6120.3	1	
2	Supplement E	2	
3	Pilot/Operator Aircraft Accident Report, NTSB Form 6120.1/2	6	
4	Simulator Training Program Excerpt - Tail Strike	1	
5	Simulator Training Program Excerpt - Transfer of Control	1	
6	FedEx Flight Operations Manual - Airplane Control	1	
7	Instructor Guide - Tail Strike	2	
8	Know Your MD-11, Landing Characteristics	6	
9	MD-11 Flight Manual Excerpt - Landing and Tail Strike	3	
10	DFDR Pitch Ralt	2	
11	DFDR VSPD Computed	3	
12	DFDR Throttle	3	
13	DFDR Elevator	3	
14	DFDR Spoilers	3	
15	DFDR Vertical G	3	
16	Statement of Party Representatives to NTSB Investigation	3	
17	Release of Aircraft Wreckage, NTSB Form 6120.15	2	
	Total Number of Pages	45	0

National Transportation Safety Board

FACTUAL REPORT
AVIATION

NTSB Accident/Incident Number: ANC95FA008

Supplement E — Second Pilot Information (continued)

Flight Time	A All A/C	B This Make & Model	C Airplane Single Engine	D Airplane Multi Engine	E Night	F Instrument Actual	G Instrument Simulated	H Rotorcraft	I Glider	J Lighter Than Air	K Other Code
35 Total Time	5055	55									
36 Pilot in Command (PIC)											
37 Instructor											
38 This Make/Model											
39 Last 90 Days		55									
40 Last 30 Days											
41 Last 24 Hours		6									

42 Landings—Last 90 Days—All Aircraft—Day: SEE NARRATIVE
A Other

43 Landings—Last 90 Days—All Aircraft—Night: N/A
A Other

44 Landings—Last 90 Days—This Make/Model—Day: SEE NARRATIVE
A Other

45 Landings—Last 90 Days—This Make/Model—Night: N/A
A Other

46 Seatbelt Available
1 ☒ Yes
2 ☐ No
A Other

47 Seatbelt Used
1 ☒ Yes
2 ☐ No
A Other

48 Shoulder Harness Available
1 ☒ Yes
2 ☐ No
A Other

49 Shoulder Harness Used
1 ☒ Yes
2 ☐ No
A Other

50 Autopsy Performed — *(This Pilot)*
1 ☐ Yes
2 ☒ No
A Other

51 Toxicology Performed — *(This Pilot)*
1 ☐ Yes
2 ☒ No
A Other

222 W 7th Ave Box ...

FORM APPROVED FOR USE THROUGH 11/30/90 BY OMB NO. 3147-0001.

NATIONAL TRANSPORTATION SAFETY BOARD
PILOT/OPERATOR AIRCRAFT ACCIDENT REPORT
This Form To Be Used For Reporting Civil Aircraft Accidents Involving Commercial and General Aviation Aircraft

Nearest City/Place, State, Zip Code	Date of Accident	Local Time (24 HOUR CLOCK)	Zone	Elevation At Accident Site
Anchorage, Alaska 99518	November 4, 1994	1925Z		124 Feet MSL; ____ Feet MSL

If The Accident Occurred On Approach, Takeoff Or Within 3 Miles Of An Airport, Complete The Following Information

Proximity To Airport:

1. [X] On Airport
2. [ ] Within 1/4 Mile
3. [ ] Within 1/2 Mile
4. [ ] Within 3/4 Mile
5. [ ] Within 1 Mile
6. [ ] Within 2 Miles
7. [ ] Within 3 Miles
8. [ ] Beyond 3 Miles

Airport Name	Airport Ident	Runway/Landing Surface And Conditions
Anchorage International	PANC	1. Direction: 06R 3. Width: 150 2. Length: 10,897 4. Surface: Grooved 5. Condition: Dry

Phase Of Operation:

1. [ ] Standing
2. [ ] Taxi
3. [ ] Takeoff
4. [ ] Climb
5. [ ] Cruise
6. [ ] Descent
7. [ ] Approach
8. [X] Landing
9. [ ] Hover/Maneuver
10. [ ] Altitude Of In-Flight Occurrence ____ Feet MSL

Registration Mark	Aircraft Manufacturer	Aircraft Type/Model	Serial Number	Cert Max Gross WT
N611FE	McDonnell-Douglas	MD-11/F	48604	625,500

Type Of Aircraft
1. [X] Airplane
2. [ ] Helicopter
3. [ ] Glider
4. [ ] Balloon
5. [ ] Blimp/Dirigible
6. [ ] Ultralight
7. [ ] Gyroplane
8. Specify ____

Type Of Airworthiness Certificate
1. [ ] Normal
2. [ ] Utility
3. [ ] Acrobatic
4. [X] Transport
5. [ ] Restricted
6. [ ] Limited
7. [ ] Experimental
8. Specify ____

Amateur Built
1. [ ] Yes
2. [X] No

Landing Gear
1. [ ] Tricycle—Fixed
2. [X] Tricycle—Retractable
3. [ ] Tailwheel—Fixed
4. [ ] Tailwheel—Retractable
5. [ ] Tailwheel—Retractable Mains
6. [ ] Amphibian
7. [ ] Skid
8. [ ] Ski/Wheel
9. Specify ____

No. Of Seats
Flight/Cabin Crew 6
Pax ____

Stall Warning System Installed
1. [X] Yes
2. [ ] No

IFR Equipped
1. [X] Yes
2. [ ] No

Engine Type
1. [ ] Reciprocating—Carburetor
2. [ ] Reciprocating—Fuel Injected
3. [ ] Turbo Prop
4. [ ] Turbo Jet
5. [X] Turbo Fan
6. [ ] Turbo Shaft

Engine Manufacturer	Engine Model/Series	Engine Rated Power	Type Of Fire Extinguishing System Used
General Electric	CF6-80C2DIF	1. ____ Horsepower 2. ✓ Lbs. Thrust 60,240	1. [X] None 2. Specify ____

Engine(s)	Date of Mfg.	Mfg. Serial No.	Total Time	Time Since Inspection	Time Since Overhaul
Engine No. 1	7-93	702916	3974:36 Hours	Hours	Hours
Engine No. 2	7-93	702919	3974:36 Hours	Hours	Hours
Engine No. 3	7-93	702918	3974:36 Hours	Hours	Hours
Engine No. 4			Hours	Hours	Hours

Type Of Maintenance Program
1. [ ] Annual
2. [ ] Manufacturer's inspection Program
3. [ ] Other Approved Inspection Program (AAIP)
4. [X] Continuous Airworthiness
5. Specify ____

Type Of Last Inspection
1. [ ] Annual
2. [ ] 100 Hour
3. [ ] AAIP
4. [X] Continuous Airworthiness

Date Last Inspection Performed: 10/17/94 (M/D/Y)
Time Since Last Inspection: 227 Hours
Airframe Total Time: 3974:36 Hours

Emergency Locator Transmitter (ELT)

ELT Manufacturer	Model/Series	Serial Number	Battery Date (M/D/Y)
DME Corporation	RLB-93		

Switch: 1. [ ] On 2. [ ] Off 3. [X] Armed
Operated: 1. [ ] Yes 2. [X] No
Aided In Accident Location: 1. [ ] Yes 2. [X] No

Registered Aircraft Owner
Wilmington Trust Co., Trustee
Address: 1100 N. Market St. Rodney Square N
Wilmington, DE 19890

Operator Of Aircraft
1. [ ] Same As Registered Owner
2. Name
3. DBS: Federal Express Corporation

Address:
1. [ ] Same As Registered Owner
2. 3101 Tchulahoma Rd.
Memphis, TN 38118

Rating(s)
1. ☐ None
2. ☐ Single Engine Land
3. ☐ Single Engine Sea
4. ☒ Multiengine Land
5. ☐ Multiengine Sea
6. ☐ Helicopter
7. ☐ Glider
8. ☐ Free Balloon
9. ☐ Airship
10. ☐ Gyroplane

Instrument Rating(s)
1. ☐ None
2. ☐ Airplane
3. ☐ Helicopter

Instructor Rating(s)
1. ☐ None
2. ☐ Airplane S.E.
3. ☐ Airplane M.E.
4. ☐ Helicopter
5. ☐ Glider
6. ☐ Instrument Airplane
7. ☐ Instrument Helicopter
8. ☐ Ground Instructor
9. Specify ______

Type Ratings/Student Endorsements
MD-11

Date Of Biennial Flight Review Or Equivalent (M/D/Y)
09/25/94

BFR Aircraft
1. Make MD-11
2. Model ______

Medical Certificate
1. ☐ None
2. ☒ Class 1
3. ☐ Class 2
4. ☐ Class 3

Date Of Last Medical (M/D/Y)
10/25/94

Limitations
NONE

Waivers

Date Of Birth
[redacted]/55

Degree Of Injury
1. ☒ None
2. ☐ Minor
3. ☐ Serious
4. ☐ Fatal

Seat Occupied
1. ☐ Left
2. ☒ Right
3. ☐ Center
4. ☐ Front
5. ☐ Rear

Seat Belt Available
1. ☒ Yes
2. ☐ No

Seat Belt Used
1. ☒ Yes
2. ☐ No

Shoulder Harness Available
1. ☒ Yes
2. ☐ No

Shoulder Harness Used
1. ☒ Yes
2. ☐ No

Source Of Pilot Flight Time Information
1. ☐ Pilot Logbook
2. ☐ Operators Estimate
3. ☐ FAA Records
4. ☒ Company
5. Specify ______

Flight Time	All A/C	This Make & Model	Airplane Single Engine	Airplane Multiengine	Night	Instrument Actual	Instrument Simulated	Rotorcraft	Glider	Lighter Than Air
Total Time		55:46								
Pilot In Command (PIC)										
Instructor										
This Make/Model										
Last 90 Days		55:46								
Last 30 Days										
Last 24 Hours		6:42								

Other Personnel

Name	Seat	Address (City & State)	Crew	Passenger Non-Revenue	Passenger Revenue	Non-Occupant	FAA	Degree Of Injury Fatal Serious Minor None
1.								
2.								
3.								
4.								
5.								
6.								

Last Departure Point
1. Airport ID KIX
2. City/Place KANSAI
3. State JAPAN

Time Of Departure
1. Time 1248Z
2. Time Zone ______

Destination
1. Airport ID PANC
2. City/Place ANCHORAGE
3. State ALASKA

Flight Plan Filed
1. ☐ None
2. ☐ VFR
3. ☒ IFR
4. ☐ VFR/IFR
5. ☐ Company (VFR)
6. ☐ Military (VFR)

If Weather Was Involved, State If Weather Briefing Was Obtained Or If Weather Reports Were Checked And How It Was Accomplished
60 SCT M-80 OVL 35 856/32/30/20/3305/910/ SWU NE-SE THN OVHD

Fuel On Board At Last Takeoff
______ Gallons
or
26.3M Pounds

Fuel Type
1. ☐ 80/87
2. ☐ 100 Low Lead
3. ☐ 100/130
4. ☐ 115/145
5. ☒ Jet A
6. ☐ Automotive
7. Specify ______

Other Services, If Any, Prior To Departure

Souce Of Weather Infomration (Pilot/Operator, Weather Observation)
Operator Wx Observation

Light Condition
1. ☐ Dawn
2. ☒ Daylight
3. ☐ Dusk
4. ☐ Bright Night
5. ☐ Dark Night

Visibility
90 Miles

Temp (°F)
31

Dew Point
23 (°F)

Altimeter Setting
29.14 "Hg

Sky/Lowest Cloud Condition
1. ☐ Clear
2. ☐ Scattered 6 Ø Feet AGL
3. ☐ Broken ____ Feet AGL
4. ☐ Overcast ____ Feet AGL
5. ☐ Partial Obscuration
6. ☐ Obscured

Wind Information
1. Direction 160
2. Velocity 3 KTS
3. Gusts ____ KTS

Restriction To Visibility
90 Miles

Type Precipitation
N/A

Intensity Of Precipitation
1. ☐ Light 2. ☐ Moderate 3. ☐ Heavy 4. Specify ____

Turbulence (Multiple entry)
1. ☐ None 2. ☒ Light 3. ☐ Moderate 4. ☐ Severe 5. ☐ Extreme 6. ☐ Clear Air 7. ☐ In Clouds

Degree Of Aircraft Damage
1. ☐ None 2. ☐ Minor 3. ☒ Substantial 4. ☐ Destroyed

Fire
1. ☐ Yes 2. ☒ No 3. ☐ In-Flight 4. ☐ On Ground

Description Of Damage To Aircraft And Other Property

Approximately 32 feet of skin damage on th underside of the tail section. Aft pressure bulkhead buckle and VHF antenna sheared.

1. ☒ No
2. ☐ Yes List The Name Of The Part, Manufacturer, Part No., Serial No. And Describe The Failure

Total Time

On Part	At Overhaul
____ Hours	____ Hours

Collision Accident
If Collison Accident Occurred, Complete The Information For Other Aircraft

Registration mark	Aircraft Manufacturer	Aircraft Type/Model	Degree Of Aircraft Damage
			1. ☐ Destroyed 2. ☐ Substantial 3. ☐ Minor 4. ☐ None

Registered Aircraft Owner | **Address**

Pilot Name | **Address** | **Pilot Certificate No.**

Assistance Received
1. ☐ Outside Person(s)
2. ☐ Auxiliary Lighting
3. ☐ Slide
4. ☐ Rope
5. ☐ Ladder
6. ☐ Specify ____

Method Of Exit (State Approximate Number Of Persons Using Each Of The Following)
1. Main Door XXX 2. Auxiliary Door ____ 3. Emergency Exit ____

Operator/Owner Safety Recommendation (Optional Entry)

Describe What Occurred In Chronological Order, The Circumstances Leading To The Accident And The Nature Of The Accident. Describe The Terrain And Include A Sketch Of Wreckage Distribution If Pertinent. Attach Extra Sheets If More Space Is Needed. State Point Of Departure, Time Of Departure, Intended Destination And Services Obtained.

We were cleared for visual approach to runway 6R behind a JAL 747. We flew the ILS to runway 6R handflown below 1000' by the First Officer. The ILS guidance was followed to 100' then visual to landing. Flare was started @50', we made a hard landing and the nose pitched up. We both pushed it over and landed. Rollout was normal. Damage to the tail section was noted.

Pilot's Statement

Date Of This Report	Signature Of Pilot/Operator
11/20/94	[redacted]

Signature Of Person Filing Report Other Than Pilot/Operator

1. Signature ______________________
2. Type Or Print Name ______________________
3. Title ______________________

NTSB Accident No.	Reviewed By NTSB Office Located At	Name Of Investigator	Date Report Received
ANC95FA008	ANCHORAGE	KOBELNYK	11/28/94

July '94

MD-11 STANDARDS PROGRAM FOR SIMULATOR TRAINING

I. **Briefing Items:**

A. **FMS/Glass Cockpit Philosophies**
B. **PF vs PNF Duties**
C. **Captain Training vs First Officer Training**
D. **Windshear**
E. **CrossWind Landing/Adverse Runway Landing Techniques**
F. **Taxi Techniques/Use of Thrust**
G. **Use of FCP/GCP**
H. **Use of Anti-Ice**
I. **TakeOff Technique: Normal vs V 1 Cut (loss of 1 or 3 vs #2)**
J. **Tail Strike Awareness: TakeOff and Landing**
K. **Flows:**

1. **Cockpit Set-Up: Captain/F/O**
2. **After Start**
3. **Cleared to Configure**
4. **Before TakeOff Checks**
5. **After TakeOff Checks**
6. **Before Landing**
7. **After Landing**
8. **Shutdown**

L. **Profiles:**

1. **Normal TakeOff: Manual/FCP vs AUTO**
2. **V 1 Cut: Manual/FCP vs AUTO**
3. **One Engine Inop Approach**
4. **Loss of Second Engine**
5. **Non-Precision Approach**
6. **Two Engine Inop Approach**
7. **Steep Turns**
8. **Stalls**

FedEx. Federal Express **FLIGHT OPERATIONS MANUAL**

STANDARDIZATION

The use of standardization enhances safety and efficiency by logically assigning to different crew members responsibility for the accomplishment of required tasks. The use of standard procedures reduces the burden of planning and promotes confidence and precision within the crew. Any crew member who observes a nonstandard procedure that has not been explained shall immediately call this deviation to the attention of the other crew members. Not all eventualities can be foreseen. However, it has been well proven that the best operations occur when a high level of planning, communication, crew support, and standardization exist. It is a goal of Flight Operations to achieve a precise level of standardization that discourages unsafe practices, carelessness, and the development of individualized procedures, but not so high that operational flexibility, good judgment, and professionalism are discouraged.

AIRPLANE CONTROL

The airplane must be under the direct control of one pilot at all times. This requirement must be satisfied before conducting any other cockpit activity. The use of the autopilot does not alter this requirement; it simply replaces one means of control with another. No element of doubt must be allowed to develop as to which of the pilots is controlling the airplane.

Any uncertainty regarding the safety of an operation is to be questioned and satisfactorily resolved before that operation is conducted or continued.

At any time, during ground or flight operations, if the First Officer is controlling the airplane and the Captain becomes concerned about the airplane's flight path or ground track, the Captain must take physical control of the airplane and state "I have the airplane." The First Officer must then completely relinquish control of the airplane.

OLD

TRAINING OBJECTIVES	INSTRUCTOR NOTES

SCAN

REVIEW

PRE-BRIEF
As required to adequately address the training events to be covered during the period.

TRAINING OBJECTIVE
Build pilot confidence in the basic capabilities of the MD-11 through hand flying exercises (no autoflight) and the use of only basic instrumentation (no FMS).

DISCUSSION
- Basic Instrument Procedures
  - Non Precision Approaches
  - Procedure Turns
  - VDP Computation
  - Flap/Slat Schedule and Approach Configuration
- Pitch Attitude References
- Stalls
  - Clean Configuration
  - Takeoff Configuration
  - Landing Configuration
- Tail Strike Awareness in the landing phase - Discuss landing techniques to be avoided to prevent tailstrikes
  - A pitch angle >12° on the PFD may cause a tail strike
  - Nominal pitch angle at touchdown (1.25Vs) with zero rate of descent and idle thrust will be at about 10°
  - A normal approach with flaps at 35° yields a 6° pitch reference on the PFD - with flaps 50° the pitch is 5°
  - At 1.3Vs the pitch angle will increase approximately 1°.
  - Tailstrikes can also occur in approaches with high rates of descent on short final with an early flare, increasing pitch attitudes, and floating in an attempt at a smooth touchdown.
  - High descent rates on final with late, abrupt flares can cause tailstrikes due to high rotational inertia forces
  - The nose-up pitching forces generated by automatic ground spoiler deployment at main gear spin-up can also contribute to tail strikes
  - Nose-up pitching forces are magnified if the automatic spoiler deflection feature malfunctions and goes to full deflection on main gear spin-up rather than delaying until the nose gear is on the ground. The nose-up pitching moment generated in this scenario will be exaggerated and must be aggressively countered if a tail strike is to be avoided.

  ½ @ main gear spin up.

- CAT I Approaches; missed approaches; landings
- Crosswind landings

Know Your MD-11

All PILOTS
FOR YOUR INFORMATION

PASS All ANC MD-11 PILOTS
JIM GRANT

LETTER NO. 3
DATE: April 14, 1993

TO: ALL MD-11 OPERATORS

FROM: FLIGHT OPERATIONS CUSTOMER SERVICE DOUGLAS AIRCRAFT COMPANY

SUBJECT: LANDING CHARACTERISTICS AND TECHNIQUES

This "Know Your MD-11" Newsletter is compiled and published by Douglas Flight Operations Customer Service. The material contained herein was accurate at the time of publication, and it is intended to provide information only. Should conflicts arise between this document and official manuals i.e., the Aircraft Flight or Flight Crew Operating Manuals, the official manuals are the final authority and shall supercede the data in this document.

Our new "Know Your MD-11" Newsletter will be issued periodically, on an as-needed basis. If you find it useful, or if you have a subject you would like discussed in a future issue, please contact Art Torosian at the address below; we would like to hear from you.

Art Torosian
DOUGLAS AIRCRAFT COMPANY
INTERNAL MAIL CODE 94-26
3855 Lakewood Blvd.
Long Beach, California 90846

From time to time we receive requests from our customers, particularly new operators, for advice on how to get good, consistent, safe landings with their new airplane. We have pooled the collective experience of our Douglas pilots, and offer the following:

RA
Wheel-spin-up,
Throttle-idle.
1445

The landing characteristics of the MD-11 are very conventional for an aircraft of its size and weight. Flight controls are responsive, well balanced and predictable, and with a little practice, pilots are able to achieve consistently smooth, well controlled landings very close to the desired point of touchdown.

The following is a phase-by-phase discussion of proven approach/landing techniques which may help you to achieve consistency; if you have questions or advice that you would like to see included in future issues, please let us hear from you.

MD-11 LANDING CHARACTERISTICS AND TECHNIQUES

Visual Approach

The aircraft should be stabilized in the final landing configuration, on a descent flight path and on speed, with appropriate wind and gust corrections applied to V_{ref} by 1000' AGL. If the aircraft is not stabilized by 500 feet a missed approach should be executed. Rate of descent should not exceed 1000 fpm below 1000'. The visual aimpoint to provide a threshold clearance height of 47' on a 3.0 degree glideslope should be approximately 1700'. This will provide a touchdown point approximately 900' from the threshold without a flare. Do not deviate from the visual glidepath in an attempt to touch down early.

Flare

Auto throttles will begin to retard after passing 50', and a slight flare should be initiated between 30 to 40 feet (approximately 2°). The aircraft should touch down in the touchdown zone. The technique described above will result in a touchdown slightly below V_{ref}. Do not hold the aircraft off in an attempt to achieve a smooth landing. This will result in a long touchdown, higher than necessary braking forces, a higher pitch attitude and reduced tail strike margin. The aft fuselage will contact the runway at approximately 10° pitch attitude with the struts compressed.

Touchdown

At touchdown, with main wheel spin up, assure ground spoiler deployment and prepare to counter any pitching tendency as the spoilers extend. This will require the pilot to fly the nosewheel to the ground.

disengages, and any nose-up elevator command would be washed out within 1 second, and a slight drop in the nose may be observed just before the flare. From a practical standpoint, this nose lowering would be barely perceptible, and of little consequence to the flare and touchdown.

These additional guidelines are emphasized:

1. Autothrottles should be used for all landings. The reduction of power, starting gradually at about 50 feet and continuing through the flare, complements a smooth transition to a well controlled and timely touchdown. The Autothrottle will continue to move the throttles to idle if not already in idle at touchdown.

2. Pilots should not trim the stabilizer during the flare. Such activity may contribute to float, a nose high touchdown attitude, a possible tail strike, and may aggravate any existing pitch up tendency after touchdown.

3. Experience has shown that approaches which result in large pitch deviations, and which never achieve true speed and glide path stability are much more likely to produce unpredictable landings; hold-offs, floats, hard touchdowns, strong rebounds and tail strikes. Such approaches make it nearly impossible to establish a proper crosswind correction, and are especially risky on contaminated or slippery surfaces. A destabilized approach is a compelling reason to initiate an early go-around.

LANDING ON WET OR SLIPPERY SURFACES

On a wet and/or slippery surface every effort should be made to ensure that reverse thrust is applied symmetrically across all three engines, and crews should be trained to carefully monitor any tendency for the aircraft to develop a skid when the surface is slippery. Should a skid condition develop, thrust should be brought to idle reverse on all three engines while the skid is corrected. When a limited amount of runway friction is available, reduced braking may improve the cornering capability of the aircraft, and with the use of rudder pedal nosewheel steering, help correct the skid. Sustained high reverse thrust in a skid will provide a force which can literally back the airplane off the downwind side runway surface.

INTERRUPTING A SYSTEMS TEST

Each of the three aircraft systems, Air, Hydraulics and Fuel, has a specified test routine to be accomplished by the flight crew before flight, usually during cockpit preparation. In examining the causes of instances in which one of these tests has failed, we have learned that while some of the failures revealed genuine system faults, many did not. Often the failure was the product of some flight crew action which unwittingly interrupted a test-in-progress.

To review, each of these systems follow a prescribed test routine which is not tolerant of disruption; such as, timing of certain activities, verification of pressure and flow checks, and things of that sort. Any conflicting demand which is made on a system during the test will cause the test to fail. In the cases of the Air and Hydraulics Systems tests, the consequences are not too disruptive; the crew can remove the conflicting demand, cycle the system to manual and back, and reinitiate the test. In the case of fuel, however, the disruption can be exasperating; consider a typical scenario:

a. A large load of fuel is being uploaded requiring, at some pumping stations, as much as an hour or more to accomplish.

b. This is the first refueling after landing, so a full Fuel System Test is initiated automatically when the fueling operation has been completed; the test may take up to 9 minutes.

c. With all flight preparations complete, and waiting only on the refueling operation, the crew requests a Pushback as soon as it is done.

d. Pressing to keep on schedule, the crew then initiates an engine start while the Fuel System Test is still in progress, and causes the test to fail.

With a "FUEL SYSTEM TEST FAIL" Alert displayed, the only action that can get the airplane back into a dispatchable status is to shut down all of the engines and have the ground crew run the test again. The ensuing delay usually means a missed departure slot, and often a protracted wait for a new one.

In an effort to reduce such occurrences, Douglas has shortened the time required to complete the Fuel System Test from 14 to approximately 9 minutes, and has made it a once-per-landing event, rather than one which occurs after every refueling. A last minute top off, for instance, will not initiate another test if a good one was performed after the initial fueling.
In summary, it is important to know the nature of the system self tests; such that any conflicting demand which is made on one of the aircraft systems while a test is in progress will always produce a failed test and a probable delay.

LANDING PROCEDURES

LANDING FLAP SETTING

Normal landing flap settings may be flaps 35° or 50° depending upon conditions.

One or more of the following conditions might cause flaps 50° to become the preferred landing flap setting.

- Short runway.
- Tailwind.
- Contaminated runway.
- Early turn off or shortening landing roll.
- High landing gross weight associated with any of the above items.

SELECTION OF FLAPS 50°

Precision	Normally after 35° and below flaps 50° limit speed.
Non-Precision	Prior to FAF except if distance from fix to runway is unusually long, maintain flaps 35° until visual contact with the runway and in a position to intercept a normal descent profile. In any case, the airplane, should be in the final configuration prior to descent below MDA.
Visual	No later than 1000 ft. above TDZE.

FINAL APPROACH CONDITION AND TOUCHDOWN

The desired visual final approach condition consists of a 3° glide path and the airspeed at V_{APP}.

V_{APP} is adjusted for wind effects. Target approach speed is V_{APP} for landing in reported winds up to 10 kts steady state. When landing in higher wind conditions, add 1/2 the steady headwind component plus the full value of the gust to V_{REF}. The total additive should not exceed 20 kts.

Early stabilization of airspeed, power and descent rate are essential to a good landing. For normal landing configurations, the descent rate will be 650 to 800 ft per minute. The pitch attitude is 5° for the MD-11 with the flaps set at 35°, mid CG, on a 2.5° glideslope at V_{APP}. In the hypothetical case, if the airplane is flared to the zero rate of descent with idle thrust and a speed of 1.25 V_S at touchdown, the pitch attitude will be 10°. However, with a typical low rate of descent at touchdown, the pitch attitude will normally be 8° to 9°. Landing with a 50° flap setting will decrease the pitch attitude approximately 1° in all cases. This body angle creates a relatively high eye level position in relation to the landing gear. For the transitioning pilot this frequently makes him want to lower the airplane's nose (duck under) when going VFR from an instrument approach or when approaching the threshold. The aiming point is 1,500 ft to 1,800 ft down the runway (40 to 60 ft threshold clearance) in contrast to the 1,000 ft point used on smaller airplanes. The radio altimeter is a good guide to assist in determining the correct position for crossing the threshold. The radio altimeter is biased to accurately indicate the height of the lowest part of the main wheels above the terrain. Radio altimeter calls are very valuable as an aid in determining wheel height to touchdown. When seated in the proper seat position the threshold should disappear under the nose at 75 ft radio altitude. At any time the radio altitude is observed to be 75 ft or less, and the approach end of the runway is still in sight, the airplane is dangerously low and corrective action should be immediately taken. One of the most important factors which may lead to ground contact with the tail is holding off in the flare which allows the airplane to float prior to touchdown. Trimming the stabilizer or leaving the power on throughout the flare will contribute to flaring too late. Flaring too early or abruptly will cause floating in ground effect which rapidly uses the runway. If speed is excessive, it is still better to set the airplane onto the runway as near the 1,500 ft point as possible rather than allowing it to float in order to bleed off airspeed. Deceleration on the runway is about 3 times greater than in the air. On touchdown, it is important to lower the nosewheel to the runway and hold a positive forward pressure to counteract nose up pitching tendencies. When this is done, the wing angle of attack is decreased, resulting in minimum lift, which places more weight on the main gear sooner. This not only increases rolling friction but increases braking effectiveness as well. This procedure is five times more effective in decelerating the airplane than that achieved from holding the nosewheel off. Do not use aerodynamic braking.

NOTE

Ground spoiler deployment causes nose up pitching moment. This effect is most noticeable at aft centers of gravity. It is important to check the nose up pitching tendency with forward pressure on the control column and smoothly lower the nosewheel to the runway. Holding sufficient forward pressure on the control column keeps the nosewheel on the runway and increases nosewheel steering effectiveness.

most gross weights the airplane will accelerate away from the stall before a pitch attitude of 5° is reached. Adjust this pitch attitude as required to accelerate to V_{MIN}. Rotate smoothly to maintain V_{MIN} but do not exceed the pitch limit indicator. When a positive rate of climb has been established, call for gear up. When the airplane has regained V_{MIN} and entry attitude, the stall maneuver is complete.

ACCEPTABLE PERFORMANCE GUIDELINES - STALL RECOVERY

- Maintain positive airplane control.
- Heading: ± 10° where applicable.
- No sink rate during entry.
- Recovery should be positive but smooth. Avoid secondary indications of stall; reactivation of the stickshaker is acceptable.
- Little or no altitude loss during recovery.

COMMON ERRORS - STALL RECOVERY

- Allowing a descent to develop prior to a stall indication.
- Tending to lower the nose below target attitude, then in an effort to minimize altitude loss, abruptly raising the nose which reactivates the stall warning by induced G loading.
- Excessive aileron input when rolling out of turns.
- Not applying enough thrust when the throttles are advanced and failure to call "firewall power" when necessary.
- Calling for gear up too early or without a positive rate of climb.
- Attempting to use rudder instead of ailerons to control lateral instability (the rudder should not be used during stall recovery as this could result in an abrupt roll).

TAIL AND WING GROUND CLEARANCE

GENERAL

During a normal takeoff, approach and landing the aerodynamic design of the MD-11 provides sufficient tail and wing clearance. Assuming that these clearances are maintained requires attention to proper technique and a thorough knowledge of airplane performance and limitations.

TAKEOFF

During a normal takeoff, rotating at the correct V_R and using a normal rotation rate of approximately 2.5° per second, lift-off will occur at a pitch attitude of about 8 degrees, which provides ample ground clearance. It is possible to experience a takeoff tail strike by using too rapid a rotation rate. This occurs when the effective lift has had insufficient time to overcome airplane inertia, thus the rapidly increasing pitch attitude results in a tail strike because the airplane has not yet achieved a sufficient rate of climb.

NOTE

Tail strikes may occur at rotation rates of 3.8° per second or greater or pitch angles in excess of 12° below 35 feet AGL.

LANDING

Attempting to make the smoothest landing possible can result in decreased clearances which in turn could result in a tail strike. Holding the airplane off in the flare and allowing it to float excessively prior to touchdown is not proper technique. As speed decreases pitch attitude will increase significantly if level flight is maintained in an effort to accomplish a minimum rate of descent touch-down. This will lead to excessively high body angles at touchdown with reduced tail clearance. Holding the airplane off additionally results in a decrease in available runway for stopping. This technique also causes increased brake wear.

A normal Flaps 35° approach at maximum landing gross weight will result in a pitch attitude of approximately 6° airplane nose up. If the speed is decreased to V_{APP} (1.3V_S) crossing the threshold the pitch will increase approximately 1°. If the airplane is flared to a zero descent rate with idle thrust, touchdown should be at 1.25 V_S with a 10° pitch attitude.

NOTE

Landing with Flaps 50° will decrease pitch attitude by approximately 1°.

PRELIMINARY INFORMATION

$ FRAME	LAPSE	UCT	ALT	RALT	IAS	VSPD	HEAD	PITCH	PITCH	PITCH	PITCH	AOAALL	AOAALL	ROLL	ROLL	FRMCNT
106.	00:07	00:07	2307.	1387.0	169.00	2048.	61.61	4.22	4.22	4.22	4.22	6.33	6.06	0.35	1.76	
			2288.	1373.0	168.50	2048.	61.61	4.22	4.22	4.22	4.22	7.56	5.80	2.81	3.16	
			2276.	1348.0	171.00	2048.	61.61	4.22	4.22	4.22	4.22	5.45	6.68	3.16	2.46	
			2260.	1372.0	167.50	2048.	61.26	4.57	4.57	4.92	4.92	6.50	5.62	1.41	0.00	486.
107.	00:07	80:07	2239.	1394.0	169.50	2048.	60.91	5.27	5.27	5.27	5.62	7.21	7.21	-1.05	-1.76	
			2215.	1410.0	170.00	2048.	60.56	5.62	5.98	5.98	6.33	7.38	8.61	-1.41	-1.41	
			2212.	1379.0	170.00	2048.	60.56	6.33	5.98	5.98	5.62	8.09	7.56	-1.41	-1.05	
			2202.	1388.0	170.50	2048.	60.91	5.27	4.92	4.92	4.57	7.56	8.44	-0.70	-0.70	487.
108.	00:07	70:07	2187.	1373.0	167.50	2048.	61.26	4.57	4.22	4.22	3.87	8.61	7.56	-0.35	0.00	
			2181.	1380.0	168.00	2048.	61.96	3.87	3.87	3.52	3.52	7.21	7.91	0.35	0.35	
			2157.	1374.0	168.00	2048.	63.02	3.52	3.16	3.16	2.81	8.09	6.50	1.05	2.11	
			2147.	1369.0	169.50	2048.	63.02	2.81	2.81	2.81	3.16	6.15	4.92	1.41	2.11	488.
109.	00:07	80:07	2133.	1328.0	167.50	2048.	63.37	3.16	3.52	3.87	3.87	5.98	7.21	3.87	3.52	
			2119.	1319.0	163.00	2048.	63.02	4.22	4.22	4.22	4.22	7.38	4.92	2.46	2.11	
			2099.	1298.0	159.00	2048.	62.31	4.22	4.22	3.87	3.87	7.38	8.61	2.11	3.52	
			2071.	1277.0	160.00	2048.	61.61	3.87	3.87	4.22	4.57	8.26	9.84	2.81	0.00	489.
110.	00:07	60:07	2055.	1257.0	162.00	2048.	61.61	4.57	4.57	4.92	4.57	10.37	8.09	-3.16	-3.87	
			4085.	1238.0	166.50	2048.	62.67	4.57	4.22	4.22	3.87	8.44	8.44	-2.81	-1.05	
			4062.	1222.0	170.00	2048.	62.67	3.87	3.52	3.52	3.52	8.44	7.38	0.70	1.41	
			4043.	1204.0	169.50	2048.	63.02	3.16	2.81	2.81	2.46	6.68	7.21	1.41	1.05	490.
111.	00:07	00:07	1975.	1192.0	169.50	2048.	63.37	2.46	2.46	2.46	2.46	7.21	5.62	0.35	0.35	
			1964.	1171.0	169.00	2048.	64.42	2.81	2.81	3.16	3.16	5.98	6.15	0.70	1.41	
			1939.	1157.0	171.00	2048.	64.77	3.16	3.16	3.16	2.81	7.21	7.03	2.11	2.11	
			1916.	1135.0	169.00	2048.	65.48	2.81	2.81	2.81	2.81	6.86	6.50	1.76	1.76	491.
112.	00:07	23:07	1898.	1116.0	169.00	2048.	66.18	3.16	3.52	3.87	4.22	6.33	6.68	2.81	2.81	
			1882.	1095.0	169.50	2048.	66.53	4.22	4.57	4.57	4.92	7.21	8.09	2.11	1.76	
			1862.	1078.0	169.50	2048.	66.53	4.57	4.57	4.57	4.57	8.26	9.14	0.70	-1.05	
			1844.	1061.0	167.50	2048.	66.18	4.22	4.22	4.22	4.57	8.09	7.03	-2.46	-1.76	492.
113.	00:07	77:07	1827.	1048.0	170.00	2048.	65.83	4.57	4.57	4.92	4.92	7.03	7.91	-0.70	0.00	
			1821.	1032.0	169.50	2048.	65.13	4.92	4.92	4.92	4.92	7.38	6.68	-0.70	-1.05	
			1809.	1020.0	168.00	2048.	64.77	4.92	4.92	4.92	4.57	7.21	7.56	-1.05	-0.70	
			1791.	1007.0	166.00	2048.	64.07	4.57	4.22	4.22	3.87	7.38	7.21	-1.41	-1.41	493.
114.	00:07	00:07	1777.	994.0	166.00	2048.	63.72	3.87	3.87	3.87	3.87	6.86	6.50	-0.70	-0.35	
			1766.	982.0	168.00	2048.	63.72	3.87	3.87	3.87	3.87	6.68	6.33	0.00	0.70	
			1745.	964.0	168.00	2048.	63.37	3.87	4.22	4.22	4.22	7.21	6.68	0.00	-1.41	
			1728.	949.0	169.00	2048.	63.37	4.22	4.22	4.22	4.22	7.21	7.91	-2.46	-2.46	494.
115.	00:07	99:07	1716.	933.0	167.00	2048.	63.37	4.57	4.57	4.57	4.57	7.38	7.03	-1.41	-1.05	
			1702.	920.0	167.00	2048.	63.37	4.57	4.57	4.57	4.57	7.38	7.56	-1.41	-1.76	
			1690.	908.0	167.50	2048.	63.37	4.22	4.22	4.22	3.87	7.56	6.86	-1.41	-1.05	
			1676.	898.0	168.00	2048.	63.72	3.87	3.87	3.87	3.87	6.33	6.50	-0.70	-0.35	495.
116.	00:07	00:07	1670.	889.0	168.00	2048.	64.07	3.87	3.52	3.52	3.52	6.50	5.80	0.00	0.00	
			1659.	880.0	168.00	2048.	64.07	3.16	3.16	3.16	2.81	5.98	6.15	0.00	0.35	
			1646.	872.0	166.50	2048.	64.42	2.81	2.81	2.81	2.46	5.27	5.27	0.35	0.00	
			1639.	861.0	168.50	2048.	64.77	2.46	2.46	2.46	2.46	5.10	5.62	-0.35	0.35	496.
117.	00:07	97:07	1631.	850.0	166.00	2048.	64.77	2.11	2.11	1.76	1.76	5.45	5.62	0.35	-0.70	
			1614.	841.0	165.50	2048.	65.13	1.41	1.05	1.05	1.05	5.10	2.81	-0.70	0.00	
			1601.	824.0	164.50	2048.	64.77	1.05	1.05	1.41	1.41	3.34	4.04	-0.35	0.35	
			1579.	804.0	165.00	2048.	64.42	3.27	1.76	1.76	1.76	5.62	6.15	1.05	0.35	497.
118.	00:07	71:07	1555.	785.0	164.50	2048.	64.07	2.11	1.76	1.76	1.76	5.98	5.45	-0.70	-1.05	
			1537.	768.0	165.00	2048.	64.07	1.76	1.76	1.76	1.76	5.27	5.10	-1.05	-1.05	
			1517.	746.0	165.00	2048.	64.07	1.76	2.11	2.11	2.11	5.27	5.27	-1.05	-1.05	
			1498.	728.0	165.50	2048.	64.07	2.11	2.11	2.11	2.11	5.45	5.45	-0.70	-1.05	498.
119.	00:07	97:07	1480.	710.0	165.50	2048.	63.72	2.46	2.11	2.11	2.11	5.98	5.62	-1.05	-0.70	
			1460.	695.0	163.50	2048.	63.72	2.11	2.11	2.11	2.11	5.62	5.10	0.70	0.70	
			1440.	675.0	162.00	2048.	63.72	2.11	2.46	2.46	2.46	5.10	5.10	0.00	0.00	
			1428.	661.0	161.00	2048.	63.72	2.46	2.46	2.81	2.81	5.10	5.45	-0.35	-0.70	499.
120.	00:07	26:07	1408.	640.0	161.50	2048.	64.07	2.81	2.81	3.16	3.52	5.15	5.27	0.00	0.35	
			1393.	623.0	160.50	2048.	64.07	3.52	3.87	4.22	4.57	5.98	6.33	0.70	0.35	
			1379.	607.0	164.50	2048.	64.07	4.57	4.57	4.57	4.57	6.30	6.86	0.70	1.05	
			1363.	594.0	163.50	2048.	64.42	4.57	4.22	4.22	4.22	7.03	6.86	1.05	0.33	500.

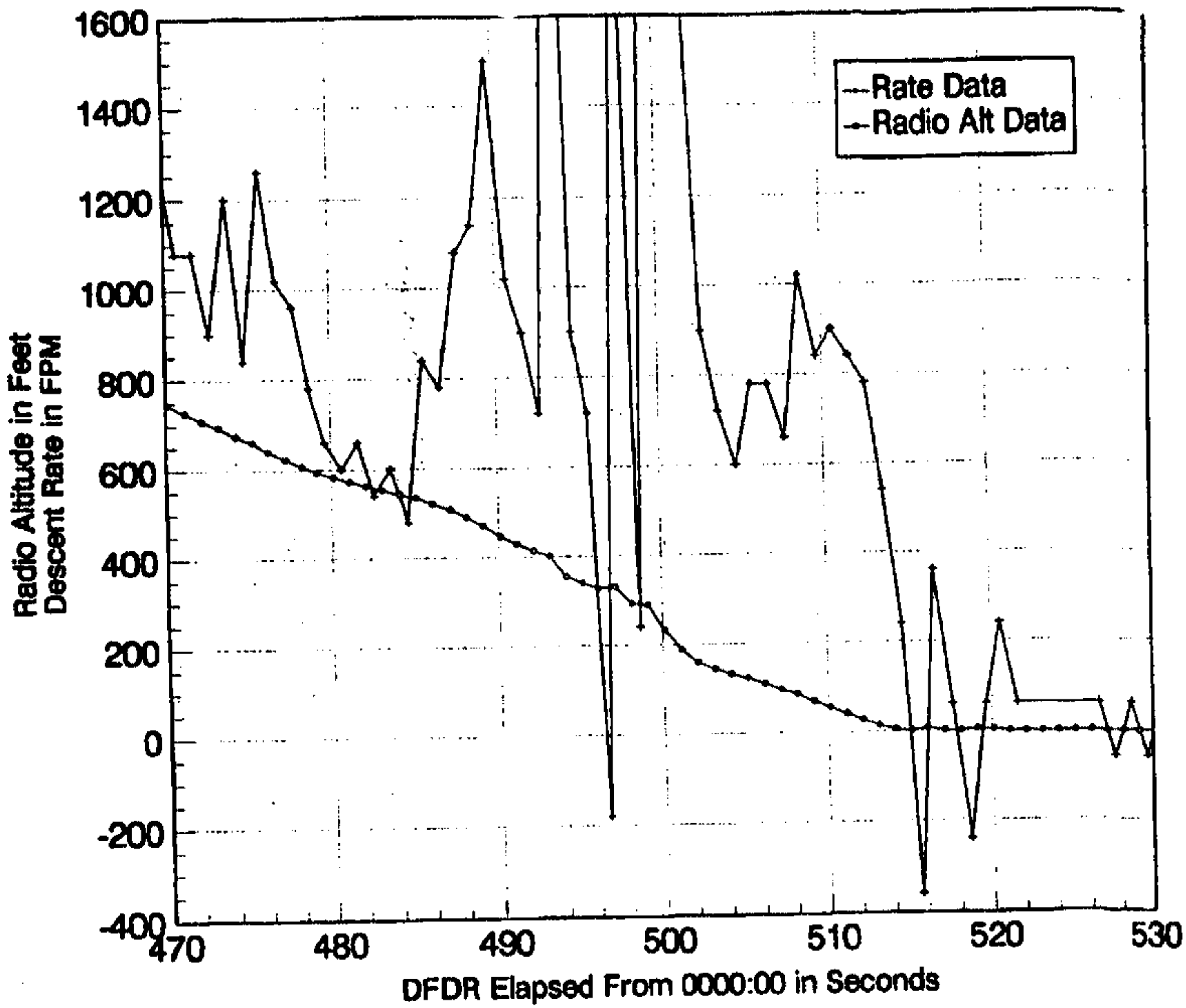
10-NOV-94 FEDEX11.RAW - FEDEX16.D01

NTSB DATA DUMP PROGRAM

PRELIMINARY INFORMATION

# FRAME	LAPSE	UCT	ALT	RALT	IAS	VSPD	HEAD	PITCH	PITCH	PITCH	PITCH	AOAALL	AOAALL	ROLL	ROLL	FRMCNT
121.	00:08	00:07	1351.	503.0	163.00	2048.	64.42	4.22	4.22	4.22	4.22	6.50	6.33	0.00	0.00	
			1343.	573.0	162.50	2048.	64.42	4.22	4.22	3.87	3.87	6.33	5.98	-0.35	-1.05	
			1335.	562.0	162.00	2048.	64.42	3.87	3.87	3.52	3.52	5.98	5.98	-1.05	-0.70	
			1328.	553.0	162.00	2048.	64.42	3.52	3.52	3.52	3.52	5.98	5.62	-0.70	-0.70	501.
122.	00:08	00:07	1312.	543.0	162.50	2048.	64.07	3.52	3.16	3.16	3.16	5.45	5.80	-1.05	-0.70	
			1303.	535.0	163.00	2048.	63.72	2.81	2.81	2.46	2.46	5.80	5.27	-1.05	-1.76	
			1288.	521.0	162.50	2048.	63.37	2.46	2.46	2.46	2.46	4.92	5.10	-1.41	-1.41	
			1276.	508.0	162.50	2048.	63.02	2.46	2.46	2.46	2.46	5.10	5.10	-0.70	0.00	502.
123.	00:08	20:07	1255.	490.0	162.50	2048.	63.02	2.46	2.46	2.46	2.46	5.10	5.62	0.35	0.35	
			1242.	471.0	162.00	2048.	62.67	2.46	2.46	2.46	2.46	5.27	5.45	0.00	-0.35	
			1229.	446.0	161.50	2048.	62.67	2.46	2.46	2.46	2.46	5.80	5.65	-0.35	-0.35	
			1208.	429.0	161.50	2048.	63.02	2.11	2.11	2.11	2.11	5.62	5.98	-0.35	-0.35	503.
124.	00:08	00:07	1193.	414.0	161.00	2048.	63.02	2.46	2.46	2.46	2.11	5.80	5.62	0.35	0.35	
			1174.	402.0	162.00	2048.	63.37	2.11	2.11	2.11	2.11	5.62	5.80	1.05	1.41	
			1158.	355.0	161.50	2048.	63.37	2.11	2.11	2.11	2.11	5.62	5.62	1.76	1.41	
			1139.	340.0	161.00	2048.	63.72	2.11	2.46	2.46	2.81	5.62	5.62	0.00	0.00	504.
125.	00:08	00:07	1122.	328.0	161.50	2048.	63.72	2.81	3.16	3.16	3.52	5.80	5.80	0.70	1.76	
			1107.	331.0	162.00	2048.	64.07	3.52	3.52	3.87	3.87	6.86	6.68	1.76	1.05	
			1087.	293.0	162.00	2048.	64.07	3.87	4.22	4.22	4.57	6.68	6.86	0.00	-0.35	
			1077.	289.0	161.50	2048.	64.42	4.57	4.57	4.57	4.57	7.83	6.68	0.35	0.70	505.
126.	00:08	76:07	1064.	232.0	161.50	2048.	64.07	4.57	4.22	4.22	3.87	6.86	6.86	0.00	-0.70	
			1053.	189.0	160.50	2048.	64.07	3.52	3.52	3.52	3.52	6.50	6.15	-0.70	-0.70	
			1042.	160.0	161.50	2048.	64.07	3.52	3.52	3.92	3.16	6.33	5.80	-0.70	-1.76	
			1035.	145.0	162.00	2048.	63.72	3.16	2.81	2.81	2.46	5.80	5.45	-2.46	-2.81	506.
127.	00:08	00:07	1014.	133.0	163.00	2048.	63.37	2.46	2.46	2.46	2.46	5.62	5.45	-2.81	-2.81	
			1004.	123.0	161.50	2048.	63.02	2.46	2.46	2.46	2.46	5.62	5.45	-2.81	-2.11	
			985.	110.0	159.50	2048.	63.02	2.46	2.46	2.46	2.46	5.62	5.62	-1.41	-2.46	
			972.	97.0	162.00	2048.	63.02	2.46	2.46	2.11	2.11	5.98	6.15	-3.52	-2.81	507.
128.	00:08	23:07	956.	86.0	161.00	2048.	63.02	2.11	2.11	2.11	2.11	5.98	5.62	-2.11	-0.70	
			919.	69.0	162.00	2048.	63.72	2.11	2.11	2.11	2.11	6.15	6.33	0.70	1.41	
			916.	55.0	162.00	2048.	64.07	2.11	2.11	2.46	2.46	4.57	4.75	1.05	1.41	
			894.	40.0	161.00	2048.	64.77	2.81	2.81	3.16	3.16	5.80	5.27	1.41	0.35	508.
129.	00:08	00:07	855.	26.0	162.00	2048.	65.48	3.16	3.16	3.16	3.87	6.15	5.98	-0.35	-0.35	
			837.	13.0	159.50	2048.	65.83	4.22	4.92	5.62	6.33	5.80	5.10	0.00	0.00	
			809.	6.0	154.50	2048.	66.53	7.03	7.38	6.09	8.09	6.15	8.62	0.00	-0.35	
			824.	0.0	154.50	2048.	66.88	8.44	8.09	7.38	6.33	8.79	7.56	0.00	1.05	509.
130.	00:08	57:07	841.	6.0	154.50	2048.	67.24	5.27	4.22	3.16	3.16	6.68	8.09	2.46	2.11	
			840.	~~336.0~~	151.50	2048.	66.88	3.16	4.22	5.27	6.48	5.80	4.22	1.41	0.00	
			798.	-1.0	146.00	2048.	66.53	7.73	9.14	10.20	11.25	4.39	4.22	-0.35	0.00	
			805.	3.0	141.00	2048.	65.83	12.30	12.66	11.95	10.90	9.49	7.91	0.70	0.35	510.
131.	00:08	70:07	787.	2.0	139.00	2048.	65.13	9.84	8.40	7.03	5.62	13.18	12.30	0.35	0.35	
			787.	-2.0	133.50	2048.	64.77	4.22	2.81	1.41	0.35	8.96	9.67	1.05	1.05	
			763.	-3.0	129.00	2048.	64.77	-0.35	0.00	0.35	0.70	5.10	1.93	1.05	1.05	
			739.	-3.0	118.50	2048.	64.77	0.70	0.35	0.00	-0.35	1.41	1.41	1.05	1.05	511.
132.	00:08	00:07	734.	-3.0	110.50	2048.	64.77	0.00	0.00	0.00	0.00	1.58	1.76	0.70	0.70	
			730.	-3.0	106.50	2048.	64.77	0.00	0.00	0.00	0.00	1.93	1.05	0.70	0.70	
			717.	-3.0	100.00	2048.	64.42	0.00	0.00	0.00	0.00	1.41	1.93	0.70	0.70	
			725.	-4.0	92.50	2048.	64.07	0.00	0.00	0.00	0.00	1.76	1.23	0.70	0.70	512.
133.	00:08	20:07	731.	-3.0	85.50	2048.	63.72	0.00	0.00	0.00	0.00	1.23	2.11	0.70	0.70	
			727.	-4.0	80.50	2048.	63.72	0.00	0.00	0.00	0.00	2.11	1.23	0.70	0.70	
			740.	-3.0	71.00	2048.	64.07	0.00	0.00	0.00	0.00	1.41	2.29	0.35	0.35	
			780.	-4.0	66.00	2048.	64.42	0.00	0.00	0.00	0.00	2.46	1.58	0.00	0.00	513.
134.	00:08	73:07	753.	-3.0	67.00	2048.	65.13	0.00	0.00	10.90	0.00	1.58	2.64	0.00	0.00	
			773.	-4.0	60.00	2048.	64.77	0.00	0.00	0.00	0.00	2.64	1.41	0.00	0.00	
			782.	-3.0	60.50	2048.	64.07	0.00	0.00	0.00	0.00	1.58	2.99	0.00	0.00	
			741.	-4.0	54.50	2048.	64.07	0.00	0.00	0.00	0.00	2.81	1.58	0.00	0.00	514.
135.	00:08	72:07	844.	-3.0	44.00	2048.	64.07	0.00	0.00	0.00	0.00	1.76	2.99	0.00	-0.35	
			826.	-4.0	46.50	2048.	65.13	0.00	0.00	0.00	0.00	2.99	1.93	-0.35	-0.35	
			921.	-4.0	44.50	2048.	65.48	0.00	0.00	0.00	0.00	1.93	3.52	-0.35	-0.35	
			1032.	-4.0	63.50	2048.	65.83	0.00	0.00	0.00	0.00	4.57	2.81	-0.35	-0.35	515.

Elapsed Time, sec	Descent Rate, FPM	
500.62500,	2580.00,	-3420.00
501.62500,	1740.00,	-4260.00
502.62500,	900.00,	-5100.00
503.62500,	720.00,	-5280.00
504.62500,	600.00,	-5400.00
505.62500,	780.00,	-5220.00
506.62500,	780.00,	-5220.00
507.62500,	660.00,	-5340.00
508.62500,	1020.00,	-4980.00
509.62500,	840.00,	-5160.00
510.62500,	900.00,	-5100.00
511.62500,	840.00,	-5160.00
512.62500,	780.00,	-5220.00
513.62500,	540.00,	-5460.00
514.62500,	240.00,	-5760.00
515.62500,	-360.00,	-6360.00
516.62500,	360.00,	-5640.00
517.62500,	60.00,	-5940.00
518.62500,	-240.00,	-6240.00
519.62500,	60.00,	-5940.00
520.62500,	240.00,	-5760.00
521.62500,	60.00,	-5940.00
526.62500,	60.00,	-5940.00
527.62500,	-60.00,	-6060.00
528.62500,	60.00,	-5940.00
529.62500,	-60.00,	-6060.00
530.62500,	60.00,	-5940.00
531.62500,	-60.00,	-6060.00
532.62500,	60.00,	-5940.00
533.62500,	-60.00,	-6060.00
534.62500,	60.00,	-5940.00
535.62500,	-60.00,	-6060.00
536.62500,	60.00,	-5940.00
543.62500,	-29100.00,	-35100.00
544.62500,	29100.00,	23100.00
545.62500,	-29100.00,	-35100.00
546.62500,	29100.00,	23100.00
552.62500,	-23100.00,	-29100.00
553.62500,	-6000.00,	-12000.00
554.62500,	2160.00,	-3840.00
555.62500,	26940.00,	20940.00
563.62500,	-60.00,	-6060.00
564.62500,	-29040.00,	-35040.00
565.62500,	29100.00,	23100.00
568.62500,	-60.00,	-6060.00
570.62500,	-29040.00,	-35040.00
571.62500,	29040.00,	23040.00
572.62500,	60.00,	-5940.00
573.62500,	-60.00,	-6060.00
577.62500,	60.00,	-5940.00
579.62500,	-60.00,	-6060.00
582.62500,	60.00,	-5940.00
583.62500,	-60.00,	-6060.00
586.62500,	60.00,	-5940.00
587.62500,	-60.00,	-6060.00
590.62500,	60.00,	-5940.00
591.62500,	-60.00,	-6060.00
592.62500,	-29040.00,	-35040.00
593.62500,	29040.00,	23040.00
596.62500,	60.00,	-5940.00


Rate Data
Radio Alt Data
Radio Altitude in Feet
Descent Rate in FPM
1600
1400
1200
1000
800
600
400
200
0
-200
-400
470
480
490
500
510
520
530
DFDR Elapsed From 0000:00 in Seconds

PRELIMINARY INFORMATION

NTSB DATA DUMP PROGRAM
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PAGE 4

# FRAME	LAPSE	UCT	TRA1	TRA2	TRA3	DPRSL	DPRSR	BRKPL	BRKPR	NGCL1	NGCR1	NGCL2	NGCR2	LNGDL	RNGDL	NGDL
106.	00:07	00:07	52.73	53.09	52.73			7.224	7.282	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	
			52.73	52.73	52.38	58.7	44.0			0.0000	0.0000	0.0000	0.0000			
			52.38	52.38	51.68			7.224	7.282	0.0000	0.0000	0.0000	0.0000			1.0000
			51.68	52.03	51.68	58.7	44.0			0.0000	0.0000	0.0000	0.0000			
107.	00:07	00:07	51.68	52.03	52.03			7.224	7.282	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	
			52.03	52.03	52.03	53.8	39.1			0.0000	0.0000	0.0000	0.0000			
			52.03	52.38	52.03			7.224	7.282	0.0000	0.0000	0.0000	0.0000			1.0000
			52.03	52.03	51.68	58.7	39.1			0.0000	0.0000	0.0000	0.0000			
108.	00:07	70:07	51.33	51.33	50.62			7.224	7.282	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	
			50.62	50.98	50.98	58.7	48.9			0.0000	0.0000	0.0000	0.0000			
			50.98	51.33	51.33			7.224	7.282	0.0000	0.0000	0.0000	0.0000			1.0000
			50.98	51.68	51.68	44.0	39.1			0.0000	0.0000	0.0000	0.0000			
109.	00:07	00:07	51.33	50.98	50.62			7.224	7.282	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	
			50.27	51.33	52.03	58.7	44.0			0.0000	0.0000	0.0000	0.0000			
			51.09	54.14	55.20			7.224	7.282	0.0000	0.0000	0.0000	0.0000			1.0000
			55.90	56.95	56.95	63.5	39.1			0.0000	0.0000	0.0000	0.0000			
110.	00:07	60:07	57.30	58.01	57.66			7.224	7.282	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	
			58.01	57.66	56.60	53.8	44.0			0.0000	0.0000	0.0000	0.0000			
			55.90	55.20	53.79			7.224	7.282	0.0000	0.0000	0.0000	0.0000			1.0000
			53.09	52.73	52.38	63.5	44.0			0.0000	0.0000	0.0000	0.0000			
111.	00:07	00:07	52.03	52.03	51.68			7.224	7.282	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	
			51.33	51.68	51.33	63.5	39.1			0.0000	0.0000	0.0000	0.0000			
			50.98	51.68	51.33			7.224	7.282	0.0000	0.0000	0.0000	0.0000			1.0000
			51.33	51.68	51.33	53.8	44.0			0.0000	0.0000	0.0000	0.0000			
112.	00:07	23:07	51.33	51.68	51.33			7.224	7.282	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	
			50.98	51.33	51.33	63.5	39.1			0.0000	0.0000	0.0000	0.0000			
			51.33	51.68	51.68			7.224	7.282	0.0000	0.0000	0.0000	0.0000			1.0000
			51.68	52.03	52.03	58.7	44.0			0.0000	0.0000	0.0000	0.0000			
113.	00:07	77:07	52.38	52.73	52.38			7.224	7.282	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	
			52.38	52.38	52.03	53.8	44.0			0.0000	0.0000	0.0000	0.0000			
			52.03	52.73	52.38			7.224	7.282	0.0000	0.0000	0.0000	0.0000			1.0000
			52.73	53.44	53.44	53.8	44.0			0.0000	0.0000	0.0000	0.0000			
114.	00:07	00:07	53.79	53.79	53.79			7.224	7.282	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	
			53.79	53.79	53.44	58.7	48.9			0.0000	0.0000	0.0000	0.0000			
			53.09	53.44	53.09			7.224	7.282	0.0000	0.0000	0.0000	0.0000			1.0000
			53.09	53.09	52.73	48.9	48.9			0.0000	0.0000	0.0000	0.0000			
115.	00:07	99:07	52.73	53.09	52.73			7.224	7.282	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	
			53.09	53.79	53.79	63.5	44.0			0.0000	0.0000	0.0000	0.0000			
			53.79	54.14	54.14			7.224	7.282	0.0000	0.0000	0.0000	0.0000			1.0000
			54.14	54.14	53.79	58.7	39.1			0.0000	0.0000	0.0000	0.0000			
116.	00:07	00:07	53.79	53.79	52.73			7.224	7.282	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	
			52.73	53.44	52.03	58.7	53.8			0.0000	0.0000	0.0000	0.0000			
			53.09	53.44	52.38			7.224	7.282	0.0000	0.0000	0.0000	0.0000			1.0000
			53.44	53.79	52.38	58.7	44.0			0.0000	0.0000	0.0000	0.0000			
117.	00:07	97:07	53.09	53.44	52.03			7.224	7.282	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	
			53.09	53.79	52.73	58.7	44.0			0.0000	0.0000	0.0000	0.0000			
			53.79	54.14	52.73			7.224	7.282	0.0000	0.0000	0.0000	0.0000			1.0000
			53.79	54.14	52.73	58.7	44.0			0.0000	0.0000	0.0000	0.0000			
118.	00:07	71:07	53.44	53.79	52.73			7.224	7.282	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	
			53.79	54.14	52.73	68.4	44.0			0.0000	0.0000	0.0000	0.0000			
			53.79	54.14	53.09			7.224	7.282	0.0000	0.0000	0.0000	0.0000			1.0000
			53.44	53.79	52.38	63.5	44.0			0.0000	0.0000	0.0000	0.0000			
119.	00:07	97:07	52.73	53.44	52.38			7.224	7.282	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	
			53.09	53.79	53.44	58.7	44.0			0.0000	0.0000	0.0000	0.0000			
			53.79	54.84	54.14			7.224	7.297	0.0000	0.0000	0.0000	0.0000			1.0000
			54.84	55.55	54.49	63.5	44.0			0.0000	0.0000	0.0000	0.0000			
120.	00:07	26:07	55.20	55.20	54.14			7.224	7.282	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	
			54.49	54.84	54.14	63.5	44.0			0.0000	0.0000	0.0000	0.0000			
			54.49	54.84	53.79			7.224	7.282	0.0000	0.0000	0.0000	0.0000			1.0000
			54.14	54.84	54.14	63.5	44.0			0.0000	0.0000	0.0000	0.0000			

PRELIMINARY INFORMATION

# FRAME	LAPSE	UCT	TRA1	TRA2	TRA3	BPRSL	BPRSR	BRKPL	BRKPR	NOCL1	NOCR1	NOCL2	NOCR2	LRGDL	RRGDL	NGDL
121.	00:08	00:07	54.84	55.55	54.84			7.224	7.297	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	
			55.20	55.90	54.84	68.4	44.0			0.0000	0.0000	0.0000	0.0000			
			55.55	55.90	55.20			7.224	7.297	0.0000	0.0000	0.0000	0.0000			1.0000
			55.55	56.25	55.20	58.7	44.0			0.0000	0.0000	0.0000	0.0000			
122.	00:08	00:07	55.90	56.25	55.20			7.224	7.282	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	
			55.90	55.90	54.84	58.7	44.0			0.0000	0.0000	0.0000	0.0000			
			54.84	55.20	54.49			7.224	7.297	0.0000	0.0000	0.0000	0.0000			1.0000
			54.84	55.20	54.49	68.4	48.9			0.0000	0.0000	0.0000	0.0000			
123.	00:08	20:07	54.49	55.20	54.49			7.224	7.297	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	
			54.84	55.20	54.14	562.5	48.9			0.0000	0.0000	0.0000	0.0000			
			54.49	55.20	54.49			7.224	7.282	0.0000	0.0000	0.0000	0.0000			1.0000
			55.20	55.55	54.84	73.3	44.0			0.0000	0.0000	0.0000	0.0000			
124.	00:08	00:07	55.20	55.55	54.84			7.224	7.297	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	
			55.20	55.55	54.84	68.4	44.0			0.0000	0.0000	0.0000	0.0000			
			55.20	55.55	54.49			7.224	7.297	0.0000	0.0000	0.0000	0.0000			1.0000
			54.84	55.20	54.49	53.8	44.0			0.0000	0.0000	0.0000	0.0000			
125.	00:08	00:07	55.20	55.55	54.84			7.224	7.282	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	
			55.20	55.90	54.84	58.7	44.0			0.0000	0.0000	0.0000	0.0000			
			55.20	55.90	55.20			7.224	7.297	0.0000	0.0000	0.0000	0.0000			1.0000
			55.55	56.25	55.55	58.7	44.0			0.0000	0.0000	0.0000	0.0000			
126.	00:08	76:07	55.90	56.60	55.90			7.224	7.297	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	
			56.25	56.95	55.90	58.7	48.9			0.0000	0.0000	0.0000	0.0000			
			56.60	56.95	56.25			7.224	7.297	0.0000	0.0000	0.0000	0.0000			1.0000
			56.60	56.95	55.20	58.7	44.0			0.0000	0.0000	0.0000	0.0000			
127.	00:08	00:07	55.20	55.55	54.14			.7.224	7.297	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	
			54.49	54.84	54.14	63.5	44.0			0.0000	0.0000	0.0000	0.0000			
			54.49	55.55	55.20			7.224	7.297	0.0000	0.0000	0.0000	0.0000			1.0000
			55.55	55.90	54.84	58.7	53.8			0.0000	0.0000	0.0000	0.0000			
128.	00:08	23:07	55.20	55.55	54.49			7.224	7.297	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	
			54.84	55.90	55.20	58.7	48.9			0.0000	0.0000	0.0000	0.0000			
			55.55	55.90	55.20			7.224	7.297	0.0000	0.0000	0.0000	0.0000			1.0000
			54.14	52.73	50.27	58.7	44.0			0.0000	0.0000	0.0000	0.0000			
129.	00:08	00:07	48.87	47.81	45.35			7.224	7.297	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	
			44.30	43.26	40.78	58.7	44.0			0.0000	0.0000	0.0000	0.0000			
			39.37	38.67	37.97			7.224	7.297	0.0000	0.0000	0.0000	0.0000			1.0000
			37.62	37.97	37.97	68.4	39.1			0.0000	0.0000	0.0000	0.0000			
130.	00:08	57:07	37.62	37.97	33.05			7.224	7.297	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	
			32.34	32.34	33.05	53.8	48.9			0.0000	0.0000	0.0000	0.0000			
			32.34	31.29	32.34			7.268	7.341	0.0000	0.0000	0.0000	0.0000			1.0000
			33.05	31.29	9.49	185.7	430.1			0.0000	0.0000	0.0000	0.0000			
131.	00:08	70:07	6.68	7.38	7.73			7.253	7.326	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	
			6.68	7.38	7.73	669.6	738.0			0.0000	0.0000	0.0000	0.0000			
			6.68	7.38	7.73			7.282	7.341	0.0000	0.0000	0.0000	0.0000			1.0000
			6.68	7.38	7.73	444.8	694.0			1.0000	1.0000	1.0000	1.0000			
132.	00:08	00:07	7.03	7.38	7.73			6.918	7.341	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	
			6.68	7.38	7.73	513.2	615.1			1.0000	1.0000	1.0000	1.0000			
			6.68	7.38	7.73			6.496	6.510	1.0000	1.0000	1.0000	1.0000			1.0000
			6.68	7.38	7.73	371.5	395.9			1.0000	1.0000	1.0000	1.0000			
133.	00:08	70:07	6.68	7.38	7.73			6.438	6.481	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	
			6.68	7.38	7.73	293.3	420.3			1.0000	1.0000	1.0000	1.0000			
			6.68	7.38	7.73			6.481	6.394	1.0000	1.0000	1.0000	1.0000			1.0000
			6.68	7.38	7.73	376.3	342.1			1.0000	1.0000	1.0000	1.0000			
134.	00:08	23:07	6.68	7.38	7.73			6.525	6.423	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	
			6.68	7.38	7.73	615.4	337.2			1.0000	1.0000	1.0000	1.0000			
			6.68	7.38	7.73			6.496	6.671	1.0000	1.0000	1.0000	1.0000			1.0000
			6.68	7.38	7.73	391.0	249.3			1.0000	1.0000	1.0000	1.0000			
135.	00:08	22:07	6.66	8.09	8.09			6.525	6.583	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	
			8.44	9.49	10.20	449.7	219.9			1.0000	1.0000	1.0000	1.0000			
			9.49	8.44	12.30			6.452	6.525	1.0000	1.0000	1.0000	1.0000			1.0000
			11.95	11.60	12.30	430.1	312.8			1.0000	1.0000	1.0000	1.0000			

NTSB DATA DUMP PROGRAM
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PRELIMINARY INFORMATION

$ FRAME	LAPSE	UCT	STAB1	STAB2	ELEVLI	ELEVRI	ELEVRO	ELEVLO	AILLS	AILRI	AILRO	AILLO	FLAPLI	FLAPLO	FLAPRO	FLAPRI
106.	00:07	00:07	-10.768		-0.264	0.439	0.703	1.055	1.142	1.494	-4.402	3.603	34.984	34.281	34.105	34.984
				-10.724	-0.527	0.000	0.791	0.703	-2.636	-4.394	-6.327	2.285				
			-10.768		0.176	0.439	2.021	2.197	-6.064	-5.888	-8.612	2.285				
				-10.724	0.176	1.670	2.812	2.724	-4.833	-4.394	-7.909	2.021				
107.	00:07	00:07	-10.768		-0.088	0.703	0.264	4.833	-1.670	-1.142	-4.394	4.306	34.984	34.457	33.929	34.984
				-10.724	0.703	2.461	1.670	1.845	3.603	3.779	-1.670	6.239				
			-10.988		1.406	-2.549	-2.812	-2.461	0.439	2.197	-2.461	6.767				
				-10.944	-2.197	-1.230	0.879	0.967	1.758	2.285	-0.527	5.976				
108.	00:07	70:07	-10.988		-0.791	0.264	0.967	1.230	1.670	1.670	0.703	9.227	34.984	34.457	34.105	34.984
				-10.944	-0.527	0.176	0.791	0.264	-0.088	0.000	-2.812	6.943				
			-10.988		-0.527	-0.615	0.879	0.703	1.318	1.758	-3.164	4.746				
				-10.944	-0.527	0.352	1.845	1.582	-1.494	-2.812	-9.403	0.703				
109.	00:07	00:07	-10.988		2.197	1.933	2.021	1.494	-0.967	-2.285	-2.461	-0.791	34.984	34.457	34.105	34.984
				-10.944	0.967	-1.582	0.000	-1.318	-5.800	-5.712	-4.921	4.042				
			-10.988		-1.055	-1.494	0.527	1.318	-1.318	-1.142	-4.482	1.055				
				-10.944	-0.615	-0.967	6.679	5.624	-5.712	-7.118	-10.106	-0.439				
110.	00:07	60:07	-10.988		5.624	-0.703	0.352	-0.352	-6.767	6.503	-0.088	9.843	34.984	34.457	33.929	34.984
				-10.944	-1.055	-1.406	1.494	1.670	7.118	6.415	4.042	7.733				
			-10.988		-0.352	0.703	0.703	0.967	3.252	3.252	-2.988	5.976				
				-10.944	-1.933	-1.406	-0.967	0.703	-0.791	-0.352	-2.549	5.976				
111.	00:07	00:07	-10.988		-1.142	-0.527	3.867	4.482	0.176	0.967	-0.527	7.821	34.984	34.457	34.105	34.984
				-10.944	1.230	0.879	1.318	0.791	1.845	0.352	-2.549	6.239				
			-10.988		-1.933	-1.494	-0.791	-0.791	0.088	0.352	-3.076	1.582				
				-10.944	-1.933	0.439	2.988	2.724	-4.833	-4.746	-3.867	4.921				
112.	00:07	23:07	-11.031		3.691	3.427	4.306	0.967	-2.461	-2.021	-4.130	-1.406	34.984	34.281	34.105	34.984
				-11.119	0.879	0.703	0.000	-0.088	-7.909	-7.733	-7.206	1.670				
			-11.119		-0.967	-0.879	0.000	0.352	-4.570	-0.173	-10.450	-1.758				
				-11.119	-0.527	0.703	4.306	5.449	-1.494	-0.439	-5.361	7.118				
113.	00:07	77:07	-11.119		2.461	1.582	2.021	3.076	1.318	1.582	-6.943	1.933	34.984	34.633	33.929	34.984
				-11.119	-1.494	-0.088	-0.439	0.967	-4.570	-4.482	-4.788	6.503				
			-11.119		-1.582	-0.088	-1.142	-0.439	1.230	1.406	-2.988	5.624				
				-11.119	-1.494	-0.088	0.439	0.879	-0.527	-0.176	-4.570	5.009				
114.	00:07	00:07	-11.119		-0.703	0.352	0.703	1.406	2.724	2.724	-0.352	6.064	34.984	34.457	34.633	38.324
				-11.075	-0.615	0.615	0.439	1.318	0.000	0.088	-3.076	5.888				
			-11.119		-0.439	0.879	1.845	0.000	-4.921	-4.658	-7.206	5.449				
				-11.119	-0.879	-0.439	0.527	2.988	-0.352	-0.264	0.527	9.227				
115.	00:07	99:07	-10.988		0.703	2.285	1.055	2.636	3.691	0.088	-2.724	5.800	39.731	38.852	39.203	42.192
				-10.724	0.352	2.197	0.703	1.845	-1.845	-0.967	-4.921	7.030				
			-10.592		-0.879	2.373	1.582	3.691	1.494	2.021	-0.967	7.646				
				-10.504	0.439	2.636	1.845	3.076	0.176	0.527	-1.845	5.888				
116.	00:07	00:07	-10.592		0.264	2.285	-0.791	1.845	0.000	0.176	-3.427	5.624	42.719	44.302	44.029	45.181
				-10.548	-0.527	2.021	1.318	3.339	-1.845	0.264	-2.724	6.064				
			-10.592		0.439	2.197	2.197	4.130	0.000	-0.088	-2.900	2.724				
				-10.548	0.439	1.845	1.230	1.933	-3.691	-3.603	-2.988	5.976				
117.	00:07	97:07	-10.592		-0.703	0.439	1.230	2.373	-3.955	-4.482	-4.658	3.603	46.235	48.697	49.576	49.927
				-10.548	0.352	1.318	2.636	3.164	-1.406	-1.142	-4.306	5.009				
			-10.548		1.933	2.812	3.515	3.603	-4.306	-0.352	-3.955	5.536				
				-10.504	1.758	2.461	2.549	2.988	-4.130	-5.009	-4.130	2.109				
118.	00:07	71:07	-10.548		1.494	1.582	2.549	2.373	-4.130	-3.603	-3.339	5.888	49.927	49.927	49.927	49.927
				-10.504	2.461	2.812	4.746	4.570	0.264	0.352	-2.549	3.164				
			-10.548		3.252	3.515	4.482	4.306	-1.406	-1.406	-1.142	7.646				
				-10.504	1.758	2.109	2.812	3.339	0.967	0.088	-2.724	6.239				
119.	00:07	97:07	-10.592		1.758	2.373	2.900	3.252	-0.176	0.088	-3.076	7.118	49.927	49.927	49.927	49.927
				-10.900	1.406	2.109	3.076	3.252	1.142	0.879	-3.867	3.955				
			-11.119		2.461	2.812	3.955	3.779	-1.845	-0.352	-5.800	3.867				
				-11.207	2.549	2.900	2.988	2.636	-2.549	-2.812	-2.812	5.976				
120.	00:07	26:07	-11.295		2.724	2.812	4.130	5.976	0.088	2.812	-0.176	8.524	49.927	49.927	49.927	49.927
				-11.207	5.273	5.185	3.515	3.076	-2.197	-1.845	-4.394	5.712				
			-11.295		2.900	0.176	0.791	1.055	-0.264	-0.088	-2.900	5.888				
				-11.251	0.527	1.582	2.812	2.900	-3.603	-4.218	-4.306	4.218				

PRELIMINARY INFORMATION

# FRAME	LAPSE	UCT	STAB1	STAB2	ELEVLI	ELEVRI	ELEVRO	ELEVLO	AILLI	AILRI	AILRO	AILLO	FLAPLI	FLAPLO	FLAPRO	FLAPRI
121.	00:08	00:07	-11.251		2.197	1.933	5.185	4.482	-1.494	-0.439	-2.988	5.800	49.927			
				-11.251	0.879	0.967	2.109	2.285	-0.176	-3.076	-5.888	3.076		49.927		
			-11.295		0.527	0.879	3.252	2.900	0.000	0.264	-2.812	5.449			49.927	
				-11.559	1.582	1.055	2.285	1.494	-0.527	-0.439	-4.921	3.867				49.927
122.	00:08	00:07	-11.779		0.088	-0.527	1.230	0.352	-2.197	-1.494	-5.009	5.624	49.927			
				-11.954	-0.703	-0.791	1.758	1.406	-0.527	-1.230	-6.593	2.812		49.927		
			-11.998		1.670	1.758	3.427	0.967	-3.339	-0.176	-2.900	5.976			49.927	
				-11.954	-0.088	0.000	1.582	2.197	2.285	2.461	-1.055	6.855				49.927
123.	00:08	20:07	-11.998		-0.176	1.055	2.197	2.373	0.791	1.230	-2.988	5.888	49.927			
				-11.998	0.352	0.879	2.109	1.230	-1.318	-0.439	-4.394	7.382		49.927		
			-12.042		0.967	0.879	0.439	0.000	1.494	0.967	-3.779	4.130			49.927	
				-11.998	1.758	2.197	3.779	2.021	-2.109	-0.264	-3.252	5.536				49.927
124.	00:08	00:07	-11.998		0.967	1.758	0.439	1.055	1.318	1.582	-1.582	5.185	49.927			
				-11.998	-0.703	2.285	2.988	3.076	-0.791	-0.615	-2.812	6.064		49.927		
			-11.998		-0.439	1.055	1.670	1.845	-0.264	-0.088	-3.164	1.230			49.927	
				-11.998	0.176	0.879	4.570	4.570	-5.185	-4.658	-2.461	6.767				49.927
125.	00:08	00:07	-12.042		1.406	1.933	1.758	1.758	1.055	0.352	-1.582	6.679	49.927			
				-11.954	0.352	0.879	4.746	4.482	-2.636	-2.373	-5.009	2.021		49.927		
			-12.042		2.900	2.021	3.076	2.812	-4.306	-4.042	-3.339	5.976			49.927	
				-11.954	0.791	1.230	1.933	0.264	1.318	0.967	-1.055	1.494				49.927
126.	00:08	76:07	-11.998		-0.264	0.439	-1.845	0.176	-4.833	-4.570	-4.218	4.921	49.927			
				-11.954	2.021	3.427	5.009	2.021	-0.967	-0.264	-3.427	5.273		49.927		
			-12.042		-0.615	1.142	-0.088	0.879	-1.758	-1.230	-3.603	2.724			49.927	
				-11.998	-1.142	-0.264	-0.352	0.439	-1.933	-1.758	-2.724	6.864				49.927
127.	00:08	00:07	-11.998		0.703	1.845	2.549	·2.549	2.724	3.076	-0.352	7.909	49.927			
				-11.998	-1.582	1.494	1.230	3.779	1.933	2.197	0.352	9.227		49.927		
			-12.042		-0.527	2.021	0.703	1.758	3.691	-1.933	-1.230	5.800			49.927	
				-11.998	-0.791	1.845	1.406	3.076	1.582	2.812	-1.933	10.458				49.927
128.	00:08	23:07	-11.779		-0.791	2.724	1.845	3.691	4.658	4.658	1.230	10.018	49.927			
				-11.559	-0.088	2.406	1.230	2.900	-0.264	0.352	-1.318	4.306		49.927		
			-11.471		0.879	1.933	6.855	6.943	-2.021	-2.109	-3.164	5.800			49.927	
				-11.471	3.339	3.427	3.515	4.306	-0.527	-4.394	-7.118	1.845				49.927
129.	00:08	00:07	-11.515		0.967	1.670	13.621	13.006	-2.461	-1.845	-4.570	4.218	49.927			
				-11.427	9.491	12.830	12.215	12.655	-2.461	-4.218	-6.767	1.933		49.927		
			-11.471		7.382	8.173	9.843	7.558	-6.591	-6.327	-8.876	0.527			49.927	
				-11.471	9.667	8.964	-4.658	-5.185	-5.800	-5.449	-5.449	3.779				49.927
130.	00:08	57:07	-11.603		-4.239	-5.624	-4.921	14.237	-2.549	-4.570	-6.767	1.933	49.927			
				-11.471	10.721	10.194	19.665	20.037	-5.712	-5.273	-5.712	3.515		49.927		
			-11.559		22.585	2.373	-3.076	-1.758	-2.988	-0.791	-4.394	5.097			49.927	
				-11.603	-6.679	-5.097	-3.867	-15.027	0.264	0.264	-3.252	6.415				49.927
131.	00:08	70:07	-11.603		-20.300	-18.367	-2.373	-0.088	0.352	0.176	-1.582	7.909	49.927			
				-11.471	6.327	8.261	12.127	20.125	1.758	-0.527	-2.900	6.239		49.927		
			-11.471		22.146	20.564	8.612	8.964	-0.088	0.088	-3.164	6.415			49.927	
				-11.559	12.391	-11.952	-15.115	-14.500	-0.615	-0.088	-3.252	6.591				49.927
132.	00:08	00:07	-11.647		-15.379	-14.764	-16.237	-16.861	-0.264	0.000	-3.076	6.943	49.927			
				-11.559	-15.379	-14.588	-17.576	-18.543	-0.176	0.088	-2.988	6.855		49.927		
			-11.647		-21.443	-21.091	-20.476	-20.564	-0.088	0.176	-2.988	6.855			49.927	
				-11.603	-21.970	-21.267	-20.915	-20.564	-0.352	0.000	-3.076	6.855				49.927
133.	00:08	70:07	-11.691		-22.234	-20.300	-19.334	-19.158	-0.264	0.176	-2.988	6.855	49.927			
				-11.603	-17.664	-17.224	-16.170	-13.709	0.264	0.439	-2.636	7.558		49.927		
			-11.691		-15.115	-14.676	-12.479	-12.303	0.703	0.791	-2.021	8.085			49.927	
				-11.603	-13.270	-13.182	-12.830	-13.182	1.055	1.318	-1.758	8.173				49.927
134.	00:08	73:07	-11.647		-13.797	-13.885	-14.149	-13.797	0.264	0.439	-2.812	7.294	49.927			
				-11.603	-14.764	-14.852	-14.500	-14.237	0.176	1.230	-2.373	7.021		49.927		
			-11.691		-15.203	-14.764	-13.973	-11.688	1.406	1.670	-1.670	8.524			49.927	
				-11.603	-12.830	-12.655	-8.876	-8.173	1.494	1.758	-2.549	7.470				49.927
135.	00:08	72:07	-11.691		-5.009	-5.009	-3.867	-2.021	0.352	0.703	-2.636	7.470	49.927			
				-11.603	-3.076	-3.076	-0.439	-0.527	0.352	0.527	-2.900	7.030		49.927		
			-11.647		-1.406	-1.230	-0.176	0.000	-0.088	0.176	-3.076	6.943			49.927	
				-11.603	-0.439	-0.967	0.176	0.264	-0.176	0.088	-3.076	7.030				49.927

PRELIMINARY INFORMATION

NTSB DATA DUMP PROGRAM
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$ FRAME	LAPSE	UCT	SPLRL1	SPLRR5	SPLRL5	SPLRR3	SPLARM	SLL4A	SLL4B	SLL2A	SLL2B	SLR4A	SLR4B	SLBISA	FRMCNT
106.	00:07	00:07	2.551	2.727				3.	3.	3.	3.	3.	3.	0.0000	
					3.782	1.231		3.	3.	3.	3.	3.	3.	0.0000	
			8.004	2.463			1.000	3.	3.	3.	3.	3.	3.	0.0000	
					4.926	1.231		3.	3.	3.	3.	3.	3.	0.0000	486.
107.	00:07	00:07	5.013	4.390				3.	3.	3.	3.	3.	3.	0.0000	
					1.319	1.583		3.	3.	3.	3.	3.	3.	0.0000	
			2.551	2.727			1.000	3.	3.	3.	3.	3.	3.	0.0000	
					1.319	1.319		3.	3.	3.	3.	3.	3.	0.0000	487.
108.	00:07	70:07	2.551	6.861				3.	3.	3.	3.	3.	3.	0.0000	
					1.319	1.319		3.	3.	3.	3.	3.	3.	0.0000	
			2.551	3.694			1.000	3.	3.	3.	3.	3.	3.	0.0000	
					6.333	1.231		3.	3.	3.	3.	3.	3.	0.0000	488.
109.	00:07	60:07	2.551	2.551				3.	3.	3.	3.	3.	3.	0.0000	
					6.421	1.231		3.	3.	3.	3.	3.	3.	0.0000	
			9.893	2.551			1.000	3.	3.	3.	3.	3.	3.	0.0000	
					1.319	1.319		3.	3.	3.	3.	3.	3.	0.0000	489.
110.	00:07	60:07	2.991	2.991				3.	3.	3.	3.	3.	3.	0.0000	
					1.231	1.407		3.	3.	3.	3.	3.	3.	0.0000	
			2.463	3.782			1.000	3.	3.	3.	3.	3.	3.	0.0000	
					1.407	1.319		3.	3.	3.	3.	3.	3.	0.0000	490.
111.	00:07	00:07	2.639	5.277				3.	3.	3.	3.	3.	3.	0.0000	
					1.407	1.319		3.	3.	3.	3.	3.	3.	0.0000	
			2.551	2.639			1.000	3.	3.	3.	3.	3.	3.	0.0000	
					2.991	1.319		3.	3.	3.	3.	3.	3.	0.0000	491.
112.	00:07	23:07	2.991	2.551				3.	3.	3.	3.	3.	3.	0.0000	
					6.773	1.231		3.	3.	3.	3.	3.	3.	0.0000	
			9.235	2.639			1.000	3.	3.	3.	3.	3.	3.	0.0000	
					5.013	1.231		3.	3.	3.	3.	3.	3.	0.0000	492.
113.	00:07	77:07	5.893	2.727				3.	3.	3.	3.	3.	3.	0.0000	
					5.189	1.231		3.	3.	3.	3.	3.	3.	0.0000	
			2.639	3.254			1.000	3.	3.	3.	3.	3.	3.	0.0000	
					4.134	1.231		3.	3.	3.	3.	3.	3.	0.0000	493.
114.	00:07	00:07	2.551	3.078				3.	3.	3.	3.	3.	3.	0.0000	
					1.407	1.319		3.	3.	3.	3.	3.	3.	0.0000	
			5.629	2.727			1.000	3.	3.	3.	3.	3.	3.	0.0000	
					2.991	3.166		3.	3.	3.	3.	3.	3.	0.0000	494.
115.	00:07	99:07	2.727	5.629				3.	3.	3.	3.	3.	3.	0.0000	
					1.847	1.583		3.	3.	3.	3.	3.	3.	0.0000	
			2.903	5.365			1.000	3.	3.	3.	3.	3.	3.	0.0000	
					1.935	1.847		3.	3.	3.	3.	3.	3.	0.0000	495.
116.	00:07	00:07	2.991	3.342				3.	3.	3.	3.	3.	3.	0.0000	
					2.199	1.847		3.	3.	3.	3.	3.	3.	0.0000	
			2.991	3.342			1.000	3.	3.	3.	3.	3.	3.	0.0000	
					2.991	2.023		3.	3.	3.	3.	3.	3.	0.0000	496.
117.	00:07	97:07	4.662	3.430				3.	3.	3.	3.	3.	3.	0.0000	
					6.157	2.023		3.	3.	3.	3.	3.	3.	0.0000	
			7.476	3.342			1.000	3.	3.	3.	3.	3.	3.	0.0000	
					2.111	1.935		3.	3.	3.	3.	3.	3.	0.0000	497.
118.	00:07	71:07	5.717	3.430				3.	3.	3.	3.	3.	3.	0.0000	
					2.023	1.935		3.	3.	3.	3.	3.	3.	0.0000	
			6.773	4.926			1.000	3.	3.	3.	3.	3.	3.	0.0000	
					2.023	1.935		3.	3.	3.	3.	3.	3.	0.0000	498.
119.	00:07	97:07	3.078	4.046				3.	3.	3.	3.	3.	3.	0.0000	
					2.023	1.847		3.	3.	3.	3.	3.	3.	0.0000	
			8.268	3.430			1.000	3.	3.	3.	3.	3.	3.	0.0000	
					2.023	1.935		3.	3.	3.	3.	3.	3.	0.0000	499.
120.	00:07	26:07	2.991	6.157				3.	3.	3.	3.	3.	3.	0.0000	
					2.023	1.847		3.	3.	3.	3.	3.	3.	0.0000	
			2.991	3.430			1.000	3.	3.	3.	3.	3.	3.	0.0000	
					2.023	1.847		3.	3.	3.	3.	3.	3.	0.0000	500.

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PRELIMINARY INFORMATION

$ FRAME LAPSE UCT	SPLRL3	SPLRR5	SPLRL5	SPLRR3	SPLARM	SLL4A	SLL4B	SLL2A	SLL2B	SLR4A	SLR4B	SLDISA	PRNCNT
121. 00:08 00:07	8.092	3.342				3.	3.	3.	3.	3.	3.	0.0000	
			3.958	1.847		3.	3.	3.	3.	3.	3.	0.0000	
	3.958	3.430			1.000	3.	3.	3.	3.	3.	3.	0.0000	
			2.111	1.847		3.	3.	3.	3.	3.	3.	0.0000	501.
122. 00:08 00:07	6.421	3.342				3.	3.	3.	3.	3.	3.	0.0000	
			2.023	1.847		3.	3.	3.	3.	3.	3.	0.0000	
	2.991	3.958			1.000	3.	3.	3.	3.	3.	3.	0.0000	
			2.023	2.287		3.	3.	3.	3.	3.	3.	0.0000	502.
123. 00:08 26:07	2.903	3.518				3.	3.	3.	3.	3.	3.	0.0000	
			2.639	1.935		3.	3.	3.	3.	3.	3.	0.0000	
	2.903	3.518			1.000	3.	3.	3.	3.	3.	3.	0.0000	
			2.023	1.847		3.	3.	3.	3.	3.	3.	0.0000	503.
124. 00:08 00:07	2.991	3.518				3.	3.	3.	3.	3.	3.	0.0000	
			1.935	1.935		3.	3.	3.	3.	3.	3.	0.0000	
	3.078	3.430			1.000	3.	3.	3.	3.	3.	3.	0.0000	
			6.838	1.847		3.	3.	3.	3.	3.	3.	0.0000	504.
125. 00:08 00:07	2.903	6.949				3.	3.	3.	3.	3.	3.	0.0000	
			2.023	1.847		3.	3.	3.	3.	3.	3.	0.0000	
	6.333	3.430			1.000	3.	3.	3.	3.	3.	3.	0.0000	
			1.847	1.847		3.	3.	3.	3.	3.	3.	0.0000	505.
126. 00:08 24:07	7.388	3.430				3.	3.	3.	3.	3.	3.	0.0000	
			2.935	1.847		3.	3.	3.	3.	3.	3.	0.0000	
	2.991	3.430			1.000	3.	3.	3.	3.	3.	3.	0.0000	
			2.023	1.935		3.	3.	3.	3.	3.	3.	0.0000	506.
127. 00:08 00:07	2.903	7.300				3.	3.	3.	3.	3.	3.	0.0000	
			1.935	6.574		3.	3.	3.	3.	3.	3.	0.0000	
	2.015	8.092			1.000	3.	3.	3.	3.	3.	3.	0.0000	
			3.078	6.773		3.	3.	3.	3.	3.	3.	0.0000	507.
128. 00:08 23:07	2.015	8.708				3.	3.	3.	3.	3.	3.	0.0000	
			1.935	1.759		3.	3.	3.	3.	3.	3.	0.0000	
	4.750	3.254			1.000	3.	3.	3.	3.	3.	3.	0.0000	
			5.981	1.847		3.	3.	3.	3.	3.	3.	0.0000	508.
129. 00:08 00:07	8.004	3.342				3.	3.	3.	3.	3.	3.	0.0000	
			4.398	1.671		3.	3.	3.	3.	3.	3.	0.0000	
	9.147	3.342			1.000	3.	3.	3.	3.	3.	3.	0.0000	
			7.124	1.671		3.	3.	3.	3.	3.	3.	0.0000	509.
130. 00:08 57:07	7.828	3.166				3.	3.	3.	3.	3.	3.	0.0000	
			27.794	25.331		3.	3.	3.	3.	3.	3.	0.0000	
	27.090	27.618			0.000	3.	3.	3.	3.	3.	3.	0.0000	
			24.980	26.123		3.	3.	3.	3.	3.	3.	0.0000	510.
131. 00:08 70:07	26.387	28.938				3.	3.	3.	3.	3.	3.	0.0000	
			25.067	26.387		3.	3.	3.	3.	3.	3.	0.0000	
	26.739	27.794			0.000	3.	3.	3.	3.	3.	3.	0.0000	
			57.259	56.995		3.	3.	3.	3.	3.	3.	0.0000	511.
132. 00:08 00:07	58.667	58.843				3.	3.	3.	3.	3.	3.	0.0000	
			58.755	57.611		3.	3.	3.	3.	3.	3.	0.0000	
	58.755	58.755			0.000	3.	3.	3.	3.	3.	3.	0.0000	
			58.667	57.875		3.	3.	3.	3.	3.	3.	0.0000	512.
133. 00:08 70:07	58.931	58.755				3.	3.	3.	3.	3.	3.	0.0000	
			58.579	57.875		3.	3.	3.	3.	3.	3.	0.0000	
	59.018	58.931			0.000	3.	3.	3.	3.	3.	3.	0.0000	
			58.667	58.051		3.	3.	3.	3.	3.	3.	0.0000	513.
134. 00:08 73:07	59.194	58.931				3.	3.	3.	3.	3.	3.	0.0000	
			58.843	58.051		3.	3.	3.	3.	3.	3.	0.0000	
	59.370	58.931			0.000	3.	3.	3.	3.	3.	3.	0.0000	
			58.755	58.139		3.	3.	3.	3.	3.	3.	0.0000	514.
135. 00:08 72:07	59.282	59.018				3.	3.	3.	3.	3.	3.	0.0000	
			58.843	58.227		3.	3.	3.	3.	3.	3.	0.0000	
	59.194	58.931			0.000	3.	3.	3.	3.	3.	3.	0.0000	
			58.843	58.403		3.	3.	3.	3.	3.	3.	0.0000	515.

PRELIMINARY INFORMATION

$ FRAME	LAPSE	UCT	RALT	LONG	LONG	LONG	LONG	VERG1	VERG1	VERG1	VERG1	VERG2	VERG2	VERG2	VERG2	FRMCNT
106.	00:07	00:07	1387.0	0.0711	0.0670	0.0670	0.0690	0.9778	0.9824	0.9824	0.9710	0.9618	0.9984	0.9687	0.9710	
			1373.0	0.0629	0.0629	0.0589	0.0548	0.9687	0.9389	0.9503	0.9778	0.9297	0.9343	0.9343	0.9091	
			1348.0	0.0589	0.0609	0.0609	0.0568	0.9229	0.9503	0.9481	0.9572	0.9503	0.9275	0.9297	0.9618	
			1372.0	0.0548	0.0487	0.0609	0.0731	0.9320	0.9389	0.9481	0.9435	0.9870	1.0122	1.0282	1.0557	
107.	00:07	60:07	1394.0	0.0711	0.0792	0.0751	0.0812	1.0788	1.0534	1.0671	1.0671	1.0603	1.0420	1.0320	1.0099	486.
			1410.0	0.0690	0.0731	0.0914	0.0893	1.0259	1.0351	1.0442	1.0855	1.1030	1.1313	1.1301	1.1175	
			1379.0	0.0873	0.0771	0.0771	0.0731	1.1030	1.0786	1.0580	1.0717	1.0442	1.0259	1.0236	1.0145	
			1388.0	0.0711	0.0670	0.0650	0.0711	1.0076	1.0168	0.9916	0.9847	1.0030	0.9732	0.9939	1.0191	
108.	00:07	70:07	1373.0	0.0853	0.0731	0.0629	0.0548	1.0397	1.0122	1.0420	0.9893	0.9755	0.9801	0.9664	0.9710	487.
			1380.0	0.0548	0.0528	0.0589	0.0711	0.9916	0.9870	0.9847	1.0099	1.0191	1.0145	1.0397	1.0305	
			1374.0	0.0731	0.0568	0.0325	0.0223	1.0420	1.0259	0.9778	0.9297	0.8475	0.7809	0.7480	0.7717	
			1369.0	0.0223	0.0406	0.0568	0.0609	0.7809	0.8427	0.9160	0.9687	1.0030	1.0305	1.0374	1.0191	
109.	00:07	80:07	1320.0	0.0690	0.0650	0.0711	0.0629	0.9824	0.9710	0.9503	0.9526	0.9458	0.9710	0.9824	0.9687	488.
			1319.0	0.0508	0.0508	0.0528	0.0670	0.9458	0.9412	0.9023	0.9000	0.9114	0.9091	0.9343	0.9458	
			1298.0	0.0832	0.0873	0.0974	0.1015	0.9755	0.9847	0.9916	0.9687	0.9664	0.9320	0.9183	0.9068	
			1277.0	0.1157	0.1238	0.1441	0.1502	0.9160	0.9137	0.9366	0.9503	0.9778	1.0076	1.0236	1.0534	
110.	00:07	60:07	1257.0	0.1563	0.1705	0.1868	0.1827	1.0717	1.1030	1.1290	1.1679	1.1908	1.1610	1.1267	1.0740	489.
			1238.0	0.1421	0.1421	0.1360	0.1279	1.0580	1.0030	1.0420	1.0511	1.0236	1.0259	1.0076	0.9824	
			1222.0	0.1137	0.1096	0.1056	0.0893	1.0030	1.0030	1.0099	1.0259	1.0282	1.0351	1.0213	1.0076	
			1204.0	0.0792	0.0670	0.0650	0.0589	0.9984	0.9595	0.9687	0.9664	0.9549	0.9503	0.9618	0.9458	
111.	00:07	00:07	1192.0	0.0548	0.0508	0.0487	0.0487	0.9297	0.9458	0.9137	0.9137	0.9206	0.9068	0.9275	0.9389	490.
			1171.0	0.0508	0.0528	0.0548	0.0609	0.9549	0.9732	0.9778	1.0030	0.9939	1.0053	1.0076	1.0168	
			1157.0	0.0650	0.0609	0.0589	0.0528	1.0282	1.0305	1.0282	1.0168	1.0053	0.9710	0.9778	0.9618	
			1135.0	0.0467	0.0487	0.0487	0.0528	0.9503	0.9641	0.9435	0.9412	0.9572	0.9972	0.9641	0.9824	
112.	00:07	23:07	1116.0	0.0568	0.0629	0.0650	0.0690	0.9870	0.9687	0.9916	0.9778	0.9847	1.0213	1.0259	1.0511	491.
			1095.0	0.0832	0.0832	0.0914	0.0954	1.0009	1.0900	1.0969	1.1004	1.1107	1.1152	1.1175	1.0992	
			1078.0	0.0914	0.0832	0.0812	0.0812	1.0969	1.0923	1.0809	1.0671	1.0740	1.0442	1.0488	1.0397	
			1061.0	0.0711	0.0690	0.0670	0.0731	1.0122	1.0282	1.0145	1.0145	1.0076	1.0030	1.0099	1.0236	
113.	00:07	77:07	1040.0	0.0731	0.0751	0.0792	0.0792	1.0259	1.0320	1.0328	1.0282	1.0351	1.0351	1.0145	1.0099	492.
			1032.0	0.0771	0.0751	0.0751	0.0751	1.0213	1.0191	1.0305	1.0351	1.0236	1.0305	1.0397	1.0282	
			1020.0	0.0731	0.0731	0.0751	0.0751	1.0236	1.0236	1.0213	1.0099	1.0145	0.9824	0.9687	0.9595	
			1007.0	0.0670	0.0711	0.0690	0.0711	0.9595	0.9618	0.9618	0.9572	0.9572	0.9572	0.9435	0.9389	
114.	00:07	00:07	994.0	0.0711	0.0711	0.0771	0.0731	0.9366	0.9412	0.9343	0.9252	0.9389	0.9412	0.9549	0.9710	493.
			982.0	0.0751	0.0771	0.0711	0.0751	0.9687	0.9801	0.9710	0.9549	0.9710	0.9572	0.9481	0.9595	
			964.0	0.0751	0.0792	0.0812	0.0853	0.9549	0.9801	1.0030	1.0145	1.0305	1.0671	1.0648	1.0763	
			949.0	0.0853	0.0812	0.0792	0.0751	1.0740	1.0603	1.0694	1.0557	1.0305	1.0191	1.0282	1.0191	
115.	00:07	99:07	933.0	0.0751	0.0751	0.0771	0.0792	1.0351	1.0397	1.0488	1.0397	1.0374	1.0442	1.0488	1.0648	494.
			920.0	0.0792	0.0812	0.0751	0.0731	1.0740	1.0855	1.0809	1.0832	1.0740	1.0580	1.0488	1.0351	
			908.0	0.0731	0.0711	0.0650	0.0609	1.0259	1.0213	1.0213	1.0122	1.0122	1.0236	1.0076	1.0122	
			898.0	0.0589	0.0548	0.0568	0.0568	1.0030	1.0076	1.0099	1.0076	1.0236	1.0397	1.0191	1.0320	
116.	00:07	00:07	889.0	0.0487	0.0467	0.0467	0.0426	1.0213	0.9893	1.0099	1.0030	1.0099	1.0168	1.0191	1.0053	495.
			880.0	0.0406	0.0284	0.0284	0.0264	1.0099	1.0122	1.0030	1.0007	0.9755	0.9687	0.9641	0.9526	
			872.0	0.0244	0.0284	0.0284	0.0244	0.9526	0.9389	0.9458	0.9503	0.9641	0.9503	0.9481	0.9024	
			861.0	0.0244	0.0325	0.0325	0.0264	0.9801	1.0030	1.0305	1.0145	1.0030	1.0213	0.9893	0.9755	
117.	00:07	97:07	850.0	0.0305	0.0244	0.0264	0.0142	0.9732	0.9526	0.9412	0.9503	0.9458	0.9458	0.9595	0.9297	496.
			841.0	0.0041	-0.0001	-0.0061	-0.0020	0.8956	0.8796	0.8450	0.8427	0.8336	0.8107	0.8130	0.8399	
			824.0	-0.0020	0.0122	0.0203	0.0203	0.8565	0.8794	0.9137	0.8977	0.9297	0.9687	0.9641	0.9710	
			804.0	0.0365	0.0426	0.0406	0.0406	0.9893	1.0168	1.0213	1.0626	1.0442	1.0168	1.0282	1.0145	
118.	00:07	71:07	785.0	0.0305	0.0284	0.0244	0.0162	1.0191	1.0420	1.0282	1.0168	1.0305	1.0213	0.9962	0.9939	497.
			768.0	0.0183	0.0162	0.0203	0.0284	0.9732	0.9710	0.9893	0.9755	0.9778	0.9824	0.9984	0.9962	
			746.0	0.0223	0.0264	0.0264	0.0264	1.0145	1.0076	1.0007	1.0122	1.0168	1.0305	1.0191	1.0145	
			728.0	0.0305	0.0345	0.0325	0.0325	1.0122	1.0320	1.0122	1.0191	1.0191	1.0145	1.0305	1.0488	
119.	00:07	97:07	710.0	0.0305	0.0244	0.0183	0.0183	1.0557	1.0626	1.0671	1.0442	1.0328	1.0099	0.9984	0.9984	498.
			695.0	0.0142	0.0183	0.0264	0.0264	0.9755	0.9595	0.9503	0.9389	0.9320	0.9389	0.9435	0.9618	
			675.0	0.0305	0.0345	0.0345	0.0365	0.9664	0.9755	0.9755	0.9801	0.9893	0.9710	0.9870	0.9824	
			661.0	0.0386	0.0406	0.0426	0.0487	0.9847	1.0168	1.0053	1.0030	1.0076	1.0030	0.9870	1.0053	
120.	00:07	36:07	640.0	0.0487	0.0528	0.0528	0.0528	1.0007	1.0145	1.0191	1.0259	1.0145	1.0351	1.0282	1.0351	499.
			623.0	0.0548	0.0589	0.0629	0.0690	1.0557	1.0580	1.0832	1.1207	1.1152	1.1129	1.1358	1.1301	
			607.0	0.0690	0.0650	0.0629	0.0589	1.1175	1.1267	1.1198	1.1015	1.1107	1.1084	1.0900	1.0740	
			594.0	0.0609	0.0548	0.0508	0.0487	1.0420	1.0213	1.0351	1.0282	1.0259	1.0351	1.0374	1.0397	500.

PRELIMINARY INFORMATION

S FRAME	LAPSE	UCT	BALT	LONG	LONG	LONG	LONG	VERG1	VERG1	VERG1	VERG1	VERG2	VERG2	VERG2	VERG2	FRMCNT
121.	00:08	00:07	583.0	0.0447	0.0447	0.0487	0.0528	1.0328	1.0145	1.0122	1.0053	1.0122	1.0053	1.0099	1.0076	
			573.0	0.0568	0.0548	0.0548	0.0528	1.0007	1.0076	1.0145	1.0099	1.0168	1.0236	1.0099	1.0168	
			562.0	0.0508	0.0528	0.0528	0.0528	1.0053	0.9939	0.9984	0.9939	0.9778	0.9732	0.9801	0.9687	
			553.0	0.0548	0.0548	0.0548	0.0528	0.9847	0.9939	0.9778	0.9824	0.9893	0.9824	0.9893	0.9893	501.
122.	00:08	00:07	543.0	0.0508	0.0508	0.0508	0.0487	0.9847	0.9870	1.0007	0.9847	0.9824	0.9824	0.9618	0.9435	
			535.0	0.0447	0.0467	0.0406	0.0386	0.9549	0.9389	0.9481	0.9549	0.9435	0.9503	0.9595	0.9320	
			521.0	0.0365	0.0345	0.0345	0.0365	0.9389	0.9366	0.9366	0.9526	0.9755	0.9687	0.9710	0.9710	
			508.0	0.0365	0.0365	0.0386	0.0365	0.9595	0.9641	0.9710	0.9503	0.9710	0.9755	0.9618	0.9732	502.
123.	00:08	20:07	490.0	0.0365	0.0406	0.0447	0.0467	0.9893	0.9710	0.9870	1.0053	0.9916	0.9962	0.9939	0.9778	
			471.0	0.0386	0.0426	0.0467	0.0447	0.9824	0.9847	0.9801	0.9778	0.9778	0.9939	0.9939	1.0145	
			446.0	0.0426	0.0406	0.0406	0.0406	0.9939	1.0007	0.9984	0.9870	0.9732	0.9710	0.9732	0.9664	
			429.0	0.0406	0.0447	0.0487	0.0487	0.9755	0.9732	0.9732	0.9664	0.9801	0.9664	0.9824	0.9984	503.
124.	00:08	00:07	414.0	0.0508	0.0487	0.0487	0.0508	0.9870	0.9847	1.0030	0.9939	0.9939	0.9984	1.0030	0.9939	
			402.0	0.0467	0.0467	0.0447	0.0447	0.9870	0.9824	0.9847	0.9801	0.9847	0.9801	0.9916	0.9778	
			395.0	0.0487	0.0487	0.0508	0.0508	0.9778	0.9778	0.9778	0.9664	0.9641	0.9595	0.9549	0.9870	
			340.0	0.0487	0.0508	0.0508	0.0528	0.9824	0.9801	1.0007	0.9916	0.9939	1.0053	0.9984	0.9984	504.
125.	00:08	00:07	320.0	0.0568	0.0629	0.0670	0.0731	1.0160	1.0397	1.0328	1.0603	1.0763	1.0534	1.0626	1.0694	
			331.0	0.0731	0.0670	0.0711	0.0731	1.0482	1.0511	1.0420	1.0282	1.0259	1.0282	1.0351	1.0648	
			293.0	0.0731	0.0771	0.0792	0.0792	1.0671	1.0740	1.0717	1.0763	1.0640	1.0717	1.0763	1.0786	
			289.0	0.0792	0.0771	0.0792	0.0812	1.0700	1.0626	1.0511	1.0557	1.0511	1.0534	1.0580	1.0603	505.
126.	00:08	76:07	232.0	0.0771	0.0731	0.0670	0.0650	1.0557	1.0557	1.0580	1.0213	1.0099	0.9801	0.9801	0.9801	
			180.0	0.0650	0.0670	0.0731	0.0751	0.9710	0.9664	0.9641	0.9939	0.9962	1.0076	1.0007	1.0007	
			160.0	0.0751	0.0690	0.0670	0.0650	0.9824	0.9962	0.9664	0.9778	1.0007	1.0076	1.0236	1.0374	
			145.0	0.0670	0.0568	0.0609	0.0487	0.9962	0.9939	0.9755	0.9595	0.9710	0.9572	0.9503	0.9755	506.
127.	00:08	00:07	133.0	0.0508	0.0426	0.0426	0.0426	0.9916	0.9526	0.9801	0.9687	0.9549	0.9641	0.9687	0.9572	
			123.0	0.0386	0.0406	0.0447	0.0467	0.9710	0.9824	0.9618	0.9549	0.9641	0.9401	0.9526	0.9710	
			110.0	0.0508	0.0508	0.0609	0.0609	0.9755	0.9778	1.0160	0.9893	1.0053	1.0397	1.0397	1.0488	
			97.0	0.0589	0.0568	0.0528	0.0568	1.0420	0.9824	0.9778	0.9801	0.9801	0.9710	0.9778	0.9732	507.
128.	00:08	23:07	86.0	0.0487	0.0508	0.0487	0.0487	0.9732	0.9778	0.9847	0.9687	0.9778	0.9595	0.9664	0.9916	
			69.0	0.0568	0.0407	0.0609	0.0447	1.0168	1.0168	1.0259	1.0145	1.0053	0.9984	0.9664	0.9847	
			55.0	0.0426	0.0528	0.0528	0.0650	0.9252	0.9366	0.9972	0.9755	0.9870	0.9801	0.9572	0.9801	
			40.0	0.0609	0.0589	0.0548	0.0447	1.0168	1.0213	1.0305	1.0374	1.0397	1.0488	1.0580	1.0488	508.
129.	00:08	00:07	26.0	0.0406	0.0345	0.0223	0.0244	1.0534	1.0374	1.0397	1.0397	1.0282	1.0053	1.0213	0.9984	
			13.0	0.0325	0.0528	0.0690	0.0751	1.0236	1.0740	1.0855	1.1038	1.1404	1.1290	1.1221	1.1633	
			6.0	0.0873	0.0995	0.1157	0.0956	1.1290	1.1450	1.1564	1.1221	1.1450	1.2687	1.6190	1.6053	
			0.0	0.1157	0.0873	0.0589	0.0426	1.6946	1.5022	1.1015	1.1336	1.0832	0.9618	1.0213	1.0305	509.
130.	00:08	57:07	6.0	0.0162	-0.0142	-0.0142	-0.0467	0.0198	0.8519	0.7786	0.5198	0.5084	0.5107	0.4328	0.4832	
			~~-006.0~~	-0.0406	-0.0386	-0.0203	0.0721	0.5519	0.5336	0.5588	0.8381	1.8801	2.5190?	2.5877?	1.7679	
			-1.0	0.0102	-0.0507	-0.0507	-0.0365	1.0923	0.6664	0.6526	0.7923	0.8336	0.6962	0.7946	0.8679	
			3.0	-0.0041	0.0826	0.1696	0.1320	0.7786	0.8313	0.9710	1.1656	1.5389	1.0534	1.0236	0.9458	510.
131.	00:08	70:07	2.0	0.0914	0.0386	-0.0203	-0.0548	1.1702	0.7191	0.9526	0.9526	0.9206	1.0191	1.0202	0.9481	
			-2.0	-0.1116	-0.1766	-0.2274	-0.2639	1.0407	1.1015	1.0213	1.0055	1.1246	0.9493	1.0511	1.0374	
			-3.0	-0.2984	-0.2964	-0.2984	-0.2984	1.0282	1.0855	1.0480	0.8862	0.9458	1.0511	1.0511	1.0259	
			-3.0	-0.3094	-0.2984	-0.3248	-0.3045	1.0648	0.9124	0.9801	0.9801	0.9687	1.0969	1.0717	0.9732	511.
132.	00:08	40:07	-3.0	-0.2842	-0.2761	-0.2842	-0.2740	0.9114	0.9114	0.9870	1.1129	1.0328	1.0420	1.0168	0.9252	
			-3.0	-0.2700	-0.2801	-0.3106	-0.2842	0.9641	1.0671	1.0145	0.9916	0.9847	0.9618	1.0259	1.0076	
			-3.0	-0.2903	-0.2700	-0.2801	-0.2903	0.9870	0.9893	0.9870	1.0282	1.0740	0.9962	0.9870	0.9801	
			-4.0	-0.2943	-0.2943	-0.2700	-0.2700	0.9870	0.9801	1.0557	0.9824	1.0053	0.9549	1.0122	1.0053	512.
133.	00:08	70:07	-3.0	-0.2622	-0.2801	-0.2943	-0.2943	1.0282	1.0191	0.9778	0.9710	1.0213	1.0053	1.0053	0.9778	
			-4.0	-0.2740	-0.2598	-0.2456	-0.2537	1.0236	1.0351	0.9732	1.0030	0.9664	1.0099	1.0534	0.9801	
			-3.0	-0.2639	-0.2619	-0.2537	-0.2558	0.9801	0.9939	1.0099	1.0900	0.9549	0.9755	0.9939	0.9962	
			-4.0	-0.2334	-0.2334	-0.2294	-0.2274	1.0122	1.0191	0.9916	1.0213	1.0213	0.9641	1.0030	1.0099	513.
134.	00:08	72:07	-3.0	-0.2213	-0.2213	-0.2294	-0.2213	1.0236	0.9572	0.9572	1.0374	1.0442	1.0122	0.9526	0.9870	
			-4.0	-0.2294	-0.2152	-0.2030	-0.2131	1.0145	1.0282	1.0213	0.9503	0.9710	1.0191	1.0328	1.0534	
			-3.0	-0.1989	-0.1908	-0.1888	-0.1725	0.9412	0.9870	0.9893	1.0259	1.0305	1.0145	0.9755	1.0053	
			-4.0	-0.1766	-0.1807	-0.1969	-0.1969	0.9916	1.0145	1.0160	0.9801	1.0145	0.9687	1.0007	1.0351	514.
135.	00:08	72:07	-3.0	-0.1766	-0.1725	-0.1746	-0.1624	1.0030	1.0420	0.9916	0.9732	1.0351	0.9595	1.0259	1.0099	
			-4.0	-0.1644	-0.1725	-0.1969	-0.1989	1.0328	1.0236	0.9572	0.9503	0.9801	1.0626	1.0488	0.9587	
			-4.0	-0.1928	-0.1868	-0.1827	-0.1847	0.9824	0.9870	1.0671	1.0282	1.0259	0.9435	0.9939	0.9939	
			-4.0	-0.1868	-0.1868	-0.1888	-0.1827	1.0580	0.9962	0.9916	1.0053	1.0236	1.0351	0.9847	0.9893	515.

SIGNATURE	NAME (Printed)	PARTY	DATE
[redacted]	BRUCE ERICKSON	FEDEX	11/6/94

NATIONAL TRANSPORTATION SAFETY BOARD
RELEASE OF AIRCRAFT WRECKAGE

ACCIDENT IDENTIFICATION NUMBER: ANC95LA008

PART I—RELEASE OF AIRCRAFT WRECKAGE

REGISTERED OWNER (name and address): FEDERAL EXPRESS CORP. MEMPHIS TN. 38118	REGISTRATION NUMBER—N: 611
	MAKE: McDonald Douglas

MODEL	DATE OF ACCIDENT	LOCATION
MD-11	11/4/94	ANCHORAGE, AK

The National Transportation Safety Board has ☒ has not ☐ completed its investigation of the aircraft wreckage described above. All wreckage except that listed on the reverse side is hereby released to the registered owner, or owner's representative, for appropriate disposition. (If no parts are retained, insert NONE.)

SIGNATURE OF NTSB REPRESENTATIVE	TITLE	DATE
[redacted] GEORGE KOBELNYK	AIR SAFETY INVESTIGATOR	11/5/94

(This section may be signed by a person, not the owner or owner's representative, who has knowledge of the disposition of the aircraft wreckage and its parts. Such signature does not place a responsibility for disposition of the wreckage upon that person.)

I HEREBY ACKNOWLEDGE:

☒ Receipt of the above described aircraft wreckage.

☐ Removal of the parts, if any, listed on the reverse side of this form.

SIGNATURE	TITLE	DATE
[redacted]	Sr. Analyst	11/5/94

REMARKS:

NTSB FORM 6120.15 (Rev. 6/79)

NATIONAL TRANSPORTATION SAFETY BOARD
RECEIPT OF AIRCRAFT PARTS

ACCIDENT IDENTIFICATION NUMBER: ANC95LA008

PART II—RELEASE OF AIRCRAFT PARTS

REGISTRATION NUMBER	MAKE	MODEL
611FE	DOUGLAS	MD-11

DATE OF ACCIDENT	LOCATION
11/4/94	ANCHORAGE, AK

The National Transportation Safety Board has retained, for further examination, those parts, pieces, or components listed below. When the examination is complete, they will be returned to:

OWNER OR OWNER'S REPRESENTATIVE—

ADDRESS

PARTS, PIECES, OR COMPONENTS RETAINED:

FDR
CVR } AT NTSB LAB FOR ANALYSIS

Flight data Recorder and Cockpit voice Recorder were sent by NTSB HQ directly back to FedEx. verbal confirmation with Frank Walsh shows they received the recorders

SIGNATURE OF NTSB REPRESENTATIVE	TITLE	DATE
[redacted]	AIR SAFETY INVESTIGATOR	11/5/94

The registered owner or owner's representative will acknowledge receipt of the materials by signing this form in the spaces designated below.

SIGNATURE OF OWNER OR OWNER'S REPRESENTATIVE	TITLE	DATE
[redacted] ADDRESS MEMPHIS TN 38118	Sr. ANALYST	11/5/94

Appendix V

ALPA Engineering Evaluation

Executive Summary

In accordance with an agreement between the FedEx Pilots' Association (FPA) and the Air Line Pilots Association (ALPA) dated June 12, 1998, ALPA has reviewed information provided by FPA and certain additional material regarding the accident involving Federal Express Flight 14, which crashed at Newark, NJ on July 31, 1997. ALPA has evaluated the progress of the investigation to date and suggested possible actions for FPA to use as a guide for their subsequent actions as a party to the investigation.

In general, we feel the following areas merit continued attention:

- The Operations and Human Performance report should go into greater detail concerning how a visual approach that appears to have been flown well within established operational parameters for a stable approach can result in an accident. The additional information will be useful in efforts to identify anything that operators can use as training and education examples to prevent recurrence.
- There should be increased emphasis in the maintenance aspects of this accident. There is an unanswered question as to whether the existing hard landing inspection, with its "layered" approach, can truly identify damage done by a hard landing. Similarly, the maintenance history of the aircraft, including at least two documented hard landings, is not included in the data that was provided for our review.
- There are several areas where the manufacturer's data is presented as results without the underlying calculations that lead to those results. Thus, there is no indication of what assumptions, if any, may be involved. There are also areas where the mathematical calculations are incorrect. We feel this is a critical area in that this data could be incorporated into other reports as fact when it is actually analysis.
- The NTSB Systems and Structures reports provided for our review could be improved by a more thorough examination of all possible causes. The current state of these reports may reflect either a work in progress or simply a lack of available resources. However, more detail would prevent the potential inference of a predisposition to view the accident as simply poor pilot technique without regard to other possibilities.

Throughout our report, we have made observations and recommendations. Recommendations are either implicit in the body of the report or explicitly stated. The explicitly stated ones are compiled at the end of the report for ease of reference. It is important to keep in mind that these observations and recommendations are intended to supplement, not replace, those that FPA has already made and is pursuing.

Introduction

This report was prepared pursuant to the agreement between the FedEx Pilots' Association (FPA) and the Air Line Pilots Association (ALPA) dated June 10, 1998. In accordance with that agreement, the Engineering and Air Safety Department of ALPA has reviewed material provided by FPA pertinent to the MD-11 accident at Newark, NJ on July 31, 1997 involving Federal Express Flight 14 (FDX 14). This report represents an evaluation of the state of the investigation, comments and observations on products provided by FPA, and recommendations for FPA action. The following documents were provided for ALPA review:

- NTSB Operations/Human Performance Group Field Notes and Factual Report with Attachment VI
- NTSB Structures Group Factual, addendum to Factual, and Field Notes
- NTSB Digital Flight Data Recorder Group Factual with attachments (includes DFDR tabular data)
- NTSB Systems Group Chairman's Field Preliminary Report of Investigation
- NTSB Airport Group Chairman's Factual Report of Investigation ("Airport Group Factual").
- Draft copy of NTSB Performance Group's Field Notes and Airplane Performance Study with Attachments (includes DFDR data displayed graphically).
- Boeing Douglas Products Division (DPD) Sink Rate Analyses (provided to NTSB)
- DPD Wing Strength Investigation
- DPD Briefing on FDX 14 accident, dated 17-19 March 1998, with appendix
- DPD Materials & Process Engineering draft report on FDX 14 accident with photographs (provided to NTSB)
- Hawker Pacific Aerospace Corp. teardown analysis of right main landing gear cylinder
- Goodyear Tire & Rubber Co. tire analysis.
- Bridgestone Aircraft Tire Co. tire analysis.
- Several packets of photographs (approximately 700-800 total photos) - sources generally unknown (except for one package labeled "FAA photographs"), but appear to be primarily from DPD.
- FedEx MD-11 Tailstrike Awareness Training handout, briefing, simulator instructor notes, and simulator guide, all dated June 1996
- FedEx MD-11 student guides for AST 3, 6, and 9, all dated April 1996
- Extracts from the FedEx MD-11 Flight Manual, pages 7-45 through 7-47, 7-99 through 7-104, 7-1-6-1 through 7-1-6-2, various dates, assumed to be current as of the accident date.
- Numerous e-mail messages (printed) to/from DPD, FPA, NTSB, and consultants concerning the accident.
- Selected extracts from 14 CFR Part 25 (Federal Aviation Regulations) concerning transport aircraft certification.

FPA made several attempts to provide ALPA with electronic copies of DFDR data to aid in the analysis, but these attempts were unsuccessful. The photographs provided were generally not individually identified (with ID numbers, catalog references, or similar), although a catalog document was provided. Many of the above documents contained photocopy reproductions of photographs, varying in quality from fair to unusable. A limited attempt was made to match some of copies (the more critical photos) in the documents with the actual photographs, but the magnitude of that effort was generally beyond the scope of the agreement. Thus, extensive analysis of details contained solely in photographs was not done.

The following documents were obtained in-house by ALPA:

- Digital Flight Data Recorder (DFDR) data from other MD-11 accidents/incidents.
- MD-11 Lamm Schematics
- MD-11F FAA Type Certificate data
- Jeppesen charts of approaches and runway at Newark
- Selected extracts from 14 CFR Part 25 (Federal Aviation Regulations) concerning transport aircraft certification.

In general, we reviewed documents in the order in which they were created to be able to evaluate them in the context of the information that was available at the time and to avoid introducing a bias caused by later developments. The review included checking technical and procedural accuracy, completeness, and general observations about the conduct of the investigation. Although it was impossible to completely avoid our own independent analysis of the facts, an attempt to identify and substantiate causal factors was beyond the scope of the agreed upon effort. Since our review was limited to material provided by FPA, additional information might exist of which we were not aware. We cannot guarantee that our observations and conclusions will remain valid in view of such information.

We have organized our observations into categories that parallel the groups formed for a typical NTSB investigation. Some observations are presented at face value with no specific recommendation other than that which can be inferred from the observation (e.g. pointing out the absence of a particular piece of data in a report suggests it may need to be obtained). For other observations, we have attempted to develop specific recommendations for future FPA action. Some of these actions are pertinent to the NTSB Technical Review and involve corrections or additions to the factual record. Others are analytical in nature and will be more appropriate for use in the development of the FPA Submission to the NTSB. Not all of our observations are about the NTSB reports or their conduct of the investigation. This is an important distinction to make inasmuch as the NTSB Factual Reports are necessarily limited to facts, as opposed to analysis. Reports, studies, and analyses conducted by NTSB or aircraft and component manufacturers have no such restriction. Since NTSB includes the expertise of parties to the investigation to aid in the development of Factual Reports, it becomes critical to ensure that items represented to be factual in the NTSB reports are the product of direct observation of factual material, not derived conclusions.

Specific Issues

Operational and Human Performance

Arguably the most significant aspect of this accident is how an apparently normal MD-11 visual approach turns into an accident with no prior indications of impending disaster. The recorded DFDR data and the crew interviews reflect a nearly flawless approach down to the initiation of the landing flare. Parameters typically used to differentiate stable from unstable approaches all reflect little or no variation. Airspeed was within 3 knots of V_{REF}, average rate of descent down to fifty feet was 822 feet per minute, and the glide slope deviation was essentially zero. These parameters, along with the "book" values, are presented in tabular form in Figure 1. It is only in the portion of the landing maneuver below about 30' that parameters are not strictly in accordance with the guidance given to crews. Viewed subjectively, even that portion is not significantly different from the guidance. The landing attitude is established somewhat late, but the pitch is not excessive. The most significant deviation from published guidance through the first touchdown is a positive pitch rate at touchdown. Even that aspect of the landing is difficult to directly associate with the subsequent accident, since pitch rate is highlighted as an element that contributes to excessive pitch up and tailstrike, neither of which occurred here. The landing attitude was established late enough that the inertia of the aircraft could not be dissipated in time to reduce the descent rate prior to touchdown, which likely lead to the firm touchdown and bounce. The timing of the flare maneuver is not addressed in the material made available for our review. To prevent recurrence, eventually MD-11 operators will have to tell crews what not to do in order to avoid a similar accident. The Operations Group Factual should include references to the landing guidance given to crews in the AFM or in simulator training.

The guidance referenced above is contradictory and inconsistent. For example, the MD-11 Student Guide says the nominal pitch attitude on final is 5° with 50° flaps and that the nominal landing attitude is 10-11°. The same guide says the flare maneuver used to transition from the 5° attitude to the 10-11° attitude is a 2.5° pitch change. Between the flight manual and the MD-11 student guide, a pilot can find references of a landing attitude of 7°, 8°, 9°, 10°, or 11°. The tailstrike awareness guide refers several times on page 4 to a parameter called "attitude rate." It seems likely that this is simply an editorial error and should be "pitch rate." Nevertheless, the guidance describing such a critical aspect of MD-11 operations should be editorially perfect. From a technical standpoint, the same guidance has a partially correct statement that we consider significant. In describing the potential hazard of trying to arrest a sink rate with the elevator, the guidance says, "This ...increases both the effective weight of the aircraft and the ...vertical velocity." This is true, but only covers part of the process. Lift and drag increase as well, and airspeed margin above stall must be considered to evaluate the aircraft's energy state.

> **RECOMMENDATION 1:** The Operations and Human Performance Group should ensure that *all* guidance to crews regarding landing is included as appendices and that discrepancies between the documents are noted.

The fact that the left landing light was discovered by the crew to be inoperative is in the Ops field notes but not the factual report. This should be included for completeness, but also to enable subsequent analysis of possible visual illusions or restrictions as possible contributing factors.

Parameter	Guidance Provided (Source)	Accident Approach & Landing
Visual approach	ROD not to exceed 1000 fpm (Flight Manual, pg 7-45) Typical ROD for 3° visual glidepath is 700 fpm no wind (Flight Manual, pg 7-46)	RA went from 501' to 55' in 34 seconds, which is 787 fpm
Acceptable performance on visual approach	Airspeed ± 5 kts ROD ≤ 1000 fpm (Flight Manual, pg 7-47)	From RA 1015' to RA 55', average ROD was 822 fpm and airspeed was V_{REF} ± 2.5
Normal approach descent rate	650 to 800 fpm in normal landing configurations	RA decreased from 501' - 55' in 34 seconds (787 fpm)
Normal pitch attitude on approach	5° with 50° flaps (MD-11 Student Guide)	Pitch varied around approx 3-4°; GS dev < 5% of full scale
50 and 40 foot CAWS callouts	Maintain stabilized flight path unless sink is high (Sim Training Guide)	From 136' to 36', variations in: Pitch: 0.7° Bank: 1.0° N_1: 2% IAS: 2 kt RA: 501' - 55' in 34 seconds (787 fpm)
30-40 feet	Flare 2° (Flight Manual, pgs. 7-46, 7-100)	Between 35-45', pitch decreases approx 1°, then increases by 2.5° (net increase 1.5°) below 35'
30 feet	Initiate smooth 2.5° flare so as to arrive below 10 feet in the landing attitude (Sim Training Guide)	Pitch change from 30' to 10' was approximately 2°. Pitch change from 30' to touchdown was approximately 4°.
Nominal landing attitude (hypothetical)	10° at 1.25 V_S, add 1° for 1.3 V_S (MD-11 Student Guide) 9° at flaps 50 (Flight Manual, pg. 7-100)	Pitch at TD: 7.5 - 8.5°
Nominal landing attitude (real world)	7-8° at flaps 50 (Flight Manual, pg. 7-100)	Pitch at TD: 7.5 - 8.5°
Basic landing technique	Below 10', hold the "fully flared" attitude (2-4 fps) by applying required control wheel pressure (Flight Manual, pg. 7-46)	At 10', pitch is 4.5-5°. Below 10', pitch is still increasing toward a maximum of approx 8.5° at first touchdown
"Advanced" landing technique	Below 10', lower the nose 1° (Flight Manual, pg. 7-46)	Below 10', pitch is still increasing toward a maximum of approx 8.5° at first touchdown

Parameter	Guidance Provided (Source)	Accident Approach & Landing
Bank angle at touchdown	"Excessive" bank angle close to the ground can result in wingtip contact (Flight Manual, pg. 7-102) Worst case crosswind should result in a 6° bank angle (Flight Manual, pg. 7-102)	Max recorded bank angle 9.49°
Bounce recovery	Maintain 7.5° pitch and arrest sink with thrust (FDX MD-11 Tailstrike Awareness material)	Resolver angles increasing prior to first touchdown and continue forward, N_1 increase lags by about 2 seconds; pitch decreases to -0.7°.
Bounce recovery	If a high bounce occurs, initiate a go-around (Flight manual, pg. 7-101)	Maximum altitude between touchdowns calculated to be 5 feet.

Figure 1

The report should be expanded to include more detailed discussion of the human factors aspects of the accident. For example, there is no discussion of the cockpit dimensions and control layout, oriented toward evaluating the ergonomics of a large forward resolver movement coupled with an aft wheel movement. Crews in at least two MD-11 accidents have highlighted this interaction. The guidance given to crews cautions against pulling back on the stick to arrest a sink rate. While this may be aerodynamically sound advice, for it to be effectively employed, the pilot must consciously overcome not only instinct, but potentially all of his or her training in other aircraft. This need to "unlearn" lessons that are generally ingrained in pilots from an early stage of training should be evaluated for its soundness.

The guidance given to pilots says they should start to flare as low as 30' and hold pitch constant below 10'. It also says descent rates of up to 1000 fpm are acceptable. This accident shows clearly that a nominally good approach, down to 30', can become a catastrophic landing event. Presumably, then, if a pilot is to make a decision that a good approach (i.e. not a go-around situation) is becoming a bad landing (indicating the need for a go-around), that decision would have to be made between 30' and 10'. At up to 1000 fpm descent rate, that means a pilot may have as little as 1.2 seconds to decide that, in spite of no adverse indications during the approach, the landing attempt must be aborted. Similarly, if the only non-standard pilot action is failure to freeze the pitch below 10', time to recognize that fact and react to it is extremely limited. The "reasonableness" of this requirement should be evaluated in a human performance context. It should also be evaluated for compliance with the FAR requirements that preclude development of procedures that require more than average piloting skill.

In the documents made available for our review, there is no discussion of possible landing illusions that may have contributed to a late or abrupt flare. Given the possibility of an inoperative landing light, there is a potential human factors issue with landing illusions that could be more fully developed. Conversations with FPA suggest that the crew who operated the aircraft into Taipei on the earlier leg of flight 14 experienced an exceptionally hard landing. However, the FDR data made available for our review does not show a high value for vertical acceleration on that landing. Interviews with crews who operated the same aircraft (same ship number) during the several previous flights or during the previous documented hard landings on the accident aircraft might prove beneficial to understanding this apparent discrepancy.

There are e-mail references to the fact that no one on the flight deck remembers feeling an impact that seems to have ripped the gear off and broken the wing in two places. This aspect of human performance should be pursued and is more than just an academic question. If the impact was not "memorable" because the people were momentarily traumatized and blocked it out, then the issue can be closed. However, if it wasn't memorable because it wasn't particularly severe that raises the possibility that the gear was somehow unable to withstand a "normal" landing load and that should be thoroughly evaluated. Similarly, the DFDR reflects the airplane rolling RWD, then left (toward wings level), then RWD again, but the flight deck crew does not describe that back and forth motion in any of their statements.

RECOMMENDATION 2: The above Human Performance issues can generally be tied to the available guidance or the inoperative landing light. If those facts are included in the Factual Report, then the rest of the above discussion can be developed by FPA in its submission. To fully understand and evaluate the human factors phenomena above, we recommend that FPA contact the NTSB Human Performance specialists or other individuals with academic expertise in Human Performance issues.

Maintenance

We feel this accident has a significant maintenance dimension. An MD-11 can clearly experience a landing hard enough to do significant damage without readily apparent cues to the crew or clues on the DFDR. It logically follows then that the existing process for determining when hard landing inspection is required may be inadequate. If the accident landing had been just slightly less stressful on the gear, we can postulate that no accident would have occurred, yet the structure would have been stressed to just short of failure. Would the existing hard landing inspection call for teardown and inspection of all the parts that may have failed early in the sequence for this accident? Portions of the Structures Group Factual Report made available for our review do not contain references to the MD-11 maintenance manual. The maintenance manual, page 601, uses 2.2g and 10 fps (*at max landing weight*) as benchmarks for when a hard landing inspection is required. There is no mention of means a mechanic can use to determine ROD at touchdown. It isn't captured explicitly in the DFDR. If personnel in the field are supposed to use the DFDR parameters that *are* recorded to determine ROD, there is no indication of how they get the data or of what data to evaluate. The accident aircraft was below max weight, and the g load was well below 2.2, so the implication from the maintenance manual is that the accident landing might not even result in a hard landing inspection. This apparent discrepancy should be fully evaluated.

The accident airplane has an accident/incident history. As we understand it, the same ship number had been involved in at least two other documented hard landing events. The records of maintenance actions performed after those events should be evaluated for their relevance to this accident.

> **RECOMMENDATION 3:** The Structures Group (or a separate maintenance records group) should obtain repair and related maintenance data for the accident airplane, evaluate its relevance, and consider including it in the Factual Report. This would allow the parties to assess the adequacy of current MD-11 hard landing inspections.

Performance

While the DPD documents are not formally part of the factual reports, they can easily be interpreted as factual items. Thus, their accuracy should be considered and careful distinctions made between facts and analysis. For example, the math on pages 7-8 of the DPD Sink Rate Analysis contains at least two errors. The errors nearly offset one another (a roll change from 5.98 to 9.49 in 0.5 seconds is a rate of 7.02, and 7.02* pi/180 * 17 equals about 2.08). Nevertheless, it shows that the data in the DPD report may not be fully developed and thoroughly checked . In general, we feel that derived or calculated values such as these should always be substantiated by "showing the work" (in this case, the slope calculation). If the DPD calculations are incorporated in NTSB documents, they should be independently verified and the calculation method, not just the result, should be thoroughly documented.

The computation referenced above derives a local sink rate at the RMLG from the roll rate. However, it does not include inertial effects. During the one second at subframe 346, the roll value goes from 5.98 to 9.49, then back to 4.57. Taken in isolation, this equates to a 7.02 degree per second right wing down roll rate that changes instantaneously to a 9.84 degree per second left wing down roll rate. The sharp "point" that this creates on the plot may also be the approximate time of ground contact. However, whether the change from right roll to left roll is assumed to be from control inputs or ground contact, the change must be consistent with the time needed to change the direction of the mass of the aircraft. All that can be said for certain is that the roll was the recorded value at the recorded time. Theoretically, any line passing through those points, straight or curved, sloped up or down, could have been the actual reflection of the motion of the aircraft. Figure 2 illustrates some of the infinite possible variations of this phenomenon. The slope of the line *from* the first point (instantaneous roll rate) may well be greater than a value derived by assuming a straight line between the two points, but the slope of the line *into* the second point can be significantly less, or even the opposite direction. In the specific case under study here, this means the actual roll rate could have been different from the rate in the DPD document.

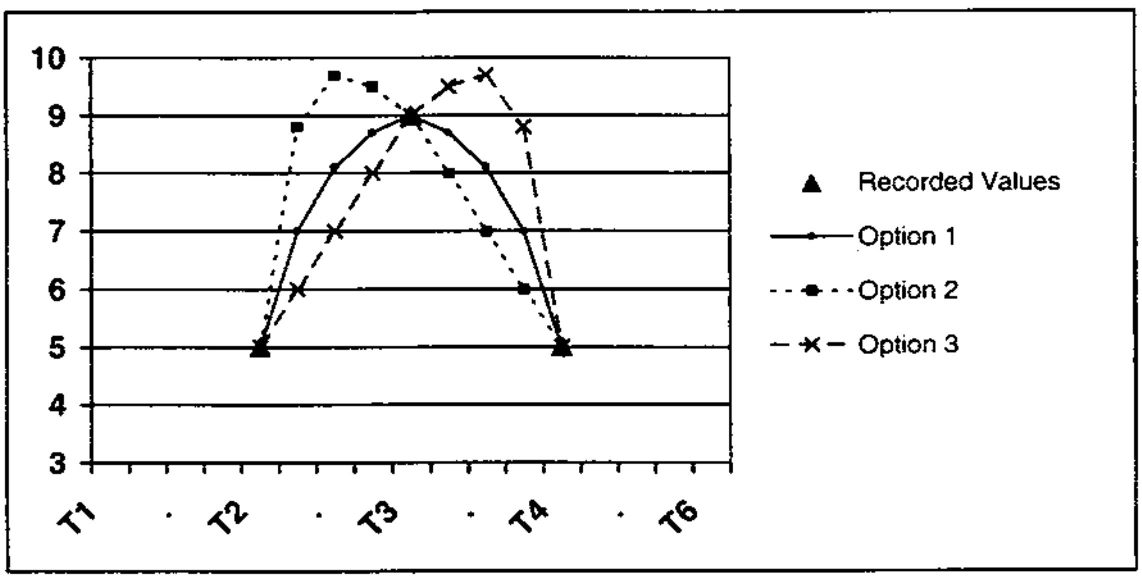


Figure 2

Although we are not specifically familiar with the "Adams-Bashford 2" integration technique used to develop the ROD numbers, it appears likely to be an accurate analytical tool. However, like all the calculations referenced here, it must be taken in the context of any assumptions and limitations inherent in the process (none of which are listed in the DPD documents). Integration techniques we're familiar with rely on establishing a known accurate point in space from which to start the calculation and are very sensitive to variation in that starting point. From the documents provided for our review, it cannot be determined that the integration from 30' AGL through the second touchdown has that known starting point.

The DPD presentation (pg. 9) mentions a 45° control wheel deflection, based on DFDR data, just prior to the second touchdown. This is apparently based on deflection recorded for a single aileron panel (ROB) and single spoiler panel (R5). Taken out of context, these deflections do correspond to an approximate 45° control wheel input. For an accurate analysis, the deflections must viewed in the context of the previous several minutes' worth of DFDR data. When this additional data is considered, it is evident that the left outboard aileron reading and the R5 spoiler reading are both consistently higher than the other aileron and spoiler panels. During this time period there is no turn evident in the other DFDR readings, suggesting the difference is due to rigging or measurement/sensing bias. Even if there's supposed to be some offset between inboard and outboard aileron panels, the spoiler readings are almost undoubtedly a bias or offset. Without that bias or offset, the corresponding control wheel deflection would be on the order of 10-15°. This same bias is likely the reason behind the apparent early deployment of the R5 spoiler panel just prior to the first touchdown.

The Performance Study makes reference to the tire marks from the first touchdown as indicative of a RWD touchdown. The marks show the RMLG skid mark starting 25' before the LMLG marks. While it is true that a RWD touchdown would leave such witness marks, other possible scenarios should be acknowledged. The same marks could be due to nose-right yaw at touchdown, or some structural difference in the mains. The DFDR shows 1.05° RWD bank at subframe 343. It is important to realize that the resolution of bank measurement on the DFDR is approximately 0.35°, according to the parameter listing. Thus, a reading of 1.05 could result from an actual bank angle anywhere in the range of 0.835-1.225 (i.e. a 0.35 range around 1.05). The performance study uses a 1 fpm additive to the vertical velocity derived from the integration process, based on a presumed roll rate to that 1° bank. While inertial effects noted above are significantly less in this case, the fact remains that using two DFDR points to infer a linear progression between them, and then derive a rate from that relationship, is not necessarily the only possible motion. The roll rate, and consequent total descent rate at the RMLG, could be any of an infinite number of values that would be added to or subtracted from the "base" descent rate of 6.6 fps (which is a derived value). For a constant ground speed, the distance between the skid marks would tend to increase as the bank increases, and decrease as the ROD increases. This relationship is shown in chart form in Figure 3.

Bank Angle (deg.)	Rate of Descent (fps)					
	6	6.4	6.8	7.2	7.6	8
0	0.0	0.0	0.0	0.0	0.0	0.0
0.2	5.0	4.7	4.4	4.2	4.0	3.8
0.4	10.0	9.4	8.8	8.3	7.9	7.5
0.6	15.0	14.1	13.2	12.5	11.9	11.3
0.8	20.0	18.8	17.7	16.7	15.8	15.0
1	25.0	23.5	22.1	20.9	19.8	18.8
1.2	30.0	28.1	26.5	25.0	23.7	22.5
1.4	35.0	32.8	30.9	29.2	27.7	26.3
1.6	40.0	37.5	35.3	33.4	31.6	30.0
1.8	45.0	42.2	39.7	37.5	35.6	33.8
2	50.0	46.9	44.1	41.7	39.5	37.5

Chart shows distance the "lower" gear would touch down prior to the "upper" gear (in feet). Values are based on 34 feet between the gear and a ground speed of 152 knots.

Figure 3

Using bank angles and roll rates that could reasonably be presumed to exist, one can see that a 25' difference between skid marks is not unreasonable. One can also see, however, that a very slight increase in ROD or decrease in bank angle would make the skid marks much closer together, meaning an observed offset in the marks would have to be due to something else (e.g. strut extension, tire characteristics, structural defect, measurement error, etc.).

> **RECOMMENDATION 4**: Data used for the investigation that is not directly measured should include a complete discussion of the origin of any derivation process, the assumptions that are included, limitations on the process, and susceptibility to errors. Ideally, the entire derivation of values, not just the result, should be shown. Any data used in studies or other analytical products should be similarly explained.

Review of the DFDR shows that while the resolver angle increases dramatically just prior to the first touchdown, the increased thrust, as indicated by N_1, does not peak until almost two seconds later, just about at the high point of the bounce. The engine and airframe geometry suggest the pitching moment from a thrust increase should be nose down, but conversations with MD-11 pilots suggest it is nose up. DPD should be able to confirm the actual pitch moment from a thrust increase. A condition that prompts the pilot to add thrust in the last few feet above the runway may be the same conditions that can result in a bounce, as it did here. During a bounce recovery, the pilot may be attempting to keep the nose from pitching up by adding forward yoke pressure (per the tailstrike awareness training). If at the same time the thrust increase is producing a rapidly changing pitching moment (either up or down), the combination could produce large, rapidly changing required stick forces. If that's the case, it may follow that there is one and only one acceptable action following a bounce - go around. All things considered, that's a little different than the stock "always consider the possible need for a go-around" or "the pilot should be prepared to go around if the bounce recovery results in a destabilized condition" or similar. It seems like it's really more like "In *all* cases, if the airplane bounces, GO AROUND." If that is determined to be the only safe alternative in the event of a bounce, one must again consider the suitability of the procedure since the FAR requires it to be within the capability of a "pilot of average skill."

In the preliminary DFDR tabular data file called "plt3p" dated August 5, 1997, there is a column called "Calculated Descent Rate." This parameter doesn't appear on any parameter listing, nor is it in the final tabular DFDR product. There is no indication of the method used to calculate the values. In the interest of completeness, the parties should be aware of the origin of this information.

Structures

Several of the documents developed by DPD are incomplete, inconsistent, or confusing. The Douglas Wing Strength investigation, for example, simply shows figures of airplane parts with arrows representing force vectors and no indication whatsoever of how the numbers were derived. If this information is intended for use other than internally at DPD, the complete derivation of the force vectors should be included.

The DPD failure analysis refers repeatedly to failures as being indicative of "overload." That statement is incomplete. Any time a part fails, it fails in overload. That is, because some load exceeded some capability. The load may act in tension, compression, or shear. The load may be within design limits on a part with diminished capability (corrosion, defect, etc.) or be beyond design limits on a part with full design capability (operation beyond design limits). To accurately represent the forces acting on a part that has failed, the failure must be described in terms of the magnitude and direction (e.g. "the bolt failed in tension at the shoulder" or "the spar cap showed evidence of compression failure"). Clearly, the direction of the force can be as critical to determining a failure mode as the magnitude of the force. Thus, if the DPD analyses are intended for inclusion in the NTSB record, a complete description of each failure is critical.

The document produced by Messrs. Feldman and Cybulski (part of the DPD "Failed Parts Inspection/Evaluation" team) says "A load of 2.5 million pounds is required to break all four lugs common to the main landing gear." The DPD Wing Strength Investigation document shows numerous forces acting on the gear. None of the forces shown approach 2.5 million pounds. The Feldman/Cybulski document also says that the flap track failed due to a 2.11g load, but does not substantiate that value either mathematically or subjectively. Both of these discrepancies are important to determining the failure sequence.

The package of FAA photos contains a number of very good pictures of what appear to be tire marks, soot trails, fuel spill puddles, and the like. None of these photos is included in the reports made available for our review. Since the photographs may represent the best factual record of perishable evidence (e.g. ground scars), it would be appropriate for some of them to be included in the factual record.

> **RECOMMENDATION 5:** The Structures Group should attempt to identify pertinent photographs, then catalog those photographs for inclusion in the factual record.

In the Structures Group Addendum, there is buckling noted on both the top and bottom of the right wing. Buckling normally suggests bending, so this implies the wing bent in both directions. This is not impossible inasmuch as bending could be due to aerodynamic loads and ground contact acting in different directions, or the wing could bend, fail, rebound and thus bend in the opposite direction.

> **RECOMMENDATION 6**: The Structures Group should be asked to verify that there was actually buckling on both surfaces.

The photographs of failed parts (included with the DPD documents and those provided separately) suggest that no pre-existing failures were present from corrosion or fatigue. However, complete metallurgical analysis of microphotographs was beyond the scope of this effort. The question of how damage occurring on the landing in Taipei might appear should be addressed to a metallurgist outside the original DPD analysis. That is, would microanalysis be able to distinguish between a failure that occurred on the accident landing and a failure that started only a few flight hours earlier and was aggravated by subsequent landings. Additional metallurgical analysis might also be useful to determine if failed parts exhibiting heat stress were heated before or after the mechanical failure. For example, the Structures Group addendum refers to heat stress and buckling evident on the right wing. Metallurgical analysis would reveal if the metal was heated then buckled or buckled then heated. This information may turn out not to be significant, but our experience is that any recoverable data should be recovered and included with the factual report, since it is not always evident what is important as the analysis portion of the investigation continues.

RECOMMENDATION 7: FPA should request additional analysis (or verification of the DPD analysis) of selected failed parts by the NTSB metallurgists.

Systems

We reviewed the Systems Group field notes only (the Factual was not made available to us). The field notes provided for our review are dated August 4, 1997 and may not be the final version. If the Factual is still being developed, FPA should attempt to make the following inputs. Detailed documentation of the condition of flight controls, especially the cables, lines, actuators, etc. should be included, if it is available. This information may or may not be recoverable, since part of the wreckage has been disposed of, but if it can be included in the factual record, it may be possible to rule in or rule out some failures.

There are at least two systems questions that have been raised in this and other MD-11 accident DFDR analysis. Both should be well-known, well-studied features of the design at this point, but both seem to be source of continuing questions and controversy. One is the function of LSAS, the specific point at which it ceases to be a factor (i.e. "washes out"), and the DFDR indication(s) of its normal and abnormal functioning. In correspondence relating to this accident, it appears that the issue is not fully understood by the people involved in MD-11 operations. The second is the difference between the inboard and outboard aileron DFDR readings. The deflections appear to indicate deliberate "droop" of the outboard ailerons. That is, the outboard panels appear to be deflected more TED than their inboard counterparts. Our understanding is that the ailerons do indeed droop to improve fuel burn, but that this feature is active only in cruise flight. With a mature design that has been in service for a number of years, there should be a more complete understanding of how the primary and secondary flight control operation looks on the DFDR.

RECOMMENDATION 8: The Systems Group should request detailed information on the LSAS and aileron systems from DPD. This should include thorough documentation of systems operation and DFDR indication of normal and abnormal operation.

Certification

An area that should be considered in an accident such as this one is whether the aircraft was designed (or should have been designed) to withstand the loads imposed by the landing. A review of pertinent parts of the design standards contained in FAR Part 25 indicates there are several parts that address landing loads that must be sustainable by landing gear. However, the calculation process required to equate the loads acting on the accident aircraft with the load limits described by the FAR are not at all straightforward. Static and dynamic reactions of all gear components and the airframe itself are required to be considered. Access to that level of detail about the MD-11 can only be obtained through the manufacturer. As such, detailed analysis of the accident landing with respect to certification criteria was beyond the scope of this effort. The FAA certification compliance report would show if the landing gear and longitudinal stability of the MD-11 were actually recertified, or if the certification was based on DC-10 components and performance.

Studies

Accident investigations typically reveal areas of aircraft operation that may merit further study, whether or not they had a direct bearing on the subject accident. We include three such areas that surfaced during our review of the accident data. It is unclear whether there is a connection between these phenomena and the accident. It may be beneficial for any of the parties in the investigation or for other organizations involved in MD-11 operations to investigate the following items.

From approximately DFDR subframe 237 to 252 the aileron traces are nearly coincident. Prior to and subsequent to that block of time, the outboard ailerons appear displaced from the inboards. This same phenomenon is present on DFDR records of other MD-11 accidents. This further exacerbates the "droop" confusion mentioned above, but also raises the question about why the apparent offset disappears then reappears. Subframe 252 is the point at which the flaps first move to 50°, suggesting a possible connection with flap extension. However, at 237, the flaps are already set at 35° and have been for several seconds.

DFDR data for the two previous landings show pitch oscillations are noticeably smaller than on the accident landing. However, both previous landings were at flaps 35, and the accident landing was at flaps 50. The oscillations on the accident landing are not more than $\pm$ 1° of pitch, but appear to be greater than on the non-accident landings.

The vertical g trace for the two previous landings show a touchdown g load of approximately 1.4g at Anchorage and 1.3g at Taipei. This is inconsistent with the anecdotal indications of an exceptionally hard landing in Taipei.

Recommendations extracted from the report

RECOMMENDATION 1: The Operations and Human Performance Group should ensure that *all* guidance to crews regarding landing is included as appendices and that discrepancies between the documents are noted.

RECOMMENDATION 2: The above Human Performance issues can generally be tied to the available guidance or the inoperative landing light. If those facts are included in the Factual Report, then the rest of the above discussion can be developed by FPA in its submission. To fully understand and evaluate the human factors phenomena above, we recommend that FPA contact the NTSB Human Performance specialists or other individuals with academic expertise in Human Performance issues.

RECOMMENDATION 3: The Structures Group (or a separate maintenance records group) should obtain repair and related maintenance data for the accident airplane, evaluate its relevance, and consider including it in the Factual Report. This would allow the parties to assess the adequacy of current MD-11 hard landing inspections.

RECOMMENDATION 4: Data used for the investigation that is not directly measured should include a complete discussion of the origin of any derivation process, the assumptions that are included, limitations on the process, and susceptibility to errors. Ideally, the entire derivation of values, not just the result, should be shown. Any data used in studies or other analytical products should be similarly explained.

RECOMMENDATION 5: The Structures Group should attempt to identify pertinent photographs, then catalog those photographs for inclusion in the factual record.

RECOMMENDATION 6: The Structures Group should be asked to verify that there was actually buckling on both surfaces.

RECOMMENDATION 7: FPA should request additional analysis (or verification of the DPD analysis) of selected failed parts by the NTSB metallurgists.

RECOMMENDATION 8: The Systems Group should request detailed information on the LSAS and aileron systems from DPD. This should include thorough documentation of systems operation and DFDR indication of normal and abnormal operation.

Appendix VI

<u>MD-11 Hard Landing Inspection Criteria</u>

Federal Express Corporation
Flight Safety
Delivery Code 0127
3131 Democrat Building C
Memphis TN 38118

US Mail PO Box 727
Memphis TN 38194-0127

Telephone 901 224 5600
Fax 901 224 5140

Wells, D

FedEx
Federal Express

May 7, 1997

Cindy Keegan
National Transportation Safety Board
490 L'Enfant Plaza East, S.W.
Washington, DC 20594

RE: Aircraft Accident Investigation, DCA97MA055

Dear Cindy,

Attached is the MD-11 Aircraft Maintenance Manual, Chapter 5, that outlines the progressive checks accomplished for Hard Landings. We checked with DPD and our procedures are identical to those they originally provided us.

If you have any questions, please contact me.

Sincerely,

[redacted]

John L. Fraley
Party Coordinator
(901) 224-5127

CHAPTER 05 - TIME LIMITS/ MAINTENANCE CHECKS

TABLE OF CONTENTS

HARD LANDING - INSPECTION/CHECK

1. General

A. This procedure has the instructions to do an inspection of the aircraft after a hard landing.

B. A hard landing condition occurs when the aircraft lands at a sink-rate of more than 10 ft (3.048 m) for each second, at or below the maximum design structural landing weight. The minimum G-load with a sink rate of 10 ft (3.048 m) for each second, at or below the maximum design structural landing weight, is 2.2G. Also, a hard landing condition occurs when the aircraft lands at a sink-rate of more than 6 ft (1.8288 m) for each second, at a weight more than the maximum design structural landing weight. If the sink-rate cannot be found when the aircraft lands, do the hard landing inspection.

C. After a hard landing, the areas to examine for damage are:

- The nose landing gear
- The main landing gear
- The centerline landing gear
- The fuselage
- The wing
- The horizontal tail (stabilizer and elevators)
- The vertical tail (stabilizer and rudders)
- The nacelles and pylons.

D. If damage is found during this inspection, make a list of the data that follows:

(1) The load factor and the airspeed read-outs from the flight data recorder.

(2) The fuel, passenger and cargo load distribution.

(3) The gross-weight of the aircraft and the center of gravity (cg) location at the time of the hard landing.

(4) The dry-nitrogen pressure (psi or kPa) in all the landing gear struts.

(5) The quantity of oil (cu. in. or cc) in all the landing gear struts.

(6) Signs of metal-to-metal "bottoming" between the piston and the cylinder in all the landing gear.

E. The inspections are divided into two groups:

(1) A-check inspection. An external inspection of the local areas of visible damage and the structure and components adjacent to the damaged area. If damage is found in an area during the A-check inspection, the applicable B-check inspection of the same area becomes necessary.

(2) B-check inspection. A careful inspection with concentration on the damaged areas found during the A-check inspection.

F. If there is structural damage, refer to the MD-11 Structural Repair Manual (SRM).

TASK 05-51-03-200-801
A-CHECK INSPECTION OF THE AIRCRAFT AFTER A HARD LANDING

2. Job Set-up Information - Hard Landing Condition - A-Check Inspection

Subtask 05-51-03-943-001

A. Fixtures, Tools, Test and Support Equipment

NOTE: Equivalent replacements are permitted for the items that follow.

REFERENCE	DESIGNATION
Not specified	Work platform, 7-8 ft (2.1-2.4 m)
Not specified	Work platform, 20 ft (6.1 m)
Not specified	Work platform, 30 ft (9.1 m)
Not specified	Aerial boom, manlift

Subtask 05-51-03-946-001

B. Reference Information

REFERENCE	DESIGNATION
TASK 05-51-03-200-802 P/B 601	B-CHECK INSPECTION OF THE AIRCRAFT AFTER A HARD LANDING
TASK 05-51-09-200-801 P/B 601	A-CHECK INSPECTION OF THE NO. 1 AND NO. 3 ENGINE PYLONS AFTER AN ENGINE FAILURE/OVERLOAD CONDITION
TASK 05-51-09-200-803 P/B 601	A-CHECK INSPECTION OF THE NO. 2 ENGINE PYLON AFTER AN ENGINE FAILURE-OVERLOAD CONDITION
TASK 32-11-01-360-801 R P/B 801	REPLACEMENT OF THE SHOCK STRUT PISTON SEALS - SPARE SEALS INSTALLED
TASK 32-11-01-360-802 R P/B 801	REPLACEMENT OF THE SHOCK STRUT PISTON SEALS - SPARE SEALS NOT INSTALLED
TASK 32-15-01-300-801 P/B 801	REPLACEMENT OF THE CENTER LANDING GEAR SHOCK STRUT PISTON SEALS - SPARE SEALS INSTALLED
TASK 32-15-01-300-802 P/B 801	REPLACEMENT OF THE CENTER LANDING GEAR SHOCK STRUT PISTON SEALS - SPARE SEALS NOT INSTALLED
TASK 32-21-01-360-801 P/B 801	REPLACEMENT OF THE NOSE LANDING GEAR SHOCK STRUT PISTON SEALS - SPARE SEALS INSTALLED
TASK 32-21-01-360-802 P/B 801	REPLACEMENT OF THE SHOCK STRUT PISTON SEALS - SPARE SEALS NOT INSTALLED

3. Procedure - Hard Landing Condition - A-Check Inspection

Subtask 05-51-03-210-001

A. Do a visual inspection of the nose landing gear (NLG). If damage is found during the A-check inspection, do the B-check inspection of the NLG. Refer to HARD LANDING, B-check Inspection of the Aircraft After a Hard Landing.
(Ref. Fig. 601/TASK 05-51-03-990-801)
(Ref. Fig. 602/TASK 05-51-03-990-802)
(Ref. TASK 05-51-03-200-802)

TASK 05-51-03-993-801
Nose Landing Gear - A-Check Inspection

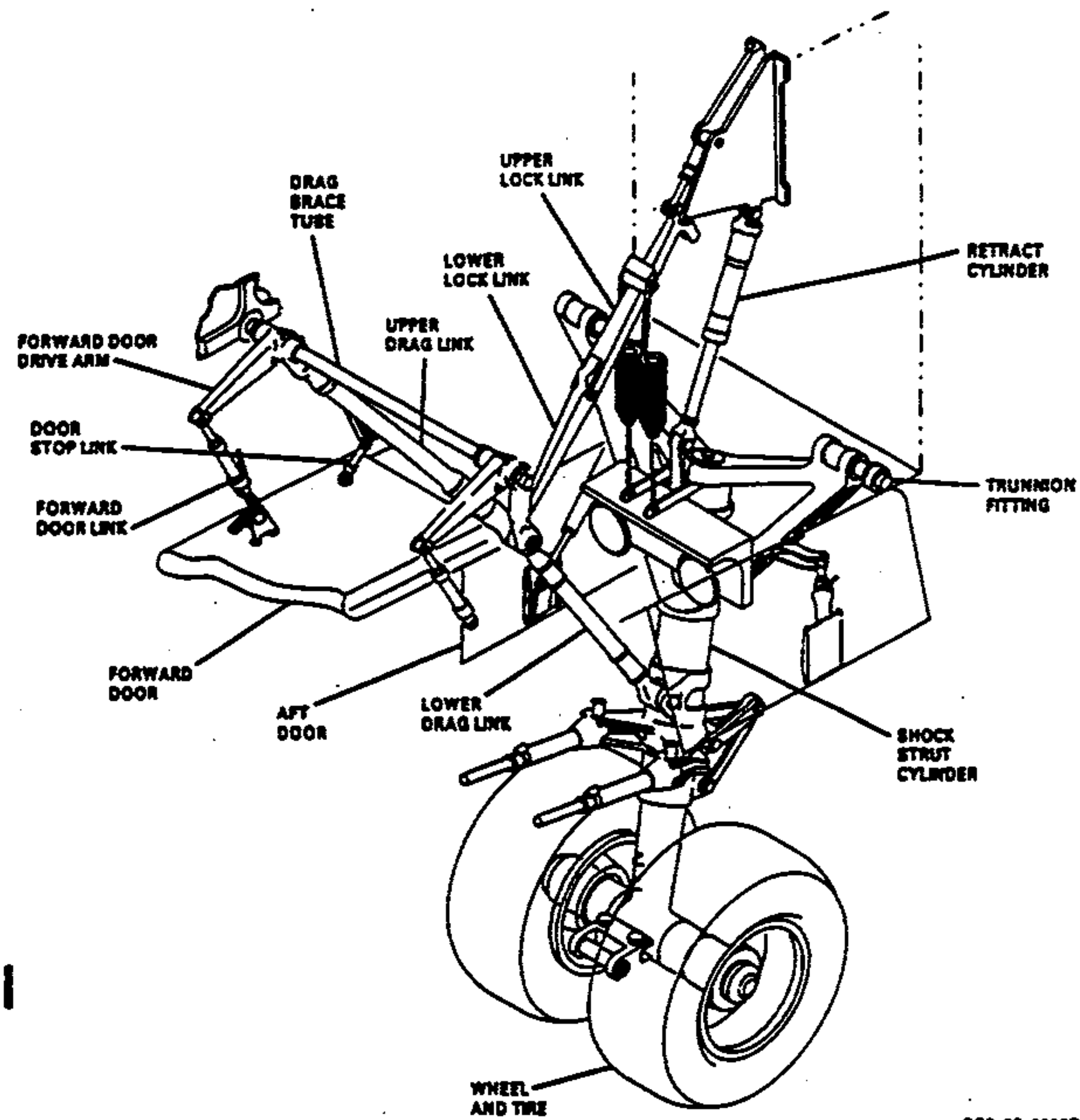
INSPECTION AREA		CHECK FOR
1	Struts, wheels, tires, doors, door attachment areas and wheel well area	- Fluid leaks - Flaking paint - Twists and bends - Loose fasteners or fasteners not there - Cracked or broken parts and other signs of damage.
2	Axles	- Distortion.

Subtask 05-51-03-360-001

B. If necessary, repair the nose landing gear (NLG). Refer to STRUT, NOSE LANDING GEAR SHOCK, Replacement of the Shock Strut Piston Seals - Spare Seals installed. Refer to STRUT, NOSE LANDING GEAR SHOCK, Replacement of the NLG Shock Strut Piston Seals - Spare Seals not Installed.
(Ref. TASK 32-21-01-360-801)
(Ref. TASK 32-21-01-360-802)

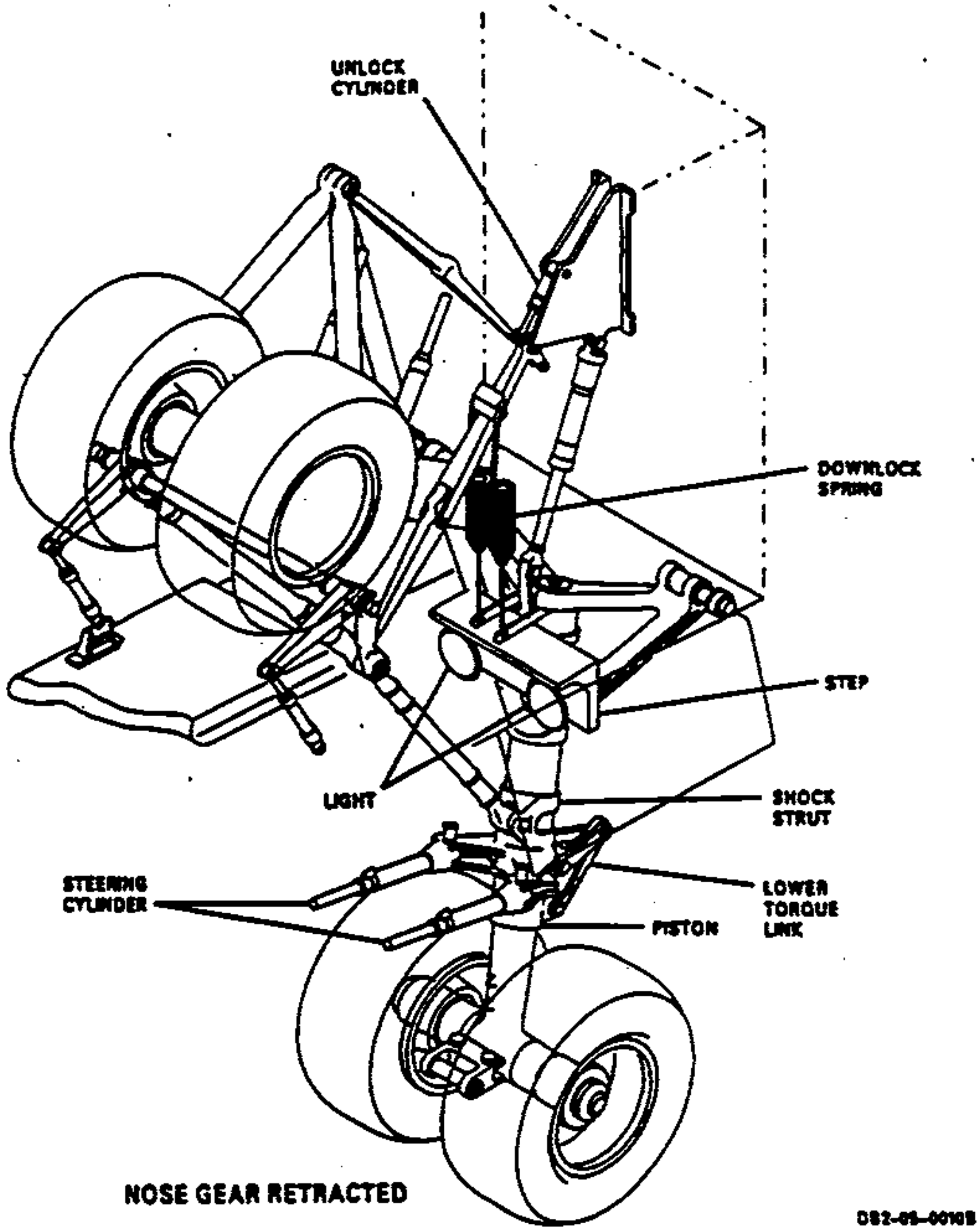
Subtask 05-51-03-210-002

C. Do a visual inspection of the main landing gear (MLG). If damage is found during the A-check inspection, do the B-check inspection of the MLG. Refer to HARD LANDING, B-check Inspection of the Aircraft After a Hard Landing.
(Ref. Fig. 603/TASK 05-51-03-990-803)
(Ref. TASK 05-51-03-200-802)



Nose Landing Gear - Inspection/Check
Figure 601/TASK 05-51-03-990-801

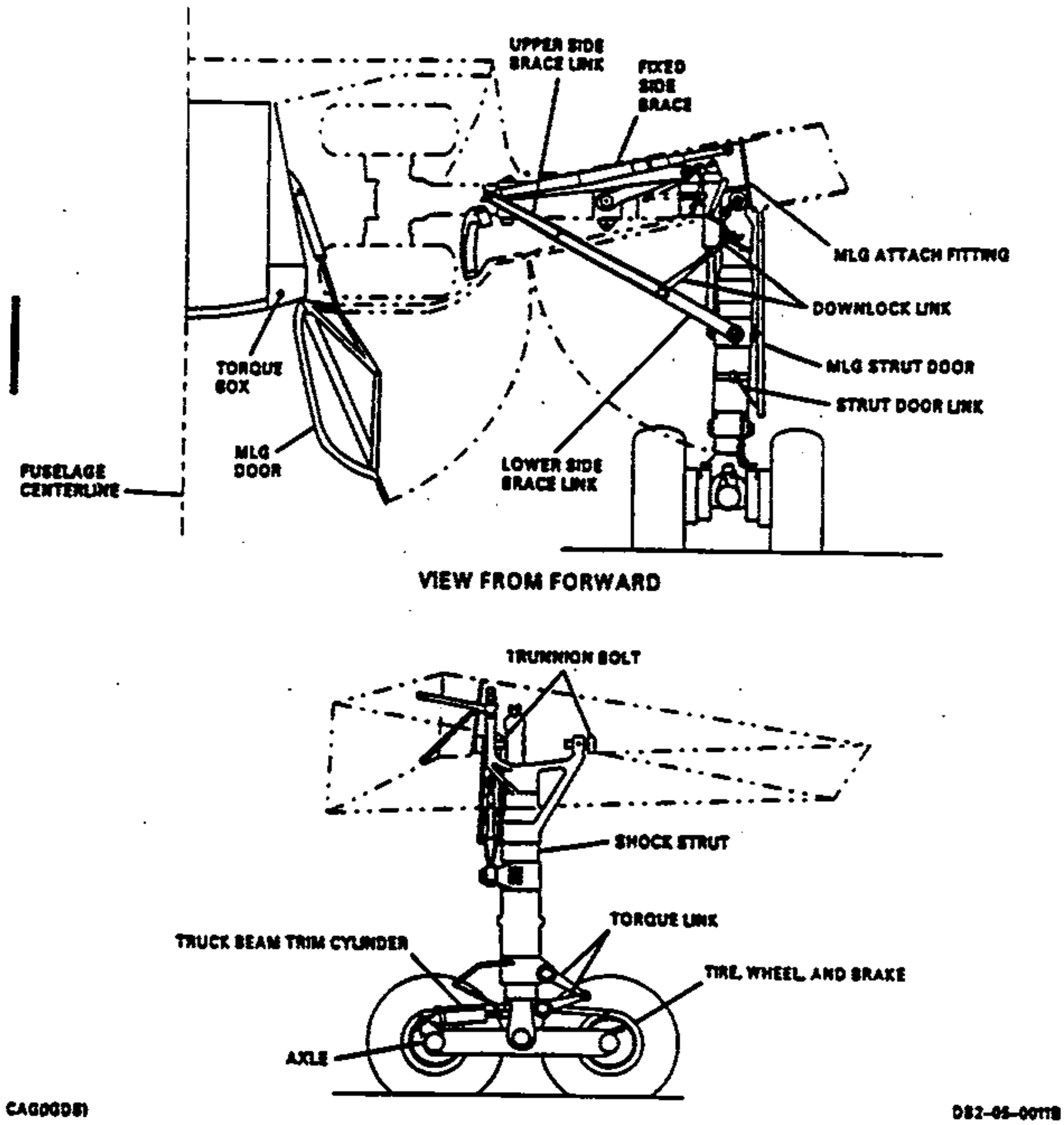
*** FOR ALL AIRCRAFT



CAG(IGDS)

Nose Landing Gear - Inspection/Check
Figure 602/TASK 05-51-03-990-802

*** FOR ALL AIRCRAFT



Main Landing Gear - Inspection/Check
Figure 603/TASK 05-51-03-990-803

*** FOR ALL AIRCRAFT

TASK 05-51-03-993-802
Main Landing Gear - A-Check Inspection

INSPECTION AREA	CHECK FOR
1 Shock strut, wheels, tires, truck beam, doors, door attachments and wheel well area	- Flaking paint - Twists or bends - Loose fasteners or fasteners not there - Cracked or broken parts - Fluid leaks.

Subtask 05-51-03-360-002

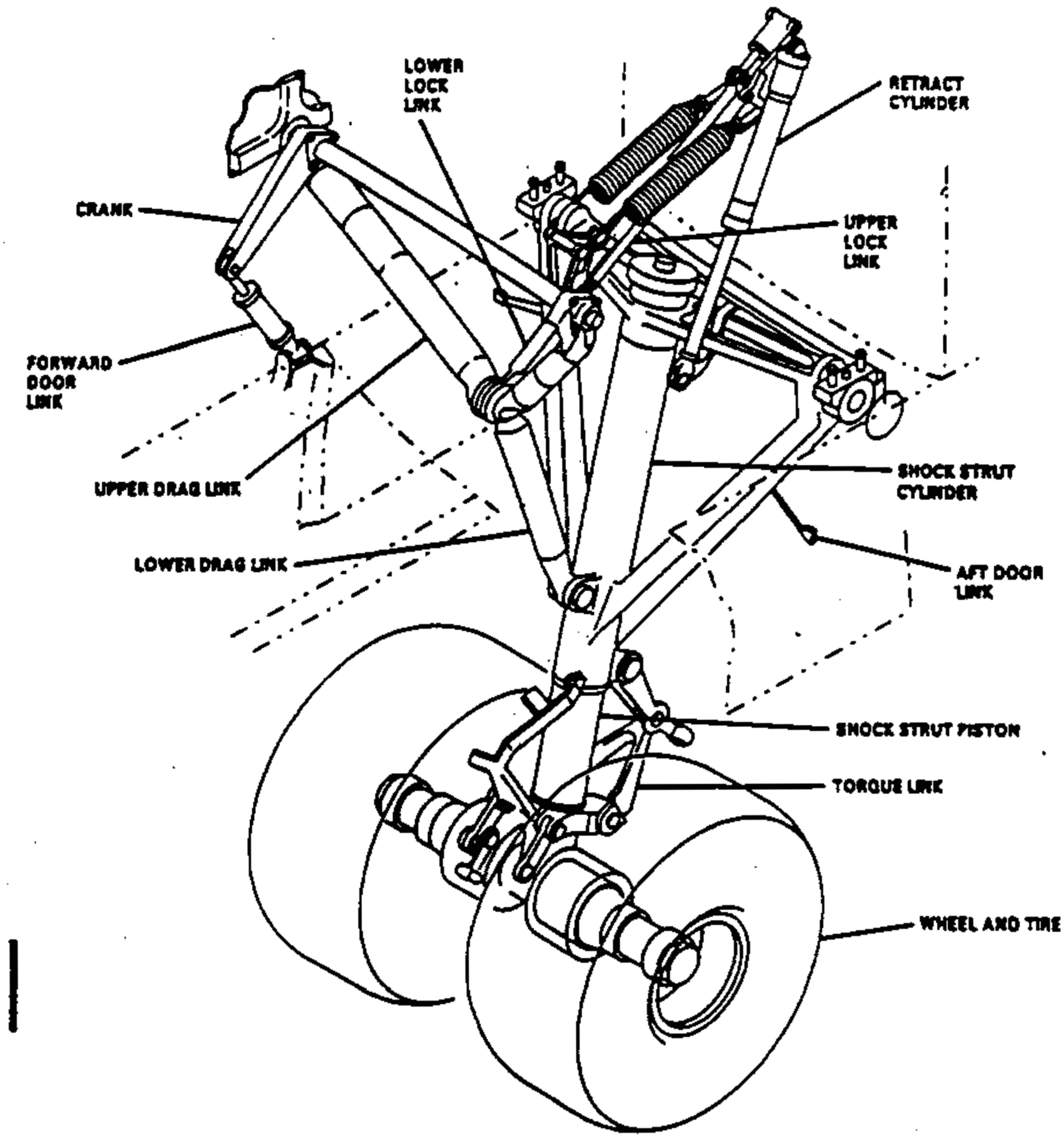
D. If necessary, repair the main landing gear (MLG). Refer to STRUT, MAIN LANDING GEAR SHOCK, Replacement of the Shock Strut Piston Seals - Spare Seals installed. Refer to STRUT, MAIN LANDING GEAR SHOCK, Replacement of the Shock Strut Piston Seals - Spare Seals not Installed.
(Ref. TASK 32-11-01-360-801)
(Ref. TASK 32-11-01-360-802)

Subtask 05-51-03-210-003

E. Do a visual inspection of the center landing gear (CLG). If damage is found during the A-check inspection, do the B-check inspection of the CLG. Refer to HARD LANDING, B-check Inspection of the Aircraft After a Hard Landing.
(Ref. Fig. 604/TASK 05-51-03-990-806)
(Ref. TASK 05-51-03-200-802)

TASK 05-51-03-993-803
Center Landing Gear - A-Check Inspection

INSPECTION AREA	CHECK FOR
1 CLG shock strut, wheels, brakes, tires, doors, door attachments and wheel well area	- Flaking paint - Twists or bends - Loose fasteners or fasteners not there - Cracked or broken parts - Fluid leaks.



Center Landing Gear - Inspection/Check
Figure 604/TASK 05-51-03-990-806

*** FOR ALL AIRCRAFT

Subtask 05-51-03-360-003

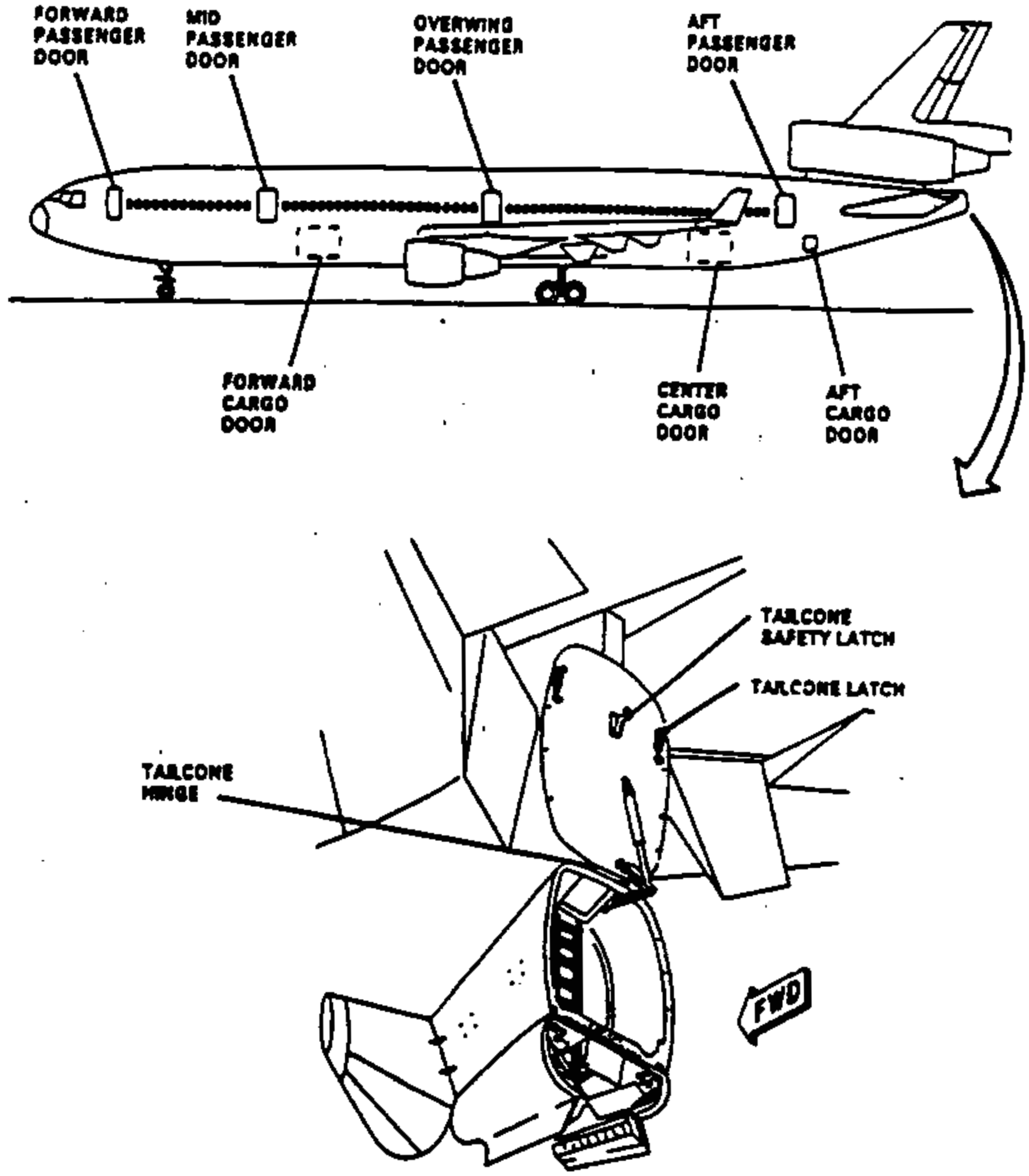
F. If necessary, repair the center landing gear (CLG). Refer to STRUT, CENTER LANDING GEAR SHOCK, Replacement of the CLG Shock Strut Piston Seals - Spare Seals installed. Refer to STRUT, CENTER LANDING GEAR SHOCK, Replacement of the CLG Shock Strut Piston Seals - Spare Seals not Installed.
(Ref. TASK 32-15-01-300-801)
(Ref. TASK 32-15-01-300-802)

Subtask 05-51-03-210-004

G. Do an A-check inspection of the fuselage. If damage is found during the A-check inspection, do the B-check inspection of the fuselage. Refer to HARD LANDING, B-check Inspection of the Aircraft After a Hard Landing.
(Ref. Fig. 605/TASK 05-51-03-990-808)
(Ref. Fig. 606/TASK 05-51-03-990-818)
(Ref. Fig. 607/TASK 05-51-03-990-811)
(Ref. TASK 05-51-03-200-802)

TASK 05-51-03-993-804
Fuselage - A-Check Inspection

	INSPECTION AREA	CHECK FOR
1	Lower half of fuselage external skin	- Twists, distortion or cracks - Loose fasteners or fasteners not there - Other signs of damage.
2	Around corners of openings of all entrances to service and cargo doors	- Twists, distortion or cracks - Loose fasteners or fasteners not there - Other signs of damage.
3	Tailcone safety latches and hinges located inside aft section of aircraft	- Extended fastener holes - Loose, broken or bent fasteners - Fasteners with heads not there.

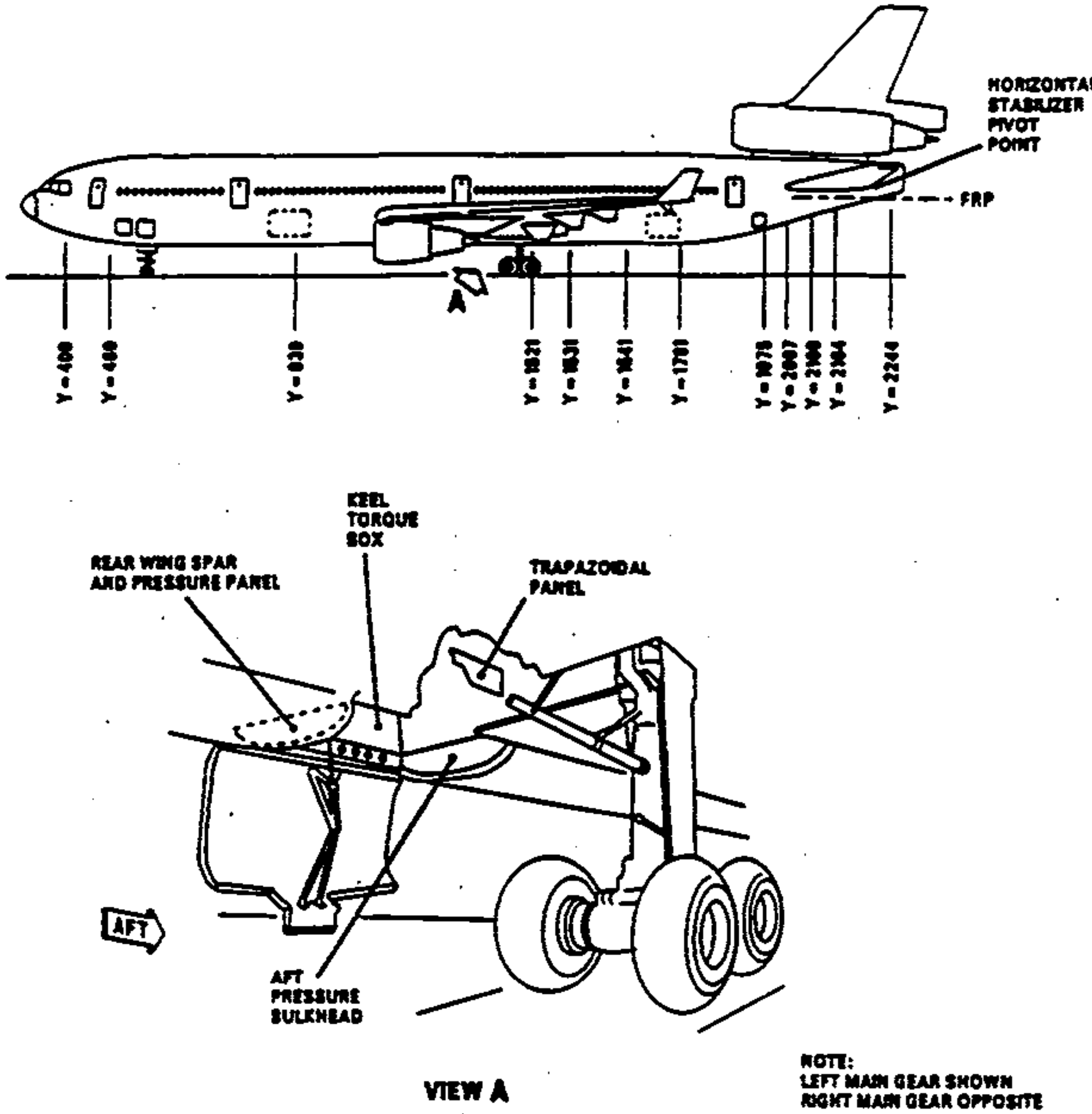


CAG(GDS)

DB2-05-0020A

Fuselage - Inspection/Check
Figure 605/TASK 05-51-03-990-808

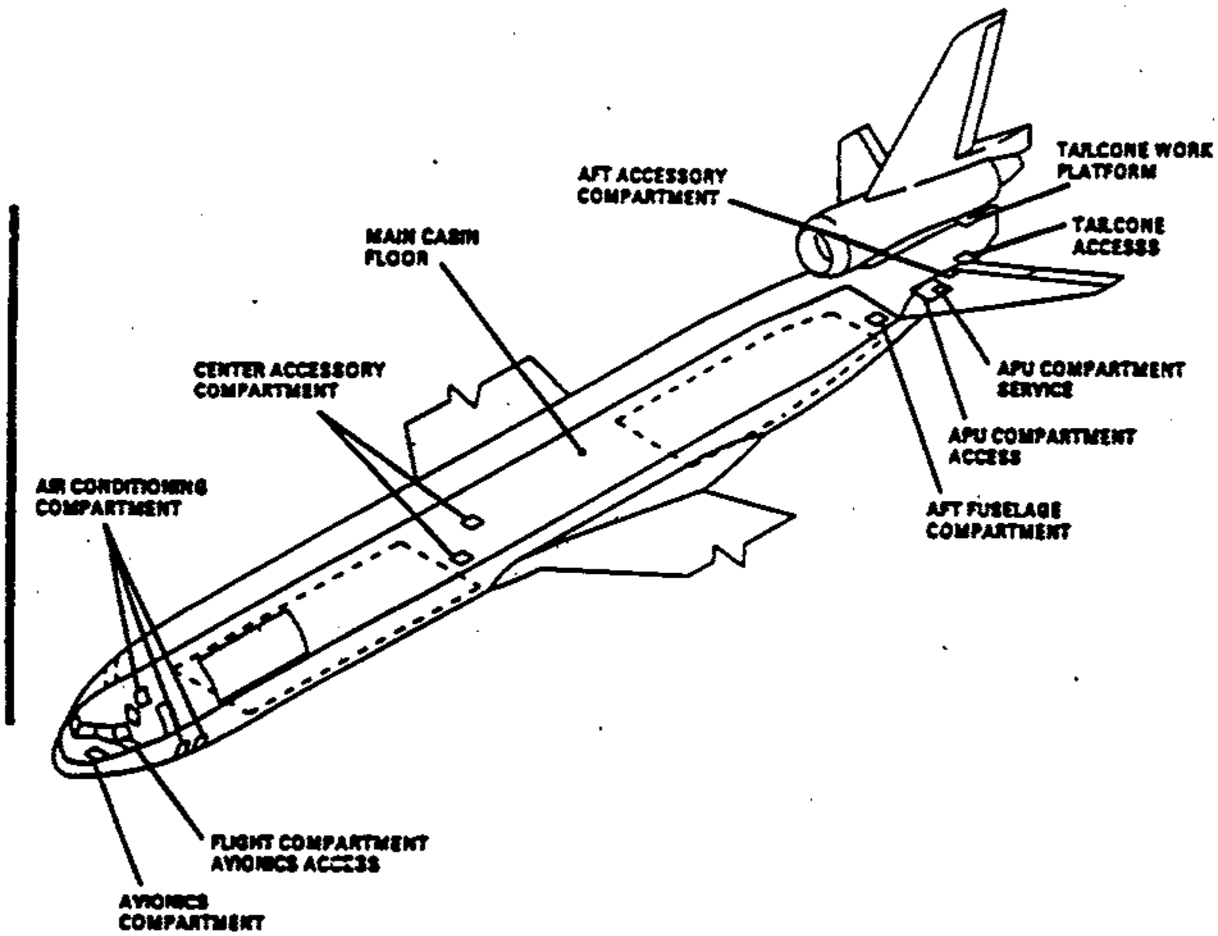
*** FOR ALL AIRCRAFT



CAG(GDB)

Fuselage - Inspection/Check
Figure 606/TASK 05-51-03-990-818

*** FOR ALL AIRCRAFT



Fuselage - Service and Access Doors - Inspection/Check
Figure 607/TASK 05-51-03-990-811

Subtask 05-51-03-210-007

H. Do an A-check inspection of the wing. If damage is found during the A-check inspection, do the B-check inspection of the wing. Refer to HARD LANDING, B-check Inspection of the Aircraft After a Hard Landing.
(Ref. Fig. 608/TASK 05-51-03-990-812)
(Ref. TASK 05-51-03-200-802)

TASK 05-51-03-993-805
Wing - A-Check Inspection

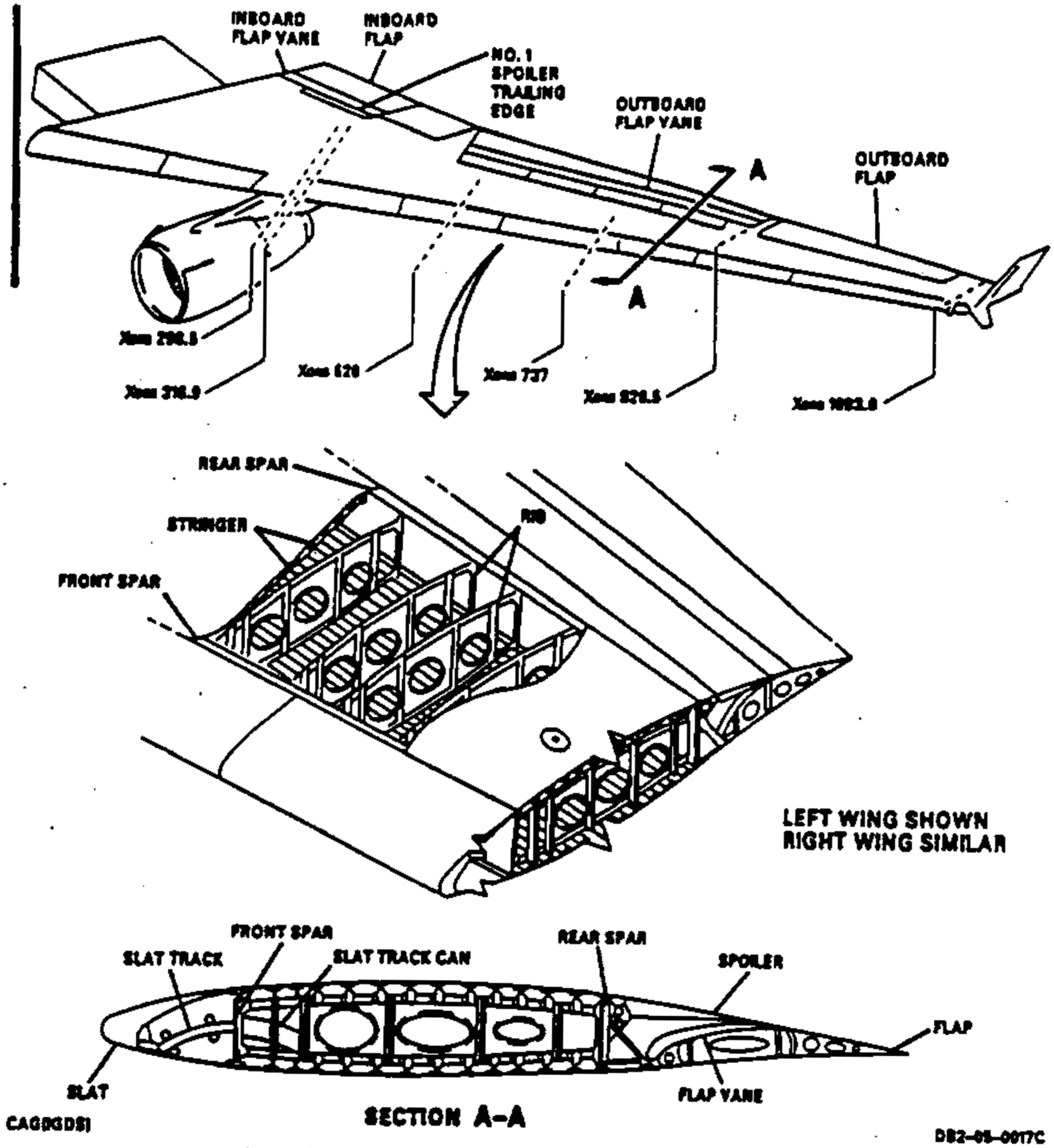
INSPECTION AREA		CHECK FOR
1	Lower wing skin, rear spar (adjacent to and inboard of MLG support fittings) external plate doublers	- Signs of fuel leaks - Loose fasteners or fasteners not there - Buckles, distortion and other signs of damage.

Subtask 05-51-03-210-008

I. Do an A-check inspection of the horizontal stabilizer. If damage is found during the A-check inspection, do the B-check inspection of the horizontal stabilizer. Refer to HARD LANDING, B-check Inspection of the Aircraft After a Hard Landing.
(Ref. Fig. 609/TASK 05-51-03-990-824)
(Ref. Fig. 610/TASK 05-51-03-990-830)
(Ref. TASK 05-51-03-200-802)

TASK 05-51-03-993-806
Horizontal Stabilizer Surfaces - A-Check Inspection

INSPECTION AREA		CHECK FOR
1	Stabilizer and elevators: function through full travel	- Interference, binding and signs of operational restrictions - Fuel leaks through spars or tank boundary bulkheads.

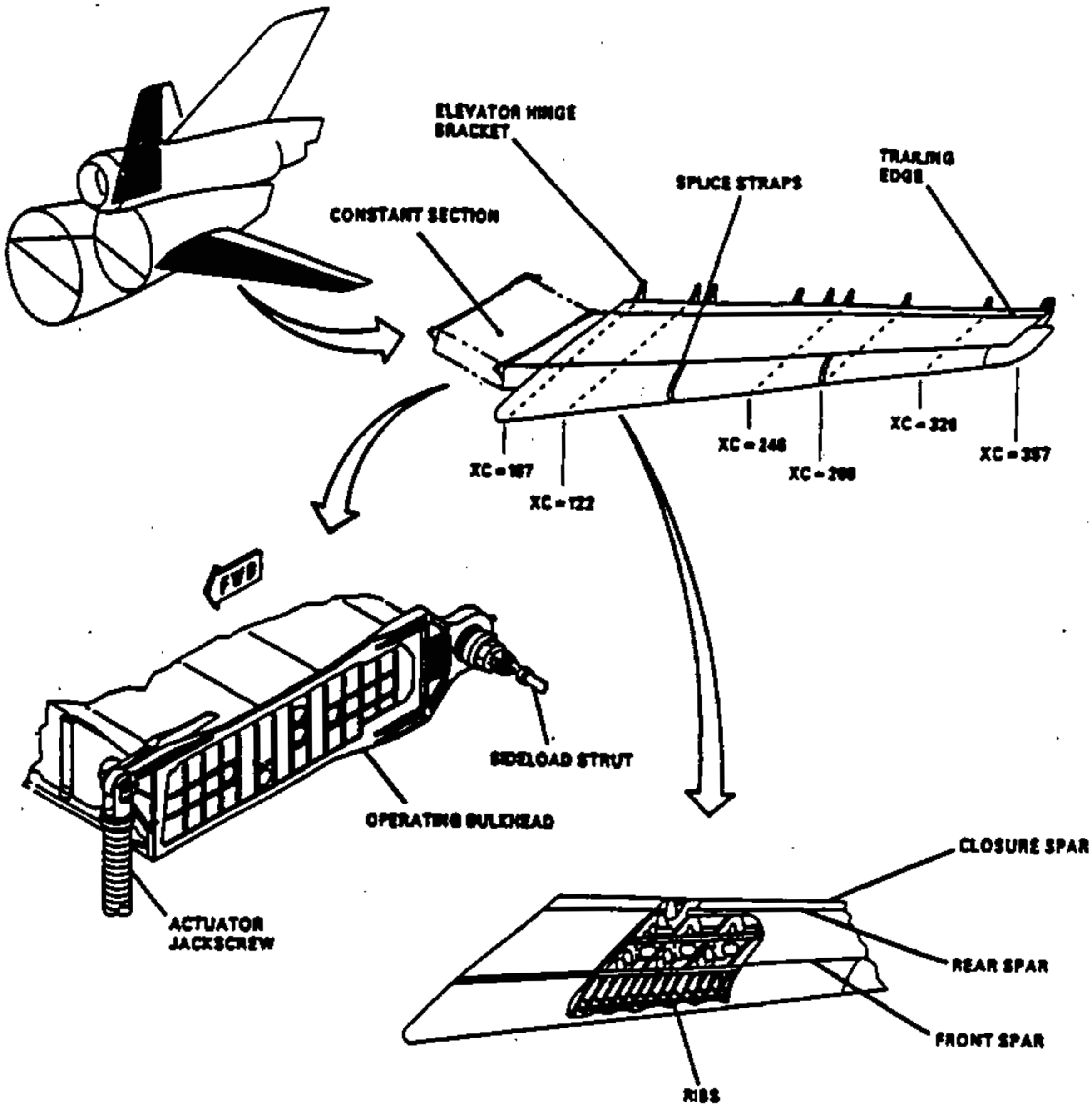


CAG(IGDS) DB2-05-0017C

Wing (External Area) - Inspection/Check
Figure 608/TASK 05-51-03-990-812

*** FOR ALL AIRCRAFT

EFF: AA ALL

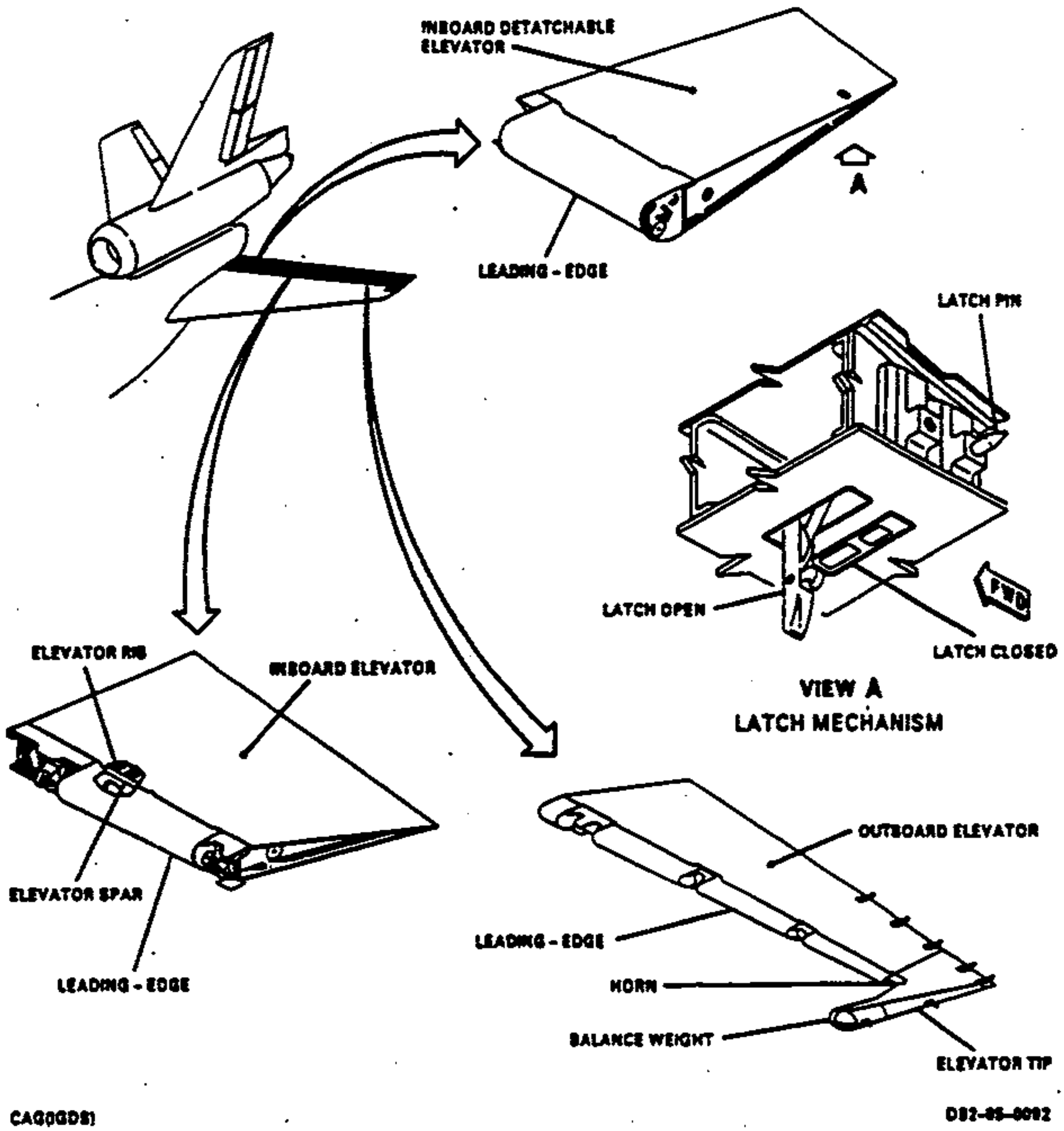


CAG(GDS)

DB2-05-0091

Horizontal Stabilizer Surfaces - Inspection/Check
Figure 609/TASK 05-51-03-990-824

*** FOR ALL AIRCRAFT



Horizontal Stabilizer Surfaces - Inspection/Check
Figure 610/TASK 05-51-03-990-830

*** FOR ALL AIRCRAFT

Subtask 05-51-03-210-009

J. Do an A-check inspection of the vertical stabilizer. If damage is found during the A-check inspection, do the B-check inspection of the vertical stabilizer. Refer to HARD LANDING, B-check Inspection of the Aircraft After a Hard Landing.
(Ref. Fig. 611/TASK 05-51-03-990-814)
(Ref. Fig. 612/TASK 05-51-03-990-821)
(Ref. TASK 05-51-03-200-802)

TASK 05-51-03-993-807
Vertical Stabilizer Surfaces - A-Check Inspection

INSPECTION AREA	CHECK FOR
1 Rudders	- Interference, binding and other signs of operational restrictions because of deformed structure, supports or mechanisms - All four sections function through full travel.

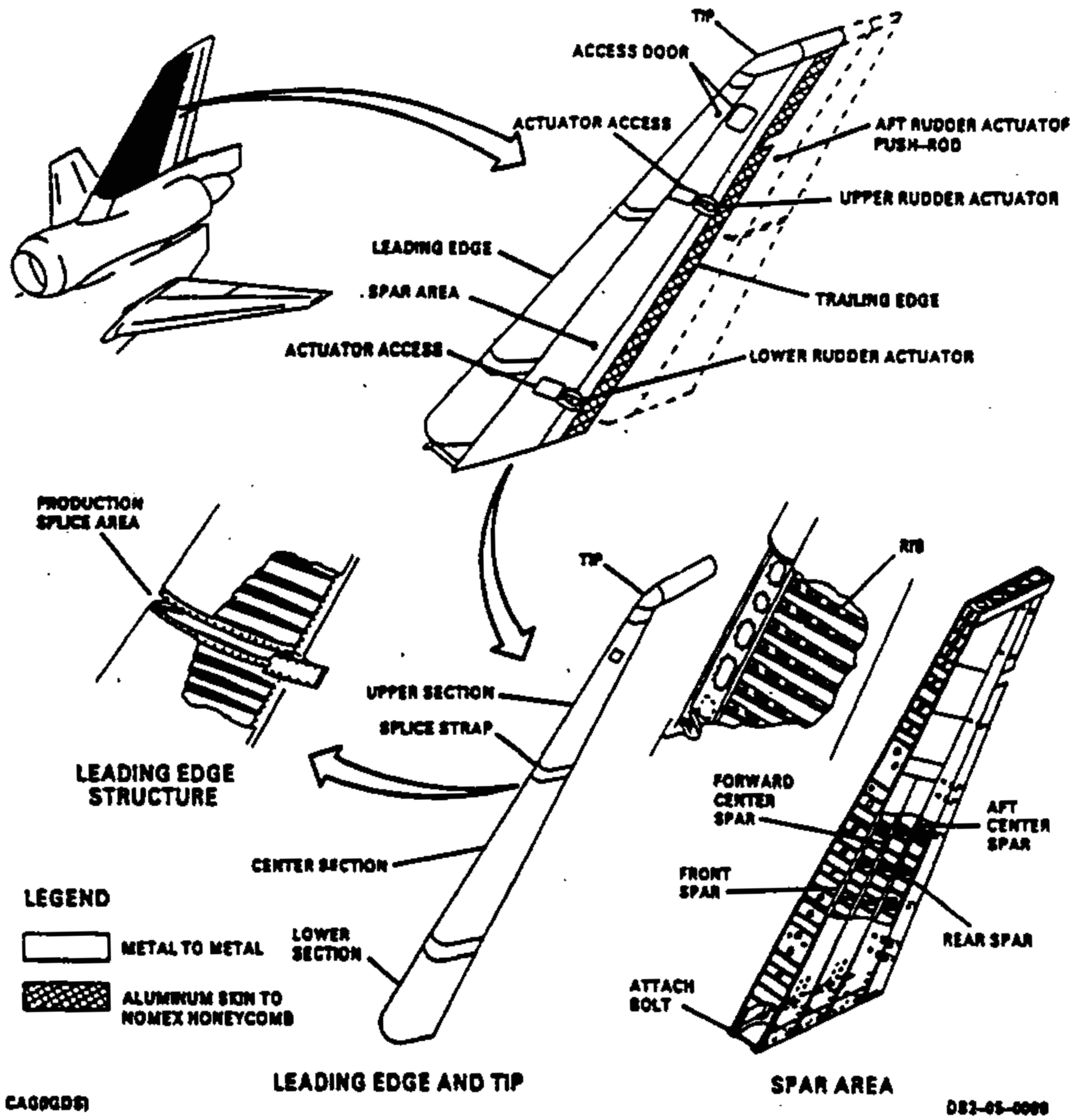
Subtask 05-51-03-210-010

WARNING: IF THE AIRCRAFT HAD A HARD LANDING, EXAMINE THE WING ENGINE PYLONS FOR STRUCTURAL DAMAGE. MAKE SURE THE INSPECTION IS DONE BEFORE THE AIRCRAFT GOES BACK INTO OPERATION. THIS WILL PREVENT INJURY TO PERSONS AND DAMAGE TO EQUIPMENT.

K. Do an A-check inspection of the nacelles and pylons. Refer to ENGINE FAILURE-OVERLOAD CONDITION, A-check Inspection of the Engine Pylons After an Engine Failure/Overload Condition.
(Ref. TASK 05-51-09-200-801)
(Ref. TASK 05-51-09-200-803)

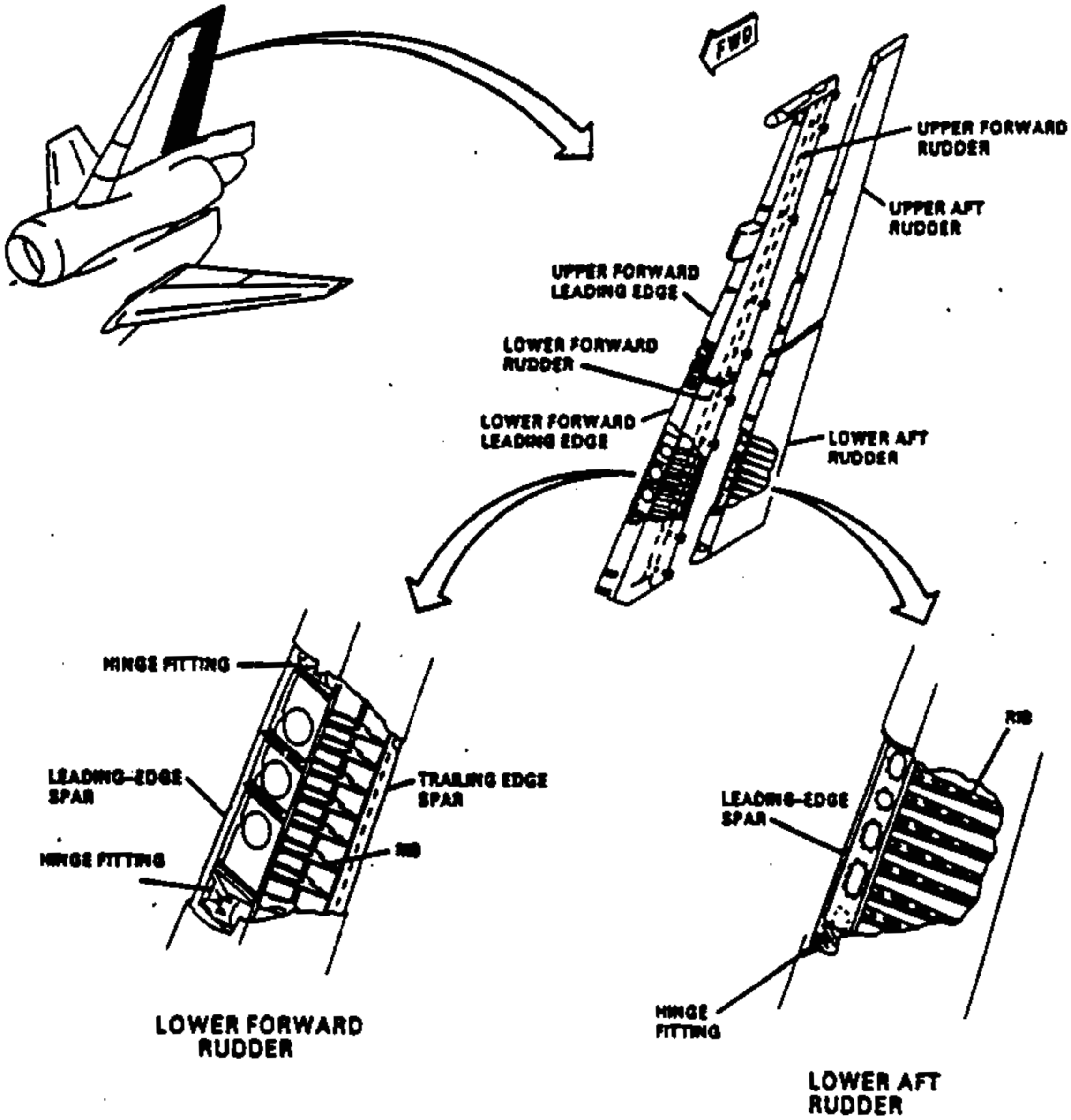
(1) If the aircraft has not had the terminating action to MD-11 Service Bulletin A54-49, Revision 1 or later accomplished, perform the respective inspection of the Upper Spar Angles stated in the Service Bulletin.

NOTE: If no damage is found to the aircraft structure and the wing pylons, a maximum of five flights is permitted on the tail pylon.



Vertical Stabilizer Surfaces - Inspection/Check
Figure 611/TASK 05-51-03-990-814

*** FOR ALL AIRCRAFT



CAG(GDS)

Vertical Stabilizer Surfaces - Inspection/Check
Figure 612/TASK 05-51-03-990-821

*** FOR ALL AIRCRAFT

4. Job Close-up - Hard landing Condition - A-Check Inspection

Subtask 05-51-03-942-001

A. Remove all the tools and equipment from the work area. Make sure the area is clean.

TASK 05-51-03-200-802
B-CHECK INSPECTION OF THE AIRCRAFT AFTER HARD LANDING

5. Job Set-up Information - Hard Landing Condition - B-Check Inspection

Subtask 05-51-03-943-002

A. Fixtures, Tools, Test and Support Equipment

NOTE: Equivalent replacements are permitted for the items that follow.

REFERENCE	DESIGNATION
Not specified	Work platform, 7-8 ft (2.1-2.4 m)
Not specified	Work platform, 20 ft (6.1 m)
Not specified	Work platform, 30 ft (9.1 m)
Not specified	Aerial boom, manlift

Subtask 05-51-03-946-002

B. Reference Information

REFERENCE	DESIGNATION
TASK 32-11-01-000-801 P/B 401	REMOVAL OF THE MAIN LANDING GEAR

Continued

REFERENCE	DESIGNATION
TASK 32-11-01-400-801 P/B 401	INSTALLATION OF THE MAIN LANDING GEAR
TASK 32-15-01-000-801 P/B 401	REMOVAL OF THE CENTERLINE LANDING GEAR ASSEMBLY
TASK 32-15-01-400-801 P/B 401	INSTALLATION OF THE CENTERLINE LANDING GEAR ASSEMBLY
TASK 32-21-01-000-801 P/B 401	REMOVAL OF THE NOSE LANDING GEAR
TASK 32-21-01-400-801 P/B 401	INSTALLATION OF THE NOSE LANDING GEAR

6. Job Set-up - Hard landing Condition - B-Check Inspection

Subtask 05-51-03-010-004

A. Make sure the applicable panels, floors, insulation, fillets, and other structure, are removed.

7. Procedure - Hard landing Condition - B-Check Inspection

Subtask 05-51-03-220-001

A. Do a B-check inspection of the nose landing gear (NLG).
(Ref. Fig. 601/TASK 05-51-03-990-801)
(Ref. Fig. 602/TASK 05-51-03-990-802)

Subtask 05-51-03-020-004

B. If damage was found on the A-check and cannot be repaired, remove the nose landing gear. Refer to GEAR, NOSE LANDING, Removal of the Nose Landing Gear.
(Ref. TASK 32-21-01-000-801)

TASK 05-51-03-993-809
Nose Landing Gear - B-Check Inspection

INSPECTION AREA	CHECK FOR
1 Wheel assemblies (disassemble as necessary)	- Deformed, cracked or bent wheel rim.
2 Drag links (disassemble as necessary)	- Distorted links caused from bending, twisting or stretching - Cracks - Elongated holes - Deformed attachments.

Subtask 05-51-03-420-001

C. If necessary, install the nose landing gear. Refer to GEAR, NOSE LANDING, Installation of the Nose Landing Gear. (Ref. TASK 32-21-01-400-801)

Subtask 05-51-03-220-002

D. Do a B-check inspection of the main landing gear (MLG).
(Ref. Fig. 603/TASK 05-51-03-990-803)
(Ref. Fig. 606/TASK 05-51-03-990-818)

Subtask 05-51-03-020-005

E. If damage was found on the A-check and cannot be repaired, remove the main landing gear. Refer to GEAR, MAIN LANDING, Removal of the Main Landing Gear. (Ref. TASK 32-11-01-000-801)

TASK 05-51-03-993-810
Main Landing Gear - B-Check Inspection

INSPECTION AREA	CHECK FOR
1 Wheel well area: trapezoidal panel	- Buckled or distorted members - Elongated fastener holes - Broken or bent attachments.

Continued

INSPECTION AREA		CHECK FOR
2	Wheel well area: keel frame, torque box and attachment to wing rear spar	- Buckled or distorted members - Elongated fastener holes - Broken or bent fasteners or fasteners not there.
3	Wheel well area: aft pressure bulkhead at Y=1521	- Buckled and distorted flanges and stiffeners - Wrinkled, distorted or torn webs - Loose, broken or bent fasteners or fasteners not there - Elongated fastener holes - Cracks.
4	Support bulkhead	- Cracks, buckles and wrinkles in webs - Cracks, buckles and deformed bulkhead caps and stiffeners - Cracked and deformed shear clips - All members for elongated fastener holes - Loose, broken or bent fasteners or fasteners not there.
5	If the main landing gear was removed due to damage, do step 6. (R)	
6	Support fitting and support structure	- Signs of interference between gear structure during cycle (clearances are critical) - Signs of deformed pivot lugs, pivot pins and other components.

Subtask 05-51-03-420-002

F. If necessary, install the main landing gear. Refer to GEAR, MAIN LANDING, Installation of the Main Landing Gear. (Ref. TASK 32-11-01-400-801)

Subtask 05-51-03-220-003

G. Do a B-check inspection of the center landing gear (CLG). (Ref. Fig. 604/TASK 05-51-03-990-806)

Subtask 05-51-03-020-006

H. If damage was found on the A-check and cannot be repaired, remove the center landing gear. Refer to GEAR, CENTER LANDING, Removal of the Center Landing Gear Assembly. (Ref. TASK 32-15-01-000-801)

TASK 05-51-03-993-811
Center Landing Gear - B-Check Inspection

INSPECTION AREA		CHECK FOR
1	Wheel well area: keel torque box and backup structure	- Buckled and distorted members, flanges and stiffeners - Wrinkled, distorted or torn webs - Loose, broken or bent fasteners or fasteners not there - Elongated fastener holes - Cracks.
2	Support bulkhead	- Cracks, buckles and wrinkles in web - Cracked, buckled and deformed bulkhead caps and stiffeners - Cracked or deformed shear clips - Elongated fastener holes in all members - Loose, broken or bent fasteners or fasteners not there.

Subtask 05-51-03-420-003

I. If necessary, install the centerline landing gear. Refer to GEAR, CENTER LANDING, Installation of the Center Landing Gear Assembly. (Ref. TASK 32-15-01-400-801)

Subtask 05-51-03-220-004

J. Do a B-check inspection of the fuselage.
(Ref. Fig. 605/TASK 05-51-03-990-808)
(Ref. Fig. 606/TASK 05-51-03-990-818)
(Ref. Fig. 607/TASK 05-51-03-990-811)

NOTE: If there is structural damage to the fuselage, refer to the MD-11 Structural Repair Manual (SRM).

TASK 05-51-03-993-812
Fuselage - B-check Inspection

INSPECTION AREA	CHECK FOR
1 External fuselage skin and fasteners in these areas:	- Wrinkles, buckles, cracks or tears in skin - Elongated fastener holes - Loose, broken or bent fasteners or fasteners with heads not there.
a Y=400 to Y=460, around ram air intake ducts	
b Y=939 to Y=1541, fully around fuselage, including keel	
c Y=1541 to Y=2007 area below main cabin floor	
d Y=2100 to Y=2164, around horizontal stabilizer pivot point	
R e Around corners of openings for all entrances to service and cargo doors and a radius of 25 in. (63.5 cm) minimum from corner of each door	

Continued

INSPECTION AREA		CHECK FOR
2	Center accessory compartment: pressure panel under wing front spar	- Cracks, distortion and elongated fastener holes in all members - Broken or bent fasteners or fasteners not there.
3	Center accessory compartment: fuselage skin	- Cracks and distortion around cutouts.

Subtask 05-51-03-220-005

K. Do a B-check inspection of the wing. (Ref. Fig. 608/TASK 05-51-03-990-812)

<u>NOTE</u>: If there is structural damage to the wing, refer to the MD-11 Structural Repair Manual (SRM).

TASK 05-51-03-993-813
Wing - B-check Inspection

INSPECTION AREA		CHECK FOR
1	Wing main torque box structure adjacent to fuel leaks found in A-check inspection	- Cracked or deformed shear clips - Cracked, bowed or deformed stringers - Cracked, deformed or elongated attachment holes - Bowed or buckled spar or bulkhead stiffeners - Cracks in spar caps or bulkheads - Loose, broken or bent fasteners or fasteners not there - Fuel leaks through spars or tank boundary bulkheads.

Subtask 05-51-03-220-006

L. Do a B-check inspection of the horizontal stabilizer.
(Ref. Fig. 609/TASK 05-51-03-990-824)
(Ref. Fig. 610/TASK 05-51-03-990-830)

<u>NOTE</u>: If there is structural damage to the horizontal stabilizer and elevators, refer to the MD-11 Structural Repair Manual (SRM).

TASK 05-51-03-993-814
Horizontal Stabilizer Surfaces - B-Check Inspection

INSPECTION AREA		CHECK FOR
1	Outboard elevator skins	- Buckles and wrinkles in skin - Cracks and deformation in trailing-edge member - Elongated fastener holes - Broken or bent fasteners or fasteners not there.
2	Horizontal stabilizer	- Fuel leaks through spars or tank boundary bulkheads.

Subtask 05-51-03-220-007

M. Do a B-check inspection of the vertical stabilizer.
(Ref. Fig. 611/TASK 05-51-03-990-814)
(Ref. Fig. 612/TASK 05-51-03-990-821)

<u>NOTE</u>: If there is structural damage to the vertical stabilizer and rudders, refer to the MD-11 Structural Repair Manual (SRM).

TASK 05-51-03-993-815
Vertical Stabilizer Surfaces - B-Check Inspection

	INSPECTION AREA	CHECK FOR
1	Lower vertical stabilizer: external skin panels and structural doors bound by No. 3 and No. 4 banjo frames and tail pylon upper and lower spars (No. 3 banjo is extension of vertical aft center spar and No. 4 banjo is extension of rear spar)	- Wrinkles, buckles, cracks and elongated attachment holes in skin and doors - Loose, bent or broken fasteners or fasteners not there.
2	Lower vertical stabilizer No. 4 banjo frame	- Buckles, cracks and deformed inboard and outboard ring flanges and transverse stiffeners - Buckles and wrinkles in ring webs - Fillet cracks - Elongated fastener holes in outboard flanges.
3	No. 2 engine inner duct skin between No. 2 and No. 3 banjo frames	- Wrinkles - Elongated holes in skin - Loose, broken or bent fasteners or fasteners not there.
4	No. 2 engine inner duct skin between No. 3 and No. 4 banjo frames	- Increase or decrease of correct clearance between structure and acoustical panels.

8. <u>Job Close-up - Hard landing Condition - B-Check Inspection</u>

Subtask 05-51-03-410-003

A. Install the applicable panels, floors, insulation, fillets and other structure.

Subtask 05-51-03-942-002

B. Remove all the tools and equipment from the work area. Make sure the area is clean.

EA 5330-M+1-21224
PG 3 OF 9

FEDERAL EXPRESS CORPORATION
Aircraft Structures Engineering
3101 Tchulahoma
Memphis, TN 38118

FAX TRANSMITTAL SHEET

Date: JANUARY 4, 1994

FROM:

Name: Mark Yerger

Phone: (901) 369-2654

Fax Phone: (901) 360-9551

4 Page(s) including transmittal sheet

TO:

Company: DOUGLAS

Name: STEVE YOUNG

Phone: (310) 593-9312

Fax Phone:

MESSAGE:

OUR MD-11 N611FE, FUS. NO. 553, WAS INVOLVED IN A HARD LANDING INCIDENT ON 1/4/94. AIRCRAFT HAD 952 HOURS AND 236 CYCLES AT THE TIME OF THE EVENT. A HARD LANDING INSPECTION HAS BEEN CONDUCTED.

KEY INFORMATION:

1. AIRCRAFT LANDING WEIGHT: 427,200 LBS
   AIRCRAFT C.G. 34.4
   MAX VERT ACCEL +2.85G
   MAX LAT ACCEL -0.45G

AF15510

2.

A HARD LANDING INSPECTION HAS BEEN CONDUCTED IN IAW WITH MD-11 MM 05-51-03. THE FOLLOWING WERE NOTED:

1. MILD TO MODERATE BUCKLING OF THE EXTERNAL SKIN AND STRINGERS FROM LONGERON 36 TO LONGERON 48, STATION 595 BULKHEAD TO APPROX. STA. 625, LEFT AND RIGHT SIDES. SEE ATTACHED SKETCH (ATCH 1). MAXIMUM DEPTH APPROX. 0.10 INCH AT THE LOWEST BUCKLE ON THE L/H SIDE. ALL DEFORMATIONS ARE SMOOTH WITH NO CREASES. SUSPECT AREAS WERE VERIFIED TO BE CRACK-FREE VIA EDDY CURRENT SURFACE PROBE. SKIN AND STRINGERS WERE ALSO VISUALLY INSPECTED FROM THE INSIDE. NO DEFECTS NOTED.

   PER DOUGLAS RECOMMENDATION, THE BULKHEAD AT STA. 595 WAS INSPECTED FOR DAMAGE. THE LOWER TEE CAP WAS INSPECTED VIA EDDY CURRENT SURFACE PROBE. A VISUAL INSPECTION OF THE FORWARD AND AFT FACE OF THE BULKHEAD FROM LONGERON 36 LEFT TO 36 RIGHT WAS CONDUCTED TO

FEDERAL EXPRESS

FOLLOW UP
ACTION REQUIRED

21224

EA# 5330-M-11-

RELEASE DATE 1-7-94

ENGINEERING AUTHORIZATION

PAGE 1 OF 9

AUDITED/ENTERED
BY: NO. 97226
DATE:

TITLE

FUSELAGE - Plates/Skin - Inspection/Repair Actions Due to Hard Landing

EFFECTIVITY		FUNCTION:		SIGNATURES:
Registry, Asset or Engine No.	N611FE		Manual Change	[redacted] Engineer
Unit Description	Fuselage, Sta 595-623, L39-48, both sides		Material Change	[redacted] Manager
			Alteration	
		X	Repair	
Mfg. P/N	N/A		Other	FAA or designee (if required)
Serial No.	N/A			

CLASSIFICATION (Alterations or repairs only)

X Major

__ Minor

REVISION RECORD:

Rev.	A		
Date	4/19/94		
Engr	AB Benjamin		
Mgr.	MSG		
FAA or designee (if required)			

MACH
EM NO. ________

REFERENCES:

1. FEDEX E.A. 0550-M11-21299
2. Fedex Fax (M. Yerger) to DAC, 1-4-94 with attachments
3. Fedex Fax (A. Benjamin) to DAC, 1-6-94
4. DAC Msg SVC-MEM-0014/SFY 11-53-00-00, 1-6-94 (FAA approval - attached)
5. (Rev A) DAC MsgSVC-MEM-0124/SFY

INSTRUCTIONS:

N611FE, DAC Fuselage 553, received fuselage damage aft of the nose gear during a hard landing caused by wind shear/turbulence on 1-4-93. The damage was documented in Ref 2. An inspection IAW the MD-11 Maintenance Manual was directed by Ref. 1. Ref. 3 requested and Ref. 4.provided FAA approval for continued operation of the aircraft subject to the constraints listed below.

PRIOR TO FURTHER FLIGHT:

1. Assure inspection per Ref. 1 has been accomplished.

2. Ensure that a swing of the nose landing gear IAW the MD-11 Maintenance Manual, Chapter 32, has been satisfactorily conducted to assure that there is no binding or noticeable unusual noises.

3. The nose gear has been visually inspected and no problems noted. However, an AML entry should be made and maintained for 30 days after return to service to alert flight crews to monitor the nose landing gear during takeoffs and landings for shimmy or any other problem which could indicate damaged components as a result of the hard landing.

AF15508

FOLLOW UP
ACTION REQUIRED

FEDERAL EXPRESS CORPORATION

ENGINEERING AUTHORIZATION

E.A.#: 1-5310-22681
Release Date: 11-6-94
Page 1 of 1

FUSELAGE- TAIL STRIKE- TEMPORARY REPAIR FOR ONETIME FERRY FLIGHT

Registry No. N611FE	RELEASE SIGNATURES	Rev A Date:	Rev B Date:	FUNCTION:
Nomenclature: SKIN AND BULKHEAD	Engineer: CRAIG IVANY [redacted]	Engr	Engr	Minor Repair
				Minor Alteration
Part Number:	Manager: JACK SPRING[redacted]	Mgr	Mgr	Major Repair X
				Major Alteration
Serial Number:	FAA/Designee:	FAA	FAA	Manual Change
				Material Change
Hours/Cycles: 3,968/922		Is this SFAR 36? NO	Is Follow-up Req'd? YES	Other

REASON/DISCREPANCY: During landing in Anchorage the subject aircraft dragged its tail causing the following damage. The fuselage skin was damaged from longeron 50R to 51L, Sta 1882 to 2040. The Sta 2007 bulkhead was also damaged from X=-24 to X=24. The center 3 vert. floor supports at sta 1975 and 1 vert. support at sta. 1987, X=0 were also found to be damaged. The subject damaged area was inspected and all shear clips and longerons are intact but slightly deformed. The tail drag inspection was accomplished and no other damage was found other than noted above.

REFERENCES: Note: For major repairs/alterations, this EA must be FAA approved or must reference previously approved data. For minor changes which affect manufacturer's limits, this section should contain substantiating information or reference attached documentation.

DAC TELEX ISC-MEM-0002/SFY
FAA 8110-3 DATED 11-7-94
SRM 51-38-01 vol. II

ACTIONS: Perform a temporary repair to the damaged skin to enable the aircraft to ferry to LAX for permanent repair as follows:	MECHANIC	CHECK BY
1. Fab a doubler from .080" 2024-T3 matl. from longeron 49R to 50L, sta. 1871 to 1997.75.		
2. Fab a doubler from .080" 2024-T3 matl. from longeron 50R to 50L, sta. 1997.75 to 2047.6. Cut out access hole in tail to match existing cutout.		
3. locate repair doublers in place, pick up existing fastener holes in longerons, shear clips and splice at sta. 1997.75. Add fasteners as required to pick up a min. of 2 rows of fasteners around entire perimeter of damaged area.		
4. Install doublers using 3/16" dia. bolts in longerons and fastener rows adjacent to Butt splice at sta. 1997.75. Install 3/16 cherry max rivets at all other locations.		
5. All other remaining damage is acceptable for a one time non-revenue unpressurized ferry flight from anchorage to LAX for permanent repair. Permanent repair to be addressed by future Engineering Authorization.		

Follow-up Tracking Entered by:	Emp. No.:	Date:	
A. FINAL/INTERIM Action Accomplished by:	Emp. No.:	Date:	Ref.: WRI/Non-Routine
B. FOLLOW-UP Action Accomplished by: (If Required)	Emp. No.:	Date:	Ref.: WRI/Non-Routine

FedEx M-165 (SH1) 10/94 FedEx Reprographics Services

AF15382

Updated [illegible]

FEDERAL EXPRESS

SPECIAL OR NONROUTINE MAINTENANCE FORM

PRINT CLEARLY. USE BLACK INK, BALLPOINT PEN ONLY. NO. S0006

1. ACFT NUMBER/SERIAL NO.	2. DATE	3. GENERATING ITEM	4. WHEN DISCOVERED/ MALFUNCTION CODE	5. EMPLOYEE NO./CERT. NO.
611FE	07/28/94	53-30/301	0006	2888

6. DISCREPANCY
LMPI - Fuselage - Plates/skin - Insp./Repair Actions Due To Hard Landing Insp. Every 1750 Hrs or 6 Months.

6A. RECOMMENDED ACTION
See LMPI + EA 5330-M11-21224 for Work Instructions

AUDITED/ENTERED BY: NO 97[illegible]

7. CORRECTIVE ACTION
Visually Insp Forward sec of 611FE [illegible] W 8/11 RII ☐
EA - Found 2 Rivets on Left side and 2 Rivets on Rt side to be in question. Awaiting on Engineering decision.
[illegible] 38459 8-6-94 10 Hrs. Above noted fasteners are Authorized for Continued Service Per EA# 5330-M11-21039 till next "C" Check

8. MECHANIC SIGNATURE	9. EMPLOYEE NO./CERT. NO.	10. DATE	11. WORK CENTER/VENDOR
[redacted]	13555	08/06/94	146 00
12. RII BUY BACK	**13. EMPLOYEE NO./CERT. NO.**	**14. DATE**	**15. WORK CENTER/VENDOR**
16. TOTAL MAN-HOURS	**17. ATA/SUBCHAPTER**	**18. DATA ENTERED**	**19. RELIABILITY CONTROL NO.**
150		AUDITED/ENTERED BY: NO. 94521 DATE: 8/18	E 77703

F-ME: M-1805 8/92 LOGOS #135512

```
AIRCRAFT 611 DISCREPANCY NUMBER 301      (MCDO)

LMPI  611  53-30  301  19APR  MC1  OPEN   LOG:000000  EMP:064415    R
     1 ***  LINE MAINTENANCE PLANNING ITEM ***
     2 ********************************************************************
     3   FUSELAGE - PLATES/SKIN - INSP./REPAIR ACTIONS DUE TO HARDLANDING
     4                        INSP. EVERY 1750 FLT HRS.OR 6 MONTH.
     5 //////////////////////////////\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\
     6 INSTRUCTIONS: VISUALLY INSP. DAMAGE AREA OF SKIN BETWEEN STA. Y-595 AND
     7               Y-615, LONGERONS 36 TO 48 (BOTH SIDES OF FUSELAGE) AT
     8               INTERVALS NOT TO EXCEED 1750 FLT. HRS.  THIS INSP. IS TO
     9               BE CONDUCTED BOTH EXTERNALLY AND INTERNALLY, LOOKING FOR
    10               EVIDENCE OF SKIN CRACKS OR FASTENER FAILURE. (SEE E.A.
    11               FOR FULL DETAILS)
    12 *
    13 REPAIR:      PERMANENT REPAIR NO LATER THAN THE NEXT "C" CHECK.
    14 //////////////////////////////\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\
    15 REINSP. NLT 3,241 A/C HRS.
 SGN   15JUN  19:08  ME1               LOG:000000  EMP:064415
UNAS   16JUN  18:49  ME1               LOG:000000  EMP:000000
***** END OF DISPLAY ******************************************************
```

AF15287

FEDERAL EXPRESS

21224

FOLLOW UP
ACTION REQUIRED

ENGINEERING AUTHORIZATION

EA# 5330-M-11-
RELEASE DATE 1-7-94
PAGE 1 OF 9

AUDITED/ENTERED
BY: NO. 97226
DATE: 8/11/94

TITLE
FUSELAGE - Plates/Skin - Inspection/Repair Actions Due to Hard Landing

EFFECTIVITY

Registry, Asset or Engine No. N611FE
Unit Description Fuselage, Sta 595-623, L39-48, both sides
Mfg P/N N/A
Serial No. N/A

FUNCTION:

___ Manual Change
___ Material Change
___ Alteration
X Repair
___ Other

CLASSIFICATION (Alterations or repairs only)

X Major
___ Minor

SIGNATURES:

[redacted]
Engineer
[redacted]
Manager

FAA or designee (if required)

REVISION RECORD:

Rev.	A		
Date	4/19/94		
Engr	AG Benjamin		
Mgr.	MG		
FAA or designee (if required)			

$0006

ATA ITEM NO. 53-30/301

REFERENCES

1. FEDEX E.A. 0550-M11-21299
2. Fedex Fax (M. Yerger) to DAC, 1-4-94 with attachments
3. Fedex Fax (A. Benjamin) to DAC, 1-6-94
4. DAC Msg SVC-MEM-0014/SFY 11-53-00-00, 1-6-94 (FAA approval - attached)
5. (Rev A) DAC MsgSVC-MEM-0124/SFY

INSTRUCTIONS

N611FE, DAC Fuselage 553, received fuselage damage aft of the nose gear during a hard landing caused by wind shear/turbulence on 1-4-93. The damage was documented in Ref 2. An inspection IAW the MD-11 Maintenance Manual was directed by Ref. 1. Ref. 3 requested and Ref. 4.provided FAA approval for continued operation of the aircraft subject to the constraints listed below.

PRIOR TO FURTHER FLIGHT:

1. Assure inspection per Ref. 1 has been accomplished.

2. Ensure that a swing of the nose landing gear IAW the MD-11 Maintenance Manual, Chapter 32, has been satisfactorily conducted to assure that there is no binding or noticeable unusual noises.

3. The nose gear has been visually inspected and no problems noted. However, an AML entry should be made and maintained for 30 days after return to service to alert flight crews to monitor the nose landing gear during takeoffs and landings for shimmy or any other problem which could indicate damaged components as a result of the hard landing.

AF15289

FOLLOW UP
ACTION REQUIRED

FOLLOW UP:

1. Until a permanent repair is accomplished, visually inspect damaged area of skin between stations Y=595 and Y=615, longerons 36 to 48 (both sides of fuselage) at intervals not to exceed 350 flight hours. This inspection is to be conducted both externally and internally, looking for evidence of skin cracks or fastener failure. Discrepancies found must be dispositioned through DAC prior to further flight. (Aircraft Structures Engineering will coordinate this activity.)

2. If an additional hard landing is encountered, prior to further flight contact DAC for additional inspection requirements. (Aircraft Structures Engineering will coordinate this activity.)

3. Accomplish the permanent repair no later than the next C check (currently scheduled for Nov 94). The permanent repair will be developed by DAC and will be provided to FEDEX. The permanent repair will be FAA approved. (Aircraft Structures Engineering will coordinate accomplishment.)

REV A - 19 Apr 94

Per ref 5, the repetitive inspections at 350 flight hours are cancelled. Instead, the inspection is to be accomplished at intervals not to exceed 1750 flight hours or six (6) months from the last inspection. Repetitive inspections are required until terminated per Option 1 of Ref 5. The revised inspection frequency is FAA approved.

AF15290

EA 5330-MH-21224
PG 3 OF 9

FEDERAL EXPRESS CORPORATION
Aircraft Structures Engineering
3101 Tchulahoma
Memphis, TN 38118

FAX TRANSMITTAL SHEET

Date: JANUARY 4, 1994

FROM:

Name: Mark Yerger
Phone: (901) 369-2654
Fax Phone: (901) 360-9551
4 Page(s)
Including transmittal sheet

TO:

Company: DOUGLAS
Name: STEVE YOUNG
Phone: (310) 593-9312
Fax Phone:

MESSAGE:

OUR MD-11 N611FE, FUS. NO. 553, WAS INVOLVED IN A HARD LANDING INCIDENT ON 1/4/94. AIRCRAFT HAD 952 HOURS AND 236 CYCLES AT THE TIME OF THE EVENT. A HARD LANDING INSPECTION HAS BEEN CONDUCTED.

KEY INFORMATION:

1.	AIRCRAFT LANDING WEIGHT:	427,200 LBS
	AIRCRAFT C.G.	34.4
	MAX VERT ACCEL	+2.85G
	MAX LAT ACCEL	-0.45G

2.

A HARD LANDING INSPECTION HAS BEEN CONDUCTED IN IAW WITH MD-11 MM 05-51-03. THE FOLLOWING WERE NOTED:

1. MILD TO MODERATE BUCKLING OF THE EXTERNAL SKIN AND STRINGERS FROM LONGERON 36 TO LONGERON 48, STATION 595 BULKHEAD TO APPROX. STA. 625, LEFT AND RIGHT SIDES. SEE ATTACHED SKETCH (ATCH 1). MAXIMUM DEPTH APPROX. 0.10 INCH AT THE LOWEST BUCKLE ON THE L/H SIDE. ALL DEFORMATIONS ARE SMOOTH WITH NO CREASES. SUSPECT AREAS WERE VERIFIED TO BE CRACK-FREE VIA EDDY CURRENT SURFACE PROBE. SKIN AND STRINGERS WERE ALSO VISUALLY INSPECTED FROM THE INSIDE. NO DEFECTS NOTED.

   PER DOUGLAS RECOMMENDATION, THE BULKHEAD AT STA. 595 WAS INSPECTED FOR DAMAGE. THE LOWER TEE CAP WAS INSPECTED VIA EDDY CURRENT SURFACE PROBE. A VISUAL INSPECTION OF THE FORWARD AND AFT FACE OF THE BULKHEAD FROM LONGERON 36 LEFT TO 36 RIGHT WAS CONDUCTED TO

AF15291

FAX TO DOUGLAS ON MD-11 553
1/5/94
PAGE 2

CHECK FOR CRACKS, LOOSE OR DAMAGED FASTENERS, OR DEFORMATION. NO DEFECTS WERE NOTED.

PER DOUGLAS RECOMMENDATION, THE NOSE WHEEL WELL SIDE BULKHEADS WERE VISUALLY INSPECTED FROM WHEEL WELL SIDE ONLY TO CHECK FOR CRACKS, LOOSE OR DAMAGED FASTENERS, OR DEFORMATION. NO DEFECTS WERE NOTED.

2. DURING PYLON INSPECTION OF NO. 1 ENGINE, CRACKING OF THE PAINT AND SEALANT AROUND THE AFT PYLON ATTACH FITTING WAS NOTED AS SHOWN ON ATTACHMENT 2. NO DEFORMATION OR DAMAGE WAS NOTED ON THE FITTINGS OR ATTACHING HARDWARE.

NO OTHER DEFECTS HAVE BEEN NOTED. THE AIRCRAFT WILL UNDERGO FURTHER EVALUATION DURING A "B" CHECK TO BEGIN TODAY.

BASED ON THE ABOVE AND DISCUSSIONS HELD WITH DOUGLAS PERSONNEL, FEDEX RECOMMENDS THE FOLLOWING:

1. COMPLETE THE "B" CHECK ON THE AIRCRAFT AND ENSURE NO OTHER DEFECTS ARE FOUND.

2. OPERATE THE AIRCRAFT WITH THE BUCKLES "AS IS." PERFORM EXTERNAL VISUAL INSPECTION AT "B" CHECK INTERVALS TO ENSURE NO CRACKS, LOOSE OR MISSING FASTENERS, OR OTHER DAMAGE.

3. WITHIN 60 DAYS, PROVIDE DOUGLAS ENGINEERING AN OPPORTUNITY TO INSPECT THE AIRCRAFT AT OUR LAX FACILITY FOR FURTHER DISPOSITION AND/OR PERMANENT REPAIR INSTRUCTIONS. PERMANENT REPAIR (POSSIBLE SKIN SECTION REPLACEMENT OR AN INTERNAL DOUBLER), IF REQUIRED, WOULD BE ACCOMPLISHED AT THE NEXT "C" CHECK, UNLESS FURTHER DAMAGE IS NOTED.

PLEASE REVIEW AND PROVIDE CONCURRENCE OR ALTERNATE PLAN. BECAUSE PERMANENT REPAIR WILL BE CLASSIFIED AS "MAJOR", PLEASE PROVIDE FAA APPROVAL FOR THIS REPAIR PLAN.

IF YOU HAVE ANY QUESTIONS, PLEASE CONTACT ME AT YOUR CONVENIENCE.

Regards,

[redacted]

Mark Yerger
Manager
ircraft Structures Engineering

PC MAIL <— In Message=RECV.9

MMMMMMMMMESSAGE STATUS/HEADERMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM
PRINTED /LBREV 020 0713AM 07JAN94 LBMEM 0005 0719AM 07JAN94 MSO 053944 LBME
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REV 020 0713AM 07JAN94
MEM 0005 0719AM 07JAN94 MSO 053944

EA 5330-MH-2122
PG 8 OF 9

LBMEM LBLBC COPY

SVC-MEM-0014/SFY 11-53-00-00 6 JAN 94

NO REPLY REQUIRED

TO: D.B. SCHREMP, MEMPHIS

FROM: M.E. CURLEY/SFY, C1-L32 (76-40)
DOUGLAS AIRCRAFT COMPANY, LONG BEACH

SUBJ: HARD LANDING - FORWARD FUSELAGE DAMAGE, MD-11 FUSELAGE 553

REF: MEM-SVC-0007/DBS, DTD 5 JAN 94

FILE: 226033

AFTER EVALUATION OF DAMAGE REPORTED IN REF AND ONSITE INSPECTION BY C. CHILVERS - DAC STRESS ENGINEER, THE AIRCRAFT IS ACCEPTABLE FOR CONTINUED SERVICE PROVIDED THE FOLLOWING IS ACCOMPLISHED.

1. SWING NOSE GEAR TO ASSURE NO BINDING OR NOTICEABLE UNUSUAL NOISES.
2. VISUALLY INSPECT DAMAGED AREA OF SKIN BETWEEN STATIONS Y=595 AND Y=615 FROM LONGERONS 36 TO 48 (L/H AND R/H SIDE) BOTH EXTERNALLY AND INTERNALLY. INSPECTIONS TO BE AT 350 FLIGHT HOUR INTERVALS LOOKING FOR FAILED FASTENERS OR SKIN CRACKS. IF ANY DISCREPANCIES ARE FOUND CONTACT DAC BEFORE FURTHER FLIGHT FOR RECOMMENDATIONS.
3. IF ANY ADDITIONAL HARD LANDING IS EXPERIENCED, CONTACT DAC BEFORE FURTHER FLIGHT FOR INSPECTION REQUIREMENTS.
4. PERMANENT REPAIR TO BE ACCOMMPLISHED AT NO LATER THAN NEXT 'C' CHECK (CURRENTLY SCHEDULED FOR NOV 94). PERMANENT REPAIR TO BE DEVELOPED BY DAC AND PROVIDED TO FM. PERMANENT REPAIR WILL BE FAA APPROVED.

THE ABOVE DISPOSITION HAS BEEN SHOWN TO COMPLY WITH THE TYPE CERTIFICATION BASIS FOR THE AIRCRAFT AND IS FAA APPROVED.

REGARDS

MAIL <-- In Message=RECV.17

MMMMMESSAGE STATUS/HEADERMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM
/LBREV 043 0 AM 07MAR94 LBMEM 0006 1537PM 07MAR94 MSQ 039973 LBMEM LS
MMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM
0717AM 07MAR94
MEM 1537PM 07MAR94 MSQ 039973

5330-M11-21224
16 9 OF 9
REV A

C COPY

0124 /SFY 11-53-00-00 7 MARCH 94

IRED

. SCHREMP, MEMPHIS

OM: M.E. CURLEY/SFY, C1-L32 (76-40)
DOUGLAS AIRCRAFT COMPANY, LONG BEACH

SUJ: LANDING - FORWARD FUSELAGE DAMAGE,
MD-11 FUSELAGE 553

: SVC-MEM-0014/SFY, DTD 6 JAN 94

E: NAA

MESSAGE APPROVED CONTINUED SERVICE OF SUBJ AIRCRAFT H SKIN WRINKLES BETWEEN FRAME STATIONS Y=595 AND Y=615 M LONGERONS 36 TO 49. REF STATED THAT REPAIR WAS TO ACCOMPLISHED AT THE NEXT 'C' CHECK IN NOV 94. SUBSEQUENT , ADDITIONAL EVALUATION BY DAC HAS DETERMINED THAT FOLLOWING OPTIONS ARE ACCEPTABLE FOR STRENGTH.

TION 1 -

LICE IN A NEW SECTION OF SKIN PER ROD SKETCH 94-01-07-001 ICH WOULD DELETE REQUIREMENTS FOR SPECIAL REPETITIVE SPECTIONS. ROD SKETCH 94-01-07-001 IS FAA APPROVED.

TION 2 -

NTINUE REVENUE SERVICE WITH WRINKLES AS REPORTED WITH PETITIVE VISUAL INSPECTIONS OF THE WRINKLED SKIN BOTH TERNALLY AND EXTERNALLY AT INTERVALS NOT TO EXCEED 1750 IGHT HOURS OR 6 MONTHS, WHICHEVER OCCURS FIRST. NO PAIR IS REQUIRED. IF ANY ADDITIONAL DAMAGE IS FOUND, NTACT DAC PRIOR TO FURTHER FLIGHT. ALSO, NOTIFY DAC OF Y ADDITIONAL HARD LANDINGS. THE ABOVE INSPECTION INTERVALS BE INITIATED AT THIS TIME AND SUPERSEDE INSPECTION TERVALS IN REF. OPTION 2 IS FAA APPROVED.

C ALSO CONCURS WITH AN FM PROPOSED INSERVICE EVALUATION FOR STALLATION OF A TEXTRON BORON BONDED REPAIR COVERING A SINGLE NGERON/ FRAME BAY IN THE WRINKLED AREA OF THE SKIN.

GARDS

FEDERAL EXPRESS

Nº 21039

E.A.# 5330 - M11 - 21039

RELEASE DATE 8-6-94

PAGE 1 OF

ENGINEERING AUTHORIZATION

TITLE

FUSELAGE - PLATES/SKIN 1700 HR SPECIAL INSP

EFFECTIVITY

Registry, Asset or Engine No. 611

Unit Description SKIN FASTNERS

Mfg. P/N

Serial No.

FUNCTION:

Manual Change

Material Change

Alteration

Repair

✓ Other

CLASSIFICATION (Alterations or repairs only)

Major

✓ Minor

SIGNATURES:

Engineer

Manager

FAA or designee (if required)

REVISION RECORD:

Rev.			
Date			
Engr			
Mgr.			
FAA or designee (if required)			

MACH
TEM NO. 53-30 301

REFERENCES:

AF15298

INSTRUCTIONS:

ON REPETITIVE HARDLANDING INSP FOUR EACH FASTNERS WHERE NOTED TO BE DISHED, LEFT HAND STRINGE 45 STATION 594 TWO EACH FASTNERS. DISHED, , RIGHT HAND STRINGER 44 STATION 599 TWO EACH FASTNERS DISHED. "NOTED SAME FOUR FASTNERS ON INITIAL INSP" THIS E.A AUTHORIZES DEFERRING FASTNERS UNTIL NEXT "C" CHECK. IN NOV 94.

PER PHONE CONVERSATION WITH ART BENJAMIN 0100Z 8-7-94

[redacted]

Fact/[illegible]

1

SPECIAL OR NONROUTINE MAINTENANCE FORM

PRINT CLEARLY. USE BLACK INK, BALLPOINT PEN ONLY. NO. S002

SHB2

1. ACFT NUMBER/SERIAL NO.	2. DATE	3. GENERATING ITEM	4. WHEN DISCOVERED / MALFUNCTION CODE	5. EMPLOYEE NO./CERT. NO.
611FE	02/25/94	WRI 53-30/787	B 000	2888

6. DISCREPANCY

C/W E.A. 5330-M11-21224 - Fus - Plates/Skin - Insp/ Repair Action Due To Hard Landing

6A. RECOMMENDED ACTION

AUDITED/ENTERED
BY: NO. 97229
DATE: 3/11/94

7. CORRECTIVE ACTION — RII ☐

C/W Followup INSP EA-5330-M11-21224 NO DISCP NOTED.

AF15490

AUDITED/ENTERED
BY: NO. 94521
DATE: 3/14

8. MECHANIC SIGNATURE	9. EMPLOYEE NO./CERT. NO.	10. DATE	11. WORK CENTER/VENDOR
[redacted]	42003	03/04/94	118
12. RII BUY BACK	**13. EMPLOYEE NO./CERT. NO.**	**14. DATE**	**15. WORK CENTER/VENDOR**

16. TOTAL MAN-HOURS	17. ATA/SUBCHAPTER	18. DATA ENTERED BY	19. RELIABILITY CONTROL NO.
4.0	05-30		E 51108

FedEx M-1805 8/92 LOGOS #135512

FEDERAL EXPRESS CORPORATION
Aircraft Structures Engineering
3101 Tchulahoma
Memphis, TN 38118

FAX TRANSMITTAL SHEET

Date: JANUARY 4, 1994

FROM:		TO:	
Name:	Mark Yerger	Company:	DOUGLAS
Phone:	(901) 369-2654	Name:	STEVE YOUNG
Fax Phone:	(901) 360-9551	Phone:	(310) 593-9312
4 Page(s) including transmittal sheet		Fax Phone:	

MESSAGE:

OUR MD-11 N611FE, FUS. NO. 553, WAS INVOLVED IN A HARD LANDING INCIDENT ON 1/4/94. AIRCRAFT HAD 952 HOURS AND 236 CYCLES AT THE TIME OF THE EVENT. A HARD LANDING INSPECTION HAS BEEN CONDUCTED.

KEY INFORMATION:

1. AIRCRAFT LANDING WEIGHT: 427,200 LBS
   AIRCRAFT C.G. 34.4
   MAX VERT ACCEL +2.85G
   MAX LAT ACCEL -0.45G

2.

A HARD LANDING INSPECTION HAS BEEN CONDUCTED IN IAW WITH MD-11 MM 05-51-03. THE FOLLOWING WERE NOTED:

1. MILD TO MODERATE BUCKLING OF THE EXTERNAL SKIN AND STRINGERS FROM LONGERON 36 TO LONGERON 48, STATION 595 BULKHEAD TO APPROX. STA. 625, LEFT AND RIGHT SIDES. SEE ATTACHED SKETCH (ATCH 1). MAXIMUM DEPTH APPROX. 0.10 INCH AT THE LOWEST BUCKLE ON THE L/H SIDE. ALL DEFORMATIONS ARE SMOOTH WITH NO CREASES. SUSPECT AREAS WERE VERIFIED TO BE CRACK-FREE VIA EDDY CURRENT SURFACE PROBE. SKIN AND STRINGERS WERE ALSO VISUALLY INSPECTED FROM THE INSIDE. NO DEFECTS NOTED.

   PER DOUGLAS RECOMMENDATION, THE BULKHEAD AT STA. 595 WAS INSPECTED FOR DAMAGE. THE LOWER TEE CAP WAS INSPECTED VIA EDDY CURRENT SURFACE PROBE. A VISUAL INSPECTION OF THE FORWARD AND AFT FACE OF THE BULKHEAD FROM LONGERON 36 LEFT TO 36 RIGHT WAS CONDUCTED TO

CHECK FOR CRACKS, LOOSE OR DAMAGED FASTENERS, OR DEFORMATION. NO DEFECTS WERE NOTED.

PER DOUGLAS RECOMMENDATION, THE NOSE WHEEL WELL SIDE BULKHEADS WERE VISUALLY INSPECTED FROM WHEEL WELL SIDE ONLY TO CHECK FOR CRACKS, LOOSE OR DAMAGED FASTENERS, OR DEFORMATION. NO DEFECTS WERE NOTED.

2. DURING PYLON INSPECTION OF NO. 1 ENGINE, CRACKING OF THE PAINT AND SEALANT AROUND THE AFT PYLON ATTACH FITTING WAS NOTED AS SHOWN ON ATTACHMENT 2. NO DEFORMATION OR DAMAGE WAS NOTED ON THE FITTINGS OR ATTACHING HARDWARE.

NO OTHER DEFECTS HAVE BEEN NOTED. THE AIRCRAFT WILL UNDERGO FURTHER EVALUATION DURING A "B" CHECK TO BEGIN TODAY.

BASED ON THE ABOVE AND DISCUSSIONS HELD WITH DOUGLAS PERSONNEL, FEDEX RECOMMENDS THE FOLLOWING:

1. COMPLETE THE "B" CHECK ON THE AIRCRAFT AND ENSURE NO OTHER DEFECTS ARE FOUND.

2. OPERATE THE AIRCRAFT WITH THE BUCKLES "AS IS." PERFORM EXTERNAL VISUAL INSPECTION AT "B" CHECK INTERVALS TO ENSURE NO CRACKS, LOOSE OR MISSING FASTENERS, OR OTHER DAMAGE.

3. WITHIN 60 DAYS, PROVIDE DOUGLAS ENGINEERING AN OPPORTUNITY TO INSPECT THE AIRCRAFT AT OUR LAX FACILITY FOR FURTHER DISPOSITION AND/OR PERMANENT REPAIR INSTRUCTIONS. PERMANENT REPAIR (POSSIBLE SKIN SECTION REPLACEMENT OR AN INTERNAL DOUBLER), IF REQUIRED, WOULD BE ACCOMPLISHED AT THE NEXT "C" CHECK, UNLESS FURTHER DAMAGE IS NOTED.

PLEASE REVIEW AND PROVIDE CONCURRENCE OR ALTERNATE PLAN. BECAUSE PERMANENT REPAIR WILL BE CLASSIFIED AS "MAJOR", PLEASE PROVIDE FAA APPROVAL FOR THIS REPAIR PLAN.

IF YOU HAVE ANY QUESTIONS, PLEASE CONTACT ME AT YOUR CONVENIENCE.

Regards,

[redacted]

Mark Yerger
Manager
Aircraft Structures Engineering

AF15476

FEDERAL EXPRESS

E.A.# 5320-M11-22058

RELEASE DATE 9/22/94

ENGINEERING AUTHORIZATION

TITLE

FUSELAGE, STA. Y = 595 TO Y = 615, LONG. 36L TO 48L
BOROW DOUBLER EVALUATION

AUDITED/ENTERED BY: NO. 97226 DATE: 11/30/94

EFFECTIVITY		FUNCTION:		SIGNATURES:
Registry, Asset or Engine No.	N611FE		Manual Change	[redacted]
Unit Description	MD-11F		Material Change	Engineer L. OKSANA BARDYGULA
			Alteration	[redacted]
			Repair	Manager JACK W. SPRINGER
A/C Serial No.	48604	X	Other EVALUATION	FAA or designee (if required)

		CLASSIFICATION (Alterations or repairs only)		REVISION RECORD:			
TST	3519			Rev.			
CYCLES	813			Date			
MFG. P/N			Major	Engr			
SERIAL NO.	N/A		Minor	Mgr.			
				FAA or designee (if required)			

ATTACH ITEM NO. ____________

REFERENCES:

1. MD-11 SRM, VOL.II, CH. 51-62-01 AND CH. 51-71-00
2. BOEING SPECIFICATION NUMBER D658-10183-1
3. ATACS MODEL 0810 REFERENCE GUIDE
4. E.O. 2-5110-7-3307
5. FAX TRANSMISSION FROM TEXTRON SPECIALTY MATERIALS, DTD 9/22/94
6. E.A. 5310-M11-22060

AUDITED/ENTERED BY: NO. 94521 DATE: 10/5

INSTRUCTIONS:

THIS E.A. GIVES INSTRUCTIONS FOR THE APPLICATION OF THE BORON DOUBLERS ON THE L/H SIDE OF A/C 611. THE DOUBLERS WILL BE APPLIED OVER THE SKIN WRINKLES FOUND FROM FUS. STA. Y =595 TO Y = 615, FROM LONGERON 36 TO LONGERON 48. REFERENCE FIG. 1 AS WELL AS THE ACTUAL SIZE MAPPING OF THE DAMAGE AND DOUBLERS.

NOTE, THESE INSTRUCTIONS REFER TO THE APPLICATION OF DOUBLERS #2 AND #4 ONLY (REF. FIG.1), HOWEVER, WITH TIME PERMITTING DOUBLER #1 MAY ALSO BE INSTALLED.

THE APPLICATION OF THE BORON DOUBLERS IS AN EVALUATION PROJECT IN CONJUNCTION WITH McDONNELL DOUGLAS AND TEXTRON. THE APPLICATION OF THE DOUBLERS DOES NOT CONSTITUTE AS A FINAL REPAIR, AT THIS TIME, FOR THE SAID WRINKLES ABOVE.

FOLLOW-UP:

UPON COMPLETION OF THIS E.A. NO FURTHER ACTION OR FOLLOW-UP IS REQUIRED PER THIS E.A. ENGINEERING WILL ISSUE ADDITIONAL DOCUMENTATION TO REFLECT FOLLOW-UP ACTIONS AT A LATER TIME.

FEDERAL EXPRESS

ENGINEERING AUTHORIZATION

DETAIL INSTRUCTIONS	MECHANIC	RII/INSP.
THE SURFACE PREPARATION USING THE "P.A.C.S." SYSTEM WILL BE DONE ON DOUBLERS #2 AND #4. BONDING WILL PROCEED ON THESE TWO DOUBLERS ONCE THE SURFACE PREPARTATION HAS BEEN COMPLETED. NOTE, ALL WORK WILL BE DONE USING CLEAN, LINT FREE GLOVES. REFERENCE ACTUAL SIZE FIGURE OF DAMAGE AND DOUBLERS AS NECESSARY.	NOT REQ'D	NOT REQ'D
1. MASK THE AREAS TO CONTAIN THE BORON DOUBLERS APPROXIMATELY THREE TO FOUR INCHES BEYOND THE DAMAGE. REFERENCE FI . MAPPING THE DAMAGE AND THE FULL SIZE SKETCH MAPPING OF THE DAMAGED AREA.	RMG 99513	NOT REQ'D
2. PERFORM A FASTENER MAPPING BY MAKING A RUBBING OF THE FASTENERS AFFECTED BY THE BORON DOUBLERS. THE RUBBING WILL BE USED TO IDENTIFY THE FASTENERS OVER THE DOUBLERS AS NEEDED FOR NDI. THE FASTENER LOCATIONS WILL ALSO BE NEEDED WHEN FACILITATING PERMANENT REPAIR. SUBMIT FASTENER MAPPING TO ENGINEERING.	RMG 99513	NOT REQ'D
USING DENATURED ALCOHOL OR SOLVENT (1,1,1 TRICHLOROETHANE OR EQUIVALENT), PREPARE MARKED AREAS TO RECEIVE BORON DOUBLERS. USE DOUBLE SOLVENT WIPE METHOD. PROVIDE A WATER BREAK FREE SURFACE ON THE ALUMINUM SKIN BY USING A SCOTCH BRITE PAD BY HAND AND MODERATE CIRCULAR SCOURING FOR 5 TO 10 MINUTES.	RMG 99513	NOT REQ'D
4. USING ONLY DISTILLED OR PURIFIED WATER, SPRAY THE PREPARED SURFACE WITH A HEAVY CONCENTRATION OF WATER. A WATER BREAK FREE SURFACE SHOULD BE WITNESSED FOR 30 SECONDS.	RMG 99513	FE-23
5. NO BREAK HAS BEEN WITNESSED. O.K. TO CONTINUE.	RMG 99513	FE-23
6. AFTER ACHIEVING SUCCESSFUL WATER BREAK ALLOW AREA TO AIR DRY. DO NOT TOUCH AREA.	RMG 99513	NOT REQ'D
7. ANY AREAS NOT TO RECEIVE THE "PACS" ANODIZATION PROCESS IMMEDIATELY, SHOULD BE BAGGED AND PROTECTED FROM SURROUNDING WORK AREA. MARK THE OUTSIDE OF THE BAGGING MATERIAL "READY FOR PACS".	RMG 99513	NOT REQ'D

AF15483

INSTRUCTIONS CONT'D	MECHANIC	RII/INSP.
8. SEAL FASTENER HEADS WHICH WILL BE AFFECTED BY THE APPLICATION OF THE BORON DOUBLERS. BE CAREFUL WHEN SEALING NOT TO CONTAMINATE THE SURFACE, SINCE IT HAS ALREADY PASSED THE WATER BREAK FREE SURFACE TEST. SEAL AS FOLLOWS: A. MIX ATACS 4103 ADHESIVE PER MANUFACTURER'S SPECIFICATION. B. USING A SMALL PAINT BRUSH, DAB THE FASTENER HEADS WITH THE ADHESIVE. BE CAREFUL NOT TO ALLOW THE ADHESIVE TO DRIP AND CONTAMINATE THE SURFACE. C. ALLOW THE ADHESIVE TO CURE. CURE TIME IS 15 MIN. AT 65-80 DEGREES F.	RMG 99513	NOT REQ'D
9. ANY AREAS NOT TO RECEIVE THE "PACS" ANODIZATION PROCESS IMMEDIATELY, SHOULD BE BAGGED AND PROTECTED FROM SURROUNDING WORK AREA. MARK THE OUTSIDE OF THE BAGGING MATERIAL "READY FOR PACS".	RMG 99513	NOT REQ'D
10. PERFORM THE PHOSPHORIC ACID ANODIZED CONTAINMENT SYSTEM ("PACS") PROCESS PER DOCUMENT D658-10183-1 SECTION 5.2 AND SECTION 6.6.9.2. ALSO REFERENCE THE ATACS MODEL 0810 GUIDE, SECTION 3.	RMG 99513	FE-23
11. AFTER COMPLETION OF "PACS" PROCESS ALLOW AREA TO AIR DRY USING HEAT LAMPS AS NECESSARY.	RMG 99513	NOT REQ'D
12. VISUALLY INSPECT THE ANODIZED AREA FOR A PURPLISH-GREEN COLOR (USING A POLARIZER IS RECOMMENDED (SEE D658-10183-1, SECTION 6.6.9.2)). NO PITTING OR UNUSUAL COLOR PATTERNS ARE ALLOWED. NO VOIDS LARGER THAN .5 SQ. IN. WITHIN ETCHED AREA ARE ALLOWED. IF ANY DISCREPANCIES ARE FOUND REPEAT STEPS 3 THRU 7 UNTIL SUCCESSFUL RESULTS ARE ATTAINED.	RMG 99513	FE-23
13. ANODIZED AREA HAS BEEN INSPECTED AND HAS PASSED AS DESCRIBED ABOVE. O.K. TO CONTINUE.	RMG 99513	FE-23

AF15484

INSTRUCTIONS CONT'D	MECHANIC	RII/INSP.
14. APPLY BR127 PRIMER ONE HOUR MAXIMUM AFTER PART HAS DRIED. APPLY A THIN COAT OF PRIMER (.0001" TO .0003" (.1 TO .3 MIL)). CURE THE PRIMER USING ONE OF THE FOLLOWING METHODS: 1. CURE PRIMER AT 250 DEGREES F +/- 10 DEGREES F FOR 60-70 MIN. PLACE TWO OR MORE THERMOCOUPLES AROUND THE PRIMER PERIPHERY WHEN USING PORTABLE HEATING DEVICES. STATION THE THERMOCOUPLES AT THE WIDEST POSSIBLE SAMPLING DISPERSION AROUND THE UNCURED PRIMER. REF. MD-11 SRM, VOL.II, CH. 51-62-01, FIG. 18 FOR BAGGING. 2. AIR DRY THE PRIMER AT AMBIENT CONDITIONS UNTIL ALL SOLVENT HAS FLASHED OFF. DRYING TYPICALLY TAKES 30 MIN. AT 70 DEGREES F. THE CURE MAY BE ACCELERATED BY THE USE OF HAND-HELD HEAT GUNS. DO NOT BOIL OR BLISTER THE PRIMER WHEN USING HEAT GUNS. DO NOT EXCEED 220 DEGREES F AT THE SURFACE. DO NOT TOUCH PRIMER SURFACE.	RMG 99513	NOT REQ'D
15. IF BONDING WILL NOT BE PERFORMED IMMEDIATELY, PROTECT ALL PRIMED BOND SURFACES FROM CONTAMINATION BY APPLYING A NONCONTAMINATING COVER OVER THE AREA UNTIL READY FOR BONDING. PROTECTION CAN BE PROVIDED BY TAPING A SHEET OF KRAFT PAPER, PVA, NYLON, TEFLON, ETC., OVER THE AREA.	RMG 99513	NOT REQ'D
16. REMOVE THE PREIMPREGNATED BORON/EPOXY TAPE FROM THE FREEZER. ALLOW THE PREPREG TO THAW AT ROOM TEMPERATURE NOT TO EXCEED 100 DEGREES F UNTIL ALL CONDENSATION HAS EVAPORATED FROM THE EXTERIOR OF THE SEALED BAG. **CAUTION:** DO NOT UNSEAL THE BAG UNTIL CONDENSATION HAS COMPLETELY EVAPORATED.	[illegible]	NOT REQ'D
17. FREEZER OUT TIMES SHALL BE RECORDED FOR ALL TIME AND TEMPERATURE SENSITIVE MATERIAL AND NOTED ON THE ROLL CONDITION LOG. **NOTE:** BORON/EPOXY MANUFACTURER GUARANTEES 10.5 DAYS OUT-TIME AT 70 DEGREES F. MATERIAL OUT TIME IS REDUCED ABOVE 80 DEGREES F. OUT 06:30 9/24/94	RMG 99513	FE-23
18. REMOVE THE FM73 OR AF163-2 FILM ADHESIVE FROM THE FREEZER. ALLOW THE ADHESIVE TO THAW AT ROOM TEMPERATURE NOT TO EXCEED 100 DEGREES F UNTIL ALL CONDENSATION HAS EVAPORATED FROM THE EXTERIOR OF THE SEALED BAG. **CAUTION:** DO NOT UNSEAL THE BAG UNTIL CONDENSATION HAS COMPLETELY EVAPOTATED.	RMG 99513	NOT REQ'D
19. VERIFY THE DIRECTION OF THE PLY LAY-UP AS SHOWN IN FIG. 2. NOTE THAT THE "0" DIRECTION WILL BE APPLIED IN THE HOOP DIRECTION (RUNNING CIRCUMFRENCIALLY).	RMG 99513	FE-23

AF15485

INSTRUCTIONS CONT'D	MECHANIC	RII/INSP.
20. PLY LAY-UP IS SIMILAR TO THAT SHOWN IN FIG. 2. O.K. TO CONTINUE.	RMG 99513	FE-23
21. CUT THE FILM ADHESIVE (GRADE 10) 1 PLY FOR EACH BOND FAYING SURFACE. DO NOT FOLD OR STRETCH THE ADHESIVE FILM. ONE ADDITIONAL PLY OF ADHESIVE MAY BE DESIRABLE FOR USE ON AREAS WITH SURFACE IRREGULARITIES. CUT ADHESIVE TO THE SHAPE OF THE DOUBLER SUCH THAT IT OVERLAPS THE EDGE OF THE DOUBLER BY APPROXIMATELY ONE EIGHTH INCH (1/8"). **CAUTION:** FILM ADHESIVE SHALL BE CUT IN AN AREA FREE FROM CONTAMINATES. CLEAN, NONCONTAMINATING GLOVES SHALL BE WORN DURING ALL CUTTING AND HANDLING OPERATIONS.	RMG 99513	NOT REQ'D
22. CARRY THE NECESSARY AMOUNT OF FILM ADHESIVE AND BORON DOUBLERS TO THE A/C COVERED IN NONCONTAMINATING PAPER.	RMG 99513	NOT REQ'D
23. APPLY THE ADHESIVE TO THE BONDING SURFACE. REMOVE THE BOTTOM PEEL PLY FROM THE BORON DOUBLER AND POSITION THE DOUBLER, LARGEST PLY ON THE BOTTOM, OVER THE ADHESIVE AS SHOWN IN FIG. 2. APPLY ONE PLY OF PEEL PLY OVER THE ENTIRE TOP SURFACE OF THE DOUBLER.	RMG 99513	NOT REQ'D
24. VACUUM BAG THE DOUBLERS PER MD-11 SRM, VOL.II, CH. 51-62-01, SECTION J. ENSURE THAT A MIN. OF THREE THERMOCOUPLES EXIST FOR EACH DOUBLER TO VERIFY TEMPERATURE OF CURE PROCESS.	RMG 99513	NOT REQ'D
25. CURE THE DOUBLERS AT 250 DEGREES F, +/- 10 DEGREES F, AT 15 +/- 2 IN. HG. FOR 90 MINUTES. RAMP FROM AMBIENT TO CURE TEMPERATURE AT 4-6 DEGREES PER MINUTE HEAT-UP RATE.	RMG 99513	NOT REQ'D
26. RAMP DOWN AT 4-6 DEGREES F PER MINUTE MAXIMUM FROM CURE TEMPERATURE TO LESS THAN 140 DEGREES F UNDER FULL PRESSURE BEFORE RELIEVING PRESSURE AND REMOVING BAGGING MATERIAL.	RMG 99513	NOT REQ'D
27. AFTER REMOVAL CHECK FOR EXTERNAL FLAWS. ADHESIVE SHALL BE CONTINUOUS AROUND THE PERIPHERY OF THE DOUBLER. THE SURFACE OF THE BORON EPOXY DOUBLER SHALL BE FREE FROM BLISTERS AND PITS.	RMG 99513	FE-16
28. PERFORM ULTRASONIC INSPECTIONS ON THE BORON DOUBLERS. VOIDS OR DEBONDS IN THE BOND LINE AS DETECTED BY ULTRASONIC METHODS SHALL NOT EXCEED REQUIREMENTS SET FORTH: 1. VOIDS AND DISBONDS SHALL NOT EXCEED .25" IN ANY DIMENSIONAL DIRECTION. 2 lower 2 outer insp c/w FE-23 2. VOIDS AND DISBONDS SHALL NOT EXCEED 2 IN ANY DOUBLER AND BE SEPARATED BY 3 IN. MINIMUM.	NOT REQ'D	FE-16
29. IDENTIFY AND PLOT ANY ANAMOLIES FOUND PER APPROPRIATE PROCEDURES.	NOT REQ'D	FE-16

INSTRUCTIONS CONT'D	MECHANIC	RII/INSP.
30. PREPARE THE SURFACE FOR PRIMING AND PAINTING BY MASKING THE DOUBLER AREA TO ESTABLISH A PERIPHERAL WORKING AREA AROUND THE DOUBLER.	MDC 19142[illegible]	NOT REQ'D
31. SOLVENT CLEAN WITH 1,1,1 TRICHLOROETHANE OR EQUIVALENT, USING A CLEAN LINT-FREE CLOTH. WIPE THE SOLVENT DRY. DO NOT ALLOW IT TO EVAPORATE.	MDC 191429	NOT REQ'D
32. APPLY ANY OF THE IMPACT RESISTANT PRIMERS SPECIFIED IN DMS 2144.	[illegible] 191429	NOT REQ'D
33. USE ANY OF THE TOP COAT IMPACT RESISTANT PAINTS SPECIFIED IN DMS 2143.	MDC 191429	NOT REQ'D

END

AF15487

L/H SIDE FUS. 611FE

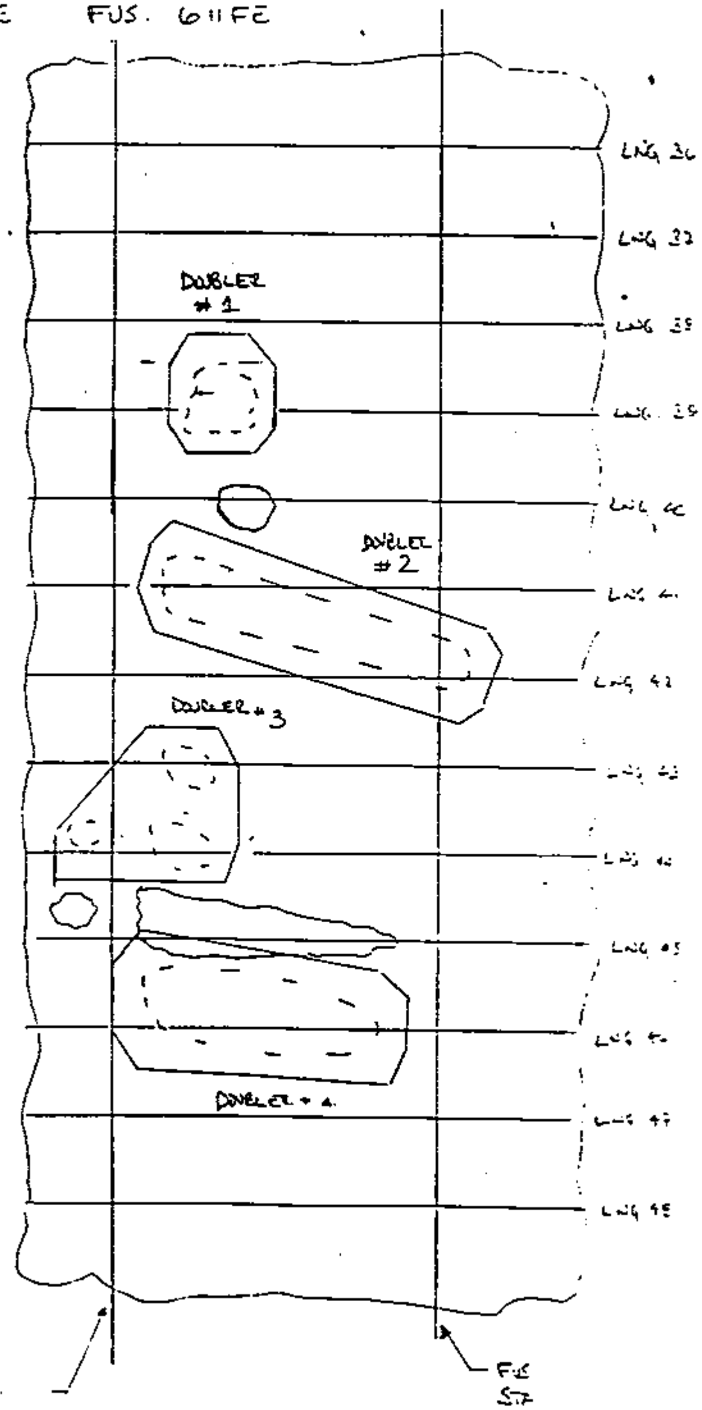


FIG. 1

AF15488

ENGINEERING AUTHORIZATION

BORON DBLR REPAIR

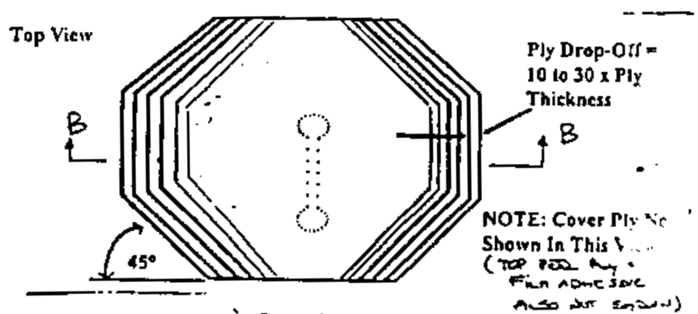
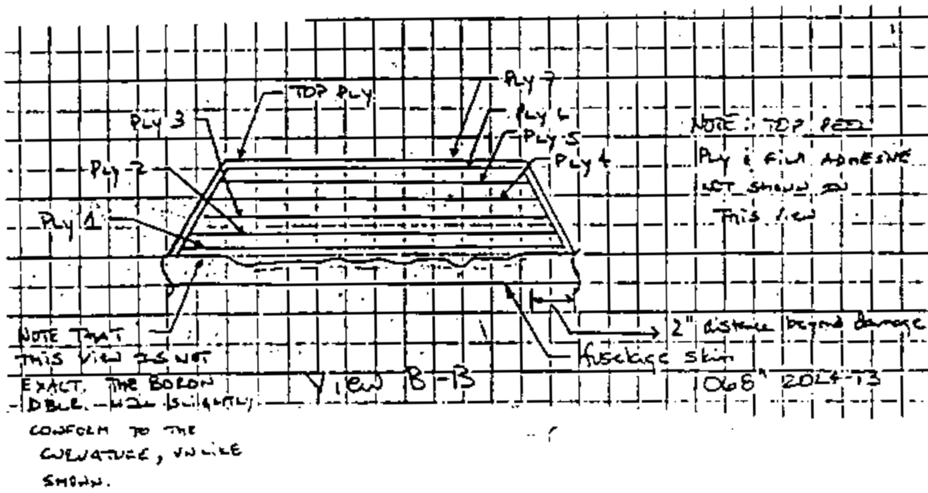


Fig. 1
Showing Boron Doubler
Repair



Ply #	Direction
1	+45°
2	0°
3	-45°
4	90°
5	-45°
6	0°
7	+45°

NOTE
"0" Direction is in the Hoop Direction

Fig. 2

AF15489

A/C TYPE	WORK CARD TITLE	CARD NO.	REV. DATE	PAGE
MD-11	RIGHT WING AND WINGLET - STRUCTURAL INSPECT	57C1214	05/03/94	2/2

GENERAL NOTE

A GENERAL VISUAL INSPECTION IS A VISUAL EXAMINATION THAT WILL DETECT OBVIOUS UNSATISFACTORY CONDITIONS/DISCREPANCIES, SUCH AS CHAFING OF TUBING, LOOSE DUCT SUPPORT, WIRING DAMAGE, CABLE AND PULLEY WEAR, FLUID LEAKS, INADEQUATE DRAINAGE AND FOR OTHER CONDITIONS WHICH COULD LEAD TO CORROSION/DAMAGE. WHENEVER PHYSICALLY POSSIBLE, INSPECTIONS WILL BE CONDUCTED WITHIN TOUCHING DISTANCE UNLESS OTHERWISE STATED.

A DETAILED INSPECTION IS AN INTENSIVE VISUAL EXAMINATION OF A SPECIFIED DETAIL, ASSEMBLY, OR INSTALLATION. IT SEARCHES FOR EVIDENCE OF IRREGULARITY USING ADEQUATE LIGHTING AND, WHERE NECESSARY, INSPECTION AIDS SUCH AS MIRRORS, HAND LENS, ETC. SURFACE CLEANING AND ELABORATE ACCESS PROCEDURES MAY BE REQUIRED.

1. CLEAN AREA TO BE INSPECTED; AREA SHOULD BE FREE OF DIRT, OIL AND FLUID SPILLS.

   NOTE: REMOVAL OF CORROSION INHIBITING COMPOUND IS REQUIRED ONLY IF INDICATION OF DETERIORATION EXISTS OR VISIBILITY OF SURFACE IS IMPAIRED.

2. RIGHT WINGLET - GENERAL VISUAL INSPECTION:

   A. DO A GENERAL VISUAL INSPECTION FOR ACCIDENTAL DAMAGE AND ENVIROMENTAL DAMAGE OF THE UPPER WINGLET AND LOWER WINGLET ATTACH FITTINGS AND BOLTS THRU ACCESS PANEL OPENINGS.

3. RIGHT WING AND WINGLET - DETAILED INSPECTION:

   A. DO A DETAILED INSPECTION FOR ACCIDENTAL DAMAGE OF THE LOWER WINGLET, TRAILING EDGE, AND UPPER WINGLET TIP (REF. SSI PHOTO 57.31.01 FIGURE PAGE 1).
   B. DO A DETAILED VISUAL INSPECTION FOR ACCIDENTAL DAMAGE AND ENVIROMENTAL DAMAGE OF THE COMPOSITE OUTBOARD FLAP AND FLAP VANE STRUCTURE HINGE AND FITTING ATTACH POINTS AND SURROUNDING STRUCTURE, WITH FLAPS EXTENDED (REF. SSI PHOTO 57.57.02 FIGURE PAGES 2 AND 3).
   C. DO A DETAILED VISUAL INSPECTION FOR ACCIDENTAL DAMAGE AND ENVIROMENTAL DAMAGE OF THE COMPOSITE OUTBOARD AILERON ATTACHMENT FITTINGS AND SURROUNDING STRUCTURE (REF. SSI PHOTO 57.63.02 FIGURE PAGES 4 AND 5).

4. APPLY CORROSION INHIBITING COMPOUND AS NECESSARY.

TECHNICAL REFERENCES	ZONES	CARD NO	PAGE
	610 - 660	57C1212	1/2

TOOLS/MATERIALS

NO SPECIAL TOOLS OR MATERIALS REQUIRED.

GENERAL NOTE

A GENERAL VISUAL INSPECTION IS A VISUAL EXAMINATION THAT WILL DETECT OBVIOUS UNSATISFACTORY CONDITIONS/DISCREPANCIES, SUCH AS CHAFING OF TUBING, LOOSE DUCT SUPPORT, WIRING DAMAGE, CABLE AND PULLEY WEAR, FLUID LEAKS, INADEQUATE DRAINAGE AND FOR OTHER CONDITIONS WHICH COULD LEAD TO CORROSION/DAMAGE. WHENEVER PHYSICALLY POSSIBLE, INSPECTIONS WILL BE CONDUCTED WITHIN TOUCHING DISTANCE UNLESS OTHERWISE STATED.

CHECKED BY	ACCOMP BY	REV. DATE	TOTAL PGS.	A/C TYPE	DATE ACCOMP	CARD NO.
		ORIG	2	MD-11	AUG 17 1995	57C1212
FE-21 I	XXXXXXXXXX	1. RIGHT WING (EXTERNAL) - INSPECT				
FE-21 I	XXXXXXXXXX	2. INSPECTION DOORS - CHECK				
						AF10078
						57C1212

		WORK CARD TITLE	AIRCRAFT NO.
PC14	Sign Off's Complete	RIGHT WING (EXTERNAL) - CHECK	N611FE

A/C TYPE	WORK CARD TITLE	CARD NO.	REV. DATE	PAGE
MD-11	RIGHT WING (EXTERNAL) - CHECK	57C1212	ORIG	2/2

1. DO A GENERAL VISUAL INSPECTION OF THE RIGHT WING AND PYLON FROM THE GROUND. PAY PARTICULAR ATTENTION TO THE FOLLOWING ITEMS.
   A. PYLON PANELS, SKIN.
   B. DRAIN MASTS.
   C. WING SKIN/PANELS LEADING AND TRAILING EDGES, TIP AND STATIC DISCHARGES.
   D. LEADING AND TRAILING EDGE FLAPS/SLATS/SPOILERS AND WING TRAILING EDGE CAVATI (WITH FLAPS AND SLATS EXTENDED).
   E. CONTROL SURFACES AND POWER CONTROL UNITS FOR OBVIOUS LEAKAGE.
   F. FUEL JETTISON NOZZLE FOR LEAKAGE.
   G. GROUND REFUELING PANEL PLACARD FOR CONDITION AND LEGIBILITY.

2. WING HINGED/LATCHED SERVICE INSPECTION DOORS.
   A. MAKE SURE DOORS LATCH AND UNLATCH CORRECTLY.

FedEx Federal Express

SPECIAL OR NONROUTINE MAINTENANCE FORM

Print Clearly, Use Black Ink, Ballpoint Pen Only.

NO. 6C22

1 ACFT NUMBER/SERIAL NO	2 DATE	3 GENERATING ITEM	4 EMPLOYEE NO CERT NO	5 MALFUNCTION CODE
N611FE	08/21/95	57C1208	97349/43	00006

6 DISCREPANCY

Small damaged area to the O/B edge of the R/H wing O/B flap vane @ flap track roller. Dot #1

7. FUNCTIONAL TEST REQUIRED	8. RII	9. MAJOR REPAIR	10. MAJOR ALTERATION	11. N/R EVALUATED BY	12. ACCESS PANELS	13. PART NO. REQUIRED	14. QTY
☐	☐	☐	☐	172271			

15. RECOMMENDED ACTION

INSPECT DAMAGED AREA & REPAIR AS NECESSARY. FIBERGLASS DAMAGE

Repaired [illegible] SRM 57-10-00

57-90-00

51-62-01 FIG 2

16 CORRECTIVE ACTION

Repaired per SRM 51-62-01 page 52 Fig 22

AF8307

17A SVC TAG NUMBER	17B SVC TAG NUMBER	17C SVC TAG NUMBER	17D SVC TAG NUMBER	18 OPEN ITEMS LIST ☐ CLOSED ☐

19A MFG P N ON	19B S N OFF	19C S N ON	19D POS	19E REASON

20. MECHANIC SIGNATURE	21 EMPLOYEE NO CERT NO	22 DATE	23 WORK CENTER/VENDOR
[redacted]	97277	9-7-95	800 L.AX

24 RII BUY BACK	25 EMPLOYEE NO CERT NO	26 DATE	27 WORK CENTER/VENDOR
FE-55	97831	SEP -7 1995	600

28. ATA/SUBCHAPTER	29. A/C ZONE	30. SKILL	31. # MEN	32. EST. HRS.	33. MILE STONE CODE(S)	34 WORK ORDER NO
57-10	60	880	1	4.0	E03	61102

FedEx M-1805(B) 5/95 LOGOS # 147168

FEDERAL EXPRESS

№ 21039

E.A.# 5330 - M11-21034

RELEASE DATE 8-6-94

PAGE 1 OF 1

ENGINEERING AUTHORIZATION

TITLE

FUSELAGE - PLATES/SKIN 1700 HR SPECIAL INSP

EFFECTIVITY

Aircraft, Assy or Engine No. 611

Description SKIN FASTNERS

Mfg P/N

Serial No.

FUNCTION

Manual Change

Material Change

Alteration

Repair

✓ Other

CLASSIFICATION (Alterations or repairs only)

Major

✓ Minor

SIGNATURES

Engineer

Manager

FAA or designee (if required)

REVISION RECORD:

Rev.			
Date			
Engr			
Mgr.			
FAA or designee (if required)			

MACH ITEM NO. 53-30 301

REFERENCES

INSTRUCTIONS

ON REPETITIVE HARDLANDING INSP FOUR EACH FASTNERS WHERE NOTED TO BE DISHED, LEFT HAND STRINGE 45 , RIGHT HAND STRINGER 4 STATION 599 TWO EACH FASTNERS DISHED. "NOTED SAME FOUR FASTNERS ON INITIAL INSP" THIS E.A AUTHORIZES DEFERRING FASTNERS UNTIL NEXT "C" CHECK. IN NOV 9

PER PHONE CONVERSATION WITH ART BENJAMIN 0100Z 8-7-94

[redacted]

SPECIAL OR NONROUTINE MAINTENANCE FORM

PRINT CLEARLY. USE BLACK INK, BALLPOINT PEN ONLY. NO. S001

1. ACFT NUMBER/SERIAL NO.	2. DATE	3. GENERATING ITEM	4. WHEN DISCOVERED/ MALFUNCTION CODE	5. EMPLOYEE NO./CERT. NO
611FE	6/16/94	EA 5330-M-11 21224		26385

6. DISCREPANCY
EA# 5330-M-11 Fuselage - Plates/Skin - Inspection Repair Actions Due to hard Landing.

S001
AF15507

6A. RECOMMENDED ACTION
AUDITED/ENTERED BY NO. 07898 DATE: 6/22/94 Rel

7. CORRECTIVE ACTION — RII ☐
Inspected external skin and fasteners in areas noted. No further damage found. BW 13299 Inspected Internal L/H side of A/C No damage found 3698 Inspected Internal portion R/H side of A/C. No damage found. Completed reinspection per EA 5330-M-11 21299 follow up step 1.

8. MECHANIC SIGNATURE	9. EMPLOYEE NO./CERT. NO.	10. DATE	11. WORK CENTER/VENDOR
BW (signature) — AUDITED/ENTERED BY NO. 94021 DATE: 6/22	13299	06/17/94	146

12. RII BUY BACK	13. EMPLOYEE NO./CERT. NO.	14. DATE	15. WORK CENTER/VENDOR

16. TOTAL MAN-HOURS	17. ATA/SUBCHAPTER	18. DATA ENTERED BY	19. RELIABILITY CONTROL NO.
7.0	53-30		E 53572

FedEx M-1805 8/92 LOGOS #135512

EA 5330-M+1-21224
PG 3 OF 8

FEDERAL EXPRESS CORPORATION
Aircraft Structures Engineering
3101 Tchulahoma
Memphis, TN 38118

FAX TRANSMITTAL SHEET

Date: JANUARY 4, 1994

FROM:

Name: Mark Yerger
Phone: (901) 369-2654
Fax Phone: (901) 360-9551
4 Page(s) including transmittal sheet

TO:

Company: DOUGLAS
Name: STEVE YOUNG
Phone: (310) 593-9312
Fax Phone:

MESSAGE:

OUR MD-11 N611FE, FUS. NO. 553, WAS INVOLVED IN A HARD LANDING INCIDENT ON 1/4/94. AIRCRAFT HAD 952 HOURS AND 236 CYCLES AT THE TIME OF THE EVENT. A HARD LANDING INSPECTION HAS BEEN CONDUCTED.

KEY INFORMATION:

1.	AIRCRAFT LANDING WEIGHT:	427,200 LBS
	AIRCRAFT C.G.	34.4
	MAX VERT ACCEL	+2.85G
	MAX LAT ACCEL	-0.45G

2.

A HARD LANDING INSPECTION HAS BEEN CONDUCTED IN IAW WITH MD-11 MM 05-51-03. THE FOLLOWING WERE NOTED:

1. MILD TO MODERATE BUCKLING OF THE EXTERNAL SKIN AND STRINGERS FROM LONGERON 36 TO LONGERON 48, STATION 595 BULKHEAD TO APPROX. STA. 625, LEFT AND RIGHT SIDES. SEE ATTACHED SKETCH (ATCH 1). MAXIMUM DEPTH APPROX. 0.10 INCH AT THE LOWEST BUCKLE ON THE L/H SIDE. ALL DEFORMATIONS ARE SMOOTH WITH NO CREASES. SUSPECT AREAS WERE VERIFIED TO BE CRACK-FREE VIA EDDY CURRENT SURFACE PROBE. SKIN AND STRINGERS WERE ALSO VISUALLY INSPECTED FROM THE INSIDE. NO DEFECTS NOTED.

   PER DOUGLAS RECOMMENDATION, THE BULKHEAD AT STA. 595 WAS INSPECTED FOR DAMAGE. THE LOWER TEE CAP WAS INSPECTED VIA EDDY CURRENT SURFACE PROBE. A VISUAL INSPECTION OF THE FORWARD AND AFT FACE OF THE BULKHEAD FROM LONGERON 36 LEFT TO 36 RIGHT WAS CONDUCTED TO

CHECK FOR CRACKS, LOOSE OR DAMAGED FASTENERS, OR DEFORMATION. NO DEFECTS WERE NOTED.

PER DOUGLAS RECOMMENDATION, THE NOSE WHEEL WELL SIDE BULKHEADS WERE VISUALLY INSPECTED FROM WHEEL WELL SIDE ONLY TO CHECK FOR CRACKS, LOOSE OR DAMAGED FASTENERS, OR DEFORMATION. NO DEFECTS WERE NOTED.

2. DURING PYLON INSPECTION OF NO. 1 ENGINE, CRACKING OF THE PAINT AND SEALANT AROUND THE AFT PYLON ATTACH FITTING WAS NOTED AS SHOWN ON ATTACHMENT 2. NO DEFORMATION OR DAMAGE WAS NOTED ON THE FITTINGS OR ATTACHING HARDWARE.

NO OTHER DEFECTS HAVE BEEN NOTED. THE AIRCRAFT WILL UNDERGO FURTHER EVALUATION DURING A "B" CHECK TO BEGIN TODAY.

BASED ON THE ABOVE AND DISCUSSIONS HELD WITH DOUGLAS PERSONNEL, FEDEX RECOMMENDS THE FOLLOWING:

1. COMPLETE THE "B" CHECK ON THE AIRCRAFT AND ENSURE NO OTHER DEFECTS ARE FOUND.

2. OPERATE THE AIRCRAFT WITH THE BUCKLES "AS IS." PERFORM EXTERNAL VISUAL INSPECTION AT "B" CHECK INTERVALS TO ENSURE NO CRACKS, LOOSE OR MISSING FASTENERS, OR OTHER DAMAGE.

3. WITHIN 60 DAYS, PROVIDE DOUGLAS ENGINEERING AN OPPORTUNITY TO INSPECT THE AIRCRAFT AT OUR LAX FACILITY FOR FURTHER DISPOSITION AND/OR PERMANENT REPAIR INSTRUCTIONS. PERMANENT REPAIR (POSSIBLE SKIN SECTION REPLACEMENT OR AN INTERNAL DOUBLER), IF REQUIRED, WOULD BE ACCOMPLISHED AT THE NEXT "C" CHECK, UNLESS FURTHER DAMAGE IS NOTED.

PLEASE REVIEW AND PROVIDE CONCURRENCE OR ALTERNATE PLAN. BECAUSE PERMANENT REPAIR WILL BE CLASSIFIED AS "MAJOR", PLEASE PROVIDE FAA APPROVAL FOR THIS REPAIR PLAN.

IF YOU HAVE ANY QUESTIONS, PLEASE CONTACT ME AT YOUR CONVENIENCE.

Regards,

[redacted]

Mark Yerger
Manager
Aircraft Structures Engineering

21299

EA# 0550-M11-21299

RELEASE DATE 1/7/94

PAGE 1 OF 2

AUDITED/ENTERED
BY: NO. 97226
DATE: 1/13/94

ENGINEERING AUTHORIZATION

TITLE

UNSCHEDULED MAINTENANCE CHECKS - HARD LANDING INSPECTION

EFFECTIVITY

Registry, Asset or Engine No. N611FE

Unit Description

Mfg. P/N

Serial No.

FUNCTION:

___ Manual Change

___ Material Change

___ Alteration

___ Repair

X Other

CLASSIFICATION (Alterations or repairs only)

___ Major

___ Minor

SIGNATURES:

[redacted]

Engineer

[redacted]

Manager

FAA or designee (if required)

REVISION RECORD:

Rev.			
Date			
Engr			
Mgr.			
FAA or designee (if required)			

MACH ITEM NO. ____________

REFERENCES:

1. EA 5330-M11-21224
2.

INSTRUCTIONS:

DISCREPANCY:

Subject aircraft suffered a hard landing upon arrival at MEM on 1/4/94. Initial inspection revealed mild to moderate buckling of the skin and attaching longerons from longeron 36 to longeron 48, left and right sides, between sta Y595 and Y625.

DISPOSITION:

1. Conduct a hard landing inspection on the aircraft in accordance with MD-11 Maintenance Manual 05-51-03, with the following changes:

	MECH	INSP
a. Based on visible damage aft of the nose gear bulkhead at sta. Y595, remove floor and sidewall liner from the lower forward cargo compartment to facilitate internal visual inspection of the damaged area.	9936	N/A

AF14822

b. Visually inspect the inner skin surface and the longerons in the damaged area for cracks and/or loose or missing fasteners.	9936	FE-75
c. Eddy current inspect the lower bulkhead Tee cap at Y595, longeron 36 left to 36 right to verify no cracks in radius.	9936	REF LH PARA CCC698 WRR. 53-10/61 FOR NDT SIGNOFF
d. Visually inspect the Y595 bulkhead and both nose landing gear sidewall bulkheads for cracks, deformation, and loose or missing fasteners.	9936	FE-75
e. It is not necessary to drain and re-service the landing gear struts and check for metal-to-metal contact between the piston and cylinders.	/	/
f. It is not necessary to remove the upper "boattail" fairing to inspect the upper surface of the No. 2 engine aft engine mount structure. Visually inspect the attach bolts and PLI washers from the lower side for condition and security.	/	/

2. Based on reports received by Engineering from this inspection, the following findings were evaluated:

   a. The noted damage to the skins aft of the nose gear bulkhead. No cracks or damaged fasteners were found in this area.

   b. A section of paint was found damaged and the fillet seal separated at the No. 1 engine pylon aft upper attach fitting on the wing side.

   If additional damage or suspect areas are noted, contact Aircraft Structures Engineering prior to further flight. The above noted findings are addressed in EA 5330-M11-21224.

END

AF14823

SPECIAL OR NONROUTINE MAINTENANCE FORM

NO. 8008

PRINT CLEARLY. USE BLACK INK, BALLPOINT PEN ONLY.

FEDERAL EXPRESS

1. ACFT NUMBER/SERIAL NO.	2. DATE	3. GENERATING ITEM	4. WHEN DISCOVERED/ MALFUNCTION CODE	5. EMPLOYEE NO./CERT. NO.
611	09/20/94	53-30/504	C	97947/M

6. DISCREPANCY
FUSELAGE PLATES / SKIN 1700 HR. SPECIAL INSP.
SEE ATTACHED. (OVER)

6A. RECOMMENDED ACTION

AUDITED/ENTERED BY: NO. 94521 DATE: 10/3

ENTER MACH DATA BY: NO. 97226 DATE: 9/30/94

RII ☐

7. CORRECTIVE ACTION
CHANGED FASTENERS (2EA) ON STRINGER 14R STA 599 (NEED NR 1048).
FASTENERS (2EA) ON STRINGER 45L STA 594
ADDRESSED PER EA 5310-M11-20060 REV A

8. MECHANIC SIGNATURE	9. EMPLOYEE NO./CERT. NO.	10. DATE	11. WORK CENTER/VENDOR
[signature]	154728	09/26/94	SM

12. RII BUY BACK	13. EMPLOYEE NO./CERT. NO.	14. DATE	15. WORK CENTER/VENDOR
FE48	97632	9/26/94	INSP

16. TOTAL MAN-HOURS	17. ATA/SUBCHAPTER	18. DATA ENTERED BY	19. RELIABILITY CONTROL NO.
20.0	53-20	AF15383	D 49502

FedEx M-1805 6/92 LOGOS #135512

FEDERAL EXPRESS

SPECIAL OR NONROUTINE MAINTENANCE FORM

PRINT CLEARLY. USE BLACK INK, BALLPOINT PEN ONLY. NO. 1051

1. ACFT NUMBER/SERIAL NO	2. DATE	3. GENERATING ITEM	4. WHEN DISCOVERED/ MALFUNCTION CODE	5. EMPLOYEE NO./CERT. NO
611	09 23 94	EA 5310-M11-22060		99076/FEZ8

6. DISCREPANCY
Upon Inspection of Interim Repair Doubler installed Per E.A. #7 ~~5310-M11-20260~~ 22060, Found Repair Doubler Installed with 0 clearance AT Vertical Side, and .005 inch clearance AT Horizontal side, around Genr Side Load Casting

6A. RECOMMENDED ACTION
See Dot #1

7. CORRECTIVE ACTION
Removed doubler to allow clearance.
Eddy-Current Trim Area, Ø cracks. FE-18
TRIMMED DOUBLER TO ALLOW CLEARANCE.
WILL BE REINSTALLED PER 1039.
~~EA 5310-M11-~~ 22060

RII ☒

8. MECHANIC SIGNATURE	9. EMPLOYEE NO./CERT. NO	10. DATE	11. WORK CENTER/VENDOR
[redacted]	181554	09 24 94	Sheetmetal

12. RII/BUY BACK	13. EMPLOYEE NO./CERT. NO	14. DATE	15. WORK CENTER/VENDOR
FE18 [redacted]	102425	9 24 94	1:15p

16. TOTAL MAN-HOURS	17. ATA/SUBCHAPTER	18. DATA ENTERED BY	19. RELIABILITY CONTROL NO.
2.4	53-20	AF15389	D 70219

FedEx M-1805 8/92 LOGOS #135512

FEDERAL EXPRESS

SPECIAL OR NONROUTINE MAINTENANCE FORM

PRINT CLEARLY. USE BLACK INK, BALLPOINT PEN ONLY. NO. 1052

1. ACFT NUMBER/SERIAL NO.	2. DATE	3. GENERATING ITEM	4. WHEN DISCOVERED/ MALFUNCTION CODE	5. EMPLOYEE NO./CERT. NO.
611	09 24 94	E.A. 5310-M11-20260		98076/FE28

6. DISCREPANCY

Upon Inspection of Interim Repair Doubler installed, Found Slot not installed in Doubler Per E.A. 5310-M11-~~20260~~ 20060 Drawing pg. 4, 1 EA Fastner hole Intersects Slot & Slot terminates within 1/16 inch of Fastner hole in Pressure web - dot #2

6A. RECOMMENDED ACTION

Insp. Note: Slot measure 3.7 inches Length, Exceeds Exceeds Length in E.A. 5310 M11-20260 pg 2 Item 3 By .700 inch

3.7 INCH LONG SLOT IS ACCEPTABLE TO ENGNR (INTERIM REPAIR) [signature] 98877 9-24-94

7. CORRECTIVE ACTION — RII ☒

RECOMMENDED ACTION CONTINUED - SHORT E.D. (1/16 INCH) HOLE IS IN DAMAGED BLKHD DOUBLER - ACCEPTABLE TO ENGNR (INTERIM REPAIR)

[signature] 98877 9/24/94 -END.

AF15391

CARD #

8. MECHANIC SIGNATURE	9. EMPLOYEE NO./CERT. NO.	10. DATE	11. WORK CENTER/VENDOR
JMH 98539	JMH 98539	9/24/94	Engr. Sheetmetal

12. RII BUY BACK	13. EMPLOYEE NO./CERT. NO.	14. DATE	15. WORK CENTER/VENDOR
ME 18 [redacted]	102425	9 24 94	INSP

16. TOTAL MAN-HOURS	17. ATA/SUBCHAPTER	18. DATA ENTERED BY	19. RELIABILITY CONTROL NO.
0	53-20		D 70 8

FEDERAL EXPRESS · **SPECIAL OR NONROUTINE MAINTENANCE FORM**

PRINT CLEARLY. USE BLACK INK, BALLPOINT PEN ONLY. **NO.** 1040

1. ACFT NUMBER/SERIAL NO.: 611
2. DATE: 09 21 94
3. GENERATING ITEM: E.A. 5330-mil-21224
4. WHEN DISCOVERED/ MALFUNCTION CODE: 0006
5. EMPLOYEE NO./CERT. NO.: 99076/FE28

6. DISCREPANCY: Y Sta. 595 AFT Press Bulkhead, Vertical Web Exhibits approx. 14 Areas of Positive & Negative Surface Buckling, Approx. .030 inch to .050 inch depth, As viewed inside #3 A/C Pack Bay Looking AFT. Between Sta. X-30 + X-75 AND Z-45 to Z-92) See Attached Copy

6A. RECOMMENDED ACTION:

7. CORRECTIVE ACTION: To Insp Every 150 cycles Per E.A. 5310-mil-22609 Pg. 5 of 7 ITEM #3. until permanent Repair is To be accomplished. No Later than 1200 Landings from E.A. Date of 23 SEP 94. REF. N/R 1039

RII ☐

8. MECHANIC SIGNATURE: [redacted]
9. EMPLOYEE NO./CERT. NO.: 99146
10. DATE: 09-26-94
11. WORK CENTER/VENDOR: SM
12. RII BUY BACK: FE-23
13. EMPLOYEE NO./CERT. NO.: ~~99146~~ 95883
14. DATE: 09 26 94
15. WORK CENTER/VENDOR: INSP
16. TOTAL MAN-HOURS: 0
17. ATA/SUBCHAPTER: 53-30
18. DATA ENTERED BY: AF15387
19. RELIABILITY CONTROL NO.: D 70223

FedEx M-1605 8/92 LOGOS #135512

SPECIAL OR NONROUTINE MAINTENANCE FORM NO. 1039

PRINT CLEARLY. USE BLACK INK, BALLPOINT PEN ONLY.

1. NUMBER/SERIAL NO	2. DATE	3. GENERATING ITEM	4. WHEN DISCOVERED/ MALFUNCTION CODE	5. EMPLOYEE NO./CERT. NO
611	09 21 94	E.A. 5330-M11-21224	0006	99076/FE28

6. DISCREPANCY: Sta. 595 AFT Press. Bulkhead, Vertical Web Exhibits Approx. 25 Areas of Positive & Negative Surface Buckling, Approx. .030 inch to .060 inch depth. As Viewed inside #1 A/c Pack Bay Looking AFT Between Sta. X27 to X42 & Sta. Z-33 to Z-102) See Attached Copy

6A. RECOMMENDED ACTION: ACTION TAKEN ON NR# 1044 WHICH GIVES DIMENSIONS OF CREASE ADDRESSED IN ~~EA 5310-M11~~ 20260. W.Cat 161665

RII ☒

7. CORRECTIVE ACTION: PER EA 5310-M11-20260 STEPS 1 thru 5 COMPLIED WITH 181554 [illegible] FE-22 W.Cat 22060 JMC 181564 / FE-03

OK TO INSTALL DOUBLER PER EA 531-M11-20260 ~~JMC 181564~~ [illegible] VOID

INSTALLED DOUBLER / ~~[illegible]~~ REF N/R 1040 1051

JMC 181564 FE-03 (OVER)

8. MECHANIC SIGNATURE	9. EMPLOYEE NO./CERT. NO	10. DATE	11. WORK CENTER/VENDOR
[redacted]	99146	09-26-94	Sheetmetal

12. RII BUY BACK	13. EMPLOYEE NO./CERT. NO.	14. DATE	15. WORK CENTER/VENDOR
FE-23	95883	09 26 94	INSP

16. TOTAL MAN-HOURS	17. ATA/SUBCHAPTER	18. DATA ENTERED BY	19. RELIABILITY CONTROL NO.
19.6	53-20	AF15385	D 70225

FEDERAL EXPRESS

SPECIAL OR NONROUTINE MAINTENANCE FORM

PRINT CLEARLY. USE BLACK INK, BALLPOINT PEN ONLY. **NO.** 8008

1. CFT NUMBER/SERIAL NO.	2. DATE	3. GENERATING ITEM	4. WHEN DISCOVERED/ MALFUNCTION CODE	5. EMPLOYEE NO./CERT. NO.
611	09/20/94	53-30/504	C	97947/M

6. DISCREPANCY
FUSELAGE PLATES / SKIN 1700 HR. SPECIAL INSP
SEE ATTACHED. (OVER)

6A. RECOMMENDED ACTION

ENTER MACH DATA

7. CORRECTIVE ACTION RII ☐
CHANGED FASTENERS (2EA) ON STRINGER 44R STA
599 (SEE NR 1048).
FASTENERS (2EA) ON STRINGER 45L STA 594
ADDRESSED PER [redacted] REV A

8. MECHANIC SIGNATURE	9. EMPLOYEE NO./CERT. NO.	10. DATE	11. WORK CENTER/VENDOR
[redacted]	154728	09/26/94	EE/SM

12. RII BUY BACK	13. EMPLOYEE NO./CERT. NO.	14. DATE	15. WORK CENTER/VENDOR
FE-48	97632	9/26/94	INSP

16. TOTAL MAN-HOURS	17. ATA/SUBCHAPTER	18. DATA ENTERED BY	19. RELIABILITY CONTROL NO.
	53-20		D 49502

M-1805 6/92 LOGOS #135512

REFERENCES:

1. DAC MSG SVC-LAX-0157/SFY
2. E.A. 5330-M11-21039
3. FUS 553
4. E.A. 5330-M11-21224
5. DAC MSG SVC-MEM-0124/SFY
6. E.A. 5320-M11-22057
7. WOC09229401
8. DAC MSG LAX-SVC-0164/SNM

INSTRUCTIONS:

This E.A. Is issued as a follow up to E.A. 5330-M11-21224, REV "A," which covers repetitive inspections and subsequent permanent repair to fuselage skin at C check in September 1994. Prior to commencement of repair work, additional inspections were performed per E.A. 5320-M11-22057 and additional damage was found in the STA 595 bulkhead area. As required by DAC Msg SVC-MEM-0124/SFY, additional damage was reported to Douglas Aircraft prior to further flight and FAA approval was obtained for repair data described herein.

ATTENTION MOCC: FOLLOW UP REQUIRED

This E.A. provides instructions for interim repair to STA 595 bulkhead web doubler at X=42. This E.A. also provides for new repetitive inspection requirements that supersede those in E.A.'s 5330-M11-21039 and 5330-M11-21224.

1. Interim repair to STA 595 bulkhead web doubler is to be performed per pages 2 - 4 of this E.A.
2. Repetitive visual inspections are to be performed at intervals not to exceed 150 landings per instructions on pages 5 - 7 of this E.A.

Permanent repair to be accomplished no later than 1200 landings from this date.
Details of permanent repair will be coordinated by LAX Engineering with DAC over the next 90 days. Permanent repair will require major repair to the STA 595 bulkhead in addition to the previously approved fuselage skin splices for both the LH and RH sides per E.A. 5330-M11-21224. Permanent repair is estimated to require approximately 4 - 6 weeks down time. LAX Engineering will supply preliminary list of required materials by JAN. 1, 1995.

AF15393

FEDERAL EXPRESS

BY: NO. 37225
DATE: 9/30/94

22060

E.A.# 5310-M11-22060 A

RELEASE DATE 26 SEP 94

ENGINEERING AUTHORIZATION

PAGE 1 OF 7

TITLE FUSELAGE - MAIN FRAME, STATION 595 PRESSURE BULKHEAD, INTERIM REPAIR

EFFECTIVITY

Registry, Asset or Engine No. N611FE

Unit Description MD-11F

STA 595 PRESS BULKHEAD

A/C Serial No. 48604

TST 3519:10

CYCLES 813

MFG. P/N NCA6244-515

SERIAL NO. N/A

MACH
ITEM NO. ____________

FUNCTION:

___ Manual Change
___ Material Change
___ Alteration
_X_ Repair
___ Other

CLASSIFICATION
(Alterations or repairs only)

___ Major
_X_ Minor

SIGNATURES:

Signed by William O. Cusato 9/23/94
Engineer William O. Cusato

Signed by Jack W. Springer 9/23/94
Manager Jack W. Springer

FAA or designee (if required)

REVISION RECORD:

Rev.	A		
Date	9/26/94		
Engr	[redacted]		
Mgr.	J. W. SPRINGER		
FAA or designee (if required)	[redacted]		

REFERENCES:

1. DAC MSG SVC-LAX-0157/SFY
2. E.A. 5330-M11-21039
3. FUS 553
4. E.A. 5330-M11-21224
5. DAC MSG SVC-MEM-0124/SFY
6. E.A. 5320-M11-22057
7. WOC09229401
8. DAC MSG LAX-SVC-0164/SNM

INSTRUCTIONS:

This E.A. is issued as a follow up to E.A 5330-M11-21224, REV "A," which covers repetitive inspections and subsequent permanent repair to fuselage skin at C check in September 1994. Prior to commencement of repair work, additional inspections were performed per E.A. 5320-M11-22057 and additional damage was found in the STA 595 bulkhead area. As required by DAC Msg SVC-MEM-0124/SFY, additional damage was reported to Douglas Aircraft prior to further flight and FAA approval was obtained for repair data described herein.

ATTENTION MOCC: FOLLOW UP REQUIRED

This E.A. provides instructions for interim repair to STA 595 bulkhead web doubler at X=42. This E.A. also provides for new repetitive inspection requirements that supersede those in E.A.'s 5330-M11-21039 and 5330-M11-21224.

1. Interim repair to STA 595 bulkhead web doubler is to be performed per pages 2 - 4 of this E.A.

2. Repetitive visual inspections are to be performed at intervals not to exceed 150 landings per instructions on pages 5 - 7 of this E.A.

3. Permanent repair to be accomplished no later than 1200 landings from this date. Details of permanent repair will be coordinated by LAX Engineering with DAC over the next 90 days. Permanent repair will require major repair to the STA 595 bulkhead in addition to the previously approved fuselage skin splices for both the LH and RH sides per E.A. 5330-M11-21224. Permanent repair is estimated to require approximately 4 - 6 weeks down time. LAX Engineering will supply preliminary list of required materials by JAN. 1, 1995.

AF15394

FEDERAL EXPRESS

22060 "A"

E.A.# 5310-M11-22060

ENGINEERING AUTHORIZATION

	Repair Instructions	MECHANIC	RII / INSPECTION
1.	Gain access to LH air conditioning compartment and remove fasteners in STA 595 bulkhead to allow installation of repair doubler and trimming of web. See attached sketch.	R. Kalipe #15971	FE-28
2.	If access permits, slide scrap section 0.020 stainless steel or titanium between STA 595 bulkhead web and vertical leg of tee to protect vertical leg of tee.	R. Kalipe #15971	NOT REQ
3.	Trim .25 inch wide slot in doubler only where web is creased. Slot to extend approximately 2 - 3 inches from lower edge of web to allow installation of doubler without excessive preload. See attached sketch.	R. Kalipe #15971	FE-51
4.	Perform Eddy Current inspection to verify no cracks exist in trim area.	R. Kalipe #15971	FE-16
5.	Fabricate repair doubler per attached sketch from 2024-T3 clad, 0.125 thick.	R. Kalipe #15971	NOT REQ
6.	Locate doubler on forward side of web and back drill 20 ea existing hi-lok holes to 0.185 dia. Back drill 10 ea existing rivet holes to 0.198 dia. See attached sketch.	JMC 181554	NOT REQ
7.	Layout and drill 16 ea repair fastener holes to 0.185 dia per attached sketch .	[illegible]	NOT REQ
8.	Remove doubler. Apply Alodine 1200 and FR primer to all exposed aluminum surfaces.	[illegible]	NOT REQ
9.	OK TO INSTALL DOUBLER.	JMC 181554	FE-51
10.	Install repair doubler wet with PR1422 or equivalent.	DAR 153174	FE-51
11.	Reinstall details removed for access and restore area to normal configuration.	JMC 181554	FE-51

Details will be installed on NR # 1029 1033

LIST OF MATERIALS:

ITEM	NAME	MATERIAL	SIZE
1.	DOUBLER	2024-T3	0.125 X 6 X 18

AF15395

MONITORING PROGRAM

Refer to FOM, Chapter 7, documentation for flight parameters.

Z-Time	Z-Date		
MACH NO.	IAS	TAS	SAT
TAT	ALT	ZFW	FOB

Pneumatic ISO Valve	1-2	1-3	
Closed Open			

Aircraft Check Valve	1/L	2/R	3/X Feed	CG Range
Closed Open				
Engine Position	1	2	3	4
Engine Bleeds Closed Open				
EPR				
N1 RPM				
EGT				
N2 RPM				
Fuel Flow				
Oil Press				
Oil Temp				
Vib (Fan)				
Vib (Turbine)				

Did the computer accept the data? ☐

OIL ADDED (U.S. Qts)	Station	Zulu Date

Employee Number/Certificate Number/Vendor Number

#1	#2	#3	#4	APU

4-1807 3/93 LOGOS # 139000

AIRCRAFT MAINTENANCE LOG

10 11

PDIS | DISCREPANCY | MDIS 94116

Continued from page

AUDITED/ENTERED BY DATE: 12/19/94

AUDITED/ENTERED BY: 94521 DATE: 10/12

ATA / WRI No. 53 10 681

Continued on page 6774

Continued from page 136760

MAINTENANCE ACTION

AIRCRAFT REQUIRES FERRY FLIGHT FROM ANC TO LAX
REF: WRI 53-10 681

I CERTIFY THE AIRCRAFT IS IN SAFE CONDITION FOR FERRY FLIGHT INTENDED. EA 1-5310-22681
AUTHORIZATION NO 94-19 BY DONALD SHELLEY 4365
SIGNATURE OF CERTIFIED MECH [signature] 11099

Continued on page 6774

Mfg Part Number	S/N Off	S/N On	Pos	Rec

MEL/CDL Reference ☐ | Open Items List ☐

Closed ☐ | Cat Status Changed ☐ ☐

Mechanic's Signature

Mfg Part Number	Nomenclature	Pos

Employee Number/Certificate Number/Vendor Number

Station | Zulu Date 11/21/94

Inspector's Signature AF15381

SERVICE CHECK | Station | Zulu Date

Mechanic's Signature

Employee Number/Certificate Number/Vendor Number

☐ RII ☐

Employee Number/Certificate Number/Vendor Number

Data Entered By

Page Number 136769

Distribution: White - Mx. Records, Goldenrod - Stay in A/C, Pink - Reliability, Canary - Station

FEDERAL EXPRESS

SPECIAL OR NONROUTINE MAINTENANCE FORM

PRINT CLEARLY. USE BLACK INK, BALLPOINT PEN ONLY. NO. 5001

1. ACFT NUMBER/SERIAL NO.	2. DATE	3. GENERATING ITEM	4. WHEN DISCOVERED/ MALFUNCTION CODE	5. EMPLOYEE NO./CERT. NO.
611	11/08/94	53-10/627	0006	97470

6. DISCREPANCY

FUSELAGE STA. 595 press. Bulkhead interm Repair C/W E.A. 1-5310-22060

AUDITED/ENTERED BY: NO. 97226 DATE: 11/29/94

6A. RECOMMENDED ACTION

7. CORRECTIVE ACTION — RII ☐

PREFORMED REPETITIVE INSPECTION PER. EA# 5310-M11-22060A PAGE 5 OF 7. NO DISCREPENCYS FOUND.

AF15356

AUDITED/ENTERED BY: NO. 94521 DATE: 11/30

8. MECHANIC SIGNATURE	9. EMPLOYEE NO./CERT. NO.	10. DATE	11. WORK CENTER/VENDOR
[redacted]	180421	11/14/94	S/M
12. RII BUY BACK	**13. EMPLOYEE NO./CERT. NO.**	**14. DATE**	**15. WORK CENTER/VENDOR**
		NOV 14 1994	

16. TOTAL MAN-HOURS	17. ATA/SUBCHAPTER	18. DATA ENTERED BY	19. RELIABILITY CONTROL NO.
8.0	53-10		D 48710

SPECIAL or NON-ROUTINE Maintenance Form

WN

PRINT Clearly and Use Black Ball Point Pen ONLY

NO. S001

1. AIRCRAFT NUMBER	2. DATE (mm/dd/yy)	3. GENERATING ITEM	4. WHEN DISCOVERED/ MALFUNCTION CODE	5. EMPLOYEE NO./CERT. NO.
N611FE	07/21/95	EA 1-5310-23155	05-25	33372

6. DISCREPANCY C/W EA 1-5310-23155

FUSELAGE, STA. Y=595 TO Y=619, LONG. 36L TO 48L-BORON DOUBLER INSPECTION

6A. RECOMMENDED ACTION

AF15299

AUDITED BY: NO. DATE: 10 . 5

7. CORRECTIVE ACTION Permanent repair accomplished no further inspection required New Skin replaced Repair area [illegible]

RII ☐

8. MECHANIC SIGNATURE	9. EMPLOYEE NO./CERT. NO.	10. DATE (mm/dd/yy)	11. WORK CENTER/VENDOR
[redacted]	97254	08-25-95	820 [illegible] LAX

12. RII BUY BACK	13. EMPLOYEE NO./CERT. NO.	14. DATE (mm/dd/yy)	15. WORK CENTER/VENDOR
FE-04	97405	AUG 25 1995	600 [illegible] LAX

16. TOTAL MANHOURS	17. ATA/SUBCHAPTER	18. DATE ENTERED BY	19. RELIABILITY CONTROL NO.
8.2	53-30	SEP 3 1995	

FEDERAL EXPRESS CORPORATION

ENGINEERING AUTHORIZATION

E.A.#: 1-5310-23155
Release Date: 1/26/95

TIT

FU..LAGE, STA. Y=595 TO Y=619, LONG. 36L TO 48L - BORON DOUBLER INSPECTION

Registry No. N611FE	RELEASE SIGNATURES	Rev A Date:	Rev B Date:	FUNCTION:	
Nomenclature: MD-11 BORON DBLR. EVALUATION	Engineer: [redacted] L. OKSANA BARDYGULA	Engr	Engr	Minor Repair	
				Minor Alteration	
Part Number: N/A	Manager: [redacted] JACK W. STRINGER	Mgr	Mgr	Major Repair	
				Major Alteration	
Serial Number: N/A	FAA/Designee:	FAA	FAA	Manual Change	
				Material Change	
Hours/Cycles: 4627/1087		Is this SFAR 36? NO	Is Follow-up Req'd? YES	Other BORON INSP.	X

REASON/DISCREPANCY:

DURING "B" CHECK INSPECTION PER EA 5310-M11-22060A, TWO BORON DOUBLERS WERE FOUND WITH DELAMINATION. THE DELAMINATION OF BOTH DOUBLERS WAS REPAIRED PER EA 1-5320-23154. THIS E.A CALLS FOR MONITORING THE SIZE OF DELAMINATION, FOR BOTH DOUBLERS, FOR GROWTH DURING THE INSPECTION PERIOD CALLED OUT BY EA 5310-M11-22060A.

MOCC FOLLOW UP:
THIS EA IS TO BE DONE IN CONJUNCTION WITH THE INSPECTIONS CALLED OUT IN EA 5310-M11-22060A. THEREFORE, THE INSPECTIONS ARE TO BE PERFORMED AT INTERVALS NOT TO EXCEED 150 LANDINGS. RESULTS OF NEGATIVE FINDINGS OF THE INSPECTIONS (I.E. DELAMINATION GROWTH) ARE TO BE REPORTED TO FEDEX ENGINEERING.
T... IATING ACTION FOR THIS INSPECTION PERIOD WILL BE THE ACCOMPLISHMENT OF PERMANENT R...IR PER EA531)-M11-22060A.

REFERENCES: Note: For major repairs/alterations, this EA must be FAA approved or must reference previously approved data. For minor changes which affect manufacturer's limits, this section must contain substantiating information or reference attached documentation.

1. EA 1-5320-23154, EA5320-M11-22058, EA5330-M11-21224, AND EA5310-M11-22060A
2. MD-11 SRM, VOL.II, CH. 51-62-01, 51-43-01 AND 51-71-00

INSTRUCTIONS: DETAILED INSPECTION	MECHANIC	CHECK BY
INSPECT BORON DOUBLERS ON THE L/H SIDE OF THE A/C FOUND AT FUS. STA. Y=595 TO Y=615, FROM LONGERON 36 TO LONGERON 48. REFERENCE FIG. 1 FOR LOCATION.	TA1 97262 AUG 25 1995	N/A FE-04

AF15301

F/-up Tracking Entered by:		Emp. No.:	Date:
INITIAL/INTERIM Action Accomplished by:	Emp. No.:	Date:	Ref.: WRI/Non-Routine
FOLLOW-UP Action Accomplished by: (If Required)	Emp. No.:	Date:	Ref.: WRI/Non-Routine

E.A.#: 1-5310-23155

ENGINEERING AUTHORIZATION

INSTRUCTIONS: (Continued)	MECHANIC	CHECK BY
INSPECT FOR GROWTH OF DELAMINATION FOUND ON DBLR. #2. DELAMINATION FOUND WAS AT THE UPPER LEFT HAND CORNER (LOOKING INBD.). THE DELAMINATION WAS 5.3" X 5.9" (SEE FIG. 2).	TAI 67262 AUG 25 1995	N/A FE-04
3. HAS DELAMINATION OF #2 DOUBLER GROWN SINCE LAST INSPECTION? IF DELAMINATION HAS GROWN CONTACT LAX FEDEX ENGINEERING (ATTN: OKSANA BARDYGULA, PHONE #(310) 649-8526, FAX #(310) 641-9475). N/A. NEW SKIN REPLACED REPAIR AREA.	TAI 67262 AUG 25 1995	N/A FE-04
4. INSPECT FOR GROWTH OF DELAMINATION FOUND ON DBLR. #3. DELAMINATION WAS FOUND AT THE UPPER EDGE RUNNING LONGITUDINALLY. THE DELAMINATION WAS 4" X 1/2" (SEE FIG. 3).	TAI 67262 AUG 25 1995	N/A FE-04
5. HAS DELAMINATION OF #3 DOUBLER GROWN SINCE LAST INSPECTION? IF DELAMINATION HAS GROWN CONTACT LAX FEDEX ENGINEERING (ATTN: OKSANA BARDYGULA, PHONE #(310) 649-8526, FAX #(310) 641-9475). N/A. NEW SKIN REPLACED REPAIR AREA.	TAI 67262 AUG 25 1995	N/A FE-04

End Of Instructions

AF15302

M ... TORING PROGRAM

Refer to FOM, ... er 7, documentation for flight parameters.

Z-Time	Z-Date

MACH NO.	IAS	TAS	SAT
TAT	ALT	ZFW	FOB

Pneumatic ISO Valve 0=Closed 1=Open	1-2	1-3		
Aircraft Pack Valve 0=Closed 1=Open	1/L	2/R	3/X Feed	CG Range
Engine Position	1	2	3	4
Engine Bleeds 0=Closed 1=Open				
EPR				
N_1 RPM				
EGT				
N_2 RPM				
Fuel Flow				
Oil Press				
Oil Temp				
VIB (Fan)				
VIB (Turbine)				

Did the computer accept the data?

OIL ADDED (U.S. Qts)	Station	Zulu Date

Employee Number/Certificate Number/Vendor Number

# 1	# 2	# 3	# 4	APU

FedEx M-1807 3/93 LOGOS # 139000

PDIS

DISCREPANCY

MDIS 9...

Continued from page

AUDITED BY: ...
DATE: 12/1/94

AUDITED / ENTERED
BY EMP. NO. 94521
DATE: 12/2

ATA / WRI No. 53 10 681

Continued on page 6774

Continued from page 136760

MAINTENANCE ACTION

AIRCRAFT REQUIRES FERRY FLIGHT FROM ANC TO LAX
REF: WRI 53-10 681

I CERTIFY THE AIRCRAFT IS IN SAFE CONDITION FOR FERRY
FLIGHT INTENDED. EA 1-5310-22681
AUTHORIZATION NO 94-19 BY DONALD SHELLEY 4365
SIGNATURE OF CERTIFIED MECH [signature] 14099

Continued on page 6774

Mfg Part Number	S/N Off	S/N On	Pos	Rea

MEL/CDL Reference ☐ Open Items List ☐

☐ Closed ☐ Cat Status Changed ☐

Mechanic's Signature

Mfg Part Number	Nomenclature	Pos

Employee Number/Certificate Number/Vendor Number

Station | Zulu Date 11/21/94

Inspector's Signature AF15381

SERVICE CHECK	Station	Zulu Date

Mechanic's Signature

Employee Number/Certificate Number/Vendor Number

☐ RII ☐

Employee Number/Certificate Number/Vendor Number

Data Entered By

Page Number 136769

Distribution: White - Mt. Records, Goldenrod - Stay in A/C, Pink - Reliability, Canary - Station

DERAL
PRESS
RPORATION

ENGINEERING AUTHORIZATION

E.A.#: 1-5310-22681
Release Date: 11-6-94
Page 1 of 1

FUSELAGE- TAIL STRIKE- TEMPORARY REPAIR FOR ONE TIME FERRY FLIGHT

gistry No. N611FE	RELEASE SIGNATURES	Rev A Date:	Rev B Date:	FUNCTION:	
menclature: KIN AND BULKHEAD	Engineer: CRAIG IVANY [redacted]	Engr	Engr	Minor Repair	
				Minor Alteration	
rt Number:	Manager: JACK SPRINGER [redacted]	Mgr	Mgr	Major Repair	X
				Major Alteration	
nal Number:	FAA/Designee:	FAA	FAA	Manual Change	
				Material Change	
urs/Cycles: 3,968/922		Is this SFAR 36? NO	Is Follow-up Req'd? YES	Other	

SON/DISCREPANCY: During landing in Anchorage the subject aircraft dragged its tail causing ie following damage. The fuselage skin was damaged from longeron 50R to 51L, Sta 1882 to)40. The Sta 2007 bulkhead was also damaged from X=-24 to X=24. The center 3 vert. floor ipports at sta 1975 and 1 vert. support at sta. 1987, X=0 were also found to be damaged. ie subject damaged area was inspected and all shear clips and longerons are intact but .ightly deformed. The tail drag inspection was accomplished and no other damage was found her than noted above.

ERENCES: Note: For major repairs/alterations, this EA must be FAA approved or must reference previously approved data. For minor changes which affect manufacturer's limits, this section should contain substantiating information or reference attached documentation

DAC TELEX ISC-MEM-0002/SFY
FAA 8110-3 DATED 11-7-94
SRM 51-38-01 vol. II

ONS: Perform a temporary repair to the damaged skin to enable e ..craft to ferry to LAX for permanent repair as follows:	MECHANIC	CHECK BY
Fab a doubler from .080" 2024-T3 matl. from longeron 49R to 50L, sta. 1871 to 1997.75.		
Fab a doubler from .080" 2024-T3 matl. from longeron 50R to 50L, sta. 1997.75 to 2047.6. Cut out access hole in tail to match existing cutout.		
locate repair doublers in place, pick up existing fastener holes in longerons, shear clips and splice at sta. 1997.75. Add fasteners as required to pick up a min. of 2 rows of fasteners around entire perimeter of damaged area.		
Install doublers using 3/16" dia. bolts in longerons and fastener rows adjacent to Butt splice at sta. 1997.75. Install 3/16 cherry max rivets at all other locations.		
All other remaining damage is acceptable for a one time non-revenue unpressurized ferry flight from anchorage to LAX for permanent repair. Permanent repair to be addressed by future Engineering Authorization.		

w-up Tracking Entered by:	Emp. No.:	Date:	
NTERIM Action Accomplished by:	Emp. No.:	Date:	Ref.: WRI/Non-Routine
OLLOW-UP Action Accomplished by: (If Required)	Emp. No.:	Date:	Ref.: WRI/Non-Routine

AF15382

FEDERAL EXPRESS

SPECIAL OR NONROUTINE MAINTENANCE FORM

PRINT CLEARLY. USE BLACK INK, BALLPOINT PEN ONLY. NO. 5001

1. ACFT NUMBER/SERIAL NO	2. DATE	3. GENERATING ITEM	4. WHEN DISCOVERED/ MALFUNCTION CODE	5. EMPLOYEE NO./CERT. NO.
611	11/08/94	53-10/627	0006	97470

6. DISCREPANCY

FUSELAGE STA. 595 press. Bulkhead interm Repair C/W E.A. 1-5310-22060

AUDITED/ENTERED BY: NO. 97226 DATE: 11/29/94

6A. RECOMMENDED ACTION

7. CORRECTIVE ACTION — RII ☐

PREFORMED REPETITIVE INSPECTION PER EA# 5310-M11-22060A PAGE 5 OF 7. NO DISCREPENCYS FOUND.

AF15356

AUDITED/ENTERED BY: NO. 94521 DATE: 11/30

8. MECHANIC SIGNATURE	9. EMPLOYEE NO./CERT. NO.	10. DATE	11. WORK CENTER/VENDOR
[redacted]	1504721	11/14/94	S/M

12. RII BUY BACK	13. EMPLOYEE NO./CERT. NO.	14. DATE	15. WORK CENTER/VENDOR
		NOV 14 1994	

16. TOTAL MAN-HOURS	17. ATA/SUBCHAPTER	18. DATA ENTERED BY	19. RELIABILITY CONTROL NO.
8.0	53-10		D 48710

FEDERAL EXPRESS

SPECIAL OI .ONRDUTINE MAINTENANC FORM

PRINT CLEARLY. USE BLACK INK, BALLPOINT PEN ONLY. **NO.** N053

1 ACFT NUMBER/SERIAL NO	2. DATE	3 GENERATING ITEM	4 WHEN DISCOVERED/ MALFUNCTION CODE	5 EMPLOYEE NO/CERT NO
#611FE	11/13/94	E.A. #1-5330-22690	0006	155971

6 DISCREPANCY FABRICATED WEB/Tee Cap IAW B/P # NJC-6040, SRM #53-40-00, Fig 4, and E.A. #1-5330-22690. FE-61

6A RECOMMENDED ACTION FAB Repair web & T chord per SRM 53-40-00 Fig 4 moved R.H. cut location of web per E.A. 1-5330-22690, install parts per SRM REF: E.A. (STEP #14)

7 CORRECTIVE ACTION OK to INSTALL. FE-61, INSTALLED WEB IAW, E.A. #1-5330-22690. **RII** ☑

AUDITED/REVIEWED BY/NO. DATE: 11/30

8 MECHANIC SIGNATURE	9 EMPLOYEE NO/CERT NO	10 DATE	11 WORK CENTER/VENDOR
[redacted]	99146	11-17-94	S/M
12 RII BUY BACK	**13 EMPLOYEE NO/CERT NO**	**14 DATE**	**15 WORK CENTER/VENDOR**
FE-55	97831		INSP
16. TOTAL MAN HOURS	**17. ATA/SUBCHAPTER**	**18 DATA ENTERED BY**	**19. RELIABILITY CONTROL NO.**
	53-10		D 43915

FedEx M-1805 8/92 LOGOS #135512

N053

FEDERAL EXPRESS CORPORATION

ENGINEERING AUTHORIZATION

E.A.#: 1-5330-22690
Release Date: 16 NOV. 94
Page 1 of 10

TITLE FUSELAGE - STA 2007 BULKHEAD REPAIR

DATE: 11/24/94

Registry No. N611FE	RELEASE SIGNATURES	Rev A Date:	Rev B Date:	FUNCTION:	
Nomenclature: MD-11F	Engineer: [redacted] William O. Cusato	Engr	Engr	Minor Repair	
				Minor Alteration	
Part Number: NJC6040	Manager: [redacted] For Jack W. Springer	Mgr.	Mgr.	Major Repair	X
				Major Alteration	
Acft. Serial Number: 48604	FAA/Designee:	FAA	FAA	Manual Change	
				Material Change	
Hours/Cycles: 3,974 / 923		Is this SFAR 36? NO	Is Follow-up Req'd? NO	Other	

REASON/DISCREPANCY:

AIRCRAFT EXPERIENCED A TAIL STRIKE DURING LANDING AT ANC. INTERIM REPAIR WAS ACCOMPLISHED TO ACCOMMODATE FERRY PERMIT TO LAX WHERE PERMANENT REPAIRS ACCOMPLISHED.

REFERENCES: Note: For major repairs/alterations, this EA must be FAA approved or must reference previously approved data. For minor changes which affect manufacturer's limits, this section should contain substantiating information or reference attached documentation.

MD-11 SRM VOL. 1, 53-40-00, FIGURE 4 - STA Y=2007 PRESS BULKHEAD AND TEE CAP SPLICE
MD-11 DRAWINGS: AGA7416, AJC7207, NJC6374, NJC6040, AJC7050
DAC MSG LAX-SVC-0208/RGS, DTD 11/14/94; SVC-LAX-0212/SFY, DTD 11/16/94
FUS 553

INSTRUCTIONS:	MECHANIC	CHECK BY
THIS E.A. PROVIDES REPAIR INSTRUCTIONS AND DOCUMENTATION FOR THE SET-UP AND REPAIR OF AFT FUSELAGE AND DETAILS FOR STA 2007 BULKHEAD INTERNAL REPAIRS. THE DATA CONTAINED HEREIN IS BASED ON TYPE CERTIFICATE DATA, STRUCTURAL REPAIR MANUAL, AND FAA APPROVED REPAIR DATA.		FE-55
THIS E.A. DOES NOT RECORD THE NUMEROUS ADDITIONAL DETAILS REPLACED PER TYPE CERTIFICATE DATA AS A RESULT OF THE TAIL STRIKE. PART REPLACEMENT IS DOCUMENTED PER APPROPRIATE GMM PROCEDURES.	DXD 165478 XC7 94967 4F15416	FE-55

Follow-up Tracking Entered by:	Emp. No.:	Date:
NO FOLLOW UP TRACKING REQUIRED	9783 / FE-55	11-16-94

	Emp. No.:	Date:	Ref.: WRI/Non-Routine
A. INITIAL/INTERIM Action Accomplished by:			
B. FOLLOW-UP Action Accomplished by: (If Required)			

FEDERAL
EXPRESS
CORPORATION

ENGINEERING AUTHORIZATION

E.A.#: 1-5330-22690

	Instructions	MECHANIC	CHECKED BY
1.	Remove number 2 engine per MD-11 Maintenance Manual.	R. Radtke 155971	NOT REQ
2.	Remove APU per MD-11 Maintenance Manual.	R. Radtke 155971	NOT REQ
3.	Jack and shore aircraft. Install shoring under each horizontal stabilizer.	R. Radtke 155971	FE-55
4.	Remove interim repair from aft belly of aircraft.	R. Radtke 155971	NOT REQ
5.	Inspect aft exterior skins for damage.	R. Radtke 155971	FE-57
6.	Perform detailed visual internal and external inspection of aft fuselage from STA 1811 - aft to tail cone. Record all discrepancies per GMM.	R. Radtke 155971	FE-57
7.	Remove damaged belly skin from STA 1862 aft to APU compartment.	R. Radtke 155971	NOT REQ
8.	Perform detailed visual inspection of in internal structure from STA 1862 aft to APU compartment.	R. Radtke 155971	FE-57
9.	Trim damaged section of STA 2007 bulkhead TEE cap per SRM VOL. 1, 53-40-00, Figure 4.	R. Radtke 155971	FE-57
10.	Trim damaged section of STA 2007 bulkhead web per SRM VOL., 53-40-00, Figure 4 and per sketch on page 6 of this E.A. Trim damaged section of X=+/- 11.25 beam installations per figure on page 6 of this E.A.	R. Radtke 155971	FE-57
11.	Fabricate replacement web section and repair details per SRM and figure on page 5 of this E.A.	R. Radtke 155971	NOT REQ
12.	Fit and locate web repair details per SRM and figure on page 6. Layout repair fastener pattern per SRM and figure on page 6.	R. Radtke 155971	FE-57
13.	Remove details for deburring processing. Apply Alodine 1200 and FR primer to all exposed aluminum surfaces.	R. Radtke 155971	FE-57
14.	OK TO INSTALL WEB REPAIR DETAILS. N/R # N053.	R. Radtke 155971	FE-57
15.	Fabricate repair details fro X=+/- 11.25 beam installations per figure on page 7 of this E.A.	R. Radtke 155971	NOT REQ
16.	Fit and locate repair details for X= 11.25 beam installation LH per figure on page 7 of this E.A.	R. Radtke 155971	FE-57
17.	Fit and locate repair details for X= -11.25 beam installation RH per figure on page 7 of this E.A.	R. Radtke 155971	FE-57
18.	Remove beam repair details for deburring and processing. Apply Alodine 1200 and FR primer to all exposed aluminum surfaces.	R. Radtke 155971	FE-57
19.	OK TO INSTALL X= 11.25 BEAM INSTALLATION DETAILS LH. N/R # N051.	R. Radtke 155971	FE-57
20.	OK TO INSTALL X= -11.25 BEAM INSTALLATION DETAILS RH. N/R # N052.	R. Radtke 155971	FE-57

ENGINEERING AUTHORIZATION

	Instructions	MECHANIC	CHECKED BY
21.	Install all details for STA 2007 web repair wet with PR1431 sealant or equivalent per SRM 53-40-00, figure 4 and sheet 6 of this E.A.	R. Hedge 155971	FE-57
22.	Install all details for X=11.25 beam installation LH wet with PR1431 sealant or equivalent per sheet 7 of this E.A.	R. Hedge 155971	FE-57
23.	Install all details for X=-11.25 beam installation RH wet with PR1431 sealant or equivalent per sheet 7 of this E.A.	R. Hedge 155971	FE-57
24.	Cut replacement lower section of AJC7240-1 Tee Cap per SRM 53-40-00, Fig 4. Fit and locate replacement section.	R. Hedge 155971	FE-55
25.	Cut replacement lower section of AJC7240-2 Tee Cap per SRM 53-40-00, Fig 4. Fit and locate replacement section.	R. Hedge 155971	FE-55
26.	Layout and drill fastener holes for new AJC7240-1 and -2 Tee Cap sections and internal repair details per NJC6040 and SRM 53-40-00, Fig 4.	R. Hedge 155971	FE-55
27.	Trim AJC7673-1 splice as shown on page 8 of this E.A. Fabricate repair angles, straps, and fillers for L47 LH per pages 8 -10 of this E.A. Fit, locate, and drill L47 repair details per pages 8 - 10 of this E.A.	R. Hedge 155971	FE-55
28.	N/R #019 Remove all Tee Cap details for processing. Deburr all holes and edges. Apply Alodine 1200 and FR Primer to all exposed aluminum surfaces in repair area.	R. Hedge 155971	FE-55
29.	* OK to INSTALL ON N/R #N036 #N053 OK TO INSTALL REPAIR SECTIONS OF AJC7240 TEE CAPS AND REPAIR DETAILS.	R. Hedge 155971	FE-55
30.	AJC7240 Tee Caps and repairs detail installed OK wet with PR1431 sealant or equivalent.	R. Hedge 155971	FE-55
31.	* N/R #N043, #N010, #N047, #N030. STA 2007 bulkhead repaired complete. OK to fit and locate AJC7207 skin installation and related details. This E.A. is completed.	165478	FE-55

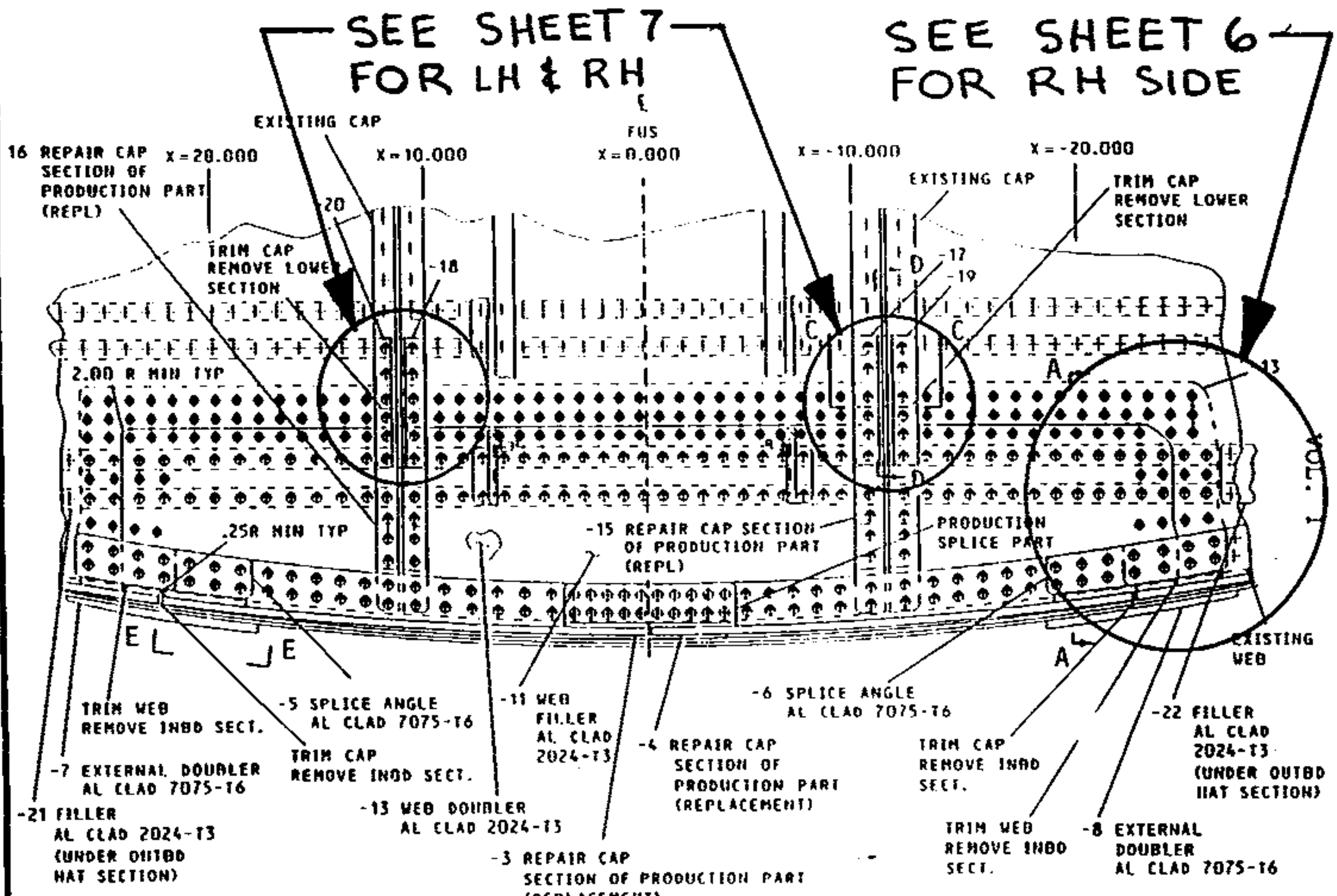
AF15418

GENERAL NOTES:

1. Final size and shape of rework to be determined on aircraft.
2. Smooth and blend all evidence of corrosion to 63 micro inch finish.
3. Typical finish on surfaces is 63 micro inch.
4. Break all sharp edges .020/.030R.
5. Shim as required to relieve preload.
6. Protect rework area against corrosion per SRM chapter 51.
7. Seal structural rework per SRM chapter 51.
8. Protect against dissimilar metal per SRM chapter 51.
9. Attachments located from part edges
   2D + .06 for details
   2D minimum acceptable on assembly
10. Added attachments to be located 2D from joggles.
11. "Equal Spaced" tolerance to be within .06.
12. Install attachments per SRM chapter 51 spacing 4D to 5D.
13. Use oversize attachments as required.

LIST OF MATERIALS:

ITEM	NOMENCLATURE	SIZE/GAGE	MATERIAL	QTY
1.	SRM 53-40-00, FIG 4 (DELETE ITEMS -17 - -20 FROM SRM, SEE ITEMS 27 and 28 OF THIS LM)	VARIOUS	VARIOUS	N/A
25.	ANGLE	0.20 x 2.0 x 2.0 x 13	7075-T6 Bar	2 ea
26.	STRAP	0.125 x 1.25 x 15	7075-T6 Clad	2 ea
27.	ANGLE	0.125 x 2 x 2	7075-T6 Bar	2 ea
28.	ANGLE	0.125 x 2 x 2	7075-T6 Bar	2 ea
29.	SPLICE	0.071 x 6 x 7	7075-T6 Clad	2 ea
30.	WEB	0.063 x 8 x 12	7075-T6 Clad	2 ea
31.	SHIM	0.054 x 1.5 x 6	7075-T6 Clad	2 ea
32.	CAP ANGLE	MK FR AJC7090-1	(S2929679)	1 ea
33.	CAP ANGLE	MK FR AJC7090-2	(S2929679)	1 ea
34.	ANGLE	0.125 x 1.25 x 1.25	7075-T6 Bar	2 ea
35.	FILLER	AR x 2 x 7	7075-T6 Clad	1 ea
36.	FILLER	AR x 2 x 3	7075-T6 Clad	1 ea
37.	STRAP	0.125 x 3 x 3	7075-T6 Clad	1 ea
38.	STRAP	0.125 x 1 x 4	7075-T6 Clad	1 ea



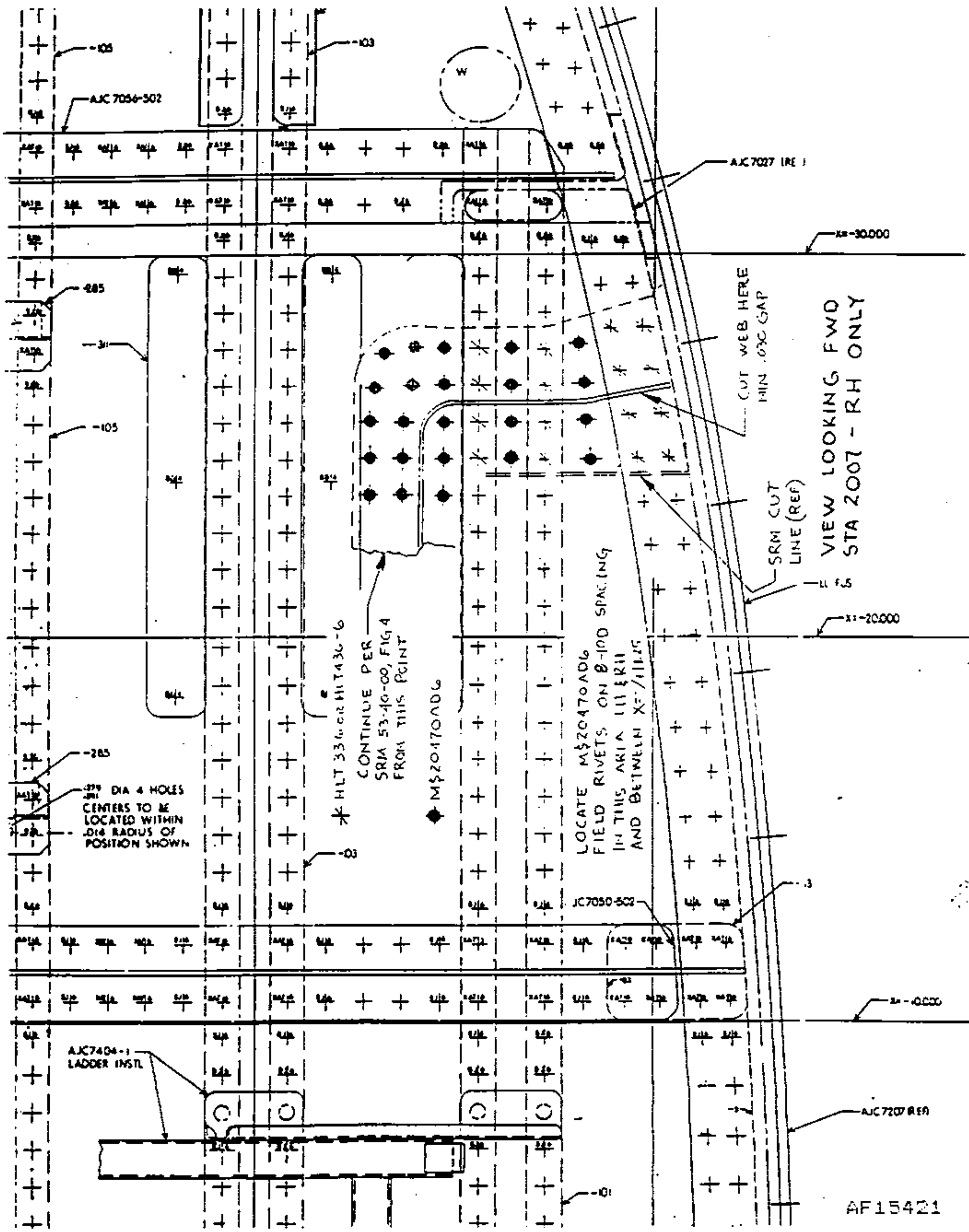
NOTES:
1. SEE SHEET 2 FOR SECTIONS A-A, C-C, D-D AND VIEW E-E.
2. SEE SHEET 3 FOR NOTES AND REPAIR PARTS.

VIEW LOOKING FORWARD
AT STA Y 2007.000

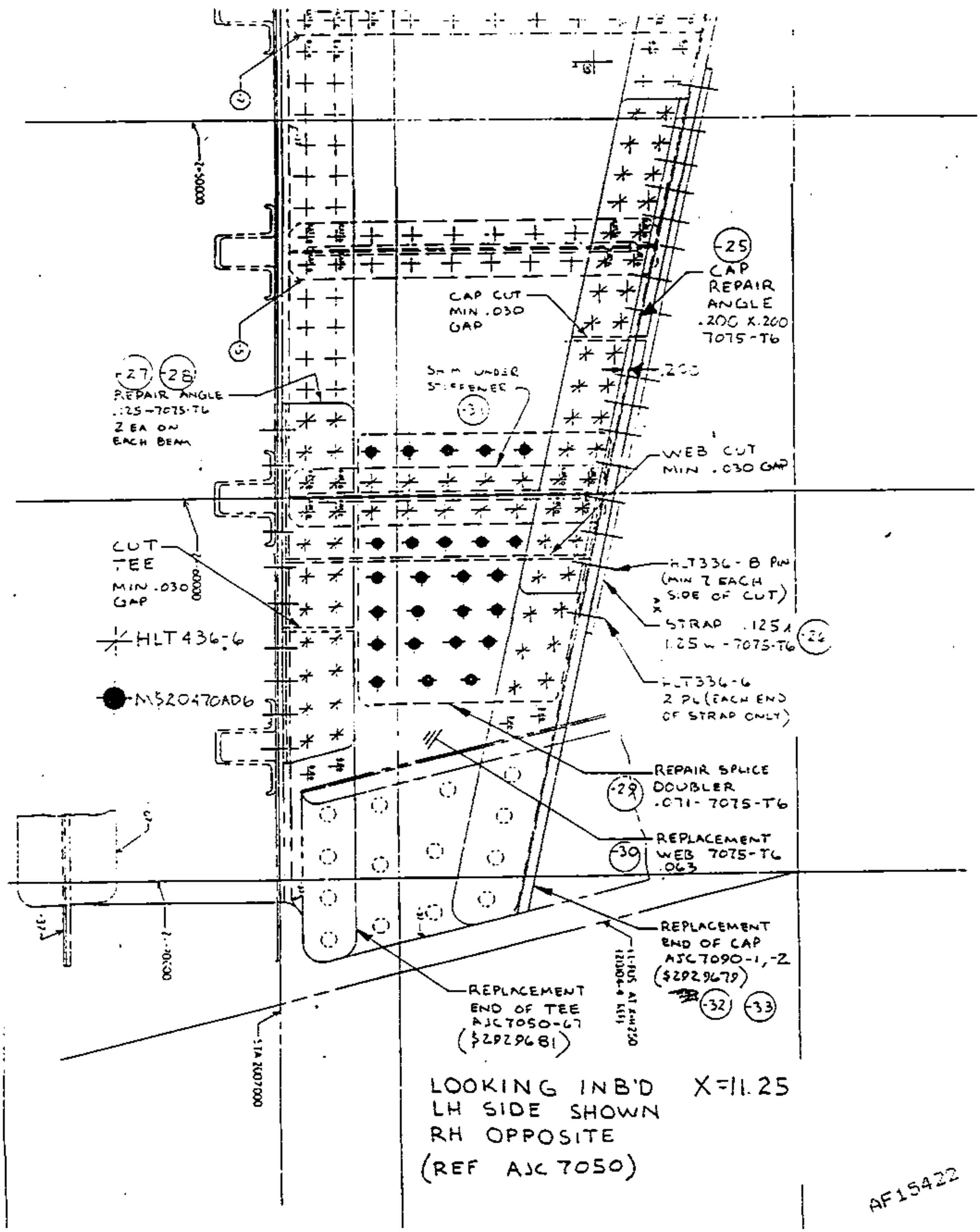
CA3-53-14440

Aft Pressure Bulkhead Lower Center Section Repair at STA. 2007
Figure 4 (Sheet 1)

AF15420

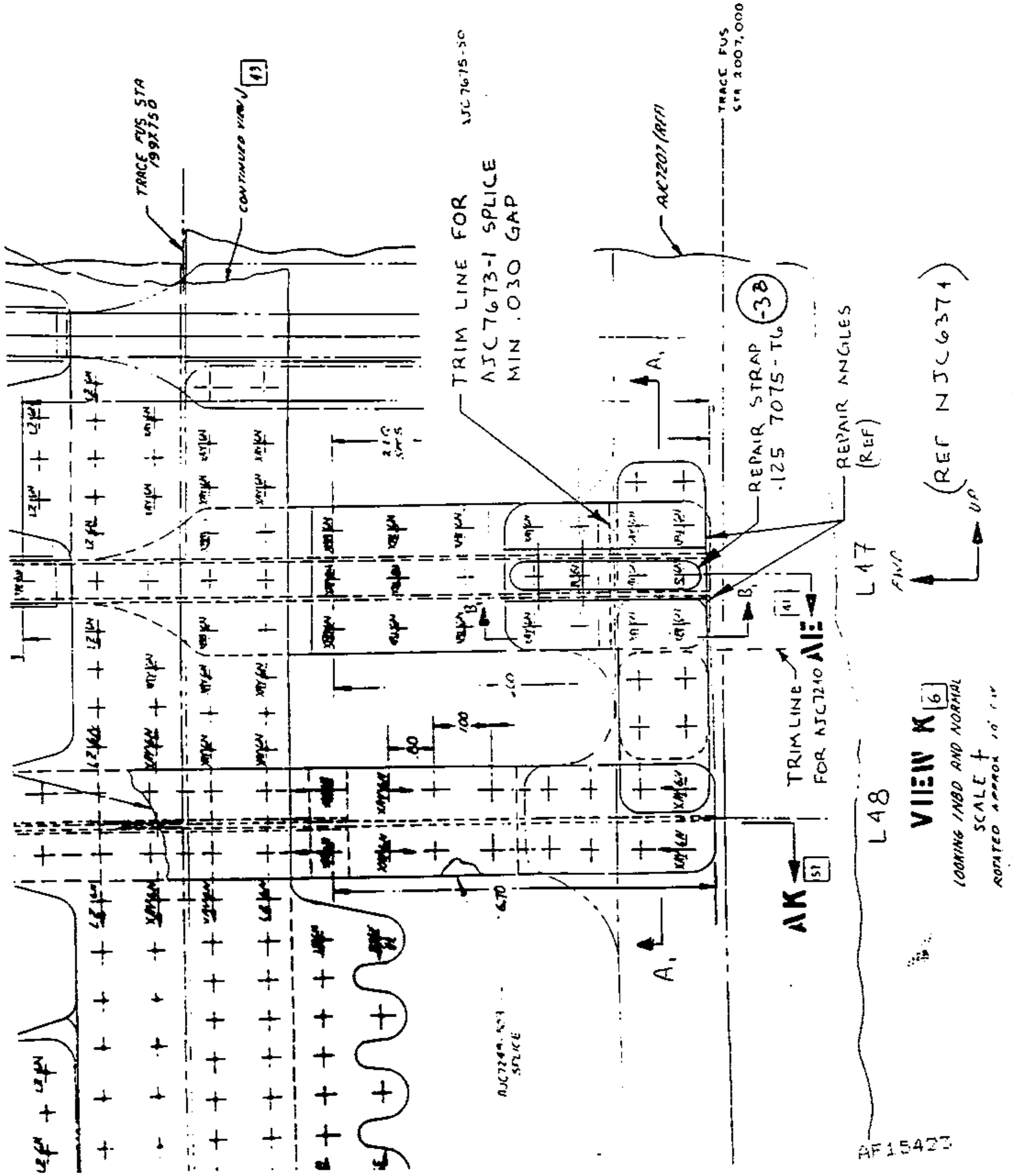

-105
AJC 7056-502
-103
W
AJC7027 (REF)
XB=-30.000
-285
-311
-105
CUT WEB HERE
MIN .030 GAP
VIEW LOOKING FWD
STA 2007 - RH ONLY
SRM CUT
LINE (REF)
CONTINUE PER
SRM 53-40-00, FIG 4
FROM THIS POINT
HLT 336 or HLT436-6
M$20470AD6
LOCATE M$20470AD6
FIELD RIVETS ON B-100 SPACING
IN THIS AREA LH & RH
AND BETWEEN XB=/11.25
XB=-20.000
DIA 4 HOLES
CENTERS TO BE
LOCATED WITHIN
.014 RADIUS OF
POSITION SHOWN
-103
JC7050-502
-3
XB=-10.000
AJC7404-1
LADDER INSTL
AJC7207 (REF)
-101

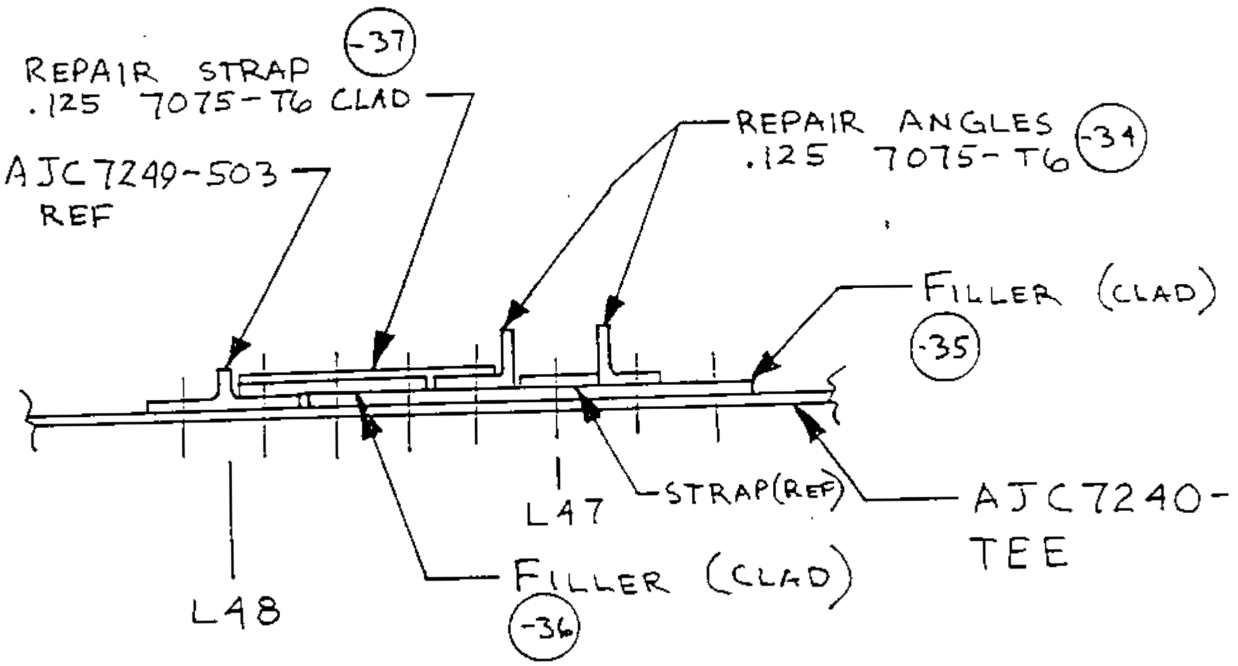
AF15421



-25
CAP
REPAIR
ANGLE
.200 X.200
7075-T6
CAP CUT
MIN .030
GAP
SHIM UNDER
STIFFENER
-31
-27 -28
REPAIR ANGLE
.125-7075-T6
2 EA ON
EACH BEAM
WEB CUT
MIN .030 GAP
CUT
TEE
MIN .030
GAP
HLT436-6
MS20470AD6
HLT336-8 PIN
(MIN 2 EACH
SIDE OF CUT)
STRAP .125 x
1.25 w - 7075-T6
-26
HLT336-6
2 PL (EACH END
OF STRAP ONLY)
REPAIR SPLICE
DOUBLER
.071- 7075-T6
-29
REPLACEMENT
WEB 7075-T6
.063
-30
REPLACEMENT
END OF CAP
AJC7090-1,-2
($2929679)
-32 -33
REPLACEMENT
END OF TEE
AJC7050-67
($2929681)
STA 2607.000
LOOKING INB'D X=11.25
LH SIDE SHOWN
RH OPPOSITE
(REF AJC 7050)

AF15422

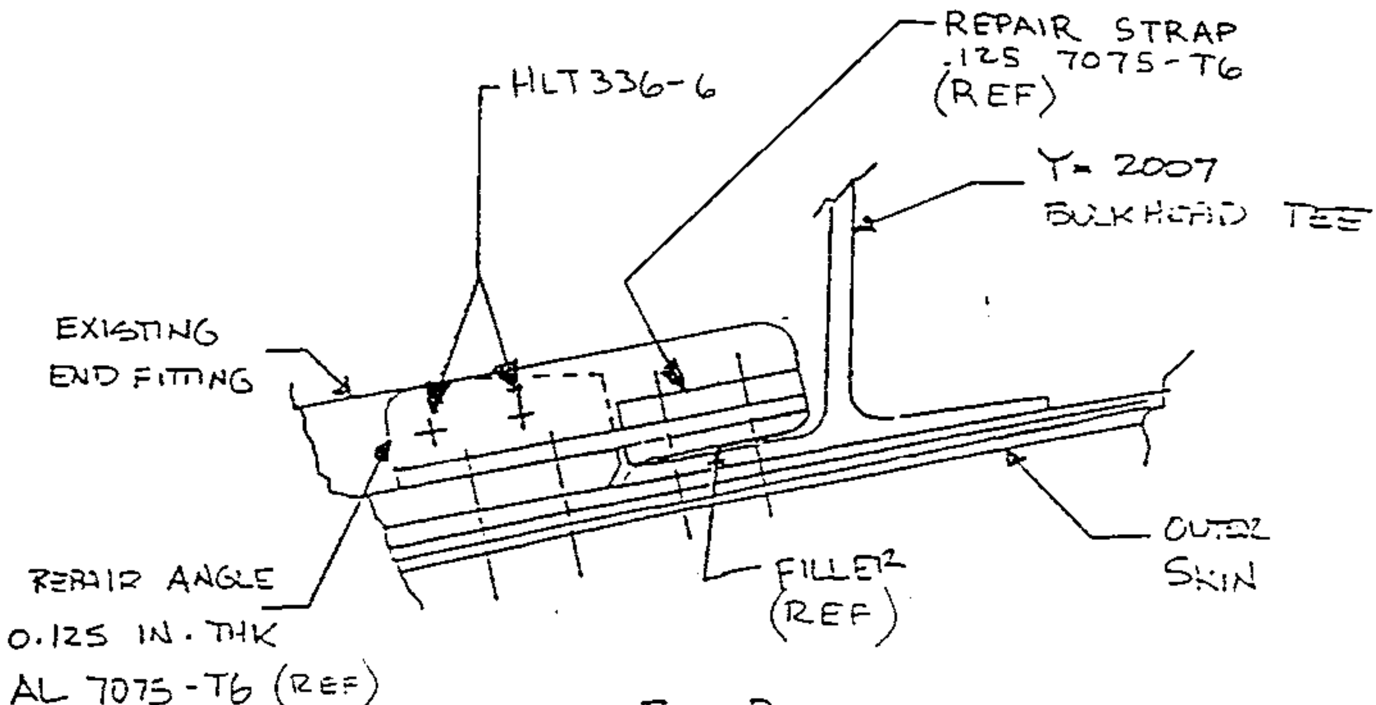

TRIM LINE FOR
AJC7673-1 SPLICE
MIN .030 GAP
REPAIR STRAP
.125 7075-T6
REPAIR ANGLES
(REF)
(REF NJC6374)
TRIMLINE
FOR AJC7210
L47
L48
VIEW K
SCALE
AK
AF15423



A1 - A1
REF NJC6374

AF15424

ENGINEERING AUTHORIZATION



B1 - B1

AF15425

ENGINE MONITORING PROGRAM

...ter 7, documentation for flight parameters.

...te	Z-Date
NN : NN	MM / DD / YY

MACH NO.	IAS	TAS	SAT
NNN	NNN	NNN	– NN
TAT	**ALT**	**ZFW**	**FOB**
NNN	NNN	NNNNNN	NNNNNN

Pneumatic ISO Valve	1-2	1-3	
0=Closed 1=Open	N	N	

Aircraft Pack Valve	1/L	2/R	3/X Feed	CG Range
0=Closed 1=Open	N	N	N	NN.N

Engine Position	1	2	3	4
Engine Bleeds 0=Closed 1=Open	N	N	N	N
EPR	N.NN	N.NN	N.NN	N.NN
N_1 RPM	NNN.N	NNN.N	NNN.N	NNN.N
EGT	NNN	NNN	NNN	NNN
N_2 RPM	NNN.N	NNN.N	NNN.N	NNN.N
Fuel Flow	NNNN	NNNN	NNNN	NNNN
Oil Press	NN	NN	NN	NN
Oil Temp	NNN	NNN	NNN	NNN
VIB (Fan)	N.N	N.N	N.N	N.N
VIB (Turbine)	N.N	N.N	N.N	N.N

☐ Did the computer accept the data? ☐

OIL ADDED	Station	Zulu Date
[illegible]	XXX	MM / DD / YY

[illegible]

FedEx M-1607 3/93 LOGOS # 136000

AIRCRAFT MAINTENANCE LOG

Page Number 00700

[redacted]

DISCREPANCY

PDIS Employee No.

MDIS [illegible]

Continued from page NNN

DURING HARD LANDING INSP. FOUND FUSELAGE SKIN DISTORTED AT THE FOLLOWING LOCATIONS, LH FUS BETWEEN STA 615 AND 652 BETWEEN LONGERONS 36 AND 48. RH FUS BETWEEN STA. 615 AND 652 LONGERONS 36 AND 48.

AUDITED / ENTERED BY: NO. 97226 DATE: 1/12/94

AUDITED / ENTERED BY: NO. 97521

ATA / WRI No. [illegible] 53-10/690 DATE: 1/13

Continued on page NNN

Continued from page NNN

MAINTENANCE ACTION

[illegible] DISPOSITION [illegible] 9931.
[illegible] FOR REPAIR [illegible] OF 350 HRS.
[illegible] 615 LONGERONS 36 [illegible] SIDES OF FUSELAGE
[illegible] HARD LANDINGS MUST [illegible] FOR INSP REQ.
[illegible] REPAIR TO BE MADE AT [illegible] INTERVAL PER E.A.
[illegible] TRANS TO OIL [illegible]

Continued on page NNN

Mfg Part Number	S/N Off	S/N On		
Replaced	[illegible]	[illegible]		
Replaced	[illegible]	[illegible]		
Replaced	[illegible]	[illegible]		
Replaced	[illegible]	[illegible]		
Replaced	[illegible]	[illegible]		

MEL/CDL Reference ☐ — ☒ Open Items List

☐ Closed — ☐ Cat Status Changed

Mechanic's Signature [signature]

Mfg Part Number	Nomenclature
Needed	[illegible]
Needed	[illegible]
Needed	[illegible]

Employee Number/Certificate Number/Vendor Number 9936

Station [illegible] Zulu Date 01.08.94

Inspector's Signature

AF15469

Employee Number/Certificate Number/Vendor

SERVICE CHECK Station XXX Zulu Date [illegible]

Employee Number/Certificate Number/Vendor Number

Data Entered By Employee No.

Page Number 000700

Distribution: White - Mx. Records, Goldenrod - Stay in A/C, Pink - Reliability, Canary - Station

Appendix VII

<u>Boeing letter concerning LSAS</u>

BOEING®

Douglas Products Division
3855 Lakewood Boulevard, MC D094-0025, Long Beach, California 90846-0001

19 May, 1998
C1-L70-SRL-98-L105

Mr. Robert Benzon
Investigator-In-Charge
National Transportation Safety Board (AS-10)
490 L'Enfant Plaza, S. W.
Washington, D. C. 20594-2000

Subject: FedEx Pilots' Association's MD-11 LSAS Questions

Reference: FedEx MD-11 Accident, Newark, New Jersey, 7/31/97

Dear Sir:

The following information is provided per your verbal request during the 11 May 1998 conference call, and in response to a question or questions posed to the NTSB by the FedEx Pilots' Association:

The MD-11's longitudinal stability augmentation system (LSAS) is contained completely within the flight control computers (FCCs). The following is a list of LSAS functions that pertain to the landing phase of flight:

- Below 100 feet radio altitude, any LSAS commanded elevator deflections are "washed out" over the period of 1 second.
- When active, LSAS has a maximum elevator authority of ± 5°.
- LSAS has a pitch attitude hold function which is activated when the autopilot is OFF and there is less than 1.8 pounds of force exerted on the control column.
- LSAS contains logic to provide nose down elevator deflections when the aircraft is in a low speed (near stall) condition. This function is only available above 100 feet.

Therefore, in order for LSAS to improperly command nose down inputs as suggested by the FedEx Pilots' Association, either a dual or quadruple failure would have to have been present. In the dual failure scenario the following would have to occur: 1) LSAS would fail to "wash out" within one second of passing below 100 feet radio altitude; and 2) Low speed protection would have to experience a failure that would cause the FCC to believe that the aircraft was flying 20 to 30 knots slower (closer to the stall speed) than it actually was.

The alternate scenario would require a quadruple failure, since the FDR data shows all four elevator panels were moving together (no apparent "outlyers"). In this scenario, each LSAS actuator (one for each elevator panel) would have to

19 May, 1998
C1-L70-SRL-98-L105

fail. Since the actuators are independent, that would require four separate failures.

There is no evidence in either the FCC non-volatile memory or the FDR data from the accident to support either of these two scenarios.

Sincerely,

[redacted]

William C. Steelhammer
DPD Party Coordinator
Flight Operations

Appendix VIII

Honeywell Documentation

Pitch Wheel: When rotated slowly, results in 100 fpm or .1 degree change per detent. In level flight with FD and or AP/FD on, initial wheel rotation selects V/S mode in 100s of fpm or FPA in degrees in the direction of wheel rotation. In a climb or descent greater than 300 fpm, the mode and display are initialized to the current V/S or FPA when either the AP or FD are engaged. Once engaged, the displayed value is always the selected value. Selection of V/S-FPA mode disengages PROF, speed on pitch (PITCH in the FMA speed window), altitude hold and glide slope modes if LAND is not annunciated. Autothrottles revert to speed control (THRUST in FMA speed window). Reselecting PROF resumes FMS descent profile operation at the selected vertical speed as a FMS edit.

Rotation of the pitch wheel causes the aircraft to depart the FCP selected altitude in vertical speed or flight path angle mode WITHOUT A FLOOR OR CEILING FCP ALTITUDE. Rotation of the pitch wheel enables the pilot to exit altitude capture for 2 seconds where upon if altitude capture conditions are satisfied, the aircraft reenters altitude capture. Otherwise the vertical speed remains selected. This feature is operable in all modes except dual flight directors control below 1500 ft, SINGLE or DUAL LAND and below 400 ft RA in the pitch autopilot or flight director takeoff or go around modes.

2.2.5.4 Auto Flight Control

The center area of the FCP provides selection/engagement of automatic approach/land modes, autopilot/autothrottles and an emergency means to disengage some FCC functions.

AFS OVRD OFF Switch: Pushing down one AFS OVRD OFF switch provides a positive means to disconnect and latch off the following FCC functions (for that FCC only):

- Autopilot
- Autothrottle
- Autothrottle Speed Protection
- Roll Control Wheel Steering (optional)

The above functions should be available through the operation of the other FCC. Pushing both AFS OVRD OFF switches down disables the aircraft function. Activating the switch reveals an AMBER and GREY diagonally colored bar.

AUTO FLIGHT Switch: Pushing the AUTO FLIGHT switch engages one autopilot and both ATs unless the aircraft is on the ground where only the ATS is engaged. Pushing the switch below 100 ft RA results in the display of the RED flashing AP OFF box in the FMA. When engaged by pushing the AUTO FLIGHT switch again above 100 ft RA, the AP OFF box is removed and a CYAN AP1 or AP2 is displayed in the FMA roll window.

Engaging the AP between 100 and 400 ft RA engages AP takeoff mode. Pushing above 400 ft engages the AP into the existing FD mode (displayed on the FMA) or with no FD, HDG/TRK HOLD and either V/S (VSI greater than 300 fpm) or altitude HOLD (VSI equal or less than 300 fpm) modes.

NOTE: Autopilot does not engage below 400 ft RA if NAV is armed or engaged.

After initial AP engagement, subsequent switch pushes alternate between APs unless one is not available, in which case, the engaged AP remains engaged. Normal disconnect of the AP may be accomplished by pushing the AP disconnect switch on either control wheel. Disconnecting the ATS may be accomplished by pushing either AT disconnect switch on the throttles.

APPR/LAND Switch: Pressing the APPR/LAND switch with a localizer frequency tuned arms the AP/FD to capture the localizer and glide slope beams. Prior to LOC capture, "LAND ARMED" is displayed in the FMA roll window. If DUAL LAND is not available after pre-landing tests are complete, the FMA displays the alternate mode SINGLE LAND or APPR ONLY. Alternate capability **("SINGLE LAND"** or **"NO AUTOLAND")** may be annunciated and displayed on the EAD at any time.

Pushing the heading/track select knob to hold heading/track cancels the "LAND ARMED" mode prior to capture. Once DUAL LAND, or SINGLE LAND (AP or dual FD approach) mode is annunciated on the FMA, only pushing the Go Around switch on the center throttle or disconnecting the AP permits exit of the land mode. More information on the automatic land modes may be found in Section 2.2.9.

If APPR ONLY is annunciated during a dual FD approach (both FD switches selected on and the AP off), only pushing the GA switch permits exit of the APPR/LAND mode. If APPR ONLY is annunciated with the AP engaged, the APPR/LAND mode may exited by selecting another mode regardless of FD status.

2.2.6 Automatic Flight System Control Panel

The AFSCP, shown in Figure 2-23, is located on the First Officers (FO)s side of the Forward Overhead Panel. It provides selectors, switches, and lights which control and indicate the status of the Longitudinal Stability Augmentation System (LSAS), Elevator Load Feel (ELF), Yaw Damper, and Flap Limiter. In addition, Automatic Pitch Trim, Roll Control Wheel Steering, and Auto Ground Spoilers are described in this section.

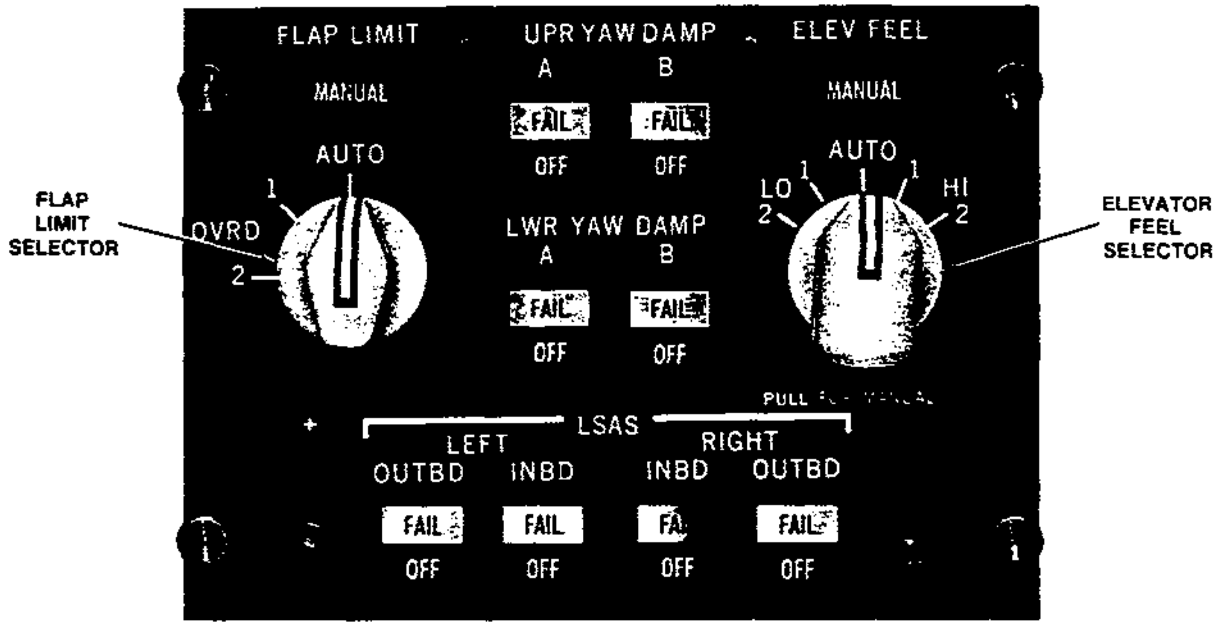


Figure 2-23
Automatic Flight System Control Panel

In normal operation, all panel lights are extinguished. As failures occur in the LSAS or Yaw Damper channels, the "FAIL" light is illuminated and channel operation is turned off. With the FAIL light on, the pilot should push the switch insuring that the channel is turned off and illuminating the "OFF" light. With a failure in the Flap Limit and Elevator Feel system the "MANUAL" light illuminates indicating that it is off and manual operation is required.

2.2.6.1 Longitudinal Stability Augmentation System

The MD-11 uses continuous augmentation of the pitch axis in order to provide conventional handling characteristics. The AP and LSAS provide longitudinal stability thereby improving the MD-11s aerodynamic efficiency and enabling the use of a smaller horizontal stabilizer as well as an aft center-of-gravity configuration. When the autopilot is "not" supplying pitch axis augmentation, LSAS provides manual control handling quality improvements through elevator commands without control wheel column movement.

LSAS engages when power is applied to the aircraft.

> NOTE: Applying electrical power to the FCC with the LSAS or Yaw Damp switches off, causes them to fail power up tests and remain failed until they are turned on and the FCC power is cycled off and back on.

Each FCC contains two redundant LSAS control channels (four total) each associated with a FCC lane and an elevator control surface (four surfaces). FCC 1 controls the right outboard and left inboard elevator while FCC 2 controls the left outboard and right inboard elevators. AP 1 cannot be engaged unless the LSAS channel controlling the left inboard elevator is operable. Likewise, AP 2 cánnot be engaged unless the LSAS channel controlling the right inboard elevator is operable. (See Figure 2-24.)

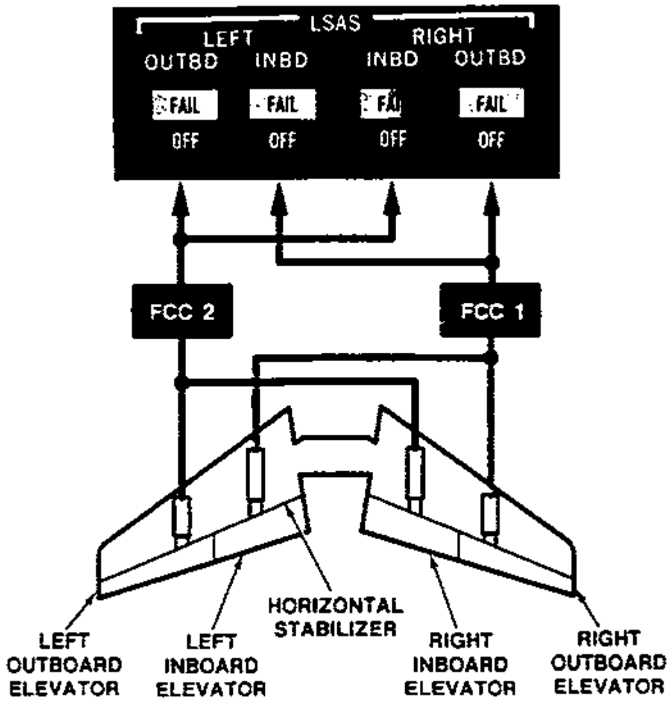


Figure 2-24
LSAS FCC Control Configuration

Each FCC LSAS lane monitors itself and the other lane for fault detection. Upon detecting a fault, both channels of the FCC shut down and two "FAIL" lights are annunciated on the corresponding LSAS switches. An EAD level 2 alert "**LSAS CHAN FAIL**" is also displayed. If all channels fail, the level 2 alert "**LSAS ALL FAIL**" is displayed. For failed channels, LSAS switches should be pushed illuminating "OFF" (deselecting channels) and then pushed again (selecting channels). If both failed lights extinguish, then the monitor fault has been reset and the LSAS channel is operating normally. With OFF illuminated, the channel is isolated from control of the elevator surface and the level 1 alert "**LSAS L** (or R) **INBD** (or OUTBD) **OFF**" is displayed. With all channels failed, the level 1 alert "**LSAS ALL OFF**" is annunciated.

With two LSAS channels "FAIL"ed, dual elevator surface control is still maintained by the other FCC. With the "FAIL"ed channels selected off, the remaining FCC is armed to revert to single channel operation for any subsequent LSAS failure. With the illumination of all four FAIL lights, the channels should be individually selected from OFF to ON looking for at least one FAIL light to extinguish thus assuring LSAS operation. For one channel operation, the gain is increased by a factor of four to provide near normal LSAS control.

NOTE: With LSAS LIB off or failed, AP 1 does not function. With LSAS RIB off or failed, AP 2 does not function.

With no forces on the control column, the LSAS holds the current pitch attitude. Pitch forces on the control wheel column greater than 2 pounds disengages LSAS augmentation and provides purely manual control. When the force is removed from the column, the aircraft holds the new pitch attitude, except during rotation, and initial stages of takeoff. LSAS provides automatic horizontal stabilizer trim to off load steady state elevator displacement. Maximum elevator deflection commanded by the LSAS is ±5 degrees.

LSAS Overspeed Protection: With the AP and ATS disengaged, the LSAS speed limiting mode is automatically engaged near Vmo computed by the Air Data Computer (or MACH equivalent) to provide overspeed protection. The LSAS speed target is Vmo + 6 knots for maximum throttle position adjusted to Vmo for throttles at idle. These speed targets are established to allow ATS speed protection the opportunity to prevent the overspeed before LSAS engagement. LSAS speed protection is implemented by reducing the −10 degree pitch attitude limit by an amount proportional to the aircraft speed above the LSAS speed target. After the airspeed is reduced below Vmo, LSAS speed protection is discontinued and ATS speed control to Vmax is resumed until the mode is changed by the pilot. Refer to Section 2.2.3 Autothrottle System for more information.

LSAS Stall Protection: For the configured aircraft, LSAS stall protection engages when the Pitch Limit Indicator (PLI) displayed on the PFD attitude sphere turns from CYAN to AMBER. If a windshear caution alert is displayed, LSAS stall protection engages when the PLI is RED.

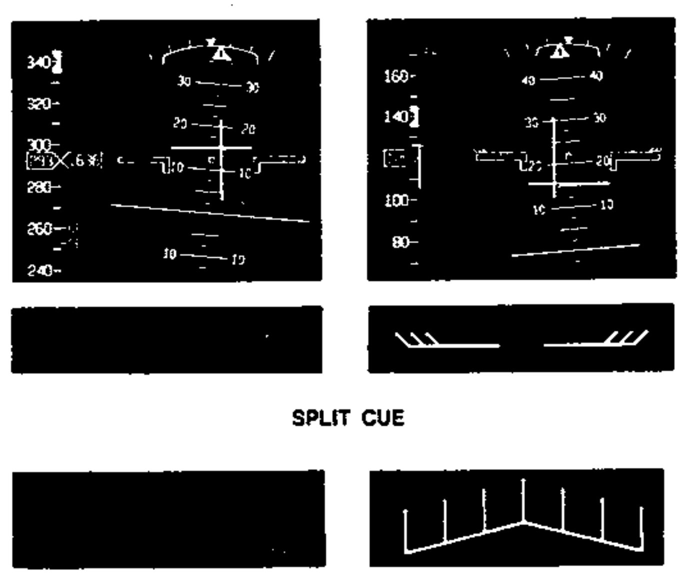
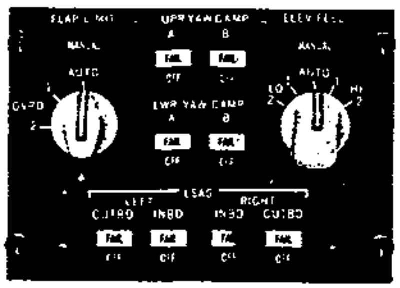


Figure 2-25
LSAS Engagement - Pitch Limit Indicator

When AT speed protection is engaged and before LSAS stall protection is entered, the FMS thrust limit goes to MCT. The PLI "AMBER" angle-of-attack (AOA) limit is omputed to be approximately 75 percent to 85 percent of stickshaker AOA depending on the amount of flap extension. This value allows ATS speed protection to control speed to the FMS Vmin speed prior to LSAS engagement. LSAS stall protection is implemented by reducing the 30 degree pitch attitude limit by an amount proportional to the aircraft AOA above the PLI AMBER limit. The pilot can overpower the LSAS stall protection by applying nose up control wheel forces in excess of 5 pounds increasing the pitch attitude limit up to a maximum of 4 degrees. After the AOA is reduced below the PLI AMBER limit, LSAS stall protection is discontinued and ATS speed control to FMS Vmin is resumed or the operating mode is changed by the pilot. For the clean aircraft, the PLI changes from CYAN to RED without transiting AMBER with the same stall protection available. LSAS stall protection is not available with the autopilot engaged. Autopilot "speed on pitch" is used to control speed to Vmax or Vmin after autothrottle has failed to control speed.



2.2.6.2 Automatic Pitch Trim

The auto pitch trim function automatically positions the horizontal stabilizer to off-load steady state AFS elevator deflection. Each FCC contains one automatic pitch trim (APT) channel. One channel is operational at a time. The second channel automatically engages when the first channel fails. Automatic and manual pitch trim rates are switched from .25 to .1 degree per second when airspeed exceeds 250 knots or when altitude exceeds 33,000 ft.

Auto Flight: With the AP engaged, automatic pitch trim is available in all modes except autoland flare. Nose up trim is delayed for 13 seconds when the AP is first engaged in takeoff and go-around modes. Auto pitch trim is supplied by the engaged FCC and switches to the other when the AUTO FLIGHT switch is pushed. Trim failures resulting in sustained out of trim conditions are annunciated as "**STAB OUT OF TRIM**" *(level 2 alert)* on the EAD and illuminate the master caution light.

.nual Flight: When LSAS is operating (AP not engaged), the first powered FCC provides pitch trim which is available during flight above 50 ft RA. During LSAS flight, pitch trim is inhibited when the:

- Bank angle exceeds 5 degrees
- Control wheel pitch force exceeds 2 pounds
- Pitch force applied which exceeds the upper or lower pitch attitude limits

Detection of a trim failure will "FAIL" both LSAS channels and automatically switch control to the other FCC. Subsequent trim failure in the second FCC which can be isolated will result in reversion to single lane LSAS and display the level 1 alert "**AUTO TRIM FAIL**" alert on the EAD and illuminate the master caution.

2.2.6.3 Yaw Damper

The yaw damper provides turn coordination and damping of dutch roll oscillations through automatic operation of the upper and lower rudder. The control wheel provides no tactile feedback of yaw damping operation. Yaw damping operates continuously after power is applied to the aircraft except turn coordination does not operate during autoland localizer track and flare or wing engine out flight. Each FCC contains two redundant yaw damper control channels enabling the FCC to be self-monitoring. Both channels of FCC 1 operate the lower rudder with FCC 2 operating the upper rudder.

A failure external to the FCC may illuminate a single yaw damp channel whereupon the pilot should push the switch (illuminates "OFF", extinguishes "FAIL" light) to isolate the channel off. If an internal FCC yaw damp fault is detected, "FAIL" is annunciated on both yaw damp channels (yaw channels disengaged) but yaw damp control is maintained by the second FCC. The pilot should push both yaw damp switches thus illuminating the "OFF" lights and extinguishing the "FAIL" lights. This "OFF" selection also arms the second FCC to revert to single channel operation with a subsequent single failure which can be isolated. With all four channels "FAIL"ed and turned off, a single channel may be reactivated by pushing each channel switch individually to extinguish its FAIL light and regain yaw damp operation. Yaw damped operation is desired in order to established parallel rudder operation for AFS landing, takeoff and go-around modes. **"YAW DAMP CHAN FAIL"** level 2 alert is displayed on the EAD with any yaw damp FAIL annunciation.

2.2.6.4 Elevator Load Feel

The elevator load feel (ELF) system is a mechanical system which provides an artificial control column pitch loading against which the pilot must apply a specific force per degree of control column rotation. The system has two

Appendix IX

<u>Excerpts from Boeing Report Number: MDC 98K1023</u>

ITEM ANALYZED	DPS 2.431-2 REQUIREMENTS	LOWER CHAMBER	UPPER CHAMBER	AIR CHAMBER OIL/WATER MIXTURE
KINEMATIC VISCOSITY UNITS CENTISTOKES (CS)	13.0 MINIMUM (DPM 6176 FOR NEW FLUID)* 13.0 MINIMUM (DPM 6177 FOR NEW FLUID)* 13.9 MINIMUM (MIL-H-5606 FOR NEW FLUID) 10.0 MINIMUM (MIL-H-5606 FOR USED FLUID)	12.1	NO SAMPLE	NO SAMPLE
PARTICLE COUNT (1) 6-15 µ (2) 16-25 µ (3) 26-50 µ (4) 51-100 µ (5) 101+ µ	(1) NO REQUIREMENT (2) <21,000 (3) <3,500 (4) <450 (5) <40	INSUFFICIENT SAMPLE	NO SAMPLE	THE SAMPLE HAD A SEPARATE OIL LAYER (86 ML) AND WATER LAYER (8ML)
ACID NUMBER, MG KOH/G	2.3-5.0 (DPM 6176) 1.5-3.5 (DPM 6177) 0.50 MAXIMUM (MIL-H-5606)	0.22	NO SAMPLE	NO SAMPLE
DENSITY, GMS/ML	NO REQUIREMENT FOR DPM 6176 & DPM 6177 0.860-0.870 (MIL-H-5606)	0.872	NO SAMPLE	NO SAMPLE
WATER CONTENT, PPM	150 MAXIMUM (DPM 6176) 550 MAXIMUM (DPM 6177) 150 MAXIMUM (MIL-H-5606)	1,245	NO SAMPLE	NO SAMPLE

*THERE IS NO REQUIREMENT FOR USED FLUID FOR DPM 6176 AND DPM 6177

4.2.3 Center Landing Gear (CLG)

4.2.3.1 Shock Strut Assembly, P/N NYG6210-505

The CLG shock strut assembly exhibited mechanical damage, evidence of fire damage, and several fractured components. See Figure 117. The following components were found fractured and completely separated from the shock strut assembly: (1) piston, P/N AYG7150-509; (2) drag brace torque tube, P/N AYG7271-1; (3) brake links, P/N AYG7171-1; (4) upper drag link, P/N AYG7181-1; (5) "E" barrel keel web, P/N AEA7052-501; (6) lever, P/N AYG7234-1; and (7) lock link, P/N AYG7182-505. Only items (1), (2), (3), (4) and the crush tube, P/N AYG7203-1, were analyzed in the M&PE laboratories. The CLG shock strut assembly was disassembled to examine the crush tube.

Visual and Macroscopic Examination

Piston

The CLG piston exhibited a complete circumferential fracture and separation in the area just below the torque and brake links. See Figure 118. The entire fracture surface was heavily charred, and was at an oblique plane which is typical of overload failure.

Drag Brace Torque Tube

The drag brace torque tube displayed a complete circumferential fracture, approximately 31-34 inches from the left hand end of the part. A number of areas displayed superficial corrosion.

See Figure 117. The mating right-hand portion of the torque tube was not received by the M&PE laboratory. Under SEM macroscopic examination, the fracture appeared to extend from the missing right-hand portion of the torque tube. See Figure 119. The fracture subsequently extended in opposite directions. One small segment extended in counterclockwise direction (looking left) for a distance of approximately 0.5-inch. The remaining portion of the fracture extended in a clockwise direction. See Figure 120. The initial portion of the fracture surface exhibited a dull coarse-grained texture, typical of overload failure; however, the fracture intersected a small, longitudinal grainy textured region. See Figure 121. This grainy textured region extended through the wall thickness and to a crack length of approximately 1.2 inches. The crack front curvature indicated that this grainy textured crack emanated from the outer surface of the torque tube.

Brake Links

Both brake links exhibited complete transverse fracture and separation through the I-beam portion. See Figure 118. Both brake links were bent in a right-hand direction and twisted in a clockwise direction (looking forward). Under macroscopic examination, the fracture surfaces exhibited fracture traces which emanated from the failure origin area along the upper, left-hand edges of the parts.

Upper Drag Link

The CLG upper drag link displayed a complete circumferential fracture and separation along its shank portion, approximately 3.5 inches from its inboard end. The mating fracture half was not received by the M&PE laboratory. A portion of the fracture surface appeared to be charred, most likely from fire exposure. Under macroscopic examination, the fracture surface exhibited a light surface rust with fracture traces that emanated from two failure origin areas along the outer surface of the drag link. A majority of the fracture extended in a clockwise direction around the part (looking inboard). The fracture surface exhibited a dull, coarse-grained texture in some areas and occurred along an oblique plane in other areas, typical of overload failure. The overall fracture characteristics indicated torsional overload failure.

Crush Tube

The crush tube was in the "crushed" position. See Figure 122. A small amount of mechanical damage was observed along the crush tube; however, it appeared to be insignificant and could have been the result of the crush tube catapulting into its "crushed" position.

<u>Scanning Electron Microscope Analysis</u>

Drag Brace Torque Tube

SEM analysis of the fracture surface at the grainy textured region of the torque tube revealed a predominant intergranular mode of rupture, indicating brittle fracture. See Figure 123. The intergranular facets exhibited evidence of corrosion. This intergranular region comprised less than 10% of the area of the fracture surface.

SEM analysis of the remainder of the fracture surface revealed a predominant dimple mode of failure, indicative of ductile overload. See Figure 124. The portion of the fracture surface nearest the failure origin revealed evidence of corrosion. See Figure 125.

The overall fracture characteristics suggested that the primary brittle failure nearest the failure origin area(s) occurred outside of the submitted section of the torque tube and that the submitted section

Appendix X

Excerpts from N611FE Maintenance Log

FedEx Federal Express

ENGINE MONITORING PROGRAM

Refer to FOM, Chapter 7, documentation for flight parameters.

Z-Time	Z-Date

MACH NO.	IAS	TAS	SAT
TAT	**ALT**	**ZFW**	**FOB**

Pneumatic ISO Valve	1-2	1-3
0=Closed 1=Open		

Aircraft Pack Valve	1/L	2/R	3/X Feed	CG Range
0=Closed 1=Open				

Engine Position	1	2	3	4
Engine Bleeds 0=Closed 1=Open				
EPR				
N_1 RPM				
EGT				
N_2 RPM				
Fuel Flow				
Oil Press				
Oil Temp				
VIB (Fan)				
VIB (Turbine)				

☐ Did the computer accept the data? ☐

OIL ADDED (U.S. Qts)	Station	Zulu Date

Employee Number/Certificate Number/Vendor Number

#1	#2	#3	#4	APU

FedEx M-1607 1/95 LOGOS # 138000

AIRCRAFT TAIL NUMBER 611

AIRCRAFT MAINTENANCE LOG 896186

PDIS 9973

DISCREPANCY ABS

MDIS

Continued from page

Prior To blockout - Annunciated Anti-Skid Failure & Auto Brake Failure - Pulled & Reset All Associated Circuit Breakers As Per Mech. Instructions, Anti-Skid Failure Was Corrected But Auto-Brake Failure Remained. Consulted M.E.L And Turned Off Auto Brakes And Continued Flight With Manual Brakes. S.M.

ATA / WRI No. 32-44/2337

Continued on page

Continued from page

MAINTENANCE ACTION

RTS ASCU & ABSCU Both Test Passed No History Noted In Maint Rpt 30 Days Sys Test Normal OK For Service

AF4146

Continued on page

☐ MEL/CDL Reference ☐ Open Items List

☒ Closed ☐ Cat Status Changed

Mechanic's Signature [redacted]

Employee Number/Certificate Number/Vendor N 109899

Station OAK Zulu Date 07/02/

Mfg Part Number	S/N Off	S/N On	Pos	Rea

Mfg Part Number	Nomenclature	Pos

Inspector's Signature

Employee Number/Certificate Number/Vendor N

SERVICE CHECK	Station	Zulu Date

Mechanic's Signature

Employee Number/Certificate Number/Vendor Number

☐ RII ☒

Date Entered By 109899

Distribution: White - Mx. Records; Goldenrod - Stay In A/C; Pink - Reliability; Canary - Station

896186

FedEx. Federal Express

ENGINE MONITORING PROGRAM

Refer to FOM, Chapter 7, documentation for flight parameters.

Z-Time	Z-Date

MACH NO.	IAS	TAS	SAT
TAT	**ALT**	**ZFW**	**FOB**

Pneumatic ISO Valve 0=Closed 1=Open	1-2	1-3	

Aircraft Pack Valve 0=Closed 1=Open	1/L	2/R	3/X Feed	CG Range

Engine Position	1	2	3	4
Engine Bleeds 0=Closed 1=Open				
EPR				
N_1 RPM				
EGT				
N_2 RPM				
Fuel Flow				
Oil Press				
Oil Temp				
VIB (Fan)				
VIB (Turbine)				

☐ Did the computer accept the data? ☐

OIL ADDED (U.S. Qts)	Station	Zulu Date

Employee Number/Certificate Number/Vendor Number

#1	#2	#3	#4	APU

FedEx M-1807 1/86 LOGOS # 139000

AIRCRAFT TAIL NUMBER 611

AIRCRAFT MAINTENANCE LOG 896188

PDIS 9973

DISCREPANCY

MDIS

Continued from page

ON FINAL APPROACH UPON LOWERING GEAR THE LEFT SIDE ANTI-SKID FAIL LIGHT & WARNING CAME ON. JAM

ATA / WRI No. 32-44/2331

Continued on page

Continued from page

MAINTENANCE ACTION

IN ASCU FAULT REVIEW SHOWED #2 WHL SPD XDUCER FAULT. RTS PAST NO HISTORY NOTED PAST 30 DAYS IAW MAINT. SYS OK FOR SERVICE

AF4144

Continued on

☐ MEL/CDL Reference ☐ Open Items List

☒ Closed ☐ Cat Status Changed

Mechanic's Signature [redacted]

Employee Number/Certificate Number/Vendor Number 109899

Station OAK Zulu Date 07/02/9

Mfg Part Number	S/N Off	S/N On	Pos	Res

Mfg Part Number	Nomenclature	Pos

Inspector's Signature

Employee Number/Certificate Number/Vendor Number

SERVICE CHECK	Station	Zulu Date

Mechanic's Signature

Employee Number/Certificate Number/Vendor Number

☐ RII ☒

Data Entered By 109899

Distribution: White - Mx. Records
Goldenrod - Stay In A/C
Pink - Reliability
Canary - Station

896188

FedEx Federal Express

ENGINE MONITORING PROGRAM

Refer to FOM, Chapter 7, documentation for flight parameters.

Z-Time	Z-Date

MACH NO.	IAS	TAS	SAT
TAT	ALT	ZFW	FOB

Pneumatic ISO Valve	1-2	1-3		
0=Closed 1=Open				
Aircraft Pack Valve	1/L	2/R	3/X Feed	CG Range
0=Closed 1=Open				
Engine Position	1	2	3	4
Engine Bleeds 0=Closed 1=Open				
EPR				
N_1 RPM				
EGT				
N_2 RPM				
Fuel Flow				
Oil Press				
Oil Temp				
VIB (Fan)				
VIB (Turbine)				

☐ Did the computer accept the data? ☐

OIL ADDED (U.S. Qts)	Station	Zulu Date

Employee Number/Certificate Number/Vendor Number

#1	#2	#3	#4	APU

FedEx M-1807 1/96 LOGOS # 139000

AIRCRAFT TAIL NUMBER 621

AIRCRAFT MAINTENANCE LOG

896193

PDIS

DISCREPANCY ABS MDIS 95062

Continued from page

Auto brakes will not arm

ATA / WRI No. 32-45/2341

Continued on page

Continued from page

MAINTENANCE ACTION

Released per MEL 32-14

Control # 19356

Expires 12 Jul 97

AF4139

Continued on page

☒ MEL/CDL Reference 32-14

☐ Open Items List

☐ Closed

☐ Cat Status Changed

Mechanic's Signature [redacted]

Employee Number/Certificate Number/Vendor Number 95062

Station ANC

Zulu Date 07/02/97

Mfg Part Number	S/N Off	S/N On	Pos	Rec

Mfg Part Number	Nomenclature	Pos

Inspector's Signature

Employee Number/Certificate Number/Vendor Number

SERVICE CHECK	Station	Zulu Date

Mechanic's Signature

Employee Number/Certificate Number/Vendor Number

☐ RII ☒

Data Entered By 95062

Distribution: White - Mx. Records; Goldenrod - Stay in A/C; Pink - Reliability; Canary - Station

896193

FedEx. Federal Express

ENGINE MONITORING PROGRAM

Refer to FOM, Chapter 7, documentation for flight parameters.

Z-Time	Z-Date

MACH NO.	IAS	TAS	SAT
TAT	ALT	ZFW	FOB

Pneumatic ISO Valve 0=Closed 1=Open	1-2	1-3		
Aircraft Pack Valve 0=Closed 1=Open	1/L	2/R	3/X Feed	CG Range
Engine Position	1	2	3	4
Engine Bleeds 0=Closed 1=Open				
EPR				
N1 RPM				
EGT				
N2 RPM				
Fuel Flow				
Oil Press				
Oil Temp				
VIB (Fan)				
VIB (Turbine)				

☐ Did the computer accept the data? ☐

OIL ADDED (U.S. Qts)	Station HKG	Zulu Date 7-3-97

Employee Number/Certificate Number/Vendor Number 136821

# 1	# 2	# 3	# 4	APU
1	Ø	Ø	⊠	Ø.

FedEx M-1807 1/95 LOGOS # 139000

AIRCRAFT TAIL NUMBER ~~[illegible]~~ 611

AIRCRAFT MAINTENANCE LOG

896195

PDIS

DISCREPANCY

ABS

MDIS 1368

Continued from page

ABS WILL NOT ARM.

~~ATA~~ / WRI No. 32-457/2341

Continued on page

Continued from page

MAINTENANCE ACTION

PERFORMED ABS RTS, ALL PASSED, ABS ARMED & NO FAULT DISPLAYED. CLEARED BMI

AF4137

Continued on page

Mfg Part Number	S/N Off	S/N On	Pos	Res

Mfg Part Number	Nomenclature	Pos

☐ MEL/CDL Reference

☐ Open Items List

☒ Closed

☐ Cat Status Changed

Mechanic's Signature [redacted]

Employee Number/Certificate Number/Vendor Number 136821

Station HKG

Zulu Date 7-3-97

Inspector's Signature

Employee Number/Certificate Number/Vendor Number

SERVICE CHECK	Station	Zulu Date

Mechanic's Signature

Employee Number/Certificate Number/Vendor Number

☐ RII ☒

Data Entered By 286021

Distribution: White - Mx Records; Goldenrod - Stay in A/C; Pink - Reliability; Canary - Station

896195

FedEx Federal Express

ENGINE MONITORING PROGRAM

Refer to FOM, Chapter 7, documentation for flight parameters.

Z-Time	Z-Date

MACH NO.	IAS	TAS	SAT
TAT	ALT	ZFW	FOB

Pneumatic ISO Valve 0=Closed 1=Open	1-2	1-3	

Aircraft Pack Valve 0=Closed 1=Open	1/L	2/R	3/X Feed	CG Range

Engine Position	1	2	3	4
Engine Bleeds 0=Closed 1=Open				
EPR				
N1 RPM				
EGT				
N2 RPM				
Fuel Flow				
Oil Press				
Oil Temp				
VIB (Fan)				
VIB (Turbine)				

☐ Did the computer accept the data? ☐

OIL ADDED (U.S. Qts)	Station	Zulu Date

Employee Number/Certificate Number/Vendor Number

#1	#2	#3	#4	APU

FedEx M-1607 1/95 LOGOS # 139000

AIRCRAFT TAIL NUMBER 611

AIRCRAFT MAINTENANCE LOG 895806

PDIS

DISCREPANCY ABS

MDIS 269638

Continued from page

DUE HISTORY OF AUTOBRAKE FAILING TO ARM FOR T/OFF, PRINT ABSCU/ASCU FAULT REVIEWS FOR MOCC.

ATA / WRI No. 32-45/2346.

Continued on page

Continued from page

MAINTENANCE ACTION

AF4126

ACCESSED ABSCU/ASCU FAULT REVIEWS - PRINTED & FAXED TO MOCC AS REQUESTED - PERFORMED ASCU R-T-S TEST. TEST PASSE NIL TIME TO C/W ABSCU DETAILED FAULT ISOLATION TEST THIS TURN.

Continued on page

☐ MEL/CDL Reference ☐ Open Items List

☒ Closed ☐ Cat Status Changed

Mechanic's Signature [signature]

Employee Number/Certificate Number/Vendor Number 269638

Station STN Zulu Date 07/04/

Mfg Part Number	S/N Off	S/N On	Pos	Res

Mfg Part Number	Nomenclature	Pos

Inspector's Signature

Employee Number/Certificate Number/Vendor Number

SERVICE CHECK	Station	Zulu Date

Mechanic's Signature

Employee Number/Certificate Number/Vendor Number

☐ RII ☒

Data Entered By 269638

Distribution: White - Mx. Records, Goldenrod - Stay in A/C, Pink - Reliability, Canary - Station

895806

FedEx Federal Express

ENGINE MONITORING PROGRAM

Refer to FOM, Chapter 7, documentation for flight parameters.

Z-Time	Z-Date

MACH NO.	IAS	TAS	SAT
TAT	ALT	ZFW	FOB

Pneumatic ISO Valve	1-2	1-3	
0=Closed 1=Open			

Aircraft Pack Valve	1/L	2/R	3/X Feed	CG Range
0=Closed 1=Open				

Engine Position	1	2	3	4
Engine Bleeds 0=Closed 1=Open				
EPR				
N_1 RPM				
EGT				
N_2 RPM				
Fuel Flow				
Oil Press				
Oil Temp				
VIB (Fan)				
VIB (Turbine)				

☐ Did the computer accept the data? ☐

OIL ADDED (U.S. Qts)	Station	Zulu Date
Employee Number/Certificate Number/Vendor Number		

#1	#2	#3	#4	APU

FedEx M-1607 1/96 LOGOS # 139000

AIRCRAFT TAIL NUMBER 611

AIRCRAFT MAINTENANCE LOG 895811

PDIS 57222

DISCREPANCY

MDIS

Continued from page

ANTI. SKID - L - FAIL Caution Light Came on when Auto brakes were selected For landing. LAVQ '2' ALERT

ATA / WRI No. 32-44/ 7354

Continued on page

MAINTENANCE ACTION

Continued from page

ASCU FAULTED WHEEL SPEED XDUCER # 2 ON REMOVAL OF #2 XDUCR FOUND WIRES BROKEN OFF CANNON PLUG USED DUMMY PINS IN PLUG TO REPAIR PLUG WIRES A + D ASCU RTS GOOD OK FOR SERVICE

AF4121

Continued on page

☐ MEL/CDL Reference ☐ Open Items List

☒ Closed ☐ Cat Status Changed

Mechanic's Signature [redacted]

Employee Number/Certificate Number/Vendor Number 10851

Station ANC Zulu Date 7/6/97

Mfg Part Number	S/N Off	S/N On	Pos	Res

Mfg Part Number	Nomenclature	Pos

Inspector's Signature

Employee Number/Certificate Number/Vendor Number

SERVICE CHECK Station Zulu Date

Mechanic's Signature

Employee Number/Certificate Number/Vendor Number

☐ RII ☒

Data Entered By 271982

Distribution: White - Mx. Records; Goldenrod - Stay in A/C; Pink - Reliability; Canary - Station

895811

FedEx. Federal Express

ENGINE MONITORING PROGRAM

Refer to FOM, Chapter 7, documentation for flight parameters.

Z-Time	Z-Date

MACH NO.	IAS	TAS	SAT
TAT	ALT	ZFW	FOB

Pneumatic ISO Valve 0=Closed 1=Open	1-2	1-3	
Aircraft Pack Valve 0=Closed 1=Open	1/L	2/R	3/X Feed	CG Range

Engine Position	1	2	3	4
Engine Bleeds 0=Closed 1=Open				
EPR				
N1 RPM				
EGT				
N2 RPM				
Fuel Flow				
Oil Press				
Oil Temp				
VIB (Fan)				
VIB (Turbine)				

☐ Did the computer accept the data? ☐

OIL ADDED (U.S. Qts)	Station	Zulu Date

Employee Number/Certificate Number/Vendor Number

# 1	# 2	# 3	# 4	APU

FedEx M-1907 1/95 LOGO# 4 138000

AIRCRAFT TAIL NUMBER 611

AIRCRAFT MAINTENANCE LOG 828679

PDIS 97128

DISCREPANCY ABS

MDIS

Continued from page

INFO ONLY. TOOK 4 ATTEMPTS TO GE[T] AUTO BRAKE TO ARM IN T/O MODE. WOULD ARM MOMENT ARILY. THEN GO TO LEVEL TWO "AUTO BRAKE FAIL". WOR[KED] OKAY ON T/O AND LANDING - NO FURTHER PROBLEM

ATA / WRI No. 32-45 2907 97128

Continued from page

MAINTENANCE ACTION

Continued on page

THANKS INFO
ABSCU R-T-S TESTS PASSED.
GRD OPS CHECKED OK A/C OK FOR SERVIC[E]

Continued on page

☐ MEL/CDL Reference ☐ Open Items List
☒ Closed ☐ Cat Status Changed

Mechanic's Signature [redacted]

Employee Number/Certificate Number/Vendor Num[ber] 138866

Station NRT Zulu Date 07/26/9[.]

Mfg Part Number	S/N Off	S/N On	Pos	Res
		AF4056		

Mfg Part Number	Nomenclature	Pos

Inspector's Signature

Employee Number/Certificate Number/Vendor Num[ber]

SERVICE CHECK	Station	Zulu Date

☐ RII ☑

Mechanic's Signature

Employee Number/Certificate Number/Vendor Number

Data Entered By 135475

Distribution: White - Mx. Records; Goldenrod - Stay in A/C; Pink - Reliability; Canary - Station

828679

FedEx. Federal Express ENGINE

[redacted]

FedEx. Federal Express ENGINE MONITORING PROGRAM

Refer to FOM, Chapter 7, documentation for flight parameters.

Z-Time		Z-Date	
MACH NO.	IAS	TAS	SAT
TAT	ALT	ZFW	FOB

Pneumatic ISO Valve 0=Closed 1=Open	1-2	1-3		
Aircraft Pack Valve 0=Closed 1=Open	1/L	2/R	3/X Feed	CG Range
Engine Position	1	2	3	4
Engine Bleeds 0=Closed 1=Open				
EPR				
N_1 RPM				
EGT				
N_2 RPM				
Fuel Flow				
Oil Press				
Oil Temp				
VIB (Fan)				
VIB (Turbine)				

☐ Did the computer accept the data? ☐

OIL ADDED (U.S. Qts)	Station	Zulu Date

Employee Number/Certificate Number/Vendor Number

#1	#2	#3	#4	APU

AIRCRAFT TAIL NUMBER 611

AIRCRAFT MAINTENANCE LOG

Page Number 828686

PDIS

DISCREPANCY ABS **MDIS** 117977

Continued from page

AUTO BRAKES WILL NOT ARM.

ATA / WRI No. 32-45/~~24~~12.

Continued on page

Continued from page

MAINTENANCE ACTION

PERFORMED BTS. PASSED PROBLEM RETURNED. PRESS 1 + 3 HYD SYS. & PULLED A/B CONT & MONITOR FOR 30 SEC AUTO BRAKES NOW CHK GOOD.

Continued on page

Mfg Part Number	S/N Off	S/N On	Pos	Res

☐ MEL/CDL Reference ☐ Open Items List

☑ Closed ☐ Cat Status Changed

Mechanic's Signature [redacted]

Employee Number/Certificate Number/Vendor Number 117977

Station	Zulu Date
STN	07-27-9?

Mfg Part Number	Nomenclature	Pos

Inspector's Signature

Employee Number/Certificate Number/Vendor Number

SERVICE CHECK	Station	Zulu Date
Mechanic's Signature		

☐ RII ☒

Data Entered By

FedEx. Federal Express

ENGINE MONITORING PROGRAM

Refer to FOM, Chapter 7, documentation for flight parameters.

Z-Time	Z-Date

MACH NO.	IAS	TAS	SAT
TAT	ALT	ZFW	FOB

Pneumatic ISO Valve 0=Closed 1=Open	1-2	1-3	
Aircraft Pack Valve 0=Closed 1=Open	1/L	2/R	3/X Feed	CG Range
Engine Position	1	2	3	4
Engine Bleeds 0=Closed 1=Open				
EPR				
N_1 RPM				
EGT				
N_2 RPM				
Fuel Flow				
Oil Press				
Oil Temp				
VIB (Fan)				
VIB (Turbine)				

☐ Did the computer accept the data? ☐

OIL ADDED (U.S. Qts)	Station	Zulu Date

Employee Number/Certificate Number/Vendor Number

#1	#2	#3	#4	APU

607 1/95 LOGOS # 138000

AIRCRAFT MAINTENANCE LOG 828685

AIRCRAFT TAIL NUMBER 611

PDIS 96513

DISCREPANCY

MDIS

Continued from page

SYS 1 BRAKE PRESS INDICATOR INDICATES 0 to 1000 (INTERMITTENT).

ATA / WRI No. 32-43/[illegible]

Continued from page

MAINTENANCE ACTION

Continued on page

NO TIME FOR T/S DEFERED #1 BRAKE SUPLY PRESSURE INDICATING SYST. INOP AS PER MEL 32-13, CAT C ITEM EXP DATE: 06 [illegible], CIL #: 20485 VERIFIED BRAKE PRESSURE ON AFFECTED ACCUMULATOR OK, AND HYD. SYST PRESSURE INDICATING SYST 1 + 3 WORKS NORMAL.

Continued on page

MEL/CDL Reference ☒ 32-13 ☐ Open Items List

☐ Closed ☒ Cat Status Changed

Mechanic's Signature [redacted]

Employee Number/Certificate Number/Vendor Number 141058

Station CDG Zulu Date 07 29

Mfg Part Number	S/N Off	S/N On	Pos	Res

Mfg Part Number	Nomenclature	Pos

Inspector's Signature

Employee Number/Certificate Number/Vendor Number

SERVICE CHECK	Station	Zulu Date

Mechanic's Signature

Employee Number/Certificate Number/Vendor Number

☐ RII ☒ AF4050

Data Entered By [signature]

Distribution: White - Mx. Records; Goldenrod - Stay in A/C; Pink - Reliability; Canary - Station

828685

MEL/CDL

DEFERRED ITEMS

F... A/C # 641	CTL # 2046	MEL / CDL PL...

Def Door Mel 78.3
#1 T/R Pump

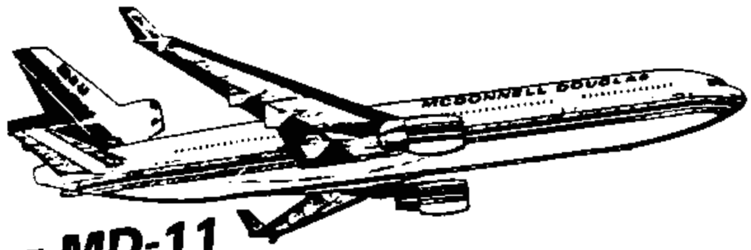
MEL / CDL MUST BE REPAIRED BY 2400 Z ON 7/5/97

FedEx ...395 3/92

Attach orange MEL/CDL Placard (FedEx ...

Appendix XI

McDonnell Douglas – Know Your MD-11



Know Your MD-11

LETTER NO. 1
DATE: May 12, 1992

TO: **ALL MD-11 OPERATORS**

FROM: **FLIGHT OPERATIONS CUSTOMER SERVICE DOUGLAS AIRCRAFT COMPANY**

SUBJECT: **OPERATIONAL PROCEDURES AND TECHNIQUES**

This "Know Your MD-11" Newsletter is compiled & published by Douglas Flight Operations Customer Service. The material contained herein is accurate at the time of publication; however, it is intended to provide information only. Should conflicts arise between this document and official manuals i.e., the Aircraft Flight or Flight Crew Operation Manuals, the official manuals are the final authority and shall supercede the data in this document.

Our new "Know Your MD-11" newsletter will be issued periodically, on an as-needed basis. If you find it useful, or if you have a subject you would like discussed in a future issue, please contact John Lane at the address below; we would like to hear from you.

John P. Lane
DOUGLAS AIRCRAFT COMPANY
Internal Mail Code 94-26
3855 Lakewood Blvd.
Long Beach, California 90846

1. Selection Direction of Turns

"I engaged Heading Select, and the darn thing turned the wrong way!!"

The above comment has been delivered to us a dozen times or more, sometimes in words decidedly more descriptive i.e. (#@(!) than those above.

How on earth can such a thing happen? Better still, can it be avoided? Yes, and here's how:

Flight Plan INIT, insert Origin and new Destination Airports, and complete the remainder of INIT Flight Plan data. Call up the Secondary PROGRESS Page and read the new destination, distance, time and fuel burn numbers.

Efforts are under way to modify our software to simplify the procedure above, but in the interim, the Closest Airport Insert method is the quickest and easiest procedure available.

3. STICK SHAKER/AUTO SLAT DURING CLIMBOUT

There have been a small number of reported incidents in which Stick Shaker activation has occurred while operating the aircraft in compliance with the Douglas recommended (and FMS programmed) speed profile. They have always occurred at heavy weights, with slats retracted during a low altitude departure, and while maneuvering in the presence of turbulence.

DAC has accomplished a complete review of our existing maneuver speed margins, and will soon propose a revised speed schedule which will ensure extra margin for the demanding conditions specified above. In the meantime, note that the Stick Shaker activation, when occurring, is sufficiently brief that the Autoslat Extend function usually does not occur. In cases where the slats do extend, it takes a minimum of 12 seconds for them to completely retract after the initiating cause has been removed, (which is usually almost instantaneous). Pilots may also find that it is prudent to leave the slats extended while maneuvering after a heavy weight takeoff, and until established on the outbound climbout course, especially if the air is bumpy.

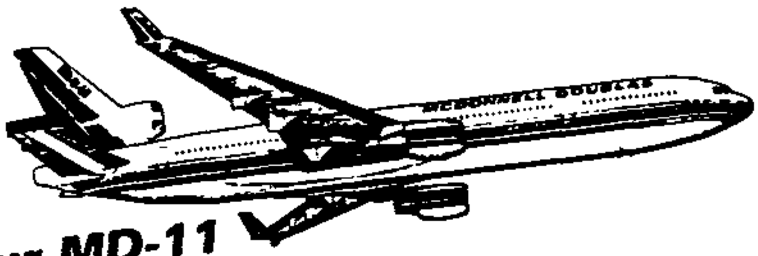
One other Stick Shaker event has been reported during a high altitude climb while operating on autopilot and in the FMS Profile climb. Preliminary evidence indicates that both FMCs were in the Time-Out mode. When this occurs, and the system loses its FMC Profile Speed, the Autopilot refers back to the speed in the Autothrottle GCP window for guidance. If that speed is below the low speed buffet for the existing altitude, shaker may occur. In the unlikely event that both FMCs time-out at the same moment, the crew should manually select an ATS speed which provides ample margin for low (and/or high) speed buffet protection.

4. BRAKE TEMPERATURE MEASUREMENT (BTM): Brake temperature spread - how much is too much?

Pilots have indicated concern over the cause of the wide range of temperatures displayed on the BTM. Some landings have produced variances between left and right gears, ranging from a low of 5° C on one wheel assembly, to a high of 222° C on another. Why are we getting such diverse readings, and what do they mean?

In any case, while we continue to investigate the cause, we would like to reiterate the corrective action. Should you find yourself in a "Confirmed" Engine Out Condition, either in flight or on the ground, and desire to cancel it, bring up the Performance Page. The CONFIRM ENGINE OUT CLEAR prompt will be displayed. Selecting this "CLEAR" will cause the Engine Out function to deactivate, and performance predictions to revert to the 3-engine state. Anytime thrust limits are stuck in MCT, or the FMS will not accept any FL above 280, be suspicious that an erroneous EO is the cause.

PAB:hro



Know Your MD-11

LETTER NO. 2
DATE: September 17, 1992

TO: ALL MD-11 OPERATORS

FROM: FLIGHT OPERATIONS CUSTOMER SERVICE, DOUGLAS AIRCRAFT COMPANY

SUBJECT: FLIGHT CONTROL SYSTEM (LSAS & RCWS)

From time to time, we receive requests from flight crews for more information on how the MD-11 Flight Control System really works, particularly the LSAS, the RCWS, and Speed Envelope Limiting. We are indebted to Captain Paul Shall from our Engineering Flight Test Group, who helped guide the certification of the MD-11 Flight Control System, for the preparation of the following article.

MD-11 OPERATING ENVELOPE PROTECTION

Besides providing a full flight regime autopilot, the MD-11 autoflight system provides stability and control augmentation, and protects against undesired aircraft attitudes and speeds, even when the auto pilot and autothrottles are off.

The following paper addresses Speed Envelope Limiting, Longitudinal Stability Augmentation, and Roll Control Wheel Steering.

SPEED ENVELOPE LIMITING

The MD-11 Auto Flight System provides full flight regime speed protection. The Auto Throttle System (ATS) forms the first line of defense against excursions outside the normal speed envelope for each aircraft configuration. If the ATS is inoperative, or is overridden by the pilot, LSAS protection begins. The various systems provide protection as follows; Autothrottle Speed Control (ATS on), Auto Throttle Self Engagement (ATS off), and LSAS Speed Limiting and Stall Protection (ATS available).

When ATS Speed Control is engaged, speed is automatically limited to the normal flight speed envelope. It is impossible to command a speed that is less than FMS-calculated Vmin+5 KIAS, or more that Vmax -5 KIAS.

at the elevators. Separate LSAS channels drive each of the four elevators. A least one FCC must be operational to provides LSAS service. If fewer than four LSAS channels are available, then full LSAS service is made available by increased gain on the surviving channels. Whenever the autopilot is disengaged and any LSAS switch is not off, LSAS is available to assist manual flying. LSAS is not affected by the position of the AFS Override Switches and is available when the aircraft is above 50 feet AGL.

LSAS PITCH ATTITUDE HOLD

In the normal flight envelope, LSAS operates whenever there is less than 2.2 pounds of push or pull force being exerted on the control wheel hub. The LSAS control law is to "hold pitch attitude and provide automatic stabilizer trim to relieve sustained elevator deflections."

LSAS uses up to 5 degrees of elevator to hold pitch attitude whenever there is less than 2.2 pounds of force on the control wheel and the bank angle is less than 30 degrees. Any sustained LSAS elevator deflection is promptly relieved by automatic LSAS stabilizer trim, provided the bank angle does not exceed 5 degrees and the control wheel force remains less than 2.2 pounds. The LSAS attempts to keep a full 5 degrees of elevator authority available by trimming out sustained elevator deflections.

Whenever there is more than 2.2 pounds force, LSAS is inoperative and provides no attitude hold, no pitch rate damping and no automatic stabilizer trim follow-up. Once the pilot applied control force exceeds about 4 pounds, friction is overcome and the elevator hydraulic actuators move in response to the pilot's commands.

PITCH ATTITUDE LIMITING

The LSAS will return the pitch attitude of the aircraft to less than 10 degrees of dive or less than 30 degrees of climb if these are exceeded.

LSAS OVERSPEED PROTECTION

During flight near the airframe speed limit (Vmo/Mmo), LSAS introduces up elevator deflection to prevent overspeed causing a nose-up pitch change. If the pilot attempts to cause an overspeed by pushing on the control column, LSAS will resist his force in an effort to prevent overspeeding the aircraft. The target speed that LSAS chooses in high speed protection is variable between Vmo/Mmo, for throttles at idle, and Vmo/Mmo plus 6 knots for throttles at full power. LSAS will not auto trim in the nose down direction in a high speed encounter. The pilot may counteract the LSAS Overspeed protection by pushing the control column and commanding down elevator through the mechanical linkage, but the first 5 degrees of this deflection will be countered by the LSAS series elevator inputs against the pilot. This results in a push force of about 50 pounds to defeat the LSAS. When the LSAS reaches its 5 degree limit of authority, further pilot inputs will produce direct elevator control and will override the LSAS. There is no autotrim when the control wheel force is above 2 pounds. If the pilot releases the push force rapidly, the LSAS will use its elevator authority to dampen the resulting pitch rate.

When control wheel force goes below 2.2 pounds, RCWS removes aileron deflection, and may apply some opposite aileron to stop the roll rate. The airplane smoothly stops rolling and holds a bank angle. It will then use its full authority to maintain that bank angle, up to 30 degrees of bank, even during atmospheric upsets. One of the most useful aspects of RCWS is the bank angle stabilization or holding.

Attempts to achieve bank angles in excess of 30 degrees require increasing pilot override force on the control wheel proportional to the amount of the bank above 30 degrees. If the pilot releases that override force, the airplane will immediately roll back to, and hold 30 degrees of bank.

During the time RCWS is active, aileron trim is ineffective and unnecessary. RCWS "reacts to" the control wheel forces when they exceed 2.2 pounds. Forces above that level command a corresponding roll rate of 4 degrees per second for each additional pound of force, 15 pounds maximum, out to the maximum aerodynamic roll rate of the aircraft.

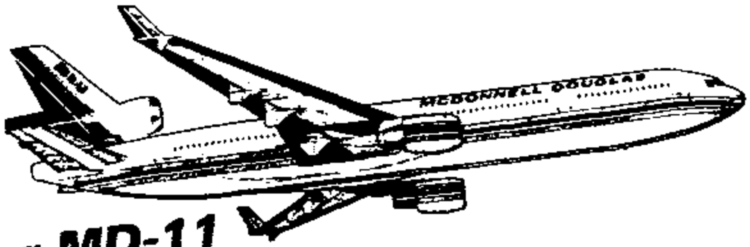
PILOT EFFECTS

Unlike LSAS, which is a series flight control feature, RCWS is a parallel feature which means that the pilot sees all the RCWS motions in the wheel. Forces below 2.2 pounds are resisted as the system attempts to hold bank angle. After the breakout force, there is a RCWS aileron deflection and a smooth buildup in roll rate. The aircraft stops rolling when the input force is less than 2 pounds. In order to stop rolling, the RCWS moves the control wheel in the opposite direction for a moment. Crews should anticipate, and should not resist, this motion.

There will be minor control wheel motions as the system counters atmospheric disturbances in an effort to hold the bank angle. Continual inputs by the pilot during RCWS operation are unnecessary, allow the RCWS to work until a different bank angle is required. Resisting the feedback motion of RCWS results in the system sensing a command in the direction of the force and reversing the response.

The MD-11 Flight Control System is flexible and easy to use. Not only does is simplify flying the aircraft with speed control and attitude stabilization, but it continually monitors that performance to ensure that no limits are exceeded. And it can always be overridden by the pilot if that is appropriate.

PJS/hro



Know Your MD-11

LETTER NO. 3
DATE: April 14, 1993

TO: ALL MD-11 OPERATORS

FROM: FLIGHT OPERATIONS CUSTOMER SERVICE DOUGLAS AIRCRAFT COMPANY

SUBJECT: LANDING CHARACTERISTICS AND TECHNIQUES

This "Know Your MD-11" Newsletter is compiled and published by Douglas Flight Operations Customer Service. The material contained herein was accurate at the time of publication, and it is intended to provide information only. Should conflicts arise between this document and official manuals i.e., the Aircraft Flight or Flight Crew Operating Manuals, the official manuals are the final authority and shall supercede the data in this document.

Our new "Know Your MD-11" Newsletter will be issued periodically, on an as-needed basis. If you find it useful, or if you have a subject you would like discussed in a future issue, please contact Art Torosian at the address below; we would like to hear from you.

Art Torosian
DOUGLAS AIRCRAFT COMPANY
INTERNAL MAIL CODE 94-26
3855 Lakewood Blvd.
Long Beach, California 90846

From time to time we receive requests from our customers, particularly new operators, for advice on how to get good, consistent, safe landings with their new airplane. We have pooled the collective experience of our Douglas pilots, and offer the following:

The landing characteristics of the MD-11 are very conventional for an aircraft of its size and weight. Flight controls are responsive, well balanced and predictable, and with a little practice, pilots are able to achieve consistently smooth, well controlled landings very close to the desired point of touchdown.

The following is a phase-by-phase discussion of proven approach/landing techniques which may help you to achieve consistency; if you have questions or advice that you would like to see included in future issues, please let us hear from you.

MD-11 LANDING CHARACTERISTICS AND TECHNIQUES

Visual Approach

The aircraft should be stabilized in the final landing configuration, on a descent flight path and on speed, with appropriate wind and gust corrections applied to V_{ref} by 1000' AGL. If the aircraft is not stabilized by 500 feet a missed approach should be executed. Rate of descent should not exceed 1000 fpm below 1000'. The visual aimpoint to provide a threshold clearance height of 47' on a 3.0 degree glideslope should be approximately 1700'. This will provide a touchdown point approximately 900' from the threshold without a flare. Do not deviate from the visual glidepath in an attempt to touch down early.

Flare

Auto throttles will begin to retard after passing 50', and a slight flare should be initiated between 30 to 40 feet (approximately 2^{o}). The aircraft should touch down in the touchdown zone. The technique described above will result in a touchdown slightly below V_{ref}. Do not hold the aircraft off in an attempt to achieve a smooth landing. This will result in a long touchdown, higher than necessary braking forces, a higher pitch attitude and reduced tail strike margin. The aft fuselage will contact the runway at approximately 10^{o} pitch attitude with the struts compressed.

Touchdown

At touchdown, with main wheel spin up, assure ground spoiler deployment and prepare to counter any pitching tendency as the spoilers extend. This will require the pilot to fly the nosewheel to the ground.

disengages, and any nose-up elevator command would be washed out within 1 second, and a slight drop in the nose may be observed just before the flare. From a practical standpoint, this nose lowering would be barely perceptible, and of little consequence to the flare and touchdown.

These additional guidelines are emphasized:

1. Autothrottles should be used for all landings. The reduction of power, starting gradually at about 50 feet and continuing through the flare, complements a smooth transition to a well controlled and timely touchdown. The Autothrottle will continue to move the throttles to idle if not already in idle at touchdown.

2. Pilots should not trim the stabilizer during the flare. Such activity may contribute to float, a nose high touchdown attitude, a possible tail strike, and may aggravate any existing pitch up tendency after touchdown.

3. Experience has shown that approaches which result in large pitch deviations, and which never achieve true speed and glide path stability are much more likely to produce unpredictable landings; hold-offs, floats, hard touchdowns, strong rebounds and tail strikes. Such approaches make it nearly impossible to establish a proper crosswind correction, and are especially risky on contaminated or slippery surfaces. A destabilized approach is a compelling reason to initiate an early go-around.

LANDING ON WET OR SLIPPERY SURFACES

On a wet and/or slippery surface every effort should be made to ensure that reverse thrust is applied symmetrically across all three engines, and crews should be trained to carefully monitor any tendency for the aircraft to develop a skid when the surface is slippery. Should a skid condition develop, thrust should be brought to idle reverse on all three engines while the skid is corrected. When a limited amount of runway friction is available, reduced braking may improve the cornering capability of the aircraft, and with the use of rudder pedal nosewheel steering, help correct the skid. Sustained high reverse thrust in a skid will provide a force which can literally back the airplane off the downwind side runway surface.

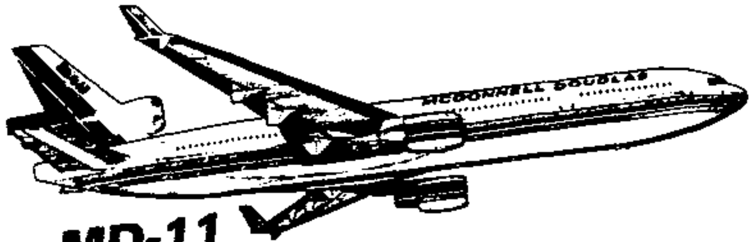
INTERRUPTING A SYSTEMS TEST

Each of the three aircraft systems, Air, Hydraulics and Fuel, has a specified test routine to be accomplished by the flight crew before flight, usually during cockpit preparation. In examining the causes of instances in which

FUEL OFF SCHEDULE ON THE GROUND

There may be occasions when Ground Service or Maintenance refuel the airplane in a manner which may cause the FUEL OFF SCHEDULE alert to appear. This usually occurs as a result of testing a pump, exercising a valve etc. during the refueling operations. For whatever reason, if the flight crew finds the FUEL OFF SCHEDULE Alert displayed after refueling, usually no action will be required other than to call up the Fuel Synoptic. If the Fuel System Controller (FSC) is operating in automatic, it will take but a few minutes for the controller to automatically reconfigure the fuel distribution to normal, once the refueling has been completed. This will be evident on the Synoptic. If the system is operating in manual, then the crew should redistribute the fuel manually. In any case, it would be a good idea to question the ground staff to as to how the fuel happens to be off schedule.

PAB/hfg
knowmd#3



Know Your MD-11

LETTER NO. 4
July 22, 1993

TO: ALL MD-11 OPERATORS

FROM: FLIGHT OPERATIONS CUSTOMER SERVICE DOUGLAS AIRCRAFT COMPANY

SUBJECT: OPERATIONAL PROCEDURES AND TECHNIQUES

The Fleet-wide Dispatch Reliabilty of the MD-11 has crossed the 97% point, and is moving upward. Most of the delays continue to be systems-related. Occasionally, however, an event will occur which causes a delay simply because the flight crew is unsure as to how to proceed; a situation may arise that the pilots have never seen before, or thought about, or have not been trained to, and given their uncertainty they elect to delay rather than proceed. Some examples follow:

ATS AMBER BOX

Flight crew, strapping in to begin their cockpit preparation, suddenly notices that an Amber Box surrounds the Autothrottle ATS CLAMP display on the PFD. Amber means not available, right? Crew calls maintenance and refuses to accept the airplane until the Amber condition is resolved. Actually, Amber is the normal condition for the ATS CLAMP display until the first engine is started - until the first FADEC is powered, actually. That step 'enables' the Autothrottle System, and changes the FMA Autothrottle Display Outline to White. Incidentally, the Autopilot box will also be boxed Amber, and will remain so until V_2 is entered/confirmed on the FMS Takeoff Page; both of these displays are normal.

SLAT ALERT

Flight crew notices, as they are about to taxi, that the Essential Items (Green Box) displays a white "SLATS," when it usually displays "STAB TRIM". The crew perceives that something must be wrong with the Slat System, and returns to the gate. Actually, the crew is correct in that they normally do see "STAB TRIM" after engine start, because the Stabilizer is often out of the Green Takeoff Range "Band", having not yet been positioned for takeoff. But on this particular day, by sheer chance, the airplane's CG is slightly aft, and the existing stabilizer position, usually 3° ANU, now falls within the required takeoff Green Band. The E&AD Essential Items requirement for the Stabilizer position for takeoff is satisfied. It then displays the next lower priority item on the Takeoff Warning System, "SLATS". Therefore, "SLATS" is a perfectly normal display here, and the crew may verify that the SLATS are functional by setting the SLATS/FLAPS to the desired takeoff position. When done, the display will then change to the next lower priority item, usually SPOILERS, and so on until all takeoff requirements are met, and a "Green Box" is displayed.

FMC RANGE DISAGREE

In addition to the normal FMC RANGE DISAGREE which we see from time to time, we have recently established that there are several additional conditions which may cause the alert:

1. When the Glareshield TCAS button is depressed, and there is no TCAS installed in the airplane, a RANGE DISAGREE will be presented; and

2. When a software anomaly in the GCP-902 causes a lockup of GCP Channel A, range disagree will be presented. This lockup occurs only occasionally, and is the result of an anomaly in the GCP-902 Software. The source of this anomaly has been identified, and was corrected in the GCP-903 update, the Service Bulletin for which was released in March 1993. If the Service Bulletin has not yet been installed, a Channel A lockup will display an FMS RANGE DISAGREE Alert, a SENSOR FAIL on the left (#1) MDCU, and the biasing of the on-side Primary Flight Display Pitch Command Bar. The loss of the Pitch Bar may not occur until after rotation, but the ALERTS on the disabled system will be visible before takeoff, and should prompt flight crew action before flight.

Should Channel A be disabled in flight, and being that it is always associated with Autopilot-1 and FCC-1, selecting the other Autopilot will provide a serviceable system. Should it occur before takeoff, maintenance can usually clear the condition by cycling the GSHLD CONTROL PNL A POWER C/B.

THE REVERSER SLOW-TO-STOW

During the certification flight test program of the G.E. powered MD-11, we discovered that in some cases the fan reverser transcowls were taking an excessive amount of time to stow. Subsequent investigation revealed that pneumatic pressure supplied to the reverser actuation system was insufficient to allow a normal stow under some bleed air configurations. This condition could lead to nuisance reverser alerts, and to unnecessary maintenance action. As an interim solution, a procedure was developed and placed in the FCOM, directing the flight crew to select the Pneumatic System ECON switch to the OFF position prior to descent. With the ECON system operating (switch ON) the engine's High Stage Bleed Valve (HSBV) modulates engine bleed to a nominal 28 PSI. When switched off, as is recommended in the interim solution, HSBV pressure is increased to a nominal 42 PSI, thus providing additional energy to expedite the transcowl stow operation.

The problem fix, implemented by the release of two Service Bulletins in early 1993, incorporates new software in the Pneumatic System Controller (-5 PSC model), new wiring and an upgraded relay which combine to provide an additional increase in pneumatic pressure to a nominal 65 PSI. The FCOM will be revised later this year to advise operators that the subject ECON OFF procedure may be deleted after Service Bulletins have been installed.

Rudder pedal limits on the amount of nosewheel steering are carefully selected by the manufacturer to prevent inadvertent over-controlling of nosewheel steering. Testing has clearly demonstrated that the nose tires maintain maximum "bite," especially on slippery surfaces, when deflected out to about 6°. In a non-skid condition, this is 6° from the fuselage centerline; in a skid, it is measured from the direction the airplane is moving. As nosewheel deflection continues to increase beyond 10° by use of the steering tiller, the tires gradually lose their adhesion. When deflection reaches 17° from the direction the airplane is moving, they have lost most of their effectiveness. Further, at high angles of nose wheel deflection, the "outboard" nose tire tends to lift off the runway; this reduces the amount of tire area in contact with the surface, with a proportional loss in steering. It is interesting to note that the dry-runway VMCG does not take advantage of nosewheel steering, and therefore represents a safety factor. On wet runways, however, VMCG is the actual minimum control speed.

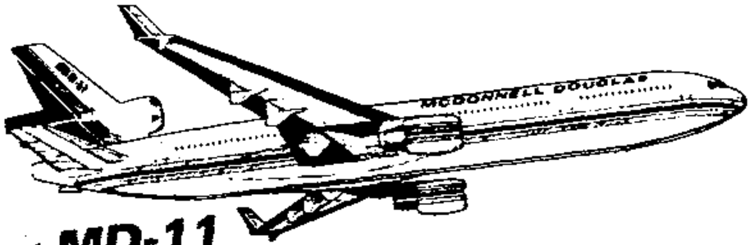
It is very difficult for the PF to control, or even to judge, how much steering deflection has been applied with the tiller on a slippery surface. The tiller should not be used at high speed, <u>especially when in a skid</u>; it is likely to aggravate, rather than to help restore, directional control.

In summary, in windy and/or slippery conditions, we have to fly the airplane all the way down to the runway turnoff for a safe, smooth and professional "arrival."

[redacted]

A. Torosian
Business Unit Manager
Operational Safety
& Customer Service

PAB:hrf



Know Your MD-11

LETTER NO. 5
February 21, 1994

FADEC ALERTS: What they mean, and what to do about them:

As with many pilots flying with a FADEC system for the first time, MD-11 pilots quickly gain confidence in the new system, particularly appreciating the ease and precision of setting power. But when FADEC MAINTENANCE or FADEC FAULT Alerts appear, indicating possible malfunction or degraded performance, pilots may become uneasy or apprehensive with FADEC because:

A. they may not be sure what the Alert means.
B. they may feel that they do not have enough control over the system to influence the future course of events.

Volume forty seven of Douglas Service Magazine published a detailed article highlighting significant aspects of FADEC Design and Operation. Copies of this article may be obtained directly from the Douglas Service Editor, Mail Code 73-30, 3855 Lakewood Blvd., Long Beach, CA. 90846. To focus on the FADEC ALERTS for the moment, the following is derived from a Douglas Powerplant Engineering Newsletter:

The FADEC controls in both the CF6-80C2 and PW4460 engines are authorized to operate for a limited time with certain failures. This concept is known as "Time Limited Dispatch", and was developed to better utilize the redundancy of modern FADEC controls.

Time Limited Dispatch is possible because of the fault tolerant design of the Engine Control. Failures can be detected and accommodated such that the operation of the failed component will not affect the operation of the engine. However, it may decrease the fault tolerant capability of the control such that the next failure may not be fully accommodated. As the number of faults accumulate, the engine may not be able to maintain operation, or the risk of abnormal operation may become too great.

A statistical failure analysis, combined with an analysis of service history, has made it possible to group these failures into two categories:

EAD ALERT	DISPATCH CATEGORY	TIME LIMIT
FADEC MAINT	No Dispatch	N/A
FADEC FAULT	Short Time Dispatch	10 days/150 Hr

Failures are grouped into these categories based on the risk of an In Flight Shut Down/Loss of Thrust Control. These failures, and the category to which they belong, are defined as an integral part of the respective Engine Type Certification Data Sheet.

Only the FADEC MAINT Alert indicates a non-dispatchable condition; for this alert, maintenance action will always be required before flight. Conversely, a FADEC FAULT indication is always dispatchable without maintenance action, as specifically authorized in the MEL Procedures Manual. After a FADEC FAULT alert appears however, a schedule for corrective action is mandated in the manual. The flight crew need only record the time of occurrence, and the engine on which the FADEC FAULT appeared.

FUEL SYSTEM
ISOLATION VALVES-GENERAL:

There are two ISOL (Isolation) valves in the MD-11 fuel system, identified as AUX ISOL and TAIL ISOL. These valves are electrically positioned by the Fuel System Controller (FSC), and their primary functions are two-fold:

A) During the fueling operation, they direct or inhibit the flow of fuel to their respective tanks (Aux and Tail); and

B) During flight, they enable the movement of fuel into or out of these tanks to appropriate destinations for further storage, for consumption and/or for Center of Gravity (CG) management. The following discussion, together with the enclosed Fuel Schematic, will add detail on how they accomplish these tasks.

AUX TANK ISOL VALVE:

Functions:

1. Isolates the aux fill/transfer manifold from the main tank fill/crossfeed manifold. This allows the crossfeed manifold to be pressurized during takeoff without pressurizing the aux fill transfer manifold which runs inside the aircraft pressure envelope.

2. Prevents fill valve bleed flow into the aux tanks when the main tank/crossfeed manifold is pressurized.

3. Provides an alternate fuel route from the lower aux tank and tail tank to the main tanks when the upper aux tank has already been emptied or has inoperable components.

Operation:

THE AUX ISOL VALVE:

1. Is opened automatically from the refueling panel when an aux tank or tail tank fill valve is armed.

2. Is controlled by the FSC in AUTO mode to perform tail fuel management.

3. Can be operated during maintenance using the CFDS FSC RETURN-TO-SERVICE menu.

?. **Momentary Control Wheel Deflection**. When the Deflected Aileron System is active and the aircraft is also equipped with the Roll Control Wheel Steering (RCWS) option, there will be a momentary control wheel deflection of approximately 12 degrees for 1 second when the ailerons initially deflect or retract after takeoff. This deflection is normal, and an explanation of this phenomena is provided below:

When the RCWS (or Autopilot) is active, one of the inboard ailerons (the left aileron for RCWS 1, the right for RCWS 2) is controlled by the Flight Control Computer (FCC) electronically. In this mode, the engaged aileron actuator will not accept mechanical inputs, and deflection must occur electronically through the FCC. The FCC attempts to accomplish this deflection at the same rate that the ADA is trying to deflect the aileron mechanically. In actual practice, however, due to small lags in the aileron response to the FCC commands, the aileron is usually moving a little slower than the ADA-directed movement. The ADA then backdrives the control wheel slightly until the aileron catches up; this causes the aforementioned momentary aileron pulse.

The characteristic explained above is normal, and actually provides a positive, tactile indication that the ailerons have deflected. Typically, if RCWS 1 is active, the control wheel will move counterclockwise when lowering the ailerons and clockwise when raising them. If RCWS 2 is active, the opposite will be true.

This same phenomena will also occur when the Autopilot is engaged while the flaps (and ailerons) are retracting after takeoff. The effect on autopilot control is negligible, will usually not be noticed by the crew unless they are specifically looking for it, and may vary slightly from aircraft to aircraft due to normal component tolerances. It is not a cause for concern by the flight crew.

ILS TUNING AND CAPTURE:

If the ILS is tuned manually by IDENT only, and if the final approach course information is not entered, the LAND ARM will be displayed yet no capture will occur; the course must be entered on the NAV RAD page to get capture. This applies after the -908 FMC software has been installed.

In the -907 FMC; if an ILS IDENT is manually entered that is the same as the ident programmed in the Flight Plan ILS approach, the FMS autotunes and validates the ILS CRS on the output bus, but does not display it on the NAV RAD page. This allows the AFS to capture the ILS. A change has been made in the -908 FMC to prevent automatic Course Selection when an ident or frequency is manually entered on the NAV RAD page without final approach course information.

LOSS OF HYDRAULIC SYSTEMS TWO AND THREE:

One operator has advised us that an incident occurred in which Hydraulic System #2 shut down in flight following the loss of system fluid, and a short time later, the crew performed a precautionary shutdown of system #3 after showing indications of overtemp. During the remainder of the flight, utilizing only Hydraulic System #1, the flight experienced a noticeably higher fuselage deck angle, and an increase in fuel burn, caused by additional drag from flight control surface float.

2. **Question:** Can Ballast fuel be burned in flight?

   Answer: As we are aware, fuel that is placed in ballast is for CG purposes, and is not intended for later consumption; FARs and AFMs have provided strong advice on that. However, should extraordinary circumstances dictate extraordinary measures, then to quote from Honeywell's MD-11 Cockpit Pilot's Guide, "Manual fuel system operation ignores FMS ballast entries and therefore ballast fuel may be used inflight (tail tank ballast fuel switches on the maintenance panel must be moved from the TAIL BLST position)."

3. **Question:** With warm brakes, how long will it take to cool them, and when can the next takeoff begin?

   Answer: Enclosed is the Douglas FCOM Vol. IV Takeoff Brake Temperature Chart. This subject is one of high focus with the FAA right now, and we are working with them to provide a simplified scheme, more readily accessible to the flight crew, to help the captain decide when he has sufficient brake capacity available to permit a takeoff. In the meantime, this chart can be used.

4. **Question:** Why do we see different ETAs to the next waypoint between the Nav Display and the FSC-MCDU Progress Page?

   Answer: The ETA to the next waypoint on the Nav Display is based on the current IRU groundspeed and the distance to the waypoint.

   The ETA(s) displayed on the FMC pages (PROGRESS, FPLN, FIX) are all based on FMS predictions. FMS predictions determine the predicted groundspeed based on current and FORECAST Winds and the FMS Speed Mode (target).

   Reasons for different resulting ETA's:

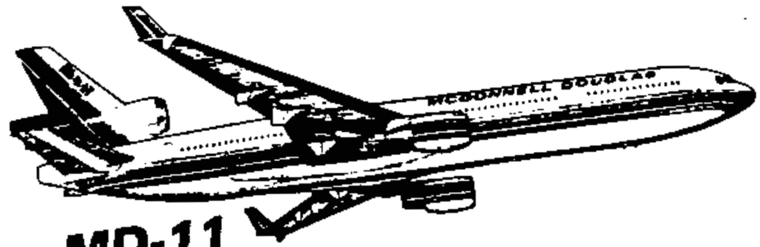
   (1) FMS software error in the calculations of winds used in Predictions. This error is believed to account for most revenue complaints of ND/FMS PAGE ETA discrepancies. This software error is being fixed in the FMS -909.

   (2) FMS SPEED Mode target significantly different from the current aircraft speed.

   (3) Lack of accurate FORECAST Wind Information in the FMS for use by FMS Predictions.

Background on MD-11 FMS use of Winds:

In cruise, FMS Predictions use a blend of current winds and FORECAST Winds (pilot entered on the VERT REV Page 2). Predictions use 100% current winds directly in front of the aircraft, ramping linearly down to 0% current winds at 200 n.m. in front of the aircraft. The use of FORECAST Winds ramps linearly from 0% at the aircraft nose to 100% at 200 n.m. in front of the aircraft; beyond 200 n.m. predictions use only FORECAST Winds. However, the predictive process is cumulative, so that predictions for all downpath waypoints are based on the results of predictions to previous waypoints. Therefore, predictions to all waypoints in the flight plan are based on both current winds (used in the first 200 n.m. of the predictive process) and FORECAST Winds (used all along the flight plan, but has more influence on the predictions beyond 200 n.m.).



Know Your MD-11

LETTER NO. 6
October 7, 1994

Know Your MD-11

Landing Over Weight

Every transport aircraft has, as part of its design specification, a specified Maximum Landing Weight. For routine operations, landing at or below this weight is the rule. Because the Maximum Structural Takeoff Weight is often substantially higher than the max landing value, and because circumstances may arise after takeoff which make it desirable to land before the fuel burnoff or fuel dump can bring the weight down to the max landing weight, the flight crew may occasionally be well advised to consider an overweight landing. The purpose of this letter is to review the factors which impact on landing overweight, and to offer guidance to the crew on how best to accomplish it.

The maximum landing weight is a value which is established by several factors, including the strength of the aircraft structures, flap limit speeds, tire limit speeds, and brake capacity. With respect to structural strength, the aircraft is designed to accept a touchdown in a normal landing attitude at up to 10 feet-per-second (600 fpm) with no damage at the maximum landing weight. When the landing weight goes above this value, a landing is still permitted, but the allowable sink rate decreases. Charts are provided in the FCOM Performance Manual which show the allowable sink rate for weights above the maximum landing weight. The flight crew should consider the following when performing an overweight landing:

Select a runway which is long enough, and is into the wind. Higher approach and landing speeds will increase landing distance, which should be determined by reference to the performance section of the AFM. Do not land on contaminated runways unless it is absolutely necessary.

The maximum landing flap setting should be used whenever possible. On some aircraft the approach speed may be higher than the maximum flap speed limit in which case the alternate flap setting must be used.

Touchdown speeds are normally on the order of 5 to 10 knots below the final approach/threshold speed, and surface wind conditions should be factored in to determine if tire limit speeds will be exceeded.

All things considered, it is preferable to reduce weight by dumping fuel when possible. If, however, an overweight landing is advised, consider the following.

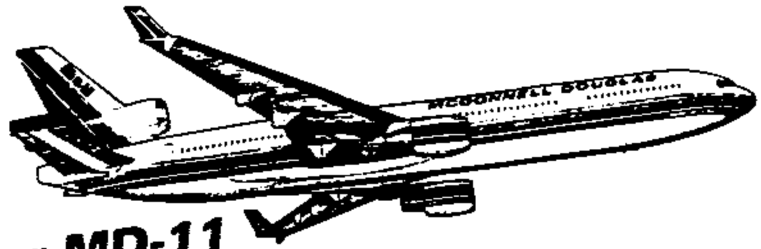
1. Determine the landing distance from the performance section in the AFM.

2. Configure the aircraft to the maximum landing flap configuration commensurate with approach flap speed restrictions.

3. Fly a speed and glide path stabilized approach using the ILS if available.

4. Use reverse thrust after landing and apply brakes normally consistent with wind, runway conditions and distance remaining.

5. Write-up the Overweight Landing event. An overweight inspection is always required; the extent of which is determined by how much the aircraft exceeded the Max Landing Weight at touchdown.



Know Your MD-11

LETTER NO. 7
October 7, 1994

KNOW YOUR MD-11

ENGINE FIRE AGENT DISCHARGE PROCEDURE

Recently an MD-11 experienced an inflight Engine Fire Warning. The engine was shut down per the emergency checklist and the fire handle was pushed down and rotated to discharge the fire extinguishing agent. However, the agent did not discharge, perhaps because the fire handle was not at the full forward limit when it was rotated.

To discharge the agent, the fire handle must be pushed full forward, against the stop to overcome the spring back load. It must be held there while rotating the handle clockwise to discharge the Number 1 Fire Agent, or counter clockwise to discharge Number 2. The Flight crew can then verify that the agent has been properly discharged by checking the Agent Low Light.

Flight crew personnel seldom have the opportunity to experience the "feel" of the spring load in the system; it is suggested that it may be useful to incorporate an exercise into the simulator training syllabus to give them a "hands-on" opportunity.

Appendix XII

Other Operator Accidents

NTSB Identification: **CHI94MA290**. The docket is stored in the (offline) NTSB Imaging System.

Scheduled 14 CFR 129 operation of ALITALIA
Accident occurred AUG-19-94 at CHICAGO, IL
Aircraft: MC DONNELL DOUGLAS MD-11F, registration: IDUPO
Injuries: 267 Uninjured.

THE AIRPLANE EXPERIENCED A HARD LANDING ON INITIAL TOUCHDOWN. SUBSEQUENTLY, THE NOSE TIRES FAILED, DAMAGE OCCURRED TO THE GENERAL AREA OF THE NOSE LANDING GEAR SUPPORT STRUCTURE, AND THERE WAS FOREIGN OBJECT DAMAGE TO THE #1 AND #3 ENGINES. THE FLIGHT DATA RECORDER (FDR) DATA INDICATED THAT THE INITIAL TOUCHDOWN ACCELERATION HAD A VALUE OF 1.9488 G'S. AT THAT TIME, THE THROTTLE RESOLVER ANGLES INDICATED 52.03, 51.33 AND 49.22 DEGREES FOR THE NUMBER ONE, TWO AND THREE ENGINES, RESPECTIVELY. ALSO, THE FDR REVEALED THAT AFTER TOUCHDOWN, THE AIRPLANE EXPERIENCED FOUR OSCILLATIONS IN THE PITCH AXIS. THE MAXIMUM PITCH ANGLE DURING THIS TIME WAS +5.98 DEGREES NOSE UP, AND THE MINIMUM VALUE WAS -2.46 DEGREES NOSE DOWN. DURING THIS TIME FRAME, SPOILER POSITIONS NEVER EXCEEDED 8.0 DEGREES OF DEFLECTION AND THE NOSE WEIGHT ON WHEELS PARAMETER CHANGED FOUR TIMES.

Probable Cause

THE FIRST OFFICER'S IMPROPER FLARE AND IMPROPER USE OF FLIGHT CONTROLS DURING THE LANDING FLARE/TOUCHDOWN.

Index for Aug 1994 | Index of Months □□□□□

NTSB Identification: **LAX93IA198**. The docket is stored in the (offline) NTSB Imaging System.

Scheduled 14 CFR 121 operation of DELTA AIRLINES
Incident occurred APR-30-93 at LOS ANGELES, CA
Aircraft: MCDONNELL DOUGLAS MD-11, registration: N803DE
Injuries: 277 Uninjured.

THE PILOT WAS INSTRUCTED TO GO-AROUND ON HIS FIRST APPROACH DUE TO PRECEDING TRAFFIC ON THE RUNWAY. AFTER THE SECOND APPROACH, HE ALLOWED THE AIRPLANE'S DESCENT RATE TO BECOME EXCESSIVE, AND IT TOUCHED DOWN FIRMLY AND BOUNCED. THE SECOND TOUCHDOWN WAS ALSO FIRM. DURING THE LANDING ROLL-OUT, THE AIRPLANE VIBRATED, BUT WAS CONTROLLED WITH BRAKES AND ENGINE REVERSING. A POST-FLIGHT EXAM REVEALED DAMAGE TO BOTH NOSE GEAR TIRES AND WHEEL RIMS, SMALL HOLES IN THE FUSELAGE AFT OF THE NOSE GEAR, AND INGESTION OF TIRE RUBBER IN THE #1 ENGINE.

Probable Cause

THE PILOT'S IMPROPER FLARE AND IMPROPER RECOVERY FROM A BOUNCED LANDING.

Full narrative available

Index for Apr 1993 | Index of Months

LAX93IA198

On April 30, 1993, at 2113 hours Pacific daylight time, Delta Airlines Flight 88, a McDonnell Douglas MD-11, N803DE, landed hard on Runway 24R at Los Angeles International Airport, Los Angeles, California. The airplane, operating as a scheduled international passenger flight under 14 CFR Part 121, sustained minor damage. There were no injuries to the 14 crewmembers or 263 passengers. Night visual meteorological conditions prevailed. The flight originated at Anchorage, Alaska, at 1545 hours.

According to the FAA, the pilot was instructed to go-around on his first approach due to the preceding traffic on the runway. On the second approach, the airplane landed hard and bounced. The pilot added power to cushion the landing, which subsequently stowed and disarmed the wing spoilers.

Examination of the airplane revealed damage to both nose gear tires and wheel rims, damage to the heat shield on the center body gear, small holes in the fuselage aft of the nose gear, and ingestion of tire rubber in the number 1 engine inlet.

Delta Airlines System Manager Flight Safety reported in part, "On arrival into LAX, the crew was cleared for an ILS 24R with about 18,000 pounds of fuel remaining. A go-around was required from short final due to failure of traffic ahead to clear the runway. On short final, [the] aircraft felt like it was sinking, but an instrument check indicated a stable approach. The Captain added additional throttle and back pressure to the controls. The aircraft touched down, the nose pitched up and the aircraft became airborne."

The system manager also stated that, "The Captain added additional power and forward pressure to the controls to counter the nose pitch-up. The second touchdown was firm and during the rollout the aircraft vibrated, but was controlled with brakes and engine reversing."

Delta Airlines did not report any mechanical failures or malfunctions with the airplane preceding the incident. Delta Airlines also reported that "training in last minute high sink rate situations and recovery techniques after a hard landing could prevent a similar occurrence."

Return to synopsis