AIRCRAFT MECHANICS FRATERNAL ASSOCIATION

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August 15, 2002

Mr. Richard Rodriquez
Investigator In Charge
Major Investigations Division
National Transportation Safety Board
AS-10, Room 5305
490 L'Enfant Plaza East, S.W.
Washington, D.C. 20594-2000

Dear Mr. Rodriguez:

In accordance with the Board's rules, the Aircraft Mechanics Fraternal Association offers the following letter of submission, which AMFA believes to be relative to Probable Cause in the accident involving Alaska Airlines flight 261, aircraft N963AS, which occurred on January 31, 2000, in the Pacific Ocean, near Anacapa Island, California.

AMFA ACCIDENT SUMMARY

On January 31, 2000, at about 1621 Pacific Standard Time (PST) Alaska Airlines flight 261, a Boeing DC-9-83, N963AS, crashed into the Pacific Ocean approximately 3 miles north of Anacapa Island, California.
The Aircraft was destroyed. There were 88 fatalities, which included 83 passengers and 5 crewmembers.
The airplane was being operated under Title 14 Code of Federal Regulations Part 121 on a regularly scheduled flight from Puerto Vallerta, Mexico, to Seattle, Washington, with an intermediate stop in San Francisco, California. Due to unrestrained movement of the horizontal stabilizer, longitudinal direction of the aircraft became uncontrollable resulting in a pitch over and ultimate loss of the aircraft.

AMFA believes this accident was avoidable and was caused by the following facts brought out in the course of the investigation. Included in this submission are Safety Recommendations which AMFA believes are essential to the prevention of future such accidents.

DC-9 TYPE CERTIFICATE DATA
According to the type certificate, the longitudinal trim system meets the requirements of CAR 4b, section 4b.320 entitled "General Control Systems." This section does not have requirements for catastrophic failure of flight control systems.
The MD-83 is certificated as a derivative model of the Douglas DC-9. The MD-83 (DC-9-83) certification basis is Federal Air Regulation (FAR) Part 25, amendment 40, with exceptions in 1985. CAR 4b, Amendment 16, was recodified to become FAR Part 25. During the codification, the certification rules essentially remained the same.
The FAA deemed that the systems design philosophy for the MD-81 and MD-83 trim system was essentially the same as the DC-9 trim system.
According to the FAA, the general system's rules state that the system must work as intended, safe flight and landing must be accomplished with a single failure. The systems rules state that the system must perform its intended function with no hazard to the airplane if the system fails.

Section 4b.322, Trim Control and Systems states in part: "Trim devices shall be capable of continued normal operation in the event of failure of any one connecting or transmitting element of the primary flight control system."
Section 4b.325, Control System Stops states: "All control systems shall be provided with stops, which *positively* limit the range of motion of the control surfaces. Control system stops shall be so located in the systems that wear, slackness, or take-up adjustments will not adversely effect the control characteristics of the airplane because of a change in the range of surface travel. Control system stops shall be capable of withstanding the loads corresponding with the design conditions for the control systems."
The manufacturer concluded, in the DC-9 Flight Controls System Fault Analysis, that the failure mode of excessively worn acme nut threads were not formally considered.
It was also noted that the acme nut was designed with a softer material than the acme screw, and was designed to wear, relying on the operator to periodically measure the nut to determine maintenance requirements based on specified wear limits.
FAR Parts 21.50, 25.1529, and Appendix H of FAR Part 25 require a type certificate holder to provide a recommended maintenance program to enable aircraft to be maintained in an airworthy condition.
The possibility of a catastrophic failure of the jackscrew assembly, according to the Boeing Company was one in one billion.

CONCLUSIONS:
AMFA believes the certification of the MD80 aircraft was without adequate redundancy.
The horizontal stabilizer acme nut and acme screw were designed on the basis that the dual, serpentine thread of the assembly, and the incorporation of a torque

tube housed within the single jackscrew, would compensate for the wear characteristics of the acme nut/screw system.
The NTSB investigation determined that the dual threads of the acme nut/screw assembly wore evenly, to a point of failure. With this fact in mind, AMFA questions the redundancy of the design.

ALASKA AIRLINES AIR CARRIER CERTIFICATE
The effective date for Alaska Airlines original air carrier certification was September 23, 1946. Alaska Airlines was reissued certificate number ASAA 8092 on April 17, 1989.
Title 14 Code of Federal Regulations (CFR) part 119.65 lists personnel required for operations conducted under part 121. The certificate holder is required to have qualified personnel serving full time in the following positions:
Director of Safety
Director of Operations
Chief Pilot
Director of Maintenance
Chief Inspector
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 as to how these duties would be apportioned.
The FAA approved the request and amended the ASA Operations Specification. Effective on June 12, 1998, the A6 operations specifications was revised, and it showed the Director of Maintenance position was vacant, and remained so for approximately two years.

The Assistant Vice President of Maintenance reported to the Staff Vice President of Maintenance and Engineering, who reported to the Executive Vice President of Technical Operations and System Control.

One person held the Director of Safety, the Director of Quality Control, and the Director of Training positions.
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 reported to the Director of Quality Control.

CONCLUSIONS:
AMFA believes that Alaska Airlines compromised critical leadership positions, as required per part 119.65 of the Code of Federal Regulations (CFR) by not filling

the vacancies of qualified personnel for each of the three dedicated Director positions.

The Director of Safety, as well as the Director of Quality Control and Training, should be permanent, separate, and dedicated positions per part 119.65 Code of Federal Regulations.

The Director of Safety and the Director of Quality Control should report directly to the President/CEO of the air carrier, and/or the highest level of the corporate structure.

MAINTENANCE STEERING GROUP

A Maintenance Steering Group (MSG-1) was established in the 1960's to develop maintenance requirements identified by FAA regulations.
It was updated in the 1970's as MSG-2 through experience gained in decision logic and was used to develop scheduled maintenance programs.
The development of Maintenance Program Development Document MSG-3 evolved in 1980.
MSG-3 analysis logic is task oriented, unlike MSG-2, which is process oriented.
MSG-3 logic is a consequence of failure analysis, which is further categorized into two basic considerations:

1) Safety
2) Economics

Intervals for individual tasks can be extended, using the MSG-3 process, based on substantiation by the air carrier and approval by the FAA.
A Maintenance Reliability Program (MRP) controls the inspection, checks, and overhaul times for the entire airplane, using an advanced set of operation factors and determines maintenance intervals and processes.
Because of this process, there may be significant differences among individual approved airline maintenance programs, including inspection and servicing of the aircraft and it's components.
Use of the "task" oriented MSG-3 concept would allow one to view the Maintenance Reliability Board (MRB) document (which is a living document established by the FAA) to see the initial scheduled maintenance program reflected for a given item.
Existing MD-80 operators, whose maintenance program is based on the MRB MSG-2 Report, may take advantage of the MSG-3 Report and it's listed intervals to adjust its existing programs in coordination with its FAA Principal Maintenance Inspector (PMI).

CONCLUSIONS:

AMFA believes the MSG-3 process is flawed, in that it allowed the extension of maintenance intervals to escalate beyond a reasonable requisite.

RELIABILITY ANALYSIS PROGRAM

Alaska Airlines (ASA) conducts their own Reliability Analysis Program (RAP) which includes all maintenance/inspection tasks or checks and associated intervals.

The RAP contains the means of changing, adding, or deleting these functions and revising the operating limits or maintenance processes of components through voting members of the RAP Control Board.

Data collection and analysis, performance standards, evaluation of corrective actions, and interval adjustments and process changes are methods for providing guidance on reliability.

ASA controls its maintenance programs by management decisions based on continuing analysis of operational data.

The ASA RAP Control Board has the authority to decide the course of action for the items presented to it for resolution.

The ASA RAP Board reports to the Staff Vice President of Maintenance and Engineering.

RAP Control Board fleet performance agenda and meeting minutes were reviewed by the NTSB Maintenance Records Group for the year 1999.

Included in the minutes were updates, discussions, and schedules concerning "watch items" that may require corrective actions.

During that period, alert notices, including histories, analysis, conclusions, and recommendations were reviewed for MD-80 airplanes.

No horizontal stabilizer reliability problems were noted, in lieu of the fact that three (3) horizontal stabilizer acme nut/screw assemblies were removed in 1999.

No discussions of engineering projects relating to MD-80 horizontal stabilizers, maintenance checks affecting the stabilizers or common components, or lubrication issues pertaining to the horizontal stabilizers were noted.

CONCLUSIONS:

The RAP Control Board has the authority, and therefore the accountability for its' actions. The objective of data analysis is to recognize the need for corrective action and determine the effectiveness or consequences of that action, including interval adjustments and process changes.

MAINTENANCE REVIEW BOARD

A Maintenance Review Board (MRB) outlines the minimum maintenance and inspection requirements to be used in the development of FAA approved airworthiness programs for individual airlines based on reports using MSG logic, service experience, and test procedures.

Alaska Airlines has it's own Maintenance Review Board (MRB) (not to be confused with the FAA MRB) which outlines minimum maintenance and inspection requirements.

Alaska Airlines' MRB meets biweekly to review and approve changes to maintenance programs using MSG philosophy, service experience and accepted practices. It also reviews selected Maintenance Programs/Technical Publications Change Request forms (ME-01) that require MRB approval.

Initially, an Industry Steering Committee (ISC) comprising of representatives from the aircraft manufacturer and intended air carriers, develops and establishes policies for the proposed MRB by directing the activities of Working Groups (WG). These Working Groups develop minimum scheduled maintenance and inspection requirements for new or derivative aircraft using the latest revision of the MSG-3 process. A maintenance program is developed using MRB guidelines, however, a MRB is not to be confused with, or thought of, as a maintenance program.

The MD-80 now uses two MRB Reports; The MSG-3 Revision 2 process, and the original MSG-2 Report, Revision Q process.

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

Alaska Airlines initially purchased used DC-9-80 airplanes from Jet America Airline that operated with an approved maintenance program under the MSG-2 report process. A "proration" of time limits on airframe, engines, and components were transferred from that maintenance program to the ASA maintenance program. The MSG-2 process was accepted and continued as an "initial" operator using MD-80 MRB MSG-2 Report, revision "Q."

Task intervals may be escalated by the air carrier, based on satisfactory substantiation and approval by the FAA, or the air carrier's reliability program. The FAA used a "tacit" approval system that allowed operators to submit several maintenance program changes at once. If no response was received from the FAA, it was considered approved by both parties.

Changes that require FAA approval include the following:

- Escalation of an individual maintenance task interval currently performed at or in excess of the interval recommended in the applicable aircraft's Maintenance Significant Item of greater than 10 % of the current interval would be required to have FAA approval.
- Escalation of periodic maintenance checks of structural inspection intervals, which are greater than 10 % of the present interval, would require FAA approval.
- Escalations that do not exceed the 10 % interval still require substantiating data for justification and must be made available to the local FAA upon request.

The ASA members on the Maintenance Review Board (MRB) are the same individuals that are on the Reliability Analysis Program (RAP) Control Board.

CONCLUSIONS:

Alaska Airlines received FAA approval to drop the "3600 flight hour" (FH) and the " Whichever comes first" requirement of the MSG-3 MRB interval for the

MD-80 "C1" Check. To date, ASA is still required *only* to meet the 15-month interval to the MD-80 "C1" Check, regardless of flight hours.

FEDERAL AVIATION ADMINISTRATION

In 1998, The FAA initiated the Air Transportation Oversight System (ATOS) which is a maintenance surveillance inspection process.
Ten initial air carriers were selected to participate in the program, which included Alaska Airlines. It's primary purpose is designed to oversee an air carrier's maintenance program and determine the carrier's adherence to it's written procedures and controls for each system element, and ensure that the established performance measures are met. The program is comprised of a Certification Management Team (CMT), which includes the following;
Principal Operations Inspector (POI)
Principal Maintenance Inspector (PMI)
Principal Avionics Inspector (PAI)
Cabin Safety Inspector (CSI)

On October 1, 1998 the ATOS system started with the Alaska Airlines certification.

The former PMI at the Alaska Airlines Certificate Management Office (CMO) began working under the new ATOS system but was not trained on the ATOS system prior to implementation at Alaska Airlines.

The FAA personnel interviewed in the Alaska Airlines CMT had little or no training on the specific aircraft types that Alaska Airline operates.
Training for the local FAA inspectors is funded nationally.

The FAA employs a process called ONTA (Operational Needs Training Assessment) which determines the training requests in order of priority for inspectors. Local FAA CMOs have limited control over who goes to school or receives training, and when.

One aspect of the ATOS program is that each Maintenance Inspector assigned to the CMT may only have aircraft specific training *requested*; not necessarily have the training.

According to the Supervisor of the Air Carrier Section in Seattle, a inspector who requests aircraft type specific training may have to wait years before they receive the requested training.

FAA staffing levels at the Alaska Airlines CMT were below staffing levels of similar sized air carriers such as America West Airlines and Trans World Airlines.

According to a November 12, 1999 FAA Memorandum from the Supervisor, Alaska Airlines Certificate Management Section (CMS) to the Manager, Flight Standards Division, ANM-200, stated that America West Airlines had 26% more aircraft and 175% more FAA staff.
The same was true at Trans World Airlines. 133% more aircraft and 250% FAA more staff.
The memorandum listed the composition of the airworthiness and cabin safety staff for Alaska Airlines, America West and Trans World airlines Certificate Management Units (CMU). Alaska Airlines CMS listed 4 members, America West Airlines CMU listed 11 members and Trans World Airlines CMU listed 14 members.
The memorandum also listed the FAA Cabin Safety Inspector (CSI) position as **vacant** at Alaska Airlines.
According to the Supervisor, Alaska Airlines CMS, " the staffing in the Seattle Flight Standards District Office (FSDO), Certificate Management Section (CMS) has reached a critical point." Moreover, he stated " If the ASAA CMS continues to operate with the existing limited number of airworthiness inspectors, and without a cabin safety inspector, diminished surveillance is imminent and the risk of incidents or accidents at Alaska Airlines is heightened."

At the time of the accident, the PMI position for the Alaska Airlines CMT was vacant. An assistant PMI was filling in as acting PMI from the fall of 1999 until February 2000 when a new PMI was assigned and actively took over.

According to FAA personnel interviewed, surveillance of Alaska Airlines decreased under ATOS due to the following three reasons.
1) Only ATOS inspectors assigned to a specific carrier are allowed to inspect that carrier.
2) The loss of geographic inspectors under the ATOS program that were available prior to the implementation of ATOS.
3) The inspectors assigned to the Alaska Airlines CMT were too busy conducting required ATOS Safety Attribute Inspections (SAIs) and Element Performance Inspections (EPIs) to conduct surveillance at levels experienced prior to ATOS implementation. The FAA CMO manager also stated that he did not have enough staff to operate under ATOS.

SAIs and EPIs were required to be completed and entered into a database.
Less than half of the ATOS required SAIs and EPIs were accomplished after one and one half years of operating under the ATOS program at the Alaska Airlines CMO according to the assistant PMI and the former PMI.
An analyst is then required to process and interpret the input data from the SAIs and EPIs. At the time of the accident, the Pacific Northwest Mountain Region of the FAA had no analyst in place to interpret the data collected. Of the seven FAA regions only the Southwest Region had an analyst in place.

CONCLUSIONS:
The manufacturer's and the FAA's position, that an operator's maintenance and inspection programs would detect wear, which was a design component in the acme nut/screw assembly, did not address the consideration for mechanical failure of the horizontal stabilizer trim assembly.

FAA staffing and training of qualified inspectors was insufficient in providing adequate surveillance of Alaska Airlines under the ATOS program, in that it allowed numerous discrepancies to exist in the maintenance and inspection programs as brought out in the FAA's "Special Inspection," and Alaska Airlines own Audit.

ME-01 TECHNICAL CHANGE REQUEST FORM
The Alaska Airlines form ME-01 titled "Maintenance Programs/Technical Publications Change Request" is a form used by the Maintenance and Engineering Departments to process Maintenance Program changes under the control of the Engineering and Quality Control departments.
Examples of change requests might include procedure changes; document changes to task cards, aircraft Maintenance Manuals or other controlled documents.
Requests and recommendations are to be submitted on the ME-01 form along with any substantiating data to support such change to the Manager of Maintenance Programs and Publications.
The ME-01 form would then be initially reviewed by the Manager of Maintenance Programs and Technical Publications who determines whether the proposed change requires MRB or RAP approval.

CONCLUSIONS:

- When the ME-01 serial number 97-002974 was processed concerning the grease change from Mobil grease 28 to Aeroshell 33 grease (BMS 3-33) on the MD-80 aircraft, Alaska Airlines failed to follow it's own published procedures.
- Processing errors including the Manager of Reliability, Director of Line Maintenance and the Director of Quality Control signature and approval blocks were left blank and not signed.
- The signature blocks of the Director of Base maintenance, Manager of Maintenance Control and Director of Maintenance Planning & Production Control were crossed out.
- Special Action Required blocks (MRB/RAP/Routine) at the top of the form were left blank.
- The Manager of Maintenance Programs and Technical Publications did not check the approved, disapproved, or Maintenance Information Letter (MIL) blocks required in the signature section.

- The Maintenance Programs, Publications Change Request accomplished block at the bottom of the ME-01 was left blank, not signed or dated, however the changes were accomplished without them.
- A grease specification change is a Maintenance Program change and is required to have RAP approval, which this form did not.

MAINTENANCE ("C" CHECK) INTERVALS

Alaska Airline's MD-80 fleet is maintained under the MSG-2 program.

The MD-80 MRB MSG-2 Report outlines the initial minimum maintenance and inspection requirements to be used in the development of an approved continuous airworthiness maintenance program.

Alaska Airlines is an *initial* operator, and uses MD-80 MRB MSG-2 Report, revision "Q," which allows maintenance intervals from MSG-3 to be borrowed at the carrier's discretion.

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.

Through the use of the MSG-3 MRB process, "C" Check (heavy check) maintenance intervals have escalated in the number of flight hour/calendar month periods beginning in March 1985, when the initial program was approved by the FAA at 2500 flight hours.

- In 1996 the "C" Checks were escalated from 13 months to 15 months, which increased the flight hours from approximately 4,500 to 4,975.
- The FAA allowed Alaska Airlines to drop the "3600 flight hour" for their "C1" check interval and go with 15 calendar months *only*.
- A "Fly Fast" program was initiated, which resulted in even higher aircraft utilization (flight hours/cycles) between "C" Checks.
- In doing so, Alaska Airline increased their average flight hours per day thereby increasing the flight hours between "C1" checks.
- Prior to February 2000, at the "C1" check interval of 15 months, the approximate flight hours of 4,775 exceeded the MSG-3 MRB and MSG-3 On Aircraft Maintenance Planning (OAMP) of 3,600 flight hours.
- The FAA PMI or CMO never required that Alaska Airlines reinstate the "3,600 flight hour" restriction called out for in the MSG-3 MRB and the MSG-3 OAMP for "C1" check intervals.

Many other inspections and task cards are based on the "C1" check interval.

By extending the "C1" check interval, the intervals of other tasks and inspections that are tied to the "C1" check interval are extended as well.

- The horizontal stabilizer acme screw and nut endplay check task card # 24627000 is required every "C2" check.
- The Alaska Airlines "C2" check interval prior to February 2000 was 30 months or approximately 9,550 flight hours, compared to the MSG-3 MRB "C2" check interval of 7,200 FH or 30 months whichever comes first, and the MSG-3 OAMP "C2" check interval of 7,200 FH.

It was during the "C2" Check at 30 calendar months, (which equated to approximately 9,550 flight hours) that the Acme Screw and Nut End Play check was accomplished. The end play check is a method for providing an operator with jackscrew wear rate information.

CONCLUSIONS:

The FAA allowed Alaska Airlines to escalate "C1" Check intervals beyond MSG-3 OAMP and MSG-3 MRB 3600 flight hour (FH) intervals by allowing ASA to base their "C1" Check interval on calendar months only and not flight hours (FH).

The practice of "Calendar Months Only," between maintenance intervals does not accurately account for the actual Flight Hours (FH) accrued on aircraft systems and components. This effects both inspections and tasks on critical flight safety components, including lubrication. MSG-3 MRB and OAMP programs both require intervals based on Flight Hours (FH).

ACME SCREW AND NUT END PLAY CHECK

McDonnell Douglas (DAC) issued an All Operators Letter (AOL) on February 28, 1967 as an update to end play checks. It allowed a more accurate method of determining end play, and increased the allowable for maximum end play. The end play limits were set at 0.003 inch minimum to 0.040 inch maximum.

It was also recommended that the initial end play check be accomplished between 3,000 and 3,500 flight hours.

The amount of wear in the threads of the acme nut and/or acme screw can be determined by the measurement of the linear movement between the acme nut and the acme screw.

By the use of a dial indicator, and a restraining fixture, which applies a specified load on the horizontal stabilizer, the assembly is moved from tension to compression and the resulting measurement (in thousandths of an inch) is used to determine the amount of wear present at the acme nut. It should be noted in measuring the wear of the acme nut, only that portion of threads with the least amount of wear are actually measured.

- The last end play check performed on N963AS was completed during a "C5" Check in October, 1997, in Oakland, California (OAK).
- The last end play check task card performed on airplane N963AS resulted in a measurement of .040 inches, which is the maximum allowable wear limit per the manufacturer.
- A MIG-4 # 4236374 was initiated on September 27, 1997, stating that the acme nut/screw was at the maximum allowable wear limit and required replacing.
- A yellow highlight mark was added to the MIG-4 indicating that parts were required. Additionally, the MIG-4 had an orange highlight added, indicating a "Priority 1."

- No part (horizontal stabilizer actuator assembly) was in stock at Alaska Airlines or at Boeing/McDonnell Douglas.
- No part was ordered, either on a Stock Parts Request Form (MIG-33) or Field Requisition (P-17A).
- A decision was made to "re-evaluate test per w/c (task card) 24627000."
- A recheck of the end play readings was ordered and performed 3 days later, on September 30, 1997, to confirm the initial measurement.
- In the corrective action section of the MIG-4 it stated, "Rechecked acme screw and nut end play per work card number 24627000. Found endplay to be within limits .033 for step 11, and .001 for step 12. Rechecked five times with same result."
- Prior to the re-evaluation of the end play check, a task card was issued for lubrication of the jackscrew acme nut assembly.
- This task card was out of sequence for a jackscrew assembly that was to be replaced.
- The subsequent reading for the additional end play check was measured at .033 inches.

Checking end play requires accomplishing the procedure through repetition until a consistent, (not an average) reading is obtained within 0.001 inches.

When performing a wear check, while the jackscrew is installed on the aircraft, the Maintenance Manual (MM) takes precedence over the overhaul manual.
The MM end play 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.

According to the NTSB, the investigation has indicated that the end play check procedure techniques are susceptible to measurement errors.
As of August 2000, due to AD 2000-03-51, the Acme Screw and Nut End play Check is now a repetitive stand alone check that is performed every 2,000 flight hours (task card 28627004).
If the end play wear is .034 inches or greater, the acme screw and nut end play check is to be repetitively checked every 1,000 flight hours.

Aircraft N963AS acquired a total of 8,885 flight hours from the last end play check, which was accomplished during a "C5" Check on September 30, 1997, until the date of the accident on January 31, 2000.
Thread wear rate of the acme screw/nut remained unchecked during this period.

During the NTSB System Group evaluation of MD-80 operator end play checks, it was noted that the accuracy of check results could be affected by deviations in individual techniques such as calibration and interpretation of the dial indicator, and installation of the indicator to the jackscrew assembly. Correct application and direction of the specified torque of the restraining fixture and use of a correctly fabricated, lubricated, and maintained restraining fixture could cause variability in the results. Rotation of the acme screw, within its gearbox during

the procedure, and its effect on the movement of the dial indicator plunger, could also result in unreliability in the end play measurement procedure.
The Safety Board has stated a concern that the current end play check procedure may not be adequate to ensure consistent, accurate, or reliable measurements of acme screw and nut wear.

CONCLUSIONS:
It is the responsibility of the airline, the oversight of the FAA, and the recommendