Docket No. SA-520

Exhibit No. 11-A

NATIONAL TRANSPORTATION SAFETY BOARD

Washington, D. C.

Maintenance Records Group Chairman's Factual Report

(70 Pages)

NATIONAL TRANSPORTATION SAFETY BOARD
Office of Aviation Safety
Washington, D.C. 20594

November 26, 2000

MAINTENANCE RECORDS GROUP CHAIRMAN'S FACTUAL REPORT

DCA00MA023

A. ACCIDENT

Location: Pacific Ocean near Anacapa Island, California

Date: January 31, 2000

Time: 1621 Pacific Standard Time (PST)

Aircraft: McDonnell Douglas DC-9-83, N963AS, Alaska Airlines, Flight 261

B. MAINTENANCE RECORDS GROUP

Chairman: Frank McGill
National Transportation Safety Board
Washington, D.C.

Member: Dean Hamilton
Federal Aviation Administration
SeaTac, Washington

Member: Kristen von KleinSmid
Federal Bureau of Investigation
Los Angeles, California

Member: Don Myck/Kevin Pape (Myck was replaced by Pape at the request of Alaska Airlines on July 18, 2000)
Alaska Airlines
Seattle, Washington

Member: Mike Lasley
Boeing Commercial Airplane Group
Long Beach, California

Member: Dave Crawley
Air Line Pilots Association
Seattle, Washington

Member: Lance Seyer
Aircraft Mechanics Fraternal Association
Seattle, Washington

C. SUMMARY

On January 31, 2000, at about 1621 Pacific Standard Time (PST),[1] Alaska Airlines (ASA)[2] flight 261, a Boeing DC-9-83,[3] N963AS, crashed into the Pacific Ocean approximately 3 miles north of Anacapa Island, California, and was destroyed. There were 88 fatalities including 83 passengers and 5 crewmembers. There were no survivors. The flight, from Puerto Vallarta, Mexico, to Seattle, Washington, with an intermediate stop in San Francisco, California, was operating under 14 Code of Federal Regulations (CFR) part 121.

On February 2, 2000, the Maintenance Records Group met at the Alaska Airlines Maintenance Headquarters located in its maintenance hangar in Seattle, Washington, to begin the field investigation of the accident. The Maintenance and Engineering Division, Aircraft Records Department maintains required historical references relating to airplane maintenance and is located at this facility. Computer databases that contain information relating to the tracking and history of airplane and component maintenance are also located here. After an initial review of records and documents of the accident airplane, the Maintenance Records Group conducted interviews with Seattle (SEA) based Dispatchers and Maintenance Controllers. By phone patch, Los Angeles (LAX) based employees, who were involved with N963AS before the accident, were also interviewed. Additionally, maintenance records and documents concerning horizontal stabilizers for N973AS, N981AS, and N982AS were reviewed. The Maintenance Records Group completed the field examination of the records on February 12, 2000.

On February 15, 2000, the Maintenance Records Group met in Oakland, California (OAK), for a site inspection of the Alaska Airlines Maintenance Hangar. All heavy maintenance

[1] Unless otherwise indicated, all times are Pacific Standard Time, based on a 24-hour clock.
[2] Three-letter International Airline Decoding Designator assigned on a worldwide basis by the International Civil Aviation Organization (ICAO). Alaska Airlines is assigned the code "ASA." The two-letter International Airline Decoding Designator is "AS." The FAA's four-letter designation is "ASAA."
[3] The FAA Type Certificate Data Sheet (A6WE) states that the "MD" designator may be used in parentheses, but must be accompanied by the official designator, that is, DC-9-83 (MD-83). McDonnell Douglas Corporation transferred ownership of the Type Certificate A6WE to The Boeing Company on January 30, 1998.

checks performed on N963AS were accomplished at this base maintenance and component overhaul shops facility.

Six OAK based maintenance technicians were interviewed by the Maintenance Records Group on February 16 and 17, 2000. The interviews were conducted to obtain details concerning nonroutine work card 4236374 that was completed on September 30, 1997, during the "C5" Check of N963AS. Interviewed were the maintenance technician who performed the first endplay check, the inspector who wrote the discrepancy, the supervisor who signed the work card, the lead maintenance technician who changed the first planned action, the maintenance technician who performed the second endplay check, and the inspector of the second endplay check. The Maintenance Records Group departed on February 18, 2000.

On March 24, 2000, two maintenance technicians were interviewed concerning lubrication performed on N963AS. One of the interviews was conducted with the maintenance technician who lubricated the jackscrew during the "C5" Check inspection performed in September 1997. The other interview was conducted with the maintenance technician who performed the last noted lubrication of the jackscrew assembly that was accomplished in SFO on September 24, 1999.

On March 25, 2000, the Maintenance Records Group met in Oakland, California, for a detailed review of maintenance check procedures performed at the Alaska Airlines Maintenance Hangar, including the inspection of "Production Control."[4] The Maintenance Records Group departed on March 26, 2000.

On April 18, 2000, the Maintenance Records Group met in Oakland, California. On April 19, 2000, the Maintenance Records Group conducted an interview with an OAK-based Lead Maintenance Technician (currently on paid administrative leave). The interview was conducted to obtain details concerning nonroutine work card 4236374 that was completed on September 30, 1997, during the "C5" Check of N963AS. The Maintenance Records Group departed on April 20, 2000.

On August 7, 8, 9, 10, 14, 15, and 16, 2000, interviews were conducted in Seattle, Washington, by the Maintenance Records Group to obtain further information on maintenance procedures. Federal Aviation Administration personnel and Alaska Airlines maintenance personnel were interviewed on the following dates:

On August 7, 2000, the Maintenance Records Group conducted FAA interviews with the former Principal Maintenance Inspector (PMI) assigned to ASA (currently a consultant for another airline) and the former supervisor of the Alaska Airlines Certificate Management Section (currently Supervisor of the Air Carrier Section of the Seattle Flight Standards District Office).

On August 8, 2000, the Maintenance Records Group conducted FAA interviews with the Assistant PMI assigned to the ASA Certificate Management Section, the current PMI assigned to

[4] Production Control is an area where administration, planning, and assignment of maintenance tasks are coordinated, while the airplane is undergoing a scheduled check.

the ASA Certificate Management Section, and the current Manager of the ASA Certificate Management Section.

On August 9, 2000, the Maintenance Records Group conducted interviews with a former ASA Inspector Supervisor of the OAK maintenance facility (currently working for ASA as a consultant), the ASA Manager of Inspection/Chief Maintenance Inspector for the airline, and the Manager of Base Maintenance at the OAK maintenance facility.

On August 10, 2000, the Maintenance Records Group conducted an interview with ASA's Director of Quality Control/Training. At the time of the accident, the Director of Quality Control/Training also held the position of Director of Safety.

On August 14, 2000, the Maintenance Records Group conducted an interview with ASA's Assistant Vice President of Engineering, Maintenance Programs and Publications, and Reliability.

On August 15, 2000, the Maintenance Records Group conducted interviews with ASA's Vice President of Maintenance and Engineering, and ASA's former Executive Vice President of Technical Operations and System Control (currently working for ASA in a management transition role).

On August 16, 2000, the Maintenance Records Group conducted an interview with ASA's Manager of Systems Engineering. The Maintenance Records Group departed on August 17, 2000.

On October 18, 2000, the Maintenance Records Group conducted an interview with FAA's Division Manager for the Flight Standards Division of the Northwest Mountain Region. The Maintenance Records Group departed on October 19, 2000.

On November 14, 15, and 16, 2000, the Maintenance Records Group, consisting of members of the NTSB, the FAA maintenance records member, and the FBI maintenance records member, conducted interviews with: former assistant PMI assigned to ASA, current PMI assigned to the ASA Certificate Management Section, current MD-80 Aircrew Program Manager assigned to the ASA Certificate Management Section, former supervisor of the ASA Certificate Management Section, Senior Regional FAA Enforcement Attorney, the current Manager of the ASA Certificate Management Section, and the former ASA Manager of Base Maintenance at SEA. The Maintenance Records Group Chairman departed on November 22, 2000.

D. DETAILS OF THE INVESTIGATION

1. Air Carrier Certificate

Alaska Airlines, Inc., P.O. Box 68900 Seattle, Washington, 98168, Certificate Number ASAA 8092 was reissued on April 17, 1989. The effective date for the certificate was September 23, 1946.

2. Operations Specifications

Alaska Airlines' Air Carrier Certificate, which included the standards, terms, conditions, and limitations contained in the Federal Aviation Administration (FAA) approved Operations Specifications (Parts A, B, C, D, and E), were reviewed. The following areas were noted:

(a) From the current A6 Management Personnel[5] listing that was FAA approved and effective on June 12, 1998, the Director of Maintenance position (to be held by the title of Assistant Vice President of Maintenance) was vacant. A temporary revision (TR-100) was issued by ASA on May 5, 1998, proposing an amendment to the Operations Specifications that would allow the Director of Line Maintenance and the Director of Base Maintenance to share the duties of the Director of Maintenance, until there was a permanent assignment. There was no explanation on how these duties would be apportioned, however, the Assistant Vice President of Maintenance would report to the Staff Vice President of Maintenance and Engineering, who in turn, would report to the Executive Vice President of Technical Operations and System Control. On June 12, 1998, the FAA approved the request and amended the ASA Operations Specifications.

(b) The Director of Safety also held the title of Director of Quality Control and Training. As the Director of Quality Control and Training, he reported to the Vice President of Maintenance and Engineering. As the Director of Safety, he reported to the Executive Vice President of Technical Operations and System Control. The Chief Inspector, which is listed on A6 of the Operations Specifications, reported to the Director of Quality Control.

(c) Aircraft Maintenance approval- General Requirements (D72) was dated August 8, 1999, with an origination date of January 15, 1993. The last Continuous Airworthiness Maintenance Program (CAMP), 0520-01013, revision for DC-9/MD-80 airplanes was dated on June 12, 1995.

(d) Reliability Program Authorization (D74)[6] for the B-737 and MD-80 fleet is "Reliability Analysis Program (RAP) Document 95-1." The original issue of this program (95-1) was April 3, 1995. Revision 9 was dated September 1, 1999. Reliability Program Authorization: entire aircraft was January 11, 1988.

(e) Short-term Escalation Authorization (D76) for the MD-80 Fleet is:

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[5] Title 14 Code of Federal Regulations (CFR) part 119.65 lists personnel required for operations conducted under part 121. The certificate holder must have qualified personnel serving full-time in the following or equivalent positions: Director of Safety, Directory of Operations, Chief Pilot, Director of Maintenance, and Chief Inspector. See Attachment 11-B, Operations Specifications Management Personnel.

[6] A Maintenance Reliability Program is an advanced set of factors that control inspections, checks, and overhaul times for the entire airplane, and is the sole control as far as operations specifications are concerned. The analytical nature of reliability control emphasizes the existence of components and systems to determine maintenance intervals and processes.

- "A" Check- 25 flight hours time in service.
- "C" Check - 15 calendar days.
- "15K" Check- 300 flight hours time in service.
- "30K" Check- 300 flight hours time in service.

The last revision was dated August 8, 1999.

(f) Parts Borrowing Authorization (D83) dated April 17, 1989, was not referenced with FAA approval.

(g) The Aircraft Listing (D85), with referenced approval, was not located in the Operations Specifications. However, a copy of the current airplane listing sent to the Principal Maintenance Inspector on February 1, 2000, listed a fleet of 87 airplanes, 34 being DC-9-82/83 airplanes (N963AS was still listed).

(h) Minimum Equipment List Authorization (D95), which also provides maximum times between deferral and repair, was approved on December 7, 1990, and was last revised on July 12, 1991. This revision allowed "Category D" items to be repaired within 120 consecutive calendar days (2,880 flight hours), excluding the day the malfunction was recorded in the aircraft maintenance log.

3. FAA Certificate Management and Surveillance

On October 1, 1998, ASA was one of ten initial cadre air carriers that began the new Air Transportation Oversight System (ATOS)[7] process. The Alaska Airlines Certification Management Team (CMT)[8], which includes Principal Operations Inspector (POI), Principal Maintenance Inspector (PMI), Principal Avionics Inspector (PAI), and Cabin Safety Inspector (CSI), numbered 33 members (including Geographic Inspectors), with one vacancy on March 4, 1999. As of October 2000, there were 26 members assigned to the team (not including Geographic Inspectors), with three vacancies to make it fully staffed. The previous PMI retired in November 1999, after eight and a half years working with ASA. The PMI position was not filled until after the accident date.

[7] ATOS is a new airline oversight process developed by the FAA with the support of Sandia National Laboratories. It embodies a system approach to certification and surveillance oversight, using system safety principles and risk management built into air carrier operations.

[8] The Certificate Management Team (CMT) is responsible for the surveillance of a specific air carrier, and will develop and execute a Comprehensive Surveillance Plan (CSP) tailored to that carrier.

Element Performance Inspections (EPIs)[9] and Safety Attribute Inspections (SAIs)[10] for aircraft airworthiness of the airline were reviewed between January 1, 1998 and March 23, 2000. Many of the EPIs and SAIs had not yet been accomplished by the FAA. During this period, an Emergency Airworthiness Directive was issued by the FAA for inspecting the horizontal stabilizer. No comments or references concerning horizontal stabilizers or associated systems were noted.

The FAA's Program Tracking and Reporting Subsystem (PTRS)[11] query on N963AS was reviewed for the period from January 1, 1999 to March 9, 2000. The following records were reviewed: 21 cockpit en route inspections, two cabin en route inspections, eight Service Difficulty Reports (SDR)[12] reviews, one de-ice inspection, and one incident investigation (Hydraulic system was inoperative on landing in Seattle, WA, because the engine driven pump had failed). All status results, with the exception of the Flight 261 accident, were coded closed or satisfactory, and no discrepancies were noted.

The FAA conducted a National Aviation Safety Inspection Program (NASIP) inspection of ASA's flight operation from August 14 through 24, 1995.

The Department of Defense's (DoD) Air Carrier Survey and Analysis team conducted a survey of ASA's flight operation from September 21 through 25, 1998.

At the direction of the Director, FAA Flight Standards Service (AFS-1), a special inspection of ASA was conducted from April 3-19, 2000. The Director stated that the inspection would serve as the FAA's follow-up review of ASA's accident. The final report was dated June 20, 2000.

4. Type Certificate Data Sheet

Federal Aviation Administration "Type Certificate Data Sheet"[13] number A6WE (revision 25) for DC-9-83 airplanes was reviewed for compliance conditions and limitations. No discrepancies were noted.

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[9] The ATOS inspection type (EPI) is designed to determine if an air carrier adheres to its written procedures and controls for each system element, and that the established performance measures for each system element are met. EPIs are planned for and executed at the element level, and are accomplished by individual inspectors.

[10] The ATOS inspection type (SAI) is designed to appraise the quality of the safety attributes (responsibility, authority, controls, procedures, process measurement, and interfaces) associated with each system element for a carrier. SAIs are executed at the element level, usually planned for at the sub-system level, and accomplished by a team of inspectors.

[11] The PTRS is a FAA computer-tracking program that includes information of inspection and surveillance activities made by Flight Standards Inspectors.

[12] A Service Difficulty Report (SDR) is a FAA summation of a "mechanical reliability" report, which is submitted by an aircraft operator or maintenance facility, as required by regulation. They are usually submitted by air carriers using FAA form 8070-1.

[13] The document that prescribes conditions and limitations under which the product, for which the type certificate was issued, meets airworthiness requirements.

Type Certificate Data Sheet number E9NE (revision 10) for Pratt & Whitney model JT8D-217C engines was reviewed for compliance conditions and limitations. No discrepancies were noted. The data sheet includes the following models: JT8D-209, 217, 217A, 217C, and 219 engines.

5. Service Difficulty Report Data

FAA Service Difficulty Reports (SDR's), which are "mechanical reliability reports"[14] that are summated by the FAA, were reviewed from all operators flying DC-9 model airplanes from January 1990 to present for the following Air Transport Association (ATA)[15] systems: 22 (autopilot), 24 (electrical power), 27 (flight controls), 29 (hydraulic power), 30 (ice and rain protection), and 55 (stabilizer). No maintenance trends or discrepancies concerning horizontal stabilizers were noted.

There were 70 SDR's for horizontal stabilizers (ATA 2740, 2741, and 2742) noted between January 1990 and February 2000 among operators of DC-9s. Three jackscrews were replaced because of corrosion, pitted threads, or wear limits. One jackscrew was replaced because of a broken upper stop. Most of the other SDR's were submitted because of malfunctions of electrical components. There were 4 SDR's sumitted by ASA (ATA 55) from January 1997 to January 2000 for airplanes in its MD-80 fleet. There were no SDRs reported by ASA for ATA (2740) coded areas.

There were 45 SDR's noted for airplane N963AS from January 1990 to present. None of the SDR's pertained to flight controls or horizontal stabilizers.

ASA did not file any SDRs for ATA chapter 2740 (horizontal stabilizer) and chapter 5500 (stabilizers) from 1985 through 1999.

6. Boeing DC-9-80 Series Aircraft

The first flight of a DC-9 airplane was in February 1965; the final DC-9 was delivered in October 1982, for a total number of 976 DC-9 series airplanes. The Douglas Aircraft Company became McDonnell Douglas Aircraft Company on April 28, 1967. The FAA certified the MD-80 (five models: MD-81, MD-82, MD-83, MD-87, and MD-88) in August 1980. The last year of production was 1999, for a total number of 1191 MD-80 series airplanes.

Note: McDonnell Douglas Corporation (MDC) built 111 MD-90 series airplanes between 1995 and 1999. In August 1994, MDC originally made application for Type Certificate of the MD-95-30. Subsequently, MDC merged with The Boeing Company (Boeing) in 1997, and updated its application for Type Certification in March 1998, with the new model designation of 717-200. Both of these models have the same Type Certificate Data Sheet as the DC-9-80 series, which is number A6WE.

[14] See Attachment 11-C, Mechanical Reliability Reports.
[15] Air Transport Association (ATA) system designations are used in aviation maintenance to create a standardized format.

7. Airplane N963AS Information

Registration	Serial Number	Line Number	Delivered New to ASA	Airplane Total Time	Airplane Total Cycles
N963AS	53077	1995	May 1992	26,584:43 Hours	14,315 Cycles

Type: DC-9-83 (MD-83)

Minimum Crew: two (pilot and copilot)

Passenger Configuration was 140 (12 first class and 128 coach).

Galleys: four

Lavatories: one forward and two aft

Forward Air Stairs: one

Aft Air Stairs: one

Required number of Flight Attendants: three

All ASA DC-9-82/83 (MD-80) airplanes are authorized to conduct CAT IIIa (50 feet DH[16]/700RVR[17]) instrument approach and landing operations.

8. Engines: P&W JT8D-217C Turbofan

The engine type is a dual spool axial flow 14-stage (seven stages are low pressure, including one fan stage, and seven stages are high pressure) compressor, four-stage turbine (three stages are low pressure, and one stage is high pressure), with nine can-annular combustion chambers, and an exhaust mixer. The maximum continuous static thrust (sea level at 19°Fahrenheit (F) temperature) is 20,850 pounds (lbs). The original engines on N963AS when the airplane was delivered to ASA in 1992 were: Position 1 (726845), Position 2 (726830).

The engines on the airplane at the time of the accident were:

	Engine Position 1 (Left Side)	**Engine Position 2** (Right Side)
Serial Number (SN)	728068	726852

[16] Decision Height (DH) is the height at which a decision as to whether a landing or a go-around will be made.
[17] Runway Visual Range (RVR) is an instrumentally derived value that represents the measured horizontal visibility (in feet) at ground level along the runway. "Touchdown," "Mid," and "Rollout" RVR values are reported to the pilot by the tower prior to the final approach.

Date of Manufacture	May 8, 1995	April 28, 1992
Time Since New (TSN)	16,970:40 hours	24,034:41 hours
Cycles Since New (CSN)	8,994 cycles	13,266 cycles
Date of Installation on N963AS	April 20, 1999	May 24, 1999

(a) Engine SN 728068 was installed in the number 1 position on N963AS on April 20, 1999 at SEA (log number 5043806). This engine replaced engine SN 708469 which had been removed from N963AS on April 13, 1999, because of a severe vibration (log number 5043805). Engine SN 728068 had been removed from the number 1 position on N942AS on April 11, 1999, in SEA, and engine SN 718114 was installed. The reason the engine was removed from N942AS was that the airplane was being returned from a lease agreement with a different engine. At the time of installation on N963AS, engine SN 728068 had a TSN of 13,820:09 hours and CSN of 7,541 cycles. At the time of the accident, the engine had 3,006 cycles remaining until the first limited inspection of the low-pressure turbine (LPT) shaft.

(b) Engine SN 726852 was installed in the number 2 position on N963AS on May 24, 1999 at SEA (log number 5008425). This engine replaced engine SN 728023 which had been removed on the same day, because of severe foreign object damage (FOD). Engine SN 726852 had been removed from N932AS on February 27, 1999, due to a time change of the low-pressure turbine shaft, and sent to GE Engine Services (Repair Station number RA1R445K) in Dallas, Texas, for repair. At the time of overhaul, the engine TSN was 21,242:47 hours and CSN was 11,993 cycles. The work performed included: rear turbine case repair, number three bearing repair, combustion chamber inner/outer outlets repair, installed new 8th stage compressor disk and serviceable N1 turbine shaft, and completion of several Service Bulletins (SBs) and Airworthiness Directives (ADs). The engine was then subjected to a test run, and accepted as serviceable on May 3, 1999. At the time of the accident, the engine had 6,305 cycles remaining until the first limited inspection of C1-C6 disks.

9. Auxiliary Power Unit on N963AS

The unit was an AiResearch GTCP85-DHF, serial number P-3017. Total time since overhaul (TSO) was 5,823:42 hours. Total cycles since overhaul (CSO) was 2,959 cycles.

10. Weight and Balance Summary

ASA's aircraft (per weight and balance program) are weighed at 36 calendar month intervals. Engineering recalculates the basic empty weight (BEW), center of gravity (CG), and the adjusted operating empty weight (AOW) at each weighing and for various configuration changes.

Leading Edge Aviation Services, Inc. last weighed N963AS on November 27, 1998, at Amarillo, Texas. The results were:

Basic Empty Weight (BEW):	80,973.8 pounds
Arm:	945.5 inches

Moment: 76560728

The configuration report for a crew consisting of two pilots and three flight attendants, dated December 10, 1998, indicates an operating empty weight (OEW) of 85,722.3 pounds, arm of 932.23 inches, moment of 79912811, and an adjusted OEW of 85,725.6 pounds.[18]

11. Maintenance Evaluation and Program Development for DC-9-83 Airplanes

The McDonnell Douglas MD-80 series is a derivative model of an in-service aircraft type, rather than a completely new type airplane. As a result, much of the structure and many of the systems, components, and installations of the DC-9-80 series are common to the earlier models of the DC-9. Thus, scheduled maintenance requirements and procedures have progressed over the years through many stages.

A new concept of maintenance evaluation and program development began in the 1960's by industry representatives to advance the use of logical analysis and decision processes. The purpose of the group was to develop maintenance requirements identified by FAA regulations. The document was known as MSG-1 (Maintenance Steering Group- 1st Task Force). With updated experience gained in decision logic, MSG-2 (2nd Task Force) was applied and used to develop scheduled maintenance programs for aircraft of the 1970's. By 1979, partly because of distinctions between safety and economics and the adequacy of treatment of hidden functional failures, the development of "Maintenance Program Development Document MSG-3" (3rd Task Force) evolved (originally issued September 30, 1980). Revision 1 was issued on March 31, 1988, and revision 2 was issued on September 12, 1993 (this is the latest revision).

MSG-3 was the combined efforts of the FAA, the Air Transport Association of America, United States (U.S.) and European aircraft and engine manufacturers, and U.S. and foreign airlines. However, MSG-3 did not constitute a fundamental departure from the previous version, but built upon the existing framework of MSG-2, which had been validated by ten years of airline maintenance programs.

Both MSG-2 and MSG-3 are analysis procedures and decision logics used primarily in the development of initial maintenance programs for new type designs. The following reflects some of the major changes generated by MSG-3R2 as compared to MSG-2:

(a) MSG-3 "decision tree" analysis logic is "task" oriented and not "process" oriented (MSG-2). This difference eliminated the confusion associated with various interpretations of Hard-Time (HT)[19], On-Condition (OC)[20], Condition-Monitoring (CM)[21], and Overhaul

[18] Adjusted OEW is the operational empty weight rounded to the nearest 100 pounds, and has the mean aerodynamic chord (MAC) units substituted in three right-hand digit positions. This combines weight and CG data into a single figure.

[19] "Hard Time (HT)" is a process that requires an item to be removed from service or overhauled at or before a previously specified time.

(OH)[22] "processes" that are defined with MSG-2 methodology. Using MSG-3 "task" methodology, logic took a "from the top down" or "consequence of failure approach," and the functional failure was assessed for consequence of failure and was assigned one of two basic categories:

(1) Safety- Is the malfunction apparent to crewmembers or mechanics? Is the malfunction hidden?

(2) Economic- Several of the potential impact areas that are examined are initial design, maintenance cost/ownership cost, and premature removal rates.

(b) Servicing and Lubrication are included as part of the logic diagram to ensure that this category of task is considered each time an item is analyzed.

Note: The MSG-2 process does not consider lubrication.

(c) The selection of maintenance tasks, as output from the decision logic, has a more specific delineation of the task possibilities contained in the logic.

(d) There is a separation between tasks that are economically desirable and those that are required for safe operation.

12. Maintenance Review Board Report (MRB)

By using either a MSG-2 or MSG-3 concept, one would be able to view the Maintenance Review Board (MRB)[23] report (this is a living document approved by the FAA) and see the initial minimum scheduled maintenance/inspection requirements for a particular transport category aircraft.

Initially, an industry steering committee (ISC) that comprises representatives from the aircraft manufacturer, appliance manufactures, and intended air carriers develops and establishes policies for the proposed MRB by directing the activities of working groups (WG). These

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[20] 'On Condition (OC)" is a process that requires periodic inspections or checks of a unit against an appropriate physical standard to determine whether it can continue in service until the next scheduled check. The purpose of the standard is to remove the unit from service before failure occurs during normal operations.

[21] "Condition Monitoring (CM)" is a maintenance process for items that have neither "Hard Time" nor "On-Condition" maintenance as the primary maintenance process. CM is accomplished through continuous data collection and analysis of components or systems. Analysis of failures or other indications of deterioration are used to evaluate the continuing airworthiness of the airplane.

[22] "Overhaul (OH)" is the disassembly, cleaning, inspection, repair, and testing of a component to the extent necessary to ensure (substantiated by service experience and accepted practices) that it is in satisfactory condition to operate for a given period. It includes the replacement, repair, adjustment, or refinishing of such parts as required, which, if not properly accomplished, would adversely affect the airworthiness of the aircraft.

[23] The Maintenance Review Board (MRB) document is a FAA report using MSG philosophy, service experience, and test procedures that outlines the initial minimum maintenance and inspection requirements to be used in the development of an approved continuous airworthiness maintenance program for airframe, powerplants, system, and components for an aircraft.

working groups develop initial minimum scheduled maintenance/inspection requirements for new or derivative aircraft using the latest revision of the MSG-3 process. The WG also establishes sampling requirements when MSG-3 analysis determines that such sampling is applicable and effective in the identification of the cause of failure.

A MRB report is normally not prepared for transport category aircraft having a maximum certified takeoff weight of 12,500 pounds or less, and is generally prepared for aircraft of more than 33,000 pounds. A maintenance program should be developed using MRB guidelines, however, a MRB is not to be confused with, or thought of, as a maintenance program.

For example, a MRB guideline might show that an item needs an operational check at the "A" Check frequency, a functional check and lubrication task at the "C" Check frequency, and a restoration task at the "D" Check frequency.

The MD-80 now has two MRB Reports. One is the MD-80 MRB Report derived through the MSG-3 Revision 2 process (original issue: March 1996). The other MRB is the original MD-80 MSG-2 Report (Revision "Q" dated March 2, 1993).

Initial MD-80 operators may use one or the other, but may not mix the programs. However, existing MD-80 operators, whose maintenance program is based on the MRB MSG-2 Report, may take advantage of the MSG-3 Report and its listed intervals to adjust its existing programs accordingly and in coordination with its FAA PMI.

MSG-3 logic was used to develop an on-wing scheduled maintenance program. With the exception of life-limited parts, the process does not normally include off-wing shop maintenance procedures (example: hydraulic pumps, fuel controllers, jackscrews, etc.). Off-wing detailed procedures are controlled by each air carrier, and are derived from the air carrier's reliability program, which may use the manufacturer's instructions for continued airworthiness required by regulation.

Intervals for individual tasks may be escalated based on satisfactory substantiation by the air carrier, and review and approval of the FAA, or the air carrier's reliability program.

Against this background, operators of MD-80 airplanes have different options (because of different philosophies, capabilities, operating parameters, etc.) to develop their individual approved programs; thus, there may be extensive differences among various airline maintenance programs.

13. FAA Maintenance Review Board (MRB) Report (MSG-2) for DC-9-80 Aircraft

Alaska Airlines uses the MD-80 MRB MSG-2 Report, (DC-9-80/MD-88), revision "Q" guidelines for its maintenance program. March 1985 was the initial maintenance program approval. The report outlines the initial minimum maintenance and inspection requirements to be used in the development of an approved continuous airworthiness maintenance program for airframe, systems, powerplants, and components for the McDonnell Douglas DC-9-80 series

airplanes. The MRB report using MSG-2 logic has the following "R," "A," and "C" Check intervals. Variations of these scheduled maintenance tasks may be performed at different intervals, and thus is called a "phase check" (example C1, C2, C3, or A1, A2, A3, etc.). Other inspection checks, such as "B" or "D," are not defined by the MRB.

"R" Check Requirements of the "R" Check, subject to the operators operating experience, will be included in the maintenance program at an interval before the "A" Check subject to approval of the Regulatory Agency. It consists essentially of a general visual security inspection including exterior structure, surfaces, landing gear well interiors, and engine accessories in addition to special items and the service check.

Note 1: The horizontal stabilizer is only viewed from ground level.

"A" Check Consists of a general inspection of the interior/exterior of the airplane with some selected areas opened up in addition to performance of special and service items. The "A" Check interval is specified at 450 flight hours (FH).

Note 1: Zone areas of the horizontal stabilizer are visually checked from a stand or ladder for structural and security conditions at A1 or A2 intervals.

Note 2: As a comparison, MSG-3 MRB "A" interval tasks are also at 450 flight hours.

"C" Check Traditionally known as heavy checks, they are detailed inspections of aircraft systems and structure. Additional detailed inspections may be referred as "D" Checks, or these additional inspections may be incorporated into a "C" Check work requirement. The DC-9/MD-80 MRB has all of these inspections incorporated into "C" Checks.

The "C" Check consists of a thorough visual check of the general condition and security of installations and adjacent structure in all designed zone areas of the airplane. Internal areas of the airplane are opened as necessary for adequate visual inspection at 3500 flight hours (FH) or 15 months, whichever comes first.

Note 1: The general security and condition of the horizontal stabilizer inspection is part of a system maintenance operational check, and is performed every "C" check (3500 flight hours or 15 months, whichever comes first).

Note 2: The "Acme Screw and Nut Endplay" check is performed at "C2" intervals (7000 FH or 30 months, whichever comes first).

As a comparison, MSG-3 MRB "C" Check interval tasks are at 3600 flight hours or 15 months, whichever comes first. Thus, the general inspection of the horizontal stabilizer is inspected at 3600 flight hours, and the

"Acme Screw and Nut Endplay Check" is also performed at"C2" intervals (7200 FH or 30 months, whichever comes first).

Note 3:There is no treatment mentioned for lubrication[24] in the MSG-2 MRB report.

As a comparison, MSG-3 MRB "C" Check interval tasks for lubrication are at 3600 flight hours or 15 months, whichever comes first.

14. Manufacturers' "On Aircraft Maintenance Program (OAMP)" Planning Document

From the FAA Maintenance Review Board Report (MRB), the Manufacturers' Aircraft Maintenance Manual (AMM), and additional aircraft requirements, a manufacturer provides a maintenance planning report to assist operators in planning an initial maintenance program for that type airplane.

For MD-80 aircraft, there are two documents. One document is derived from MSG-2 logic, and the other uses MSG-3 logic.

"MD-80 On-Aircraft Maintenance Planning (OAMP) report number PS 761-93," MSG-2, revision date: August 1993. The report is derived from MSG-2 logic, and contains a complete listing of basic routine (scheduled) maintenance requirements as specified by the FAA DC-9-80/MD-88 MRB report and additional requirements recommended by McDonnell Douglas.

"MD-80 On-Aircraft Maintenance Planning (OAMP) report number ME-0098," MSG-3, revision date: May 1996. The report is derived from MSG-3 logic, and contains a complete listing of basic routine (scheduled) maintenance requirements as specified by the FAA MRB-MD-80 MSG-3 report and additional requirements recommended by McDonnell Douglas.

The OAMP also contains repetitive inspection items outlined in Airworthiness Directives (ADs), All Operator Letters (AOLs), Service Bulletins (SBs), Alert Service Bulletins (ASBs), revisions to the MRB, and other regulatory documents. However, the OAMP does not contain detailed procedural type information for inspection or check items. Detailed procedural type information is provided in the DC-9 Maintenance Manual or the appropriate DC-9 Maintenance Task Card. The information is intended to serve as a guide, and must not be construed as mandatory or official. The OAMP is divided into two sections:

(a) In-Service Maintenance (normally termed as Line Maintenance):

(1) Servicing (fuel, oil, hydraulics, etc.)

(2) Walk-Around Checks (general condition of exterior surfaces)

[24] Lubrication, as defined in the MSG-3 MRB report, is "any act of lubricating or servicing for the purpose of maintaining inherent design capabilities."

(b) Out-of Service Maintenance:

(1) Scheduled Maintenance Checks

Scheduled maintenance includes "A" Checks, "C" Checks, Structural Significant Items[25] (SSIs), etc. These scheduled checks may also included tasks such as "Acme Screw and Nut Endplay Checks," as noted below.

- The *MSG-2 OAMP*[26] recommends that "A" Check intervals be performed at 450 flight hours, and "C" Check intervals be performed at 3,500 flight hours or 15 months, whichever comes first. The "Acme Screw and Nut Endplay Check" is recommended at "C2" intervals (7,000 flight hours or 30 months, whichever comes first).

- The *MSG-3 OAMP*[27] recommends that "A" Check intervals be performed at 450 flight hours, and "C" Check intervals be performed at 3,600 flight hours. The "Acme Screw and Nut Endplay Check" is recommended at "C2" intervals (7,200 flight hours).

(2) Lubrication

General requirements as noted by MSG-3:

"Proper lubrication of all airplane components is especially necessary in cold weather. Bearings, mechanisms, and lubricated surfaces exposed to the washing and diluting effects of extreme weather and de-icing solution will require more frequent lubrication service. Systems and parts, which operate normally in warm climates, might bind when the operating clearances are reduced by extremely cold temperatures, unless properly lubricated. Mechanisms that operate in oil will stiffen considerably at lower temperatures. This condition is normal, and the use of high forces to obtain warm-weather operating time or ease is not desirable. Continued sluggish functioning of some units might indicate a change in lubricant; however, problems of this nature are localized, and should be handled accordingly. Normal forces applied steadily at a slower rate ordinarily provide satisfactory operation."

In both MSG-2 and MSG-3 documents, general information to MD-80 lubrication can be found in Douglas Process Standard (DPS) 3.17-49, revision "AK," issued April 15, 1999, for lubrication of DC-9, MD-80, MD-90, and 717

[25] Structural Significant Item (SSI) is any detail, element or assembly, which contributes significantly to carrying flight, ground, pressure, or control loads and whose failure could affect the structural integrity necessary for the safety of the aircraft.
[26] See Attachment 11-D, MD-80 On Aircraft Maintenance Planning (OAMP): MSG-2
[27] See Attachment 11-E, MD-80 On Aircraft Maintenance Planning (OAMP): MSG-3

aircraft. However, the document does not identify instructions or procedures for changing lubricant types or brands.

General and airframe lubrication grease are noted as wide temperature range (WTR), with a specification procurement number of MIL-G-81322. "MIL" is a military material specification specifically prepared to support and define a material. This particular lubrication (MIL-G-81322) is designed for an operating temperature range of -65° to 350° Fahrenheit (-54° to 177° Celsius).

Lubrication for the horizontal stabilizer is noted as follows:

- *MSG-2 OAMP* recommends that lubrication of the horizontal stabilizer jackscrew and stop fitting be performed at:

  Low Interval 600 flight hours
  High Interval 900 flight hours

- *MSG-3 OAMP* recommends that lubrication of the horizontal stabilizer jackscrew at every "C" Check (3,600 flight hours).

15. Douglas Maintenance Inspection Procedures for MD-80 Airplanes (Generic)

From OAMP guidance and the airplane maintenance manual, Douglas produces maintenance work cards that provide required inspection procedures that must be performed at scheduled intervals. The program includes relevant servicing tasks and unscheduled maintenance procedures. It also includes pertinent data, text, and illustrations with a task card index. An airline may even purchase a configured and customized set of maintenance task procedures taken from the operator's customized maintenance manual.

A review of the generic MSG-2 (December 1991) and MSG-3 (June 1996) versions of Douglas MD-80 Acme Screw and Nut Operation and Endplay "C2" Check showed that many of the ASA task card procedures were the same. ASA used the MSG-2 version to develop its customized task card (number 24627000). Some of the task instructions included:

(a) Apply 250 to 300 inch-pounds torque to horizontal stabilizer by shorting restraining fixture and record dial indicator readings. *(MSG-2, MSG-3, and ASA have the same instructions)*

(b) Check that endplay limits are between .003 and .040 inch. Readings in excess of above are cause for replacement of Acme jackscrew and nut. *(MSG-2, MSG-3, and ASA have the same instructions)*

The ASA task card adds, "should replacement become necessary, accomplish EO 8-55-10-01, if not previously accomplished. However, this EO is not used to actually

replace a jackscrew. Procedures for replacement of the jackscrew are taken from chapter 27 of the MM.

Note: EO 8-55-10-01 replaces horizontal stabilizer fairing support hi-lock fasteners with bolts and nut plates. The EO affected nine ASA airplanes, however, N963AS was not one of them, and therefore was not applicable.

16. Jackscrew Wear Rate and Lubrication

An Acme screw and nut endplay check is a method for providing an operator with jackscrew wear information, however, without recording this information over a period of time, wear rate may not be determined. Over the years, recommended changes have been made to the check and lubrication procedures. Several of these changes are as follows:

(a) On November 4, 1966, Douglas Aircraft Company (DAC) issued an All Operators Letter (AOL) 9-48 for DC-9 operators on how to perform this check. The AOL stated that the application and release of a 150 inch-pound torque on the restraining fixture (jackscrew check tool) was to be performed, and the dial indicator readings indicating the amount of endplay were recorded after each torque change. This procedure was to be repeated at least two times to assure results were consistent within .001 inch maximum. Endplay limits of the jackscrew assemblies were .003 inch minimum to .0265 inch maximum. When jackscrew assemblies reach a measured endplay of .020 to .022 inch, an endplay check should have been made subsequent to each 1,000 flight hour period. The expected wear rate at the nut was approximately .001 inch during each 1,000 flight hours. The AOL also stated that nuts and jackscrews are not individually interchangeable, and must remain in matched sets, each are serialized with the same number.

(b) On February 28, 1967, DAC issued AOL 9-48A to all DC-9 operators, as an update to the endplay check. It recommended a more accurate method of determining endplay, and increased the allowable for maximum endplay. The restraining fixture torque was changed to a range of 150 to 200 inch pounds, and at least three readings were to be taken until the results obtained were consistent within .001 inch maximum. The new endplay limits were set at .003 inch minimum to .040 inch maximum. When jackscrew assemblies reach a measured endplay of .034 to .036 inch, the check should have been made at intervals which did not exceed 1,000 flight hours. It was also recommended that the initial endplay check be accomplished between 3,000 and 3,500 flight hours. As a matter of information, Douglas tests indicated that wear between the nut and screw was occurring at the rate of approximately .004 inches per 1,000 flight hours.

(c) On May 29, 1984, DAC issued AOL 9-1526 to all DC-9 and MD-80 operators concerning lubrication requirements of the horizontal stabilizer actuator assembly, because two operators reported three instances of premature replacements due to excessive endplay limits. These assemblies had accumulated less than 6,000 flight hours each, since new. They were returned to Douglas for investigation. The Acme nut installed in each assembly exhibited severe wear of the thread surfaces. In addition, grease samples taken

from the lubrication passages in the screw gimbals installed on two of these assemblies were dry and without evidence of recent renewal. Accordingly, Douglas was of the opinion that the most probable cause of the observed Acme nut thread wear and subsequent excessive endplay was inadequate lubrication of the actuator assemblies. References from the DC-9 OAMP and MD-80 OAMP referred to the recommend interval of 600 flight hours. The AOL also emphasized the importance of maintaining a conscientious lubrication program to minimize Acme nut thread wear and extend the service life of the actuator assembly.

(d) On December 6, 1990, DAC issued AOL 9-2120 to all DC-9 and MD-80 operators concerning horizontal stabilizer jackscrew wear rate data, because one operator had discovered a low time jackscrew assembly worn beyond allowable limits. The in-service reliability data at Douglas indicated a meantime between removal (MTBR) and mean time between unscheduled removal (MTBUR) of 25,000 to 30,000 flight hours. An operator survey about lubrication frequency, wear rate measurements, and MTBR and MTBUR times were proposed.

(e) As a result of AOL 9-2120, on September 5, 1991, DAC issued AOL 9-2120A to all DC-9 and MD-80 operators concerning horizontal stabilizer jackscrew wear rate data. The results of the survey were as follows:

Model	Lube Interval Flight Hours	MTBR	MTBUR	Wear Rate per 1000 Flight Hours
DC-9	1,329	34,054	34,395	.0011 inch
MD-80	804	24,397	28,397	.0013 inch

The AOL concluded that Douglas recommended, for increased service life, that operators lubricate the jackscrew assembly repetitively at the 600 hour interval called out in the OAMP document, or sooner.

17. Alaska Airlines Scheduled Out-of-Service Maintenance Intervals

From the guidance of MSG-2, MSG-2 MRB, McDonnell Douglas (MD) Maintenance Manual (MM), McDonnell Douglas OAMP, ADs, SBs, AOLs, Vendors Manuals, and other references, ASA submitted its maintenance program, including maintenance task intervals, for FAA approval.

Each check may also have mandatory tasks such as AD accomplishment, Certification Maintenance Requirements (CMRs)[28], structural repairs, component removal and replacement for overhaul, clearance of deferred discrepancy maintenance items, special operator or manufacturer inspections, and others. Discretionary tasks such as SBs, structural sampling inspections, and age-exploration programs, components replaced for safety or convenience, and installation or

[28] CMRs are requirements to detect the presence of significant latent failures from system or component analysis, and are integral to the type certification of the design.

repair of passenger appearance/comfort items are several areas where work may also be performed.

The type and interval of scheduled Alaska Airlines out-of-service maintenance time requirements for McDonnell Douglas DC-9-80 series airplanes (GMM 18-4-0, dated February 5, 1998) is as follows:

(a)	Walk-Around Check:	Accomplished at ASA maintenance staffed stations after each arrival.
(b)	Service Check:	Accomplished when the airplane remains on the ground for eight or more hours at a maintenance staffed station capable of performing at least "A" Check maintenance.
(c)	"A" Check:	250 Flight Hours. An "A" check matrix segments the check into eight separate checks (A1, A2, A3, etc.).
(d)	"C" Check:	Accomplished at 15 calendar month intervals. The checks are numbered sequentially, with no limit on the numbering sequence (C1, C2, C3, etc.). There is a "C" Check matrix to determine specific tasks at each check.

(1) *A brief chronological record of "C" Check intervals is as follows:*

In March 1985, when the FAA initially approved the MD-80 maintenance program, "C" Checks were performed at 2,500 flight hours.

In July 1988, "C" Checks were established at 13 calendar months, which was approximately 3,200 flight hours.

In April 1996, "C" Checks were escalated from 13 months to 15 months, which has increased from approximately 4,500 flight hours to 4,975 flight hours. This has been the last change.

The approval to make changes is contained in the Reliability Analysis Program (RAP) and issued by an Alaska Airlines Control Board Directive. Although many RAP Control Board Directives will not require FAA approval, any substantiating data used to approve the directive must be available for FAA review. The last "C" Check escalation (Control Board Directive 96-04-07) was

approved by Alaska Airlines control board members and the FAA Principal Maintenance Inspector. This directive escalated the "C" Check interval from 13 months to 15 months.

The number of ASA heavy maintenance checks performed, including "C," "15K," and "30 K," from 1995 to 2000, were 413 (324 in-house and 89 outsourced). Because ASA engine capabilities are limited by operation specification authorization, all heavy engine maintenance is outsourced.

(2) *A brief chronological record of the "Acme Screw and Nut Endplay Check" requirements is as follows:*

One of the many tasks performed during specified "C" Check intervals include the Acme Screw and Nut Endplay Check. This procedure involves pulling down on the horizontal stabilizer by applying torque to a restraining fixture to change the load on the Acme screw from tension to compression. The resultant movement is measured with a dial indicator as "endplay" between the Acme nut and screw. This measurement is intended to be representative of the actual gap, including wear, between the flanks of the Acme nut threads and the Acme screw threads within the jackscrew assembly. If the endplay limits are not between 0.003 and 0.040 inches[29], the Acme screw and nut assembly must be removed and replaced. However, the results of the check are not required to be recorded. The required time interval for the check is as follows:

Acme Screw and Nut Endplay Check:	Accomplished at "C2" intervals. (which is 30 calendar months and approximately 9,550 flight hours).

- In March 1985, the "Acme Screw and Nut Endplay Check" was accomplished at "C2" intervals, which was 5,000 flight hours.

- In July 1988, the "Acme Screw and Nut Endplay Check" was accomplished at "C2" intervals, which was 26 calendar months (approximately 6,400 flight hours).

- In July 1996, The "C" Check was escalated to 15 calendar months. The "Acme Screw and Nut Endplay Check" was still accomplished at "C2"

[29] According to Boeing Engineering, an endplay of 0.040 inch results in an approximately 0.030 to 0.037 inch reduction of the Acme nut thread thickness. The Acme nut, fabricated from an aluminum bronze alloy that is softer than the steel alloy Acme screw, is intended to be the principal wearing component within the jackscrew. A new jackscrew is manufactured with 0.003 to 0.010 inches of endplay, which cannot be included when calculating thread wear. The thread thickness at the pitch diameter of a new Acme nut is 0.125 inches. A subsequent in-service endplay reading of 0.040 inches should indicate a remaining Acme nut thread thickness of approximately 0.088 to 0.095 inches.

intervals, which now was 30 calendar months (approximately 9,950 flight hours).

- In August 2000, due to AD 2000-03-51, the "Acme Screw and Nut Endplay Check" is now a repetitive "stand alone" check (phase II of AD 2000-03-51) that is performed every 2,000-flight hours (task card 28627004). If the endplay wear is 0.034 inches or greater, the "Acme Screw and Nut Endplay Check" is to be repetitively checked every 1,000 flight hours. The jackscrew is lubricated after the endplay check. The results of the check are now recorded, and any discrepancies must be reported to the FAA.

Note: A phase I check (AD 2000-03-51) is performed every 650 hours, which inspects the jackscrew, Acme nut and surrounding area for metal flakes/shavings/slivers. The jackscrew is also lubricated after completing this inspection. However, there is no endplay check performed.

(3) *Tools Listed on Acme Screw and Nut Endplay Check:*

Douglas MD-80, MSG-2 generic task card for the Acme Screw and Nut Operation (Card number 0855, December 1991) states that Douglas is the manufacturer of the horizontal stabilizer "restraining fixture"[30] (4916750-1) and Starrett is the manufacturer of the dial indicator (model 196). However, it also notes that equivalent substitutes may be used instead of these items.

The "Tool and Test Equipment Control Program" electronically tracks tools by ASA's equipment identification process. Tools with 0-1301-x-xxxx designations require no calibration, and do not require inspection after initial receiving inspection.

Equipment requiring calibration (0-1300-x-xxxx), such as measuring and test equipment in day-to-day use, is subject to wear, strain, and other degrading effects, which may deteriorate the accuracy and serviceability. FAR 121.369 (b)(5) requires periodic inspections and calibrations of precision tools, measuring devices, and test equipment, to return-to-service any aircraft, component, or appliance.

ASA tools listed in the OAK maintenance facility that were used for the last endplay check performed in September 1997 were:

[30] The horizontal stabilizer (HS) "restraining fixture" is a tool that attaches between brackets on the lower surface of the HS at the leading edge and the top web of the vertical stabilizer adjacent to the left side of the actuator. A torque of 250 to 300 inch-pounds is applied to the restraining fixture in the shortening direction to change the load on the Acme screw from tension to compression. The resultant movement is measured with a dial indicator as "endplay" between the Acme nut and screw.

- Until the accident, ASA had only one restraining fixture tool in its inventory, and this tool was located in OAK. It was an ASA tool manufactured in-house and not a tool manufactured by Douglas or Boeing. The restraining fixture had been tracked (initial set up) since June 30, 1984; however, no initial inspection documentation was available. There was no documentation available indicating that the tool had ever been repaired. The tool was tracked as: ASA part number (P/N): 0-1301-0-0169 and serial number (S/N): 2018; manufacturer's P/N: 4916750-1.

- Two dial indicators (1.0-0.001 inch, 5 pieces, NSK brand) were listed in OAK as ASA P/N: 0-1301-0-0689.

  One of the dial indicators was tracked as ASA S/N 1879, and was purchased on July 24, 1991.

  The other dial indicator was tracked as ASA S/N 8399, and was purchased on April 18, 1990. However, this tool was later removed from service on June 27, 1999, because the stem would not retract and the large indicator needle was bent.

  The materials/tools section of the "Acme Screw and Nut Endplay Check" task card refers to the "dial indicator set" as tool (0561). The number (0561) was a designation used before the current ASA computer tracking system; it is still used on ASA's task card for the designation of the dial indicator. On ASAs task cards from 1992 to 1996 (2462700), the number (196) was from the original Douglas task card that listed Starrett as the manufacturer of the dial indicator.

- Three "go-no go"[31] tools were listed in OAK as ASA P/N: 0-1300-0-0172, part number 804605. These tools were manufactured in-house per drawing by machine shop. The three tools were:

  ASA P/N: 1511 and MFG S/N: CE51511, dated June 15, 1990, MFG P/N: 804605.

  ASA P/N: 1512 and MFG S/N: CE51512, dated June 15, 1990, MFG P/N: 804605.

  ASA P/N: 1581 and MFG S/N: CE51581, dated March 6, 1995, MFG P/N: 804605.

[31] A "go-no go" tool is a gauge that measures the clearance between the bottom of the Acme nut and the top of the lower stop collar ("BG" dimension). The travel limit of the HS movement is 12.2 degrees leading edge down (airplane nose up trim) to 2.1 degrees leading edge up (airplane nose down trim). These "BG" dimensions should also measure 12 13/16 (± 5/32) inches (nose up) and 1 5/16 (± 9/64) inches (nose down), and may also be measured by the "go-no go" tool.

Note: Since March 2000, 12 of the go-no go tools have been manufactured in-house by machine shop per Boeing-MDC drawing. However, as of September 14, 2000, these tools are listed as unserviceable.

April 28, 1992, task card 24627000 (Acme Screw and Nut Endplay Check) was revised to include tool part numbers on the card. It listed tools as:

Tool: 0-1301-0-0169 horizontal stabilizer restraining fixture (4916750-1). (4916750-1 is the designation for a Boeing restraining tool, which this one was not).

Tool: 0-1301-0-0689 tool number 0561, dial indicator (196).

On October 7, 1996, task card 24627000 was revised to add the part number for the "go-no go" tool. (This was the card used on N963AS for the last endplay check.) It listed tools as:

Tool: 0-1301-0-0169 (4916750-1) horizontal stabilizer restraining fixture.

Tool: 0-1301-0-0689 tool number (0561), dial indicator.

Tool: 0-1300-0-0172 (804605) "go-no go."

On December 9, 1999, task card 24627000 was revised to clarify applicable airplanes for EO requirements. Tool designations remained the same.

The Douglas engineering drawing of the restraining fixture (4916750) (original date of drawing May 25, 1965) indicates three fixture configurations, -1, -503, and -505. The -1 configuration is used on DC-9 airplanes, series 10 through 50 and MD-80 series airplanes, except MD-87, to line number 1325. The -503 configuration is used on MD-80 series airplanes, except MD-87, line number 1326 and subsequent (N963AS was 1995, therefore the tool would be specified as 4916750-503). The -505 configuration is used on MD-87 series airplanes. The last noted engineering change for the drawing was on November 19, 1990.

On April 13, 2000, Boeing sent a message (M-7200-00-00975)[32] to all DC-9, MD-80, MD-90, and 717 operators to ensure that horizontal stabilizer inspection tooling conforms to the tool's drawing requirements. It stated that the wear checks require the use of a restraining fixture (tool P/N 4916750). Any variation in the tooling thread quality, pitch, or amount of thread

[32] See Attachment 11-F, Boeing message concerning tooling.

engagement could affect the wear check results. Operators were requested to ensure the restraining fixtures being utilized fully conform to the tool's drawing requirements.

After the accident, ASA manufactured 11 restraining fixtures similar in design to their original fixture, and purchased 7 that were manufactured by Boeing.

On August 2, 2000, ASA reported a concern to the FAA that the restraining fixture tool used in the endplay check (those manufactured in-house by ASA) may not be "an equivalent substitute" for the Boeing/McDonnell Douglas fixture, as called for in the MD-80 MM. Among several potential areas of concern, was the problem that some of these tools could bottom out during the check, thus potentially yielding an erroneous measurement. ASA then quarantined all to the tools that were not manufactured by Boeing.

On August 4, 2000, an additional 15 Boeing manufactured restraining fixture tools were purchased; all tools were verified as conforming to drawing requirements.

(e)	Major Airframe Checks "15K" and "30K":	15,000 and 30,000 flight hours. Special structural inspections, functional checks, and other maintenance tasks accomplished during the checks, including Structural Significant Item (SSI) inspections. A 15K and 30K matrix determines tasks at each check.
(f)	Corrosion Program:	Corrosion Prevention and Control (CPC) Checks are numbered 1 through 19 at "not to exceed" calendar repeat intervals. The intervals vary from check to check (minimum is 18 months, maximum is 120 months). Note: CPC 1, 2, and 4 were accomplished on N963AS at the "C6" Check. No discrepancies were noted.
(g)	Lubrication of Horizontal Stabilizer:	Maximum interval of eight calendar months. A "time-controlled task

card"[33] accomplishes the lubrication task.

(1) *A brief chronological record of lubrication intervals is as follows:*

- In March 1985, stabilizer lubrication was accomplished at "B2" intervals, which was 700 flight hours (the initial maintenance program incorporated "B" Checks, which were performed at 350 flight hour intervals).

- In March 1987, the "B" Check interval escalated to 500 flight hours, and the stabilizer lubrication changed to a "B1" interval; thus, lubrication was accomplished every 500 flight hours.

- In July 1988, "B" Check requirements were taken out of the MD-80 maintenance program and incorporated into "A" and "C" Checks. The program was changed to segmented "A" Checks (eight of them), which were accomplished at 125 flight hours. The stabilizer lubrication task was now performed at the "A8" Check interval, which increased the lubrication to 1,000 flight hours.

- In February 1991, "A" Checks were escalated to 150 flight hours. Stabilizer lubrication was still accomplished at "A8" intervals, which now was 1,200 flight hours.

- In December 1994, the "A" Check was escalated to 200 flight hours. Stabilizer lubrication was still accomplished at "A8" intervals, which now was 1,600 flight hours.

- In July 1996, stabilizer lubrication was removed from the segmented "A" Check program and placed on a time-controlled stand-alone task card (28312000, titled "Elevator/Stabilizer- Lube") with a maximum interval of eight months (approximately 2,550 flight hours). The approval to make this stabilizer lubrication change was issued by Alaska Airlines Control Board Directive 96-07-09. The interval was selected to provide approximate mid "C" Check interval lubrication.

  Lubrication was also performed at each "C" Check using task card (24312000, titled "Elevator/Tab and Stabilizer Lube"), and this task card specified the lubrication task to be accomplished by using the time-controlled task card (28312000), which is the stand-alone card.

- In October 1996, the stabilizer lubrication was combined with the elevators and elevator tabs. The stand-alone task card 28312000, was re-titled "Lube Horiz

[33] A "time-controlled task card" is a stand-alone maintenance task card that is individually tracked by the operator.

Stab, Elev and Elev Tabs." The intervals remained at eight months (approximately 2,550 flight hours).

- On December 18, 1997, task card 24312000 changed the lubrication grease from Mobilgrease 28 to Aeroshell Grease 33 (BMS 3-33). The maintenance technician was instructed to perform the lubrication per task card 28312000.

- On January 6, 1998, task card 28312000 changed the lubrication grease from Mobilgrease 28 to Aeroshell Grease 33 (BMS 3-33).

- On April 6, 2000, the time interval for the lubrication of the horizontal stabilizer was changed from eight months (approximately 2,550 flight hours) to 650 flight hours.

Note: AD 2000-03-51 requires a repetitive inspection of the horizontal stabilizer jackscrew assembly every 650 flight hours.

- On April 5, 2000, the FAA issued a letter to ASA stating that there was insufficient support for a change to Aeroshell grease 33 from Mobilgrease 28. On April 28, 2000, task card 28312000 returned the lubrication grease from Aeroshell Grease 33 (BMS 3-33) back to Mobilgrease 28 (MIL-G-81322/DPM 5348).

18. Review of Maintenance Comparisons

Task Description	MSG-2 MRB Interval	MSG-2 OAMP Interval	MSG-3 MRB Interval	MSG-3 OAMP Interval	ASA Prior to February 2000	ASA (Currently)
MD-80 Airplane "C1" Check	3,500 FH or 15 Months (whichever comes first)	3,500 FH or 15 Months (whichever comes first)	3,600 FH or 15 Months (whichever comes first)	3,600 FH	*15 Months Approximately 4,775 FH*	15 Months
Acme Screw and Nut Endplay Check	"C2" Check 7,000 FH or 30 Months (whichever comes first)	"C2" Check 7,000 FH or 30 Months (whichever comes first)	"C2" Check 7,200 FH or 30 Months (whichever comes first)	"C2" Check 7,200 FH	*"C2" Check 30 Months Approximately 9,550 FH*	2,000 FH
Lubrication of Jackscrew	Not included in Logic Diagram.	Low 600 FH High 900 FH	"C1" Check 3,600 FH or 15 Months (whichever comes first)	"C1" Check 3,600 FH	*8 Months Approximately 2,550 FH*	650 FH

19. Lubrication Greases:

(a) Boeing Airplanes

Airlines use many different types of grease to lubricate many components on an airplane. Operationally, this can be confusing and expensive. For years, airlines have been asking for consolidation of grease types from airplane manufacturers. The most commonly used grease types on Boeing airplanes are MIL-G-23827, MIL-G-21164, BMS 3-24, and MIL-G-81322. In response, Boeing developed BMS 3-33 to standardize these grease types for Boeing airplanes.

However, operators of both Boeing and McDonnell Douglas airplanes also wanted consolidation of grease types that existed among the airplanes. Some of the following events lead to the development of BMS 3-33:

(1) Boeing Service Letters about greases used on Boeing-designed airplanes:

- Boeing produced document D6-56491, dated October 30, 1992, "Performance Requirements for General Purpose Greases" to allow customer airlines in evaluation of greases developed by vendors for use in general maintenance of Boeing airplanes. The tests were intended to ensure that greases met the minimum performance standards.

  As a result of D6-56491, Boeing Service Letter (BSL), dated December 23, 1992, 767-SL-20-20, "Evaluation of General Purpose Greases for Routine Relubrication during Airplane Maintenance," provided a means for operators to test and approve the use of an alternate grease in place of MIL-G-23827 greases for general purpose use. In the past, Boeing has had repeated requests from operators for a "No Technical Objection" or an approval of greases other than those called out in the maintenance manuals or other Boeing documentation. These requests were based on technical and service data as well as the desire to standardize the lubrication throughout the operators' fleet. "Boeing has no objection to operators using a particular grease in place of MIL-G-23827 provided the grease meets the requirements of the reference document….To date, two greases, Aeroshell Grease 7 and Castrolease AI, meet the requirements of the reference document."

- Boeing Service Letter, 777-SL-20-003, dated December 21, 1995, "BMS 3-33 General Purpose Aircraft Grease," advised operators of a new general-purpose grease specification designated BMS 3-33, which provides improved corrosion and wear protection compared to MIL-G-23827 and other greases. The development of the BMS 3-33 specification was initiated to help alleviate the time, expense, and confusion of the different lubricant requirements by identifying one grease, which could be used for different applications. BMS 3-33 may be used for routine lubrication per Chapter 12 of the maintenance manual for all Boeing airplane models where MIL-G-23827 or BMS 3-24 is specified or where MIL-G-21164 is

listed as an option to MIL-G-23827. "*Routine lubrication points requiring the use of MIL-G-81322..., however, have unique lubrication requirements that currently do not facilitate of the use of BMS 3-33.*"

Shell Oil Company developed and manufactures "Aeroshell Grease 33 (green tint)," to comply with BMS 3-33 material specifications.

- Boeing Service Letter, 777-SL-20-006-B, "Summary of Most Commonly Used Greases on Boeing Airplanes," dated June 30, 1997, states that MIL-G-23827 is a synthetic diester oil-base product, and has long been the favored lubricant for general use on Boeing airplanes. "This grease is incompatible with MIL-G-81322 grease and due to the diester base oil is incompatible with BMS 10-100 paint as well. Contact with this paint by MIL-G-23827 grease will cause the paint to deteriorate and eventually dissolve. The base oil is also known to attack and degrade phenolic[34] compounds. Some brand names for MIL-G-23827 are Aeroshell Grease 7, Royco 27, and Exxon 627.

The BSL also states that MIL-G-81322 is a polyalphaolefin oil-base product and is non-soap thickened. Because of its high operational temperature range, it is a good choice for high temperature applications such as high speed bearings. MIL-G-81322 is considered a hydrophobic lubricant (repels water). This may be a disadvantage in applications where irregular rotating parts are stationary during long cold soak conditions, when moisture that has been repelled may collect and form ice. "*In some cases…, MIL-G-81322 is incompatible with MIL-G-23827 grease and therefore the two greases should not be intermixed.*" Some brand names for MIL-G-81322 are Mobilgrease 28, Aeroshell Grease 22, and Royco 22.

(2) Boeing 737 Maintenance Manuals:

In addition to operating MD-80 airplanes, ASA also operates Boeing 737-200/400/700 model airplanes. In January 1996, ASA changed the grease it used on Boeing airplanes to a new preferred alternative general-purpose grease developed by Boeing designated, BMS 3-33 grease.

- From the maintenance manual for Boeing 737-200 airplanes (MM 12-20-0, page 500, dated June 20, 1993), MIL-G-21164 and MIL-G-23827 are referred to as general-purpose airplane lubricants. MIL-G-21164 is equivalent to MIL-G-23827, but it has 5 percent molybdenum disulfide added, which makes MIL-G-21164 black or very dark, and can cause stains. Each operator can make the decision of which grease to use.

[34] Phenolics come from a large family of synthetic polymers, such as plastics, resins, and adhesives.

The stabilizer trim jackscrew lubrication per MM 12-22-41, page 201, dated February 1, 1996, is specified as MIL-G-23827.

- From the maintenance manual for Boeing 737-300/400/500 airplanes (MM 12-22-41, page 301, dated November 15, 1998), MIL-G-23827 is specified as the lubricant for the stabilizer control system.

MM 12-20-00, dated July 15, 1997, page 303, list BMS 3-33 as a general purpose aircraft grease, which provides improved corrosion and wear protection compared to MIL-G-23827 and other greases types, and is the preferred alternative to MIL-G-23827.

MM 12-22-41, dated March 12, 2000, page 302 states, "some incompatibility may exist between MIL-G-23827 and MIL-G-21164 greases that are thickened with clay and those thickened with lithium soap. Therefore, intermixing of brand name greases that employ different thickening systems should be avoided. *Whenever changing a brand name grease, flush out old grease to minimize intermixing*."

MM 12-20-00, page 303, dated March 12, 2000, states, "BMS 3-33 is a general purpose aircraft grease which provides improved corrosion and wear protection compared to MIL-G-23837 and other grease types. BMS 3-33 is the preferred alternative to MIL-G-23827, BMS 3-24 and where MIL-G-21164 is listed, as an option to MIL-G-23827."

- From the maintenance manual for Boeing 737-600/700/800/900 airplanes (MM 12-22-41, dated February 5, 1999, page 303, lists BMS 3-33 as lubricant for the stabilizer trim jackscrew, ballnut and gimbals.

MM 20-20-00, dated June 10, 2000, pages 302-303 state, "BMS 3-33 is better than MIL-G-23827 and MIL-G-21164 for general routine lubrication. While BMS 3-33 is the preferred grease, because it demonstrates improved wear, corrosion, and low temperature torque properties, it is acceptable to use MIL-G-23827 grease where BMS 3-33 is specified. Although MIL-G-23827 grease and BMS 3-33 grease can be intermixed, repeated intermixing is not recommended. When switching between greases, the *new grease shall be applied until it is seen at the grease exits.*

(3) Boeing Standard Overhaul Practices Manual:

From the Boeing Standard Overhaul Practices Manual (OHM 20-60-03, Lubricants, dated September 1, 1996, pages 2-4), BMS 3-33 and MIL-G-23827 are considered interchangeable for aircraft general-purpose grease.

(b) Douglas Airplanes

The Douglas MD-80 Maintenance Manual (MM 12-21-00, dated July 1, 1994, page 5) specifies MIL-G-81322 as the specified wide temperature range (WTR) grease for general airframe lubrication, including the jackscrew on MD-80 airplanes.

The Maintenance Manual also recommended Mobilgrease 28 (red tint), produced by Mobil Oil Company and Aeroshell Grease 22 (amber tint), produced by Shell Oil Company, as products for MIL-G-81322. There is also a lubrication service notation about intermixing different brands of engine oil; however, there is no mention of intermixing different brands of grease. Except for lubing vented bearings, there is no mention of procedures or techniques for greasing other types of lubrication fittings, such as the jackscrew assembly.

The MD-80 MSG-2 generic task card for horizontal stabilizer lubrication (card number 0237, ATA chapter 12, inspection check at 600 flight hours, revised January 1993) lists MIL-G-81322 as the lubricating grease.

The MD-80 MSG-3 generic task card for horizontal stabilizer lubrication (card number 801C-026, ATA 27, inspection check at "C1" intervals, revised September 1995) lists MIL-G-81322 as the lubricating grease.

Note: A list of lubricants that qualify under military specification MIL-G-81322 is prepared for the use by or for the U.S. Government in the acquisition of products covered by the specification, and is maintained by the Naval Air Warfare Center Aircraft Division (QPL-81322-18 on March 16, 1993, listed 13 vendors).

(c) Alaska Airlines General Maintenance Manual

The ASA General Maintenance Manual (GMM), section 6-1-0, dated October 5, 1996, notes the preferred lubricants for Douglas and Boeing aircraft is as follows:

Douglas Aircraft

Specification	Principal Use	Preferred	1st Alternate	2nd Alternate
MIL-G-2382B MIL-G-23827	Flight Controls And Doors	Aeroshell Grease 7	Mobilgrease 27	Mobilgrease 28
MIL-G-3545C MIL-G- 81322	Wheel Bearings	Aeroshell Grease 5	Aeroshell Grease 22	Mobilgrease 28

Boeing Aircraft

Specification	Principal Use	Preferred	1st Alternated	2nd Alternated
MIL-G-2382B MIL-G-23827 BMS 3-33	Flight Controls And Doors	Aeroshell Grease 33	Aeroshell Grease 7	Mobilgrease 28
MIL-G-3545C MIL-G-81322	Wheel Bearings	Aeroshell Grease 5	Aeroshell Grease 22	Mobilgrease 28

Note: The GMM also states, "The above listing of greases is provided for information reference only, and is not to be an all inclusive list of lubricants used on Alaska Airlines aircraft."

20. Events leading to ASA's selection of jackscrew lubrication for the MD-80

In January 1996, ASA received Boeing approval towards the use of BMS 3-33 (Aeroshell Grease 33), as an all-purpose grease, on its Boeing airplanes.

A request by ASA through the Douglas Field Service Representative (SEA), January 16, 1996, was made to substitute Aeroshell Grease 33 in lieu of Mobilgrease 28 in suitable areas on MD-80 airplanes to standardize lubricants.

On February 23, 1996, Douglas Aircraft Company replied that Aeroshell Grease 33 would require laboratory testing for use on Douglas airplanes.

On January 24, 1997, Douglas stated that laboratory testing of Aeroshell Grease 33 was currently underway; however, no schedule had been set for completion, and it was probably at least a year away. Aeroshell Grease 33 is not currently approved for use on Douglas airplanes.

On June 19, 1997, Douglas stated that it was pursuing the possibility of a "no technical objection," for ASA to use Aeroshell Grease 33 on Douglas airplanes. However, it was not a sure thing, considering the liability of providing consent for the use of such an important substance on the airplane before the substance has been fully evaluated. Another possibility was an in-service evaluation by ASA of the grease.

On June 23, 1997, the Douglas Field Service Representative sent a message to Douglas noting that ASA welcomed the offer to conduct an in-service evaluation of Aeroshell Grease 33, and would await guidelines regarding its use.

On July 18, 1997, Douglas stated that it was pursuing a "no technical objection" for ASA, and hoped to have it prepared and approved by the end of September 1997.

On July 23, 1997, ASA issued a "Maintenance Programs/Technical Publications Change Request," form ME-01[35], (97-002974), to revise applicable lubrication cards by replacing Mobilgrease 28 with Aeroshell Grease 33 (BMS 3-33), for flight controls, doors, and landing gear (except wheel bearings) on MD-80 airplanes.

On September 26, 1997, Boeing (then Douglas) issued message number SVC-SEA-0122/MRL (action number 332808)[36] stating that Douglas had "no technical objection" to the use of BMS 3-33 (Aeroshell Grease 33) in place of MIL-G-81322 grease for the lubrication of ASA MD-80 airplanes, with one known restriction. The restriction is that Aeroshell Grease 33 may not be used in areas subjected to temperatures in excess of 250° Fahrenheit, including landing gear wheel bearings.

It was also noted that initial results of laboratory testing comparing Aeroshell Grease 33 with Mobilgrease 28 (MIL-G-81322) indicated that Aeroshell Grease 33 was less resistant to water washout than Mobilgrease 28. The message also stated that a potential exists that the required frequency of lubrication could be affected in areas exposed to outside conditions or airplane washing and cleaning. Additionally, the "no technical objection" was provided before the completion of the Douglas Aeroshell Grease 33 study, and therefore Douglas could not verify the performance of the grease.

The Boeing message also stated that ASA had the responsibility to monitor lubrication areas for any reactions. Further, it would be the responsibility of ASA to obtain any FAA approval for use of this grease on its MD-80 airplanes.

On December 18, 1997, task card 24312000 (lubrication of horizontal stabilizer) was revised per ME-01 (97-002974), noting the material change to use Aeroshell Grease 33 (BMS 3-33), instead of Mobilgrease 28 (MIL-G-81322).

Note: Thirty-four other lubrication task cards (flaps, slats, spoilers, ailerons, landing gear, etc.) were also revised in December 1997. The task cards reflected the switching of grease from Mobilgrease 28 to Aeroshell Grease 33. In April 2000, all of these task cards, including the lubrication of the horizontal stabilizer, were changed back to Mobilgrease 28.

ASA's monthly task card audit report of all changes and revision dates of task cards for December 1997[37], including card for 24312000 per ME-01 (97-002974), were sent to the FAA. However, a complete grease justification package was not submitted to the FAA at that time. The FAA did not comment or take action regarding this change.

[35] ME-01 is an ASA serialized form that is used to process requests and recommendations for changes to current maintenance program procedures, intervals, existing maintenance documents (such as task cards, maintenance manuals, and policy and procedures manuals), and other documents under the control of the Engineering and Quality Control departments. See Attachment 11-G, ME-01 Technical Change Request.
[36] See Attachment 11-H, Boeing Message Concerning Lubrication Change.
[37] See Attachment 11-I, Monthly task card changes sent to FAA in December 1997.

On December 17, 1999 (ASA-SEA-00442F)[38], ASA requested comments from Boeing about the performance of Aeroshell Grease 33 lubrication on MD-80 elevators and elevator tabs, while operating in low temperatures. ASA had experienced several flight control problems when its airplanes were operating in very low temperatures.

On December 22, 1999, (ASA-SEA-99-00440H)[39] Boeing responded that Aeroshell Grease 33 had been tested with a 25 percent water content. The water-laden grease was subjected to torque testing at the lower end of its operating temperature range, minus 100 degrees F, and found to exhibit a 25 percent increase in friction. However, the increase did not appear to be significant for the operation of the MD-80 elevators and elevator tabs. Assuming a similar friction increase in the water-laden Aeroshell Grease 33 at the lower end of Mobilgrease 28's (MIL-G-81322) operating range, minus 65 degrees F, Aeroshell Grease 33 still exhibited significantly less friction than Mobilgrease 28. It was also noted that Mobilgrease 28 (MIL-G 81322) is the standard production grease for elevator and elevator tab surface hinge bearings, and has acceptable friction characteristics throughout its operating temperature range when used in these hinges.

Boeing also referenced the September 26, 1997 letter of "no technical objection," and ASA's responsibility to obtain FAA approval to use Aeroshell Grease 33.

In March 2000, the FAA requested and received from ASA informational material regarding the substitution of Aeroshell Grease 33, for Mobilgrease 28, that occurred in December 1997. The justification material was to be reviewed to substantiate the substitution of BMS 3-33 for MIL-G-81322 grease.

On April 5, 2000, the FAA issued a letter to ASA stating that the documentation did not support this change, and requested ASA to refrain from utilizing BMS 3-33 grease in those areas where the airplane maintenance manual specifically recommends the use of MIL-G-81322, until such time as additional justification for the substitution can be documented.

On April 28, 2000, task card 28312000 (lubrication of the horizontal stabilizer) was revised to reflect the return to Mobilgrease 28 (MIL-G-81322/DPM 5348), instead of Aeroshell Grease 33 (BMS 3-33), as the lubricating grease.

On June 23, 2000, a letter of investigation (LOI) involving lubricants was sent by the FAA to ASA.

21. DC-9 Overhaul Manual (OHM)

Component overhaul is the restoration on an item in accordance with the instructions defined in the relevant manual and in accordance with 14 CFR part 43.2. In order to perform overhaul restoration on components listed in the various chapters (coded by ATA standards) of the manual, a company must have specially trained technicians using designated specialized

[38] See Attachment 11-J, Boeing message concerning acceptability of grease.
[39] See Attachment 11-K, Boeing message concerning Aeroshell Grease 33 lubrication.

tooling. Each unit or subject is a separate manual (book) from the OHM. The manual provides shop procedures that will enable mechanics to restore designated components to a serviceable condition. This information is prepared specifically for shop maintenance and not for line or service maintenance. It may also provide permissible wear tolerances to determine the extent of wear of a unit. Common parts to the DC-9, or new configurations to existing parts, will be found in the existing Overhaul Manuals. New parts for MD-80 airplanes will be found in Component Maintenance Manuals (CMM). The OHM and CMM are not FAA approved.

Douglas Overhaul Manuals and Component Maintenance Manuals for each type of airplane operated by ASA are authorized in the FAA approved maintenance program, and are under the control of the Engineering and Quality Control department. OAK and SEA are the only stations that issue OHMs and CMMs, and they are for the airplane types that are scheduled for major maintenance. The DC-9 overhaul chapter for horizontal stabilizers is named "Horizontal Stabilizer Actuator Control Installation."

Horizontal Stabilizer Actuator Control Installation

The horizontal stabilizer (HS) actuator control installation (also called jackscrew assembly) is located in chapter 27-41-1, revision 24, dated April 15, 1998, of the DC-9/MD80/MD90/717 manual, called the DC-9 Overhaul Manual (OHM).

Note 1: ASA does not perform overhaul restoration of jackscrew assemblies. When a unit does not meet on-wing inspection specifications as prescribed in the ASA maintenance program, the unit is removed from the airplane and sent to an approved vendor for overhaul.

The current supplier of the Acme screw and nut assembly is Integrated Aerospace, Santa Ana, California. Peacock Aerospace, Norwalk, California, supplied the assembly that was on N963AS to McDonnell Douglas in June 1990. In 1994, Peacock Company was purchased by Derlan Industries, which in turn was purchased by Trig Aerospace in July 1999. Trig Aerospace became Integrated Aerospace in October 2000.

The HS actuator control installation consists of an actuator assembly, primary drive unit, alternate actuator motor, full-wave power supply, gearboxes, Acme screw assembly, gimbals ring assembly, nut assemblies, gaskets, pin assembly, attaching hardware, and support assemblies. Some highlighted areas noted in chapter 27-41-1 of the DC-9 OHM are as follows:

(a) Total actuator control installation weighs 99.01 pounds.

(b) The screw assembly and the nut assembly are a matched set and should be kept together.

(c) Fits and Clearances: Assembly fits for the axial endplay of the screw assembly shall be 0.0030-inch minimum to 0.0400-inch maximum. If the

axial endplay exceeds 0.0400 inch, replace screw assembly. Screw Assemblies with measured endplay between 0.0340 and 0.0390 inch may be reinstalled in the aircraft if wear check is made every 1000 flight hours maximum.

Note 2: On March 20, 2000, the FAA sent a letter to ASA stating that until Boeing clarifies whether the 1,000-flight hour re-inspection of the MD-80 jackscrew for 0.034 to 0.039 inch endplay measurement needs to be incorporated into the airplane maintenance manual, they (FAA) are requiring that these inspections be performed by ASA. This applies to the jackscrew assemblies that meet the criteria for the 1,000-hour re-inspection.

Note 3: In a May 26, 2000, message to ASA (ASA-SEA-00-00410H), Boeing states that these wear check intervals pertain only to units that have been removed from the airplane and overhauled per the reference /F/ overhaul manual. Boeing also stated that the recommendation of a 1000-hour wear check interval following the installation of an overhauled jackscrew exhibiting 0.034/0.039 inch endplay would not be included in the overhaul manual if it were being written today. This frequency was included in the OHM early in the DC-9 program when the expected wear rate for jackscrews had not yet been verified in service, and the OHM has not been revised to reflect the in-service history that has established a reliable wear rate for properly maintained jackscrews.

"When performing a wear check, while the jackscrew is installed in the aircraft, the maintenance manual takes precedence over the overhaul manual. The maintenance manual endplay measurement of 0.040 inch is based on an expected wear rate that has been confirmed as appropriate by in-service history and is valid for on-aircraft usage."

22. ASA MD-80 Fleet Horizontal Stabilizer History

MD-80 fleet discrepancy histories for horizontal stabilizers (ATA 27 and ATA 55) were reviewed between January 1999 and February 2000. There were 72 discrepancies recorded, however, none were recorded on airplane N963AS, N973AS, N981AS, or N982AS, and no established common trend was observed. The replacement of the jackscrew assembly for N975AS on November 17, 1999 was listed, however, the replacement assemblies for N951AS on November 26, 1999, and N947AS on June 12, 1999 were not on the list.

ASA initiated a computer program that tracked the purchasing of appliances and components in February 1995; earlier records are not available. From this tracking program, there were three recorded jackscrew and support assemblies purchased in 1999.

After the replacement of the first assembly in June 1999, jackscrew and Acme nut assemblies were moved from a non-stocked item category, to a rotable[40] *component category on June 22,*

[40] Rotables are parts and appliances that are economically repairable, and are periodically overhauled to a fully serviceable condition. These parts and appliances have specific requirements to track time and location at a serialized level. Since records indicate that ASA had never replaced a jackscrew assembly and did not stock the unit in its inventory, the company did not begin tracking the assembly until after the first replacement on N951AS

1999; therefore, there were no earlier maintenance histories (overhaul status, last maintenance, vendor tear down reports, etc.) for jackscrew assemblies.

> Note: When a new Douglas airplane was delivered to a customer, a "packing sheet" was provided that listed serial numbers (S/N)[41] and part numbers (P/N)[42] of selected installed equipment. A jackscrew assembly normally would not be included on this list. In comparison, Boeing airplanes are supplied with an "aircraft readiness log," which provides an inventory of specific serialized components.
>
> For a unit that is not already listed in the rotable category: when ASA first removes an appliance or component from an airplane for whatever reason, the S/N is then noted for serialized computer tracking. Up to this time, the unit is only tracked as an ASA P/N.

The following three ASA units removed and replaced in 1999 were:

(a) *N951AS on November 26, 1999 in PHX, by Aviation Management Systems (AMS) during a "30K" Check inspection:*

The jackscrew assembly installed on N951AS at the time of the check was (MFG P/N 5910962-71, ASA P/N 8-2740-9-8023, MFG S/N: 0951). ASA purchased the airplane in October 1987, from Jet America; however, there was no ASA recorded maintenance history or information about the jackscrew assembly before or after the acquisition.

During the "30K" inspection, the Acme screw and nut endplay check measurement was recorded at 0.046 inches, and the assembly was removed. On January 11, 2000, S/N: 1645 (log number 4374961) installed. Airplane total time was 52,884:02 flight hours. Airplane total cycles were 30,284.

S/N: 0951 was exchanged by ASA with AAR Allen Aircraft, Wood Dale, Illinois, for S/N: 1645, which had been overhauled by Aerotron AirPower, LaGrange, Georgia. The Aerotron AirPower shop evaluation and work report for S/N: 1645 stated:

> Shop Evaluation: No removal reason was given. Unit functionally tested. Passed preliminary diagnostic test. Disassembled, cleaned, and inspected unit. Found the following discrepancies: unit inspects to overall criteria. Requires overhaul and modification of unit to the following: 5910962-71 per customer request, replacing crank part number 3914177-505 to meet modification specifications.

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in June 1999. Simultaneously, the unit entered the ASA reliability program rotable component statistical alerting system.

[41] Serial number (SN) is a non-repetitious numeric or alphanumeric identifier used to segregate one item from another. Items could have the same part number.

[42] Part number (P/N) is a numeric or alphanumeric designation assigned to a part or assembly for identification purposed. In this report, the jackscrew assembly is noted as P/N is 5910962-71.

Work Accomplished: "Unit overhauled to 0.00 T.S.O. in accordance with OEM specifications. Replaced all worn and precautionary items. Reassembled and tested unit in accordance with OEM specifications. No ADs or SBs were accomplished during this shop visit. Modified unit to the following number: 5910962-71.

The Memphis Group, Memphis, Tennessee, later acquired S/N: 0951 and shipped it to Trig Aerospace for repair. The assembly was overhauled on May 19, 2000, per Boeing/Douglas Manual 27-41-1, revision 24, dated April 15, 1998, and Boeing letter C1-L4L-00-0892, dated May 5, 2000, which concerned special overhaul instructions. It included a list of replaced parts and a FAA Form 8130-3[43], "Airworthiness Approval Tag."

ASA later purchased the unit (S/N: 0951) from the Memphis Group.

On June 4, 2000, (Log number 4222574) S/N: 1645 was removed from N951AS by AMS in PHX, because of "change for fleet standardization," per MM 27-40-01, MIG 85's 287837 and 287838. S/N: 0951 was re-installed on N951AS. S/N: 1645 was returned to the Memphis Group.

(b) *N975AS on November 17, 1999 in OAK, during a "C5" Check inspection:*

The jackscrew assembly installed on N975AS at the time of the check was (MFG P/N 5910962-71, ASA P/N 8-2740-9-8023, MFG S/N: 2272). The airplane was delivered new to ASA in May 1994; however, ASA records cannot verify that this assembly had not been previously repaired. During the "C5" inspection, the Acme screw and nut endplay check measurement was recorded at 0.042 inches. The assembly was replaced with S/N: 1171. Airplane total time was 19,946:20 flight hours. Airplane total cycles were 10,786.

Assembly (S/N: 1171) was a unit exchange with Mitchell Aircraft Spares, Inc. Trig Aerospace had previously overhauled it. The overhaul evaluation report stated:

(1) Grease was on the nut assembly.
(2) After the unit had been disassembled and cleaned, the axial endplay of nut and screw assembly measured 0.031 inches, and the radial endplay of the nut and screw assembly measured 0.003 inches.
(3) Nicks and burrs were on all threads of the Acme nut.

Mitchell Aircraft Spares had jackscrew assembly (S/N: 2272) overhauled by Aerotron AirPower on January 17, 2000, which included a FAA Form 8130-3, "Airworthiness Approval Tag." The overhaul evaluation and work accomplished stated:

(1) No reason given for removal. Unable to functionally test unit due to damage. Disassembled, cleaned, and inspected unit. Found the following discrepancies:

[43] FAA Form 8130-3 is one of several ways of determining a part's eligibility for installation on an airplane, but its use is not regulatory. In the case of components, which have been repaired and approved for return-to-service, the use of the form is also discretionary.

damaged/missing hardware. Bolt heads and threads worn, nut threads worn, and washers worn. Rings defective. Seals bad. Contamination found in unit. Unit requires overhaul.

(2) Unit overhauled to 0.00 T.S.O. in accordance with OEM specifications. Replaced all worn and precautionary items. Reassembled and tested unit in accordance with OEM specifications. No ADs or SBs were accomplished during this shop visit.

Jackscrew assembly (S/N: 2272) was re-purchased by ASA, and sent to Trig Aerospace stating that the unit "needs overhaul to bring to serviceable condition." It was overhauled by Trig Aerospace on February 27, 2000 per Boeing/Douglas Overhaul Manual 27-41-1, revision 24, dated April 15, 1998.

On April 3, 2000, (log number 5117352) during accomplishment of task card 28622700 per step 4.C. and 4.E. paragraph 2, it was determined that the jackscrew endplay was out of limits at 0.0345 inches, and S/N: 1171 was removed and replaced with S/N: 1876.

Trig Aerospace had overhauled S/N: 1876 on February 20, 2000. The unit had previously failed the AD inspection while on airplane N968AS.

(c) *N947AS on June 12, 1999 in OAK, during a "30K" Check inspection:*

The jackscrew assembly installed on N947AS at the time of the check was (MFG P/N 5910962-71, ASA P/N 8-2740-9-8023, MFG S/N: 1935). The airplane was delivered new to ASA in December 1990; however, ASA records cannot verify that this assembly had not been previously repaired.

On June 5, 1999, at OAK, during the "30K" Check, the horizontal stabilizer upper stop bolt was sheared (MIG-4 nonroutine number 4330166). The jackscrew assembly was removed and the Acme nut and screw was disassembled to gain access to the upper stop, per MM 27-40-01. The upper stop assembly was replaced, and the Acme nut and screw was reassembled per MM 27-41-1, pages 18A-20B. Replacement of jackscrew assembly was covered by MIG-4 nonroutine number 4330204 on June 12, 1999.

On June 9, 1999, at OAK, during the same "30K" Check, MIG-4 nonroutine number 4330204 was generated. The discrepancy reads, "elevator jackscrew has excessive play at Acme nut and screw." No endplay measurements were recorded. The jackscrew assembly was removed and replaced per MM 27-40-01, pages 409-412. The assembly was replaced with S/N: 3383, a new unit. Airplane total time was 27,860:25 flight hours. Airplane total cycles were 15,906 cycles.

Assembly (S/N: 1935) was overhauled by Trig Aerospace on February 27, 2000. The overhaul included a list of replaced parts and a FAA Form 8130-3. The overall evaluation report created stated:

(1) Grease was on the nut assembly

(2) No shavings were present on the unit.
(3) Chafed marks on threads of screw.
(4) Upper-stop broken, corner sheared, and inner splines on stop sheared.
(5) After the unit had been disassembled and cleaned, the axial endplay of nut and screw assembly measured 0.029 inches, and the radial endplay of the nut and screw assembly measured 0.006 inches.
(6) Gouges and burrs were found on the entire thread surface of the Acme nut.

23. Airplane N963AS Maintenance History

(a) Scheduled Out-of-Service Maintenance Checks:

May 27, 1993 — "C1" Check accomplished (OAK). At the time of the check, the airplane had 2,674:43 flight hours. Acme Screw and Nut Endplay Check completed. Four associated nonroutine discrepancies were noted.

Nonroutine number 50013: left elevator center tab two inboard hinge bolts were loose. Corrective action: Bolts torque checked good per MM 27-30-04, page 202A and MM 20-30-01, page 208.

Nonroutine number 50014: right elevator outboard tab, outboard hinge bolt was loose and support hole worn, also bearing worn. Corrective action: Installed right elevator anti-float tab and replaced bushings and bolts per MM 27-30-14, pages 202, 202A, 202B number 3A, B-3A, and A1-2.

Nonroutine number 50015: right elevator inboard tab, number three hinge bolt was loose. Corrective action: Bolt torque checked good per MM 27-30-03, page 202 and MM 20-30-01, page 202.

Nonroutine number 50019: right elevator damper was leaking excessively. Corrective action: Replaced right elevator damper per MM 27-30-05, page 201. Leak checked good.

April 27, 1994 — "C2" Check accomplished (OAK). At the time of the check, the airplane had 5,484:55 flight hours. No associated nonroutine work cards were generated for the horizontal stabilizer.

May 17, 1995 — "C3" Check accomplished (OAK). At the time of the check, the airplane had 9,194:49 flight hours. Acme Screw and Nut Endplay Check completed. Five associated nonroutine discrepancies were noted.

Nonroutine number 4009802: area around left hand elevator hydraulic actuator was dirty. Corrective action: cleaned area around left hand elevator actuator.

Nonroutine number 4009803: nutplates, two each, were broken on top of right hand elevator at trim-tab access cover. Corrective action: replaced nutplates using blind rivets per Structural Repair Manual (SRM)[44] 57-30-8, page one.

Nonroutine number 4009804: area around right hand elevator hydraulic actuator was dirty. Corrective action: cleaned area around right hand hydraulic elevator actuator.

Nonroutine number 4009805: horizontal stabilizer jackscrew compartment dirty on vertical stabilizer. Corrective action: cleaned compartment.

Nonroutine number 4009806: The seal is worn on inboard end of left hand horizontal stabilizer leading edge. Corrective action: removed and replaced seal at right hand horizontal stabilizer leading edge.

June 20, 1996

"C4" Check, including "15K" Check and CPC 2 and 4, accomplished (OAK). At the time of the check, the airplane had 12,906:55 flight hours. Seven associated nonroutine discrepancies were noted.

Nonroutine number 4079671: right elevator mid tab, both control rod end bearings were worn. Corrective action: removed and replaced rod end bearing per MM 27-30-04, pages 201-204. Rig check required. Rig check good per MM 27-30-04, page 207.

Nonroutine number 4079672: left elevator mid tab, both control rod end bearings were worn. Corrective action: removed and replaced rod end bearings per MM 27-30-04, pages 201-214.

Nonroutine number 4079673: fairing attach strip was cracked on right elevator, between mid outboard tabs. Corrective action: fabricated repair strip per SRM 55-01, figure 2, sheet 2, and installed. Anti-float tab check complied per MM 27-30-14, page 206.

[44] Structural Repair Manuals (SRMs) contain descriptive information and specific instructions and data pertaining to field repair of primary and secondary structure. The procedures are FAA approved.

Nonroutine number 4079674: right elevator outboard tab outboard bearing was worn. Corrective action: removed and replaced bearing per MM 20-10-7, pages 22 and 29.

Nonroutine number 4079722: right elevator hydraulic cylinder aft rod-end was worn. Corrective action: removed and replaced preload-indicating (PLI) washer. Installed and torque per MM 27-30--08, page 202. Resealed nut and bolt.

Nonroutine number 4079948: skin damage was around screw holes located on top and bottom surfaces of right hand horizontal stabilizer, marked in red. Corrective action: Blended out gouges around screw holes on right hand horizontal stabilizer per SRM 55-01, page 3, figure 1. Treated and primed per SRM 51-10-3, pages 13-18. Touched up paint as required.

Nonroutine number 4079949: skin damage was around screw holes located on top and bottom surfaces of left hand horizontal stabilizer, marked in red. Corrective action: Blended out gouges around screw holes on left hand stabilizer horizontal per SRM 55-01, page 3, figure 1. Treated and primed per SRM 51-10-3, pages 15-18. Touched up paint as required.

October 2, 1997

"C5" Check, including CPC 2, accomplished (OAK). Acme Screw and Nut Endplay Check[45] completed (this was the last stabilizer endplay check performed before the accident). At the time of the check, the airplane had 17,699:59 flight hours. Thirteen associated nonroutine discrepancies were noted.

Nonroutine number 4236374[46]*:* horizontal stabilizer- Acme screw and nut has maximum allowable endplay limit (.040 inch). Corrective action: rechecked Acme screw and nut endplay per task card number 24627000. Found endplay to be within limits (.033 for step 11 and .001 for step 12). Rechecked five times with same result.

Nonroutine number 4236399: left hand horizontal stabilizer forward inboard seal was torn. Corrective action: removed and replaced forward inboard seal per MM 55-10-01, pages 201-207.

Nonroutine number 4236400: left hand elevator control tab hinge number one bearing was worn (2 each). Corrective action:

[45] See Attachment 11-L, Acme Screw and Nut Endplay Check.
[46] See Attachment 11-M, MIG-4 Non-Routine Work Card.

removed and replaced hinge hardware per MM 27-30-03-2, pages 1-4.

Nonroutine number 4236401: left hand elevator control tab hinge number three hardware was rusty. Corrective action: cleaned off rust and treated area per MM 51-10-3, page 21.

Nonroutine number 4236402: evidence of leak at left hand elevator power actuator at "B" nut fitting. Corrective action: cleaned and tighten "B" nut. Leak checked good.

Nonroutine number 4236403: left hand elevator powered actuator piston has play at aft mount fitting. Corrective action: removed and replaced universal rod end per MM 27-30-08, page 201. Operations check required

Nonroutine number 4236404: paint worn at right hand horizontal stabilizer tip. Corrective action: touch up paint as required.

Nonroutine number 4236405: right hand horizontal stabilizer forward inboard seal was torn. Corrective action: removed and replaced seal per SRM 51-30-1 and 51-20-0.

Nonroutine number 4236406: right hand elevator anti-float tab pushrod aft end bearing or bolt is broke. Corrective action: removed and replaced right hand elevator anti-float tab push rod per MM 27-30-03-2, page one. Throw check was performed per MM27-30-02, pages 201-204.

Nonroutine number 4236407: right hand elevator control tab pushrod end-bearing has play. Corrective action: removed and replaced right hand elevator control tab push rod forward end-bearing per MM 27-30-14-2, page one. Throw check was performed per MM 27-30-02, pages 201-206.

Nonroutine number 4236408: evidence of a leak at right hand power actuator at "B" nut fitting. Corrective action: cleaned and tighten "B" nut. Leak checked good.

Nonroutine number 4236416: horizontal stabilizer Acme screw drive motor upper conduit support bracket broken. Corrective action: fabricated new bracket in accordance with Structural Repair Manual (SRM) 51-10-2, page 2, figure 5, and installed as required.

	Nonroutine number 4236417: horizontal stabilizer Acme screw drive unit lower mount outboard clip not secured with retaining plate- left hand and right hand side. Corrective action: this configuration is normal per MM 27-40-01-4, page 1-10B. Bolts are only installed when the gimbals ring retaining pins are removed to facilitate maintenance.
January 13, 1999	"C6" Check, including CPC 1, 2, and 4, accomplished (OAK). At the time of the check, the airplane had 22,407:33 flight hours. This was the last "C" Check performed before the accident. Four associated nonroutine discrepancies were noted. *Nonroutine number 4117588:* right hand lower horizontal stabilizer fairing was cracked at leading edge. Corrective action: fabricated and installed doublers and fillers and primed per SRM 53-03, page 33-12B. Installed rub strip and painted. Reinstalled lower right hand stabilizer fairing, panel 3804, per task card 24399001. *Nonroutine number 4117628:* left and right elevator geared tab attach bolts were loose. Corrective action: tightened loose gear tab attach bolts, and replaced corroded fasteners on left and right sides per MM 27-30-04, page 202A. *Nonroutine number 4117636:* elevator accumulator leaking. Corrective action: removed and replaced accumulator per MM 27-30-11, pages 202-205. Leak checked good. *Nonroutine number 4249369:* right hand elevator boost cylinder has hydraulic leak at forward "B" nut. Corrective action: cleaned area and torque "B" nut on boost cylinder per MM 20-12-01, page 204A. Leak checked good.
July 24, 1999	"A1" Check accomplished (PDX). No associated nonroutine work cards were generated for the horizontal stabilizer.
August 14, 1999	"A2" Check accomplished (PDX). No associated nonroutine work cards were generated for the horizontal stabilizer.
September 5, 1999	"A3" Check accomplished (LAX). No associated nonroutine work cards were generated for the horizontal stabilizer.
September 27, 1999	"A4" Check accomplished (SFO). No associated nonroutine work cards were generated for the horizontal stabilizer.

October 20, 1999	"A5" Check accomplished (PDX). No associated nonroutine work cards were generated for the horizontal stabilizer.
November 10, 1999	"A6" Check accomplished (SFO). No associated nonroutine work cards were generated for the horizontal stabilizer.
November 30, 1999	"A7" Check accomplished (LAX). No associated nonroutine work cards were generated for the horizontal stabilizer.
December 23, 1999	"A8" Check accomplished (LAX). No associated nonroutine work cards were generated for the horizontal stabilizer.
January 11, 2000	"A1" Check accomplished (SEA). No associated nonroutine work cards were generated for the horizontal stabilizer.
January 30, 2000	Walk-Around Check accomplished (ANC). This was the last walk-around check recorded. The check was also accomplished in SEA, after the ANC-SEA flight; however, the logbook page was not located.
January 30, 2000	Service Check accomplished (SEA).

(b) Lubrication of Elevators/Stabilizers:

June 20, 1996	Task Card 28312000 accomplished (OAK) at "C4" and "15K" Check.
February 27, 1997	Task Card 28312000 accomplished (SFO).
October 2, 1997	Task Card 28312000 accomplished (OAK) at "C5" Check. Card specified Mobilgrease 28 as the lubricant grease.
June 26, 1998	Task Card 28312000 accomplished (SFO). Card specified Aeroshell 33 as the lubricant grease.
January 13, 1999	Task Card 28312000 accomplished (OAK) at "C6" Check. Card specified Aeroshell 33 as the lubricant grease.
September 24, 1999[47]	Task Card 28312000 accomplished (SFO). Card specified Aeroshell 33 as the lubricant grease. *This was the last noted lubrication of the jackscrew assembly.*

24. Deferred Maintenance that was listed on N963AS before the Accident

[47] See Attachment 11-N, Elevator/Stabilizer Lubrication Task Card.

(a) There was one open maintenance item deferred using the policies and procedures of the Minimum Equipment List (MEL)[48] and Configuration Deviation List (CDL)[49] manual on log number 5133736 on January 30, 2000. The discrepancy was "the cabin overhead bin at row 13DEF will not close." The overhead bin was blocked, and the discrepancy was deferred at SEA per MEL 25-11.

(b) There were four Significant Structural Inspection (SSI) items deferred using a deferral code to identify repairs in SSI areas on the airplane, and to track any additional inspections which may be required. The SSI items were:

(1) Right main landing gear upper torque link gap excessive. Shimmed torque link, but replace link after 3,000-flight hours.

(2) All right hand inner acoustic windowpanes have coating flaking off. Flaking was removed from inner windowpanes. Re-inspect at the next "C" Check, and replace at the next "K" Check.

(3) All left hand inner acoustic windowpanes have coating flaking off. Flaking was removed from inner windowpanes. Re-inspect at next "C" Check, and replace at next "K" Check.

(4) A temporary repair was found below captain's sliding window. Inspected and determined to be secure. Re-inspect at next "C" check, and install a permanent repair at "30K" Check.

(c) For other types of deferred maintenance, after assessment is deemed to have no affect on airworthiness, ASA records and monitors specific discrepancies with monitoring information codes. There were four "scratch and dent" (SAD) discrepancies found at various locations on the airplane. This code identifies scratches, dents, and deteriorated top coatings on airplanes that have been evaluated and found to be within limits prescribed by ASA or the manufacturer.

25. Logbook Discrepancies on N963AS

Maintenance log sheets were reviewed from January 1, 1999 to January 31, 2000. ASA's electronic display discrepancy histories were also reviewed with specified ATA codes, which listed deferred items and corrective maintenance actions. The Maintenance Records Group reviewed all systems of the airplane. However, except for those noted below, no other discrepancies or unusual events concerning the horizontal stabilizer or flight controls was found to be significant.

[48] A MEL, developed for each aircraft type, identifies specific items of equipment that may be inoperative for a limited period until repairs are made.
[49] A CDL, developed for each aircraft type, allows an operator to fly in various nonstandard configurations by identifying specific minor parts that may be missing from the aircraft.

(a) Stabilizer Discrepancies:

The jackscrew and support of the horizontal stabilizer (manufacturer's part number: 5910962-71, ASA part number: 8-2740-9-8023 0963) was installed at McDonnell Douglas, and had never been replaced. Some of the discrepancies concerning elevators/horizontal stabilizer are:

(1) Log number 0089710 (PDX) on April 15, 1998: Lightning strike on approach. Corrective action: accomplished lightning strike check per maintenance manual (MM) 05-53-00-6. Found right hand elevator outboard static wicks damaged. Both static wicks were replaced. No other damage found.

(2) Log number 4117636 (OAK) on January 13, 1999: Elevator accumulator leaking. Corrective action: removed and replaced elevator accumulator per MM 27-30-11, pages 202-205.

(3) Log number 5076050 (SEA) on October 25, 1999: On approach to SEA, the autopilot trim comparator came on and the stabilizer trim (alternate) stuck at plus one degree. Primary trim was used to get back to trim. Autopilot and alternate trim was later normal at four to six degrees stabilizer. Corrective action: no faults logged on flight fault report. Cycled trim numerous times, while monitoring stabilizer trim primary (STP) sensor information. No defects noted. Returned-to-service per MM 22-01-05. Airplane remains autoland 1 and 2.

(4) Log number 5081608 (SEA) on November 17, 1999: Alternate trim switches intermittent inoperative for nose down trim. Corrective action: replaced alternate trim motor switch S10-7. Operation checks normal per MM 27-40-09.

26. Airworthiness Directive (AD) Summary

ASA's electronic record of ADs on N963AS was reviewed. This list was compared to the FAA compliance list, which included airframe, engine, and appliances. All ADs issued by the FAA on MD-80 airplanes, regardless of when they were issued, that required recurring inspections or actions were also reviewed, and terminating actions were noted.

The airframe ADs associated with type certificate A6WE were reviewed in detail for ADs relating to the empennage structure, empennage-mounted flight controls and control systems, and other related areas. The detailed review was limited to ADs issued from 1991 to the present.

The following is a list of ADs, associated manufacturer's documents, and the affected areas of the airplane:

Date:	AD Number:	AD Description:

91-10-11	SB A27-313	Variable elevator load feel mechanism loose or missing bolts.
91-13-03	SB A27-320	Rudder control tab crank cracks.
91-21-07	SB A27-316	Primary trim control relays, inspection and periodic replacement. Note: Overheating of the relays creates potential for fire in the forward cargo compartment. Failure of a relay generally results in an inability to command the stabilizer in one direction using the primary trim system. However, the failure of a primary trim relay does not, by itself, disable the alternate trim system.
92-02-04	SB A27-301	Uncontrolled rudder sideslip due to ineffective rudder actuator.
92-22-08R1	CPC Document (MDC K 4606)	Corrosion Prevention Control Program (CPCP).
93-05-16R1	SB A27-321	Rudder actuator control valve slide retention nut safety wire.
94-01-08	SB A53-264	Aft pressure bulkhead cracks.
96-05-01	SB A27-342	Primary trim motor shaft incorrectly manufactured.
96-10-11	Aging Aircraft (MDC K 4606)	Inspections and modifications to help prevent structural failures.
96-16-04	SB A53-232	Aft pressure bulkhead cracks.
97-04-10	SB MD80-22-122	Autopilot and autothrottle engage switch prevent disengagement.
99-07-14	SB MD80-55-064	Vertical-to-horizontal stabilizer hinge plate corrosion. Note: Boeing received in-service reports of corrosion within the hinge bores of the steel hinge plates for the horizontal stabilizer, and it was found that an unnecessary brush-cadmium process was being applied to the hinge bores, in production, after they were machined to their final diameter. The plates were installed in a manner that

		allowed entrapment of a residual brush-cadmium solution that initiated corrosion.
99-24-04	SB MD80-63-201	Aft pressure bulkhead tee cracking.
Status of previously listed ADs as they relate to airplane N963AS:		
91-10-11	SB A27-313	N/A by SB effectivity.
91-13-03	SB A27-320	N/A by part number of the crank.
91-21-07	SB A27-316	Relays were last replaced on July 16, 1997. Replacement due each 16,000-flight hours.
92-02-04	SB A27-301	N/A by SB effectivity.
92-22-08R1	CPC Document	ASA document A.A. number 0520-01013 is the FAA approved CPC program used by ASA. Items CPC 9, 10, 13, 14, 17, and 19 are relevant to the empennage and aft pressure bulkhead. None of these items is due for action until May 2001, at the earliest.
93-05-16R1	SB A27-321	Terminating action accomplished on September 29, 1992 in compliance with AD 91-18-03. Lockwire installed.
94-01-08	SB A53-264	N/A by SB effectivity.
96-05-01	SB A27-342	Affected motor serial number not installed.
96-10-11	Aging Aircraft (MDC K1572)	N/A by SB effectivity and time in-service.
96-16-04	SB A53-232	N/A by SB effectivity.
97-04-10	SB MD80-22-122	Terminating action accomplished September 15, 1997.
99-07-14	SB MD80-55-064	Compliance not due until November 2000.
99-24-04	SB MD80-63-201	Compliance not due until December 2003.

27. Listing of Engineering Modifications Performed on N963AS

(a) A listing of 13 engineering modifications known as "Action Authorizations (AA),"[50] one of which is classified as "Engineering Mandatory (EM),"[51] was reviewed. This list was classified as "major repair."[52] It also noted whether the EM status was open or closed (with completion dates). EM 5510-01072 (Inspection of stabilizer hinge plates per AD 99-07-14) had not yet been accomplished, however, compliance was not due until November 2000. The last major repair EM was completed on October 24, 1997 (AD 97-04-04, APU containment ring). No discrepancies were noted.

(b) A listing of (96) action authorizations classified as "Engineering Orders,"[53] including service bulletin attachments, was reviewed. The method of compliance and open or closed status, including repetitive inspections, were also reviewed. EO 2780-00003 (repetitive inspection to detect cracks of the actuator cylinder support brackets of the slat drive mechanism assembly per AD 99-21-06, which supersedes AD 91-21-11) was accomplished on January 7, 1999 (task card 28527003). No discrepancies were noted.

(c) A listing of engineering modifications classified as EMs or EOs, with attached SBs if applicable, and including open or closed status (with completion dates) was reviewed. Manufacturer's part numbers and serial numbers, including ASA's part numbers and serial numbers for related parts, were included in the database information. No discrepancies were noted.

(d) A listing of 26 action authorizations classified as EOs and "major alterations"[54] were reviewed. It also noted whether the EO status list was open or closed (with completion dates). The last major alteration EO was completed on May 15, 1999 (remove and replace tailcone slide cover harness assembly). No discrepancies were noted.

(e) A listing of 43 Engineering Authorizations (EA)[55] were reviewed. No discrepancies were noted. The only EA associated with the stabilizer or flight control systems was EA number 5530-01033, which is classified as a secondary structure. The EA was issued on May 15, 1995, to accomplish a Permanent repair on a crack of the removable center fairing section on the upper vertical stabilizer.

28. Supplemental Type Certificates listed on N963AS

[50] Action Authorization (AA) is engineering approval to allow modifications to ASA airplanes. The term AA is generic and is used to cover all types of modifications, which might be performed on airplanes or components.
[51] Engineering Mandatory (EM) is an action authorization issued to meet AD or FAR requirements. A copy of the AD and all applicable maintenance documents must accompany the EM during the approval process.
[52] Major Repair means a repair that, if improperly done, might appreciably affect weight, balance, structural strength, performance, powerplant operation, flight characteristics, or other qualities affecting airworthiness.
[53] Engineering Order (EO) is an action authorization that modifies an airplane or component.
[54] Major Alteration means an alteration not listed in the aircraft or engine specifications that that might appreciably affect weight, balance, structural strength, performance, powerplant operation, flight characteristics, or other qualities affecting airworthiness.
[55] An Engineering Authorization (EA) provides the engineering division with a means to issue specific instructions and authorizations without the development of an EO. EA procedures are designed to expedite engineering instructions to maintenance for providing an approved document to accomplish work.

Six vendors Supplemental Type Certificates (STC),[56] including EOs generated by revisions to the original STC, were reviewed. No discrepancies were noted. None of the STCs were considered relevant to the circumstances of the accident.

29. Aircraft Records System of Time Controlled Components, Inspections, and Tasks for N963AS

The aircraft record list of time-controlled components, inspections, and tasks for N963AS were reviewed. The list included allowable time and allowable life of these items. The components were ATA coded with manufacturer's part numbers and ASA's part numbers. Total time on each part and time remaining were also listed. Under flight control systems, ATA 2740 is the designation for the horizontal stabilizer. The following rotable components from N963AS (ATA 2740) are tracked to aid in the flow through the repair cycle.

(a) Alternate trim drive motor for horizontal stabilizer (D1775-1), "on-condition."

The unit was installed on September 19, 1993, and had never been overhauled. Total time on the unit was 43,421.63 flight hours and 27,154 cycles.

(b) Primary trim drive motor for horizontal stabilizer (9590-6), "on-condition."

The unit was installed on November 24, 1996, and the time since overhaul (TSO) was 12,046.25 flight hours and 6,138 cycles. The total time on the unit was 36,501.64 flight hours and 22,679 cycles.

(c) Motion stabilizer sensor for horizontal stabilizer (5756000-404), "on-condition."

The unit was installed on May 26, 1992, by the manufacturer, and had never been overhauled. The total time on the unit was 26,584.71 flight hours and 14,315 cycles.

(d) Gearbox for horizontal stabilizer (4372-505), "on-condition."

The unit was installed on May 26, 1992, by the manufacturer, and had never been overhauled. The total time on the unit was 26,584.71 flight hours and 14,315 cycles.

(e) Jackscrew and support assembly (5910962-71), "on-condition."

The unit was installed on May 1, 1992, by the manufacturer, and had never been overhauled. The total time on the unit was 26,584.71 flight hours and 14,315 cycles.

[56] STC is a certificate issued by the FAA authorizing a major change or alteration to aircraft, engine, or component that has been built under an approved type certificate.

30. Events Leading to the Emergency Airworthiness Directive AD 2000-03-51

During the period that the Maintenance Records Group was investigating N963AS at the Alaska Airlines Maintenance Headquarters, three other airplanes (N973AS, N981AS, and N982AS) experienced horizontal stabilizer problems, and a review of these airplanes is included.

Airplane N973AS, flight number 631, departed Reno, Nevada, and was en route to Seattle, Washington, on February 5, 2000, when it experienced a problem with the primary and alternate stabilizer trim system, and executed an air turn-back. For further information about the airplane and event, see section 32.

On February 10, 2000, jackscrew discrepancies were found on N981AS and N982AS. For further information about the airplanes and events, see sections 33 and 34.

Some of the events leading up to the issuance of an Emergency Airworthiness Directive and the maintenance discrepancies on these three airplanes are as follows:

- On February 9, 2000, Alaska Airlines issued Engineering Order (EO) 2740-01036 to accomplish a special inspection of horizontal stabilizer assembly, jackscrew stops, limit switches, and general condition of the mechanism and its attaching structure. It was noted in the EO that during the operational check that "the jackscrew may squeal during operation."

- On February 9, 2000, Boeing Service Engineering issued a message (M-7200-00-00456) to all DC-9, MD-80, MD-90, and 717 customers regarding the NTSB's concern about horizontal stabilizer jackscrew assemblies. The message was a request for operators to provide Boeing with findings of various inspection conditions of the jackscrew assembly.

- The jackscrews on N981AS and N982AS failed the inspection because metal shavings greater than 1/16 inch were found. The jackscrews from both airplanes were replaced and the failed units were turned over to the NTSB for further analysis.

- On February 11, 2000, Boeing issued Alert Service Bulletin DC9-27A362 to all operators of DC-9 and MD-80 airplanes with affected fuselage serial numbers describing procedures for inspecting the general condition of the jackscrew assembly. The FAA was also reviewing the service bulletin for possible airworthiness directive action.

- On February 11, 2000, the FAA (Regulatory Support Division) issued an Emergency Airworthiness Directive (AD) 2000-03-51 to all operators of DC-9, MD-90-30, Model 717, and model MD-88 airplanes for inspecting the general condition of the jackscrew assembly and the area around the jackscrew assembly to

detect the presence of metal shavings and flakes. Inspection results, including all endplay checks and any discrepancies, are now to be recorded and reported to the FAA.

- On February 11, 2000, Alaska Airlines issued Mandatory Engineering Order (EM) 2740-01037 as an action authorization to meet the requirements of AD 2000-03-51.

- On February 12, 2000, Boeing issued revision 01 of Alert Service Bulletin DC9-27A362. This revision addressed the distinction between bronze and non-bronze metal shavings that might be found on the jackscrew during inspection. The revised bulletin was approved as an alternate method of compliance (AMOC), first alternate, for Emergency Airworthiness Directive 2000-03-51.

- On February 12, 2000, Alaska Airlines issued EM 2740-01037, revision A, which provided an AMOC to the AD.

- On February 14, 2000, Boeing Service Engineering issued a message (M-7200-00-00477) to all DC-9, MD-80, MD-90, and 717 customers that included a copy of an FAA Form 8110-3 and its associated "Record Summary," dated February 12, 2000, which approved an AMOC for the AD. The approval is design data approval only and not installation approval. Some of the areas of the "Record Summary" are as follows:

  "Operators accomplishing inspections per the referenced AD are finding small amounts of aluminum bronze material in the region of jackscrew assembly. The findings are in the form of flakes or hair-like slivers. These can be attributed to normal wear from the operation of the horizontal stabilizer, and does not affect the operation and integrity of the system." By following the steps below, an airplane may be dispatched for continued service or replacement of parts, as required.

  (a) If materials other than aluminum-bronze are found on the jackscrew threads and mechanical interface with nut, see SB revision.

  (b) If aluminum-bronze material is found on the jackscrew threads and mechanical interface with nut, clean and remove old grease from jackscrew/nut and perform endplay check. If endplay is less than 0.03 inches, the assembly is acceptable for continued service.

  If endplay is greater than 0.03 but less than 0.0399 inches, and the jackscrew assembly has 15,000 flight hours or greater, the assembly is acceptable for continued service. Continue with AD and SB inspections.

If endplay is greater than 0.03 but less than 0.0399 inches, and the jackscrew assembly has less that 15,000 flight hours, replace the assembly prior to further flight.

(c) If endplay is 0.040 inches or greater, replace jackscrew assembly prior to further flight.

(d) If materials other than aluminum-bronze are found on the web or surrounding area, see SB revision.

(e) If aluminum-bronze material is found on the web or surrounding area, clean and remove old grease from jackscrew/nut and perform endplay check. If endplay is less than 0.0399 inches, the assembly is acceptable for continued service to the next "A" Check or 450 flight hours, whichever is greater.

If endplay is 0.040 inches or greater, replace jackscrew assembly prior to further flight.

- On March 24, 2000, Alaska Airlines issued EM 2740-01037, revision B, which revised work cards to include the 1000 flight hour repetitive endplay check on jackscrew with endplay measurements with 0.034 inch and greater per FAA letter of March 20, 2000 (see note 2 of section 22). The EM also included the requirements of SB DC9-27A362, revision 2, and removed the 450-flight hours check and created the repetitive visual check every 650 flight hours. For other operators flying MD-80 airplanes, Phase II established repetitive endplay inspections every 2,000 flight hours.

- On March 30, 2000, Boeing issued revision 02 of Alert Service Bulletin DC9-27A362 as an AMOC to the AD (second alternate). This revision incorporated conditions for the presence of bronze metal similar to Boeing message M-7200-00477, except the check interval remained at 650 hours instead of the 450 hours stated in the message.

- On August 3, 2000, Alaska Airlines issued EM 2740-01037, revision C, which added general requirements to revised work cards identifying the restraining fixture used for endplay checks.

31. Airplane N973AS History as of February 5, 2000

Registration	Serial Number	Line Number	Delivered New to ASA	Airplane Total Time	Airplane Total Cycles
N973AS	53449	2077	March 1994	21,390:43 Hours	11,595 Cycles

A review of ASA's electronic record of accomplishments for the AD status on N973AS included airframe, engine, and appliances. The document denotes aircraft applicable, terminating action, and additional requirements. No discrepancies were noted.

(a) Scheduled Out-of Service Maintenance Checks:

April 13, 1995	"C1" Check accomplished (OAK). Acme Screw and Nut Endplay Check completed. No associated nonroutine work cards were generated for the horizontal stabilizer.
April 21, 1996	"C2" Check accomplished (OAK). No associated nonroutine work cards were generated for the horizontal stabilizer.
August 2, 1997	"C3" Check accomplished (OAK). Acme Screw and Nut Endplay Check completed. (1) Horizontal jackscrew cover has chaff marks at 10 and 2 o'clock positions, also on frame at same position. Corrective action: Blended chaffing condition on cover and frame per SRM 55-01, p.3-1-2. FR primer was applied on noted surfaces.
June 20, 1998	"C4" Check, which included "15K" Check, accomplished (OAK). (1) Left hand HS forward lower side roller is worn. Corrective action: Replaced with new roller. (2) Right hand HS forward lower side roller is worn. Corrective action: Replaced with new roller. (3) Left hand hydraulic boost actuator is static leaking from shaft. Corrective action: cleaned area, static checked, and pressure checked actuator. No leaks noted. (4) Left hand elevator damper is leaking from shaft. Corrective action: Replaced elevator damper. (5) Horizontal jackscrew lower compartment is full of grease. Corrective action: Cleaned compartment.
October 8, 1999	"C5" Check was accomplished by Aviation Management Systems, Inc. (AMS), located in Phoenix, Arizona (PHX). AMS was listed on D91 of the Operations Specifications list as being authorized to perform substantial maintenance for ASA. The Acme Screw and Nut Endplay Check (task card 2462700) was completed September 30, 1999. No associated nonroutine work cards were generated for the horizontal stabilizer.
October 30, 1999	"A1" Check accomplished (LAX). No associated nonroutine work cards were generated for the horizontal stabilizer.
November 21, 1999	"A2" Check accomplished (PDX). No associated nonroutine work cards were generated for the horizontal stabilizer.

December 13, 1999 "A3" Check accomplished (SFO). No associated nonroutine work cards were generated for the horizontal stabilizer.

January 4, 2000 "A4" Check accomplished (SFO). No associated nonroutine work cards were generated for the horizontal stabilizer.

January 25, 2000 "A5" Check accomplished (OAK). No associated nonroutine work cards were generated for the horizontal stabilizer.

February 5, 2000 Service Check accomplished (OAK).

(b) Lubrication of Elevators/Stabilizer:

April 13, 1995 Task Card 24312004 accomplished (OAK).

April 21, 1996 Task Card 24312004 accomplished (OAK).

December 31, 1996 Task Card 28312000 accomplished (SEA).

August 2, 1997 Task Card 28312000 accomplished (OAK).

March 28, 1998 Task Card 28312000 accomplished (SFO).

June 20, 1998 Task Card 28312000 accomplished (OAK).

February 27, 1999 Task Card 28312000 accomplished (SFO).

October 8, 1999 Task Card 28312000 accomplished (PDX).

(c) Stabilizer Discrepancies:

The jackscrew and support assembly of the horizontal stabilizer (manufacturer's part number: 5910962-71, ASA part number: 8-2740-9-8023 0973) was installed at McDonnell Douglas, and had never been replaced.

Pilot log discrepancies and maintenance nonroutine discrepancies generated between January 1, 1999 and January 31, 2000 were reviewed. Some of these discrepancies concerning elevators/horizontal stabilizer are:

(1) Log number 5044187 (SEA) on June 25, 1999: The main stabilizer trim was intermittently inoperative. It stopped working in climb from either switch. The trim worked normally later in the climb and during descent. Corrective action: operations checked normal per maintenance manual (MM) 27-40-01.

(2) Log number 5044188 (SEA) on June 25, 1999: The stabilizer trim failed during preflight check. Corrective action: removed and replaced main stabilizer trim motor per MM 27-40-01, pages 401-405. Checked per MM 27-40-01, pages 601-607.

(3) Log number 5034256 (PDX) on July 16, 1999: The alternate longitudinal trim failed in flight. Corrective action: removed and replaced alternate longitudinal trim actuator motor, no help. Removed and replaced longitudinal trim switch, no help. Found wire broken off at the connector P10-37. Repaired broken wire. Trim checks normal. Performed return-to service check per MM 22-01-05.

(4) Log number 5135734 (RNO) on February 5, 2000: Following takeoff out of Reno with flap 4 degrees, primary stabilizer trim and alternate stabilizer trim became inoperative. Flight returned and landed with flaps 40 degrees. Primary and alternate trim worked once during the landing, and then both trims failed again. Corrective action: maintenance used trouble-shooting (T/S) procedures MM 27-40-00, and the discrepancy was transferred for further T/S.

Log number 5135735 (RNO) on February 6, 2000: Removed the Digital Flight Data Recorder (DFDR), and replaced with another unit.

Log number 5135736 (RNO) on February 6, 2000: Removed the Cockpit Voice Recorder (CVR), and replaced with another unit.

Log number 5135737 (RNO) on February 6, 2000: Required an over-weight landing inspection. A level one and two inspection, per MM 05-51-04, were accomplished.

Log number 5135738 (RNO) on February 7, 2000: Replaced the longitudinal trim actuator, captain's and first officer's toggle switches, and trim brake switch.

Log number 5135739 (RNO) on February 7, 2000: Replaced alternate trim actuator.

Log number 5135740 (RNO) on February 7, 2000: Performed longitudinal trim actuator mechanism check per MM 27-40-01, pages 601-602A. No discrepancies were noted.

Log number 5135741 (RNO) on February 7, 2000: Performed return-to-service (RTS) check, because of maintenance on the alternate longitudinal trim system.

Log number 5135742 (RNO) on February 7, 2000: Primary trim actuator heater failed check. Replaced the heater.

Log number 5135743 (SEA) on February 8, 2000: Service Check due, MIG-2C initiated. Service Check complied with, and MIG-2C (09976) items closed.

Log number 5135744 (SEA) on February 8, 2000: Seat belt on seat 16D is missing spring latch, which secures belt to seat. Removed and replace seat belt at 16D.

Log number 5135745 (SFO) on February 10, 2000: Service Check due. MIG-2C issued. Complied with Service Check. Cleared all open items on MIG-2C (08303).

Log number 5135746 (SEA) on February 10, 2000: The horizontal stabilizer jackscrew and actuator assembly were inspected per EO 2740-01036. No discrepancies were noted.

Log number 5135747 (PDX) on February 11, 2000: Service Check due, MIG-2C (00573 initiated). Service Check complied with, and MIG-2C (00573) complete.

Log number 5135748 (OAK) on February 12, 2000: Service Check due, MIG-2C initiated. Service Check complied with, and MIG-2C (06184) complete.

Log number 5135749 (OAK) on February 12, 2000: Accomplish AD 2000-03-51. Failed AD 2000-03-51, found shavings and flakes on bottom of surrounding areas.

Log number 5128550 (OAK) on February 12, 2000: Nose gear pin installed. Removed and stowed gear pins.

Log number 5128551 (OAK) on February 16, 2000: Service Check initiated MIG-85, number 273068. Service Check complete for MIG-85, number 273068.

Log number 5128552 (OAK) on February 15, 2000: Jackscrew failed operation 003 of EM 2740-01037. Horizontal stabilizer inspection of endplay dimension on MIG 100 D, job 001. Corrective action: removed and replaced jackscrew and Acme nut with serviceable unit per MM 27-40-01, page 411-412 up to step 8. Installed gearbox and actuator motor per MM 27-40-01, page 412, steps 9-19.

Log number 5128553 (OAK) on February 15, 2000: Thoroughly clean jackscrew compartment (upper and lower) before new jackscrew is installed. Cleaned upper and lower jackscrew compartment.

Log number 5128554 (OAK) on February 16, 2000: Per EM 2740-01037, section 1, step 02, found metal shavings evident on horizontal stabilizer jackscrew area. Replaced jackscrew assembly. Refer to log number 5128552.

Log number 5128555 (OAK) on February 16, 2000: Accomplish EM 2740-01037, horizontal stabilizer jackscrew and Acme nut inspection , section one, two, and three. Accomplished EM 2740-01037, sections 1, 2, and 3 on horizontal stabilizer jackscrew inspection. Jackscrew removed and replaced on log number 5128552.

32. Airplane N981AS History as of February 10, 2000

Registration	Serial Number	Line Number	Delivered New to ASA	Airplane Total Time	Airplane Total Cycles
N981AS	53472	2178	March 1997	10,432:19 Hours	5,601 Cycles

A review of ASA's electronic record of accomplishments for the AD status on N981AS included airframe, engine, and appliances. The document denotes aircraft applicable, terminating action, and additional requirements. No discrepancies were noted.

(a) Scheduled Out-of -Service Maintenance Checks:

August 2, 1998 "C1" Check accomplished (OAK). Acme Screw and Nut Endplay Check completed. No associated nonroutine work cards were generated for the horizontal stabilizer.

December 9, 1999 "C2" Check accomplished (OAK). No associated nonroutine work cards were generated for the horizontal stabilizer.

January 2, 2000 "A1" Check accomplished (LAX). No associated nonroutine work cards were generated for the horizontal stabilizer.

January 24, 2000 "A2" Check accomplished (OAK). No associated nonroutine work cards were generated for the horizontal stabilizer.

February 2, 2000 Service Check accomplished (SEA).

February 9, 2000 Service Check accomplished (PDX)

February 9, 2000 Walk-Around Check accomplished (PDX).

(b) Lubrication of Elevators/Stabilizer:

January 1, 1998 Task Card 28312000 accomplished (SEA).

August 2, 1998 Task Card 28312000 accomplished (OAK).

April 26, 1999 Task Card 28312000 accomplished (SFO).

December 9, 1999 Task Card 28312000 accomplished (OAK).

(c) Stabilizer Discrepancies:

The jackscrew and support of the horizontal stabilizer (manufacturer's part number: 5910962-71, ASA part number: 8-2740-9-8023 0981) was installed at McDonnell Douglas, and had never been replaced.

Pilot log discrepancies and maintenance nonroutine discrepancies generated between February 1999 and February 2000 were reviewed. Some of these discrepancies concerning elevators/horizontal stabilizer are:

(1) Log number 0160966 (SEA) on March 14, 1999: The horizontal stabilizer left side trailing wick was missing, and the discrepancy was deferred per CDL 23-60-01 authority, placard R64575. The missing static wick was replaced on March 23, 1999 (ANC) per MM 23-60-01, and checked per MM 23-60-00.

(2) Log number 5020262 (SEA) on June 10, 1999: The autopilot "pumped" during acceleration and flap retraction after takeoff. It functioned fine during other phases of flight. No faults were indicated in either digital flight guidance system (DFGS), and no history in the computer display file was noted. Airplane remained in autoland status.

(3) Log number 5126924 (PDX) on February 10, 2000: While complying with EO 2740-01036, step nine, found particles under jackscrew area. Corrective action: removed and Replaced horizontal stabilizer jackscrew and support per MM 27-40-01. Checked mechanism per 27-40-01.

(4) Log number 5126925 on (PDX) on February 13, 2000: Corrective action: accomplished EM 2740-01037, sections 1, 2, and 3.

33. Airplane N982AS History as of February 10, 2000

Registration	Serial Number	Line Number	Delivered New to ASA	Airplane Total Time	Airplane Total Cycles
N982AS	53473	2183	April 1997	10,206:35 Hours	5,424 Cycles

A review of ASA's electronic record of accomplishments for the AD status on N982AS included airframe, engine, and appliances. The document denotes aircraft applicable, terminating action, and additional requirements. No discrepancies were noted.

(a) Maintenance Checks:

September 5, 1998	"C1" Check accomplished (OAK). Acme Screw and Nut Endplay Check completed. No associated nonroutine work cards were generated for the horizontal stabilizer.
December 17, 1999	"C2" Check accomplished (OAK). No associated nonroutine work cards were generated for the horizontal stabilizer.
January 7, 2000	"A1" Check accomplished (SFO). No associated nonroutine work cards were generated for the horizontal stabilizer.
January 28, 2000	"A2" Check accomplished (LAX). No associated nonroutine work cards were generated for the horizontal stabilizer.
February 7, 2000	Service Check Completed (OAK).
February 9, 2000	Walk-Around Check Completed (SEA).

(b) Lubrication of Elevators/Stabilizer:

September 5, 1998	Task Card 28312000 accomplished (OAK).
May 5, 1999	Task Card 28312000 accomplished (SFO).
December 17, 1999	Task Card 28312000 accomplished (OAK).

(c) Stabilizer Discrepancies:

The jackscrew and support of the horizontal stabilizer (manufacturer's part number: 5910962-71, ASA part number: 8-2740-9-8023 0982) was installed at McDonnell Douglas, and had never been replaced.

Pilot log discrepancies and maintenance nonroutine discrepancies generated between February 1999 and February 2000 were reviewed. Some of these discrepancies concerning elevators/horizontal stabilizer are:

(1) Log number 5018553 (SEA) on May 3, 1999: The primary longitudinal trim (PLT) would not work from either yolk. The circuit breakers (CBs) on the left generator bus were recycled before PLT worked normally. The alternate trim and the autopilot worked normally. Corrective action: removed and replaced the primary stabilizer trim actuator per MM 27-41-71.

(2) Log number 5033866 (ANC) on May 29, 1999: The primary trim motor moves too quickly (three units in 5 seconds). Corrective action: removed and replaced the primary trim motor per MM 27-40-01, operations checked good.

(3) Log number 5089931 (OAK) on August 25, 1999: The return-to-service (RTS) check failed indicating mach trim failures on both sides (diagnostic 444). Checked and released per MEL 22-15-E, placard 78520. Corrective action: replaced mach trim actuator per MM 22-22-01 (ANC) on August 26, 2000. Operations checked normal, removed placard.

(4) Log number 5104332 (PDX) on September 11, 1999: The Primary Longitudinal Trim (PLT) actuator heater blanket was inoperative. Deferred by MEL 27-40. Corrective action: replaced trim actuator heater cap per 27-40-01 on September 14, 1999 (SEA). Operations checked good.

(5) Log number 5135399 (SEA) on February 10, 2000: While complying with the requirements of EO 2740-0136, metal shavings and chips were found in excess grease and in areas protruding from the top of the Acme nut. Corrective action: removed horizontal jackscrew assembly per MM 27-40-01. The jackscrew assembly was replaced per EM 2740-01037 on February 14, 2000.

34. ASA Reliability Analysis Program

The Reliability Analysis Program Document (95-1), as authorized in D74 of the Operations Specifications, defines ASA's Reliability Analysis Program (RAP) and the procedures used to monitor, evaluate, and improve the effectiveness of the maintenance program. The Boeing 737-200/400/700 and Boeing (McDonnell Douglas) MD-82/83 airplanes are covered under this program. Data collection and analysis, performance standards, evaluation of corrective actions, and interval adjustments and process changes are several methods for providing guidance on reliability.

(a) Typical sources of data collection include the following: Unscheduled removals, mechanical delays and cancellations, pilot reports, sampling inspections, shop findings, functional checks, bench checks, service difficulty reports, mechanical interruption summaries, etc.

(b) The objective of data analysis is to recognize the need for corrective action, establish what corrective action is needed, and determine the effectiveness of that action. For example, component unscheduled removals are considered a secondary reliability parameter of the RAP. In addition to those components that exceed a statistical alert value, components that display poor performance in terms of operational reliability may also be detected through the analyses of the primary reliability parameters. Other indicators of component reliability used to detect unfavorable trends are:

(1) Reports of operational incidents; and

(2) Direct input from Maintenance Control, the Component Shops, or Repairs Control concerning components judged to be discrepant.

The RAP encompasses all scheduled maintenance/inspection tasks or checks and associated intervals. It also contains the means of changing, adding, or deleting these functions, and revising the operating limits or maintenance processes of components. The objectives are better airworthiness, reliability, and cost effectiveness. ASA controls its maintenance programs by management decisions based on continuing analysis of operational data.

The main governing body of the program is the permanent-voting members of the RAP Control Board, which reports to the Staff Vice President of Maintenance and Engineering. The Reliability Department serves the RAP Control Board as the administrator of the program, and is responsible for reviewing and analyzing collected data, issuing alert notices, providing notification of reliability issues, and facilitating the board meetings and decisions. The RAP Control Board has the authority to decide the course of action for the items presented to it for resolution, and to task appropriate development or implementation of its decisions. The RAP Control Board meets once a month and consists of the following members:

Manager Reliability (also serves as Board Chairman)
Director Base Maintenance
Director Line Maintenance
Director Quality Control
Director Engineering
Manager Maintenance Control/Technical Services
Manager Maintenance Programs and Publications
Director Maintenance Planning and Production Control

When it becomes necessary to revise the Reliability Analysis Program Document, a RAP Control Board Directive, including local FAA approval, must approve all permanent changes. Any substantiating data must be available for review by the FAA, if requested.

There is also an ASA Maintenance Review Board (MRB) [this MRB is different from the FAA MRB document that outlines minimum maintenance and inspection requirements] that meets biweekly to review and approve changes to the maintenance program (GMM 3-7-0, March 5, 1997). It also reviews selected ME-01 requests that require MRB approval. The Manager of Maintenance Programs and Publications initially reviews the ME-01 and determines whether the requested change requires the approval of the MRB. If the ME-01 does not require MRB/RAP Control Board approval, the request will be routed to the affected personnel (as determined by the Manager, Maintenance Programs and Technical Publications) in the following order:

Manager Reliability
Director Engineering
Director Line Maintenance
Director Base Maintenance

Manager Maintenance Control
Director Quality Control
Director Maintenance Planning and Production Control

The members on the MRB are the same individuals that are on the RAP Control Board.

A subset of the full RAP Control Board is called a "Reliability Action Board (RAB)." An RAB meeting addresses specified problems that are considered critical or urgent and cannot wait until the next RAP Control Board meeting. An RAB meeting does not require the attendance of the full RAP Control Board, but must be attended by the RAP Chairman (or designee) and other members appropriate to the issue being discussed.

Any actions decided upon by a RAB that require changes to the activities controlled by the RAP program require a RAP Control Board Directive be prepared and approved.

(a) GMM "Maintenance Time Limitations" Revision

(1) Changes that require FAA approval:

- Addition or deletion of an aircraft manufacturer's MSG-2 Maintenance Planning Document[57] (MPD), recommended Maintenance Significant Item[58] (MSI), or an aircraft manufacturer's MSG-3 MPD recommended systems maintenance, structural, or zonal task.

- Addition or deletion of an MSG-2 MRB recommended MSI or an MSG-3 MRB recommended systems maintenance, structural, or zonal task.

- Escalation of hard-time component overhaul intervals, periodic maintenance checks of structural inspection intervals, which are greater than 10 percent of the present interval.

- Escalation of an individual maintenance task interval (currently performed at or in excess of the interval recommended in the applicable aircraft's MPD) of greater than 10 percent of the current interval.

- Addition or deletion of an ASA recommended MSI, (for MSG-2 style listings) or systems maintenance, structural, or zonal task (for MSG-3 style listings).

[57] Maintenance Planning Document (MPD) is a manufacturer's document that provides general guidance to operators in the formulation and establishment of individual maintenance programs for designated airplanes.
[58] Maintenance Significant Item (MSI) is an item identified by the manufacturer whose failure: could affect safety (on ground or in flight) and/or is undetectable during operations, and/or could have significant operational economic impact, and/or could have significant non-operational impact.

(2) Items, which cannot be changed or for which change approval beyond the local FAA is required:

- Those tasks listed as Certification Maintenance Requirements (CMRs)[59], Airworthiness Limitation Items (ALIs)[60], or fixed maintenance intervals unless approval is granted from the FAA Aircraft Certification Office.
- Life limits mandated by the manufacturer.
- Time limits mandated by an Airworthiness Directive (AD), except in accordance with the AD.
- Time limits mandated by an aircraft's Type Certificate Data Sheet.
- Time limits mandated by FAR, "Preparation of Hazardous Materials for Transportation."

(3) Changes that do not require FAA approval:

- Escalation of hard time component overhaul intervals, periodic maintenance check intervals, or structural inspection intervals, which do not exceed 10 percent of the present interval. (Although approval of the FAA is not required for these escalations, substantiating data for justification must be available for the local FAA upon request.)
- Escalation of an individual maintenance task interval (which is not listed on the airplane's MRB) up to the interval recommended in the applicable airplane's maintenance planning document, irrespective of the percentage increase.
- Periodic maintenance intervals of those Maintenance Significant Items (MSIs) identified as "condition monitored" items, which have a periodic maintenance activity or task at some ASA determined interval.
- Maintenance process changes for MSG-2 based maintenance programs.
- Maintenance task code changes for MSG-3 based maintenance programs.

(b) Periodic Maintenance Check or Structural Inspection Interval Adjustment

[59] CMRs are requirements that detect the presence of a significant latent failure from system/component analysis, and are integral to the type certification of the design.

[60] ALIs are documents that contain information, which defines mandatory replacements times for safe-life structure, inspection requirements for principal structural elements, and provides specific non-destructive inspection (NDI) techniques and procedures for each principal structural element.

A maintenance check or structural inspection interval may be increased without FAA approval up to 10 percent of the existing interval, when it can be shown that the previous check findings revealed no significant discrepancies and that the extension will not adversely affect the airworthiness or operational reliability of the airplane. An increase greater than 10 percent requires FAA approval.

(c) Individual Maintenance Task Interval Adjustment

A "Maintenance Programs/Technical Publications Change Request," form ME-01, documents approval of an individual maintenance-task interval adjustment (if FAA approval is not required and if a revision of GMM Maintenance Time Limitations is not required). If either of the preceding requirements is present, the adjustment must be documented on a RAP Control Board Directive.

(d) Maintenance Programs/Technical Publications Change Request (ME-01)

The ME-01 is an ASA form that is used to process requests and recommendations for changes to current maintenance program procedures, existing maintenance documents such as task cards, aircraft maintenance manuals, policy and procedures manuals and other documents under the control of the Engineering and Quality Control departments.

The RAP/MRB Control Board voting member representing the department requesting the change will review the ME-01 and then sign it. The ME-01 will then be forwarded to the Manager of Maintenance Programs and Technical Publications department for processing.

MRB approval is required for any change to the GMM. RAP approval is required for any maintenance program change.

The ME-01 is not required for the following:

(1) Typographical errors.
(2) Part number changes.
(3) Clarification of existing procedures.
(4) Torques, clearances and limit changes required to reflect manual revisions.
(5) Changes generated by EM's or EO's general requirements.

Note: ME-01's submitted for Illustrated Parts Catalog (IPC)[61] changes/revisions only need Engineering approval.

[61] Illustrated Parts Catalog (IPC) is a list of drawings in a service manual showing all parts of a component, along with its proper name, part number, and number required for assembly.

35. Reliability Analysis Program (RAP) for MD-80 Airplanes

A review of one year RAP meeting minutes relevant to the MD-80 Horizontal Stabilizer (ATA 2740, 2730 and 5500).

(a) Primary Reliability Parameter Alert Notices

Alert Notice Number:

8-99-07-04: 14 delays or cancellations for HS and 1 delay for elevator tabs
8-99-05-04: 7 delays or cancellations for HS, 1 for elevator tabs
8-99-05-18: 9 pilot reports of HS, 1 elevator tabs
8-99-04-04: 5 delays for HS, 1 elevator tabs
8-99-04-17: 6 pilot reports of HS, 2 elevator tabs
8-99-03-44: 4 delays or cancellations for HS, 2 for elevator tabs
8-99-03-12: 5 pilot reports of HS, 3 elevator tabs

(b) Unscheduled removal alert report summary (for exceedances)

Primary Trim Drive Motor:

September 1999, 1 occurrence
January 1999, 1 occurrence
September 1998, 1 occurrence

Alternate Trim Drive Motor:

July 1999, 1 occurrence
June 1999, 2 occurrences
May 1999, 2 occurrences
December 1998, 1 occurrence
November 1998, 1 occurrence
August 1998, 1 occurrence

Gearbox:

April 1999, 1 occurrence

(c) Aircraft System Reliability Monthly Statistical Reports

The Aircraft Systems Reliability Reports for October, November, and December 1999 were reviewed. Each report gives operations statistics, fleet utilization, mechanical delays, pilot reports and engine statistics, and has one year's collection of data.

For 1999, the average number of flight hours per day was 10.61, and the average number of cycles per day was 5.47, for the MD-80 fleet.

There were 35 mechanical delays and cancellations involving horizontal stabilizers (ATA 27-40) for 1999, with a three-month moving rate per 100 departures that averaged 0.050 for the year. The "alert value,"[62] from August 1999 to the end of the year, was 0.090 for a three-month moving rate per 100 departures. There were no structure group stabilizers (ATA 5500) reported for the 12-month period. Statistics associated with RAP Control Board minutes showed alert notices that exceeded alert parameters, however, no trends or irregularities were established concerning the horizontal stabilizer or common components.

The unscheduled removal alert report for 1999, including a three-month rate per 1,000 unit hours was reviewed for the following components:

- Motor, alternate trim drive horizontal stabilizer (8-2740-9-8007): 5 removed

- Motor, primary trim drive horizontal stabilizer (there were 3 different motors)
  (8-2740-9-8008): 24 removed
  (8-2740-9-8021): 1 removed
  (8-2740-9-8022): 0 removed

- Sensor, motion stabilizer (8-2740-9-8009): 0 removed

- Gearbox, horizontal stabilizer (8-2740-9-8013): 1 removed

- Screw and support horizontal stabilizer (8-2740-9-8023): The report listed 2 units removed, however, there were 3 removed. The third unit was removed in November 1999; however, a new unit was not installed until January 2000, and thus the airplane check and component report was not completed until January 2000. Even though 2 removals occurred in November 1999, at no time did the component unscheduled removal rate trigger the alerting system that an investigation was required. The unscheduled removal rate per 1,000 unit hours was a very small number.

(d) Another area of mechanical reliability data that the RAP evaluates is called, "Significant Impact," which is defined as those matters affecting:

(1) Safety of flight.
(2) Airworthiness.
(3) Delays and cancellations.

[62] "Alert value" is the limit of acceptable performance for each statistical alert program reliability parameter (set by ASA's program). Exceedence of an alert value prompts an investigation, which will result in a corrective action if warranted. A typical alert value is determined from the mean of a 3-month moving rate. A standard deviation of the mean is computed.

(4) The subjects of reliability program alert notices.
(5) Those items which are exhibiting adverse trends; and
(6) Those items which a significant cost impact on the maintenance operation.

Items which fit into the above categories may be brought to the RAP Control Board's attention by anyone by forwarding an ASA MIG-13 Form. There were no records of MIG-13 forms concerning jackscrew assemblies.

36. RAP Control Board Fleet Performance Agenda/Meeting Minutes

RAP Control Board fleet performance agenda and meeting minutes were reviewed for 1999, and included attendance, performance summaries, reliability discussion items, and engineering projects that were submitted for Control Board consideration. Included in the minutes were updates, discussions, and schedules concerning "watch items" that require corrective actions. Copies of agendas and meeting minutes are on file for a minimum of one year.

During the last year, alert notices, including histories, analysis, conclusions, and recommendations were reviewed for MD-80 airplanes. No horizontal stabilizer reliability problems were noted. No discussions or engineering projects involving the horizontal stabilizer, maintenance checks affecting the stabilizer or common components, or lubrication pertaining to the horizontal stabilizer were noted.

Frank McGill
Maintenance Records Group Chairman

LIST OF ATTACHMENTS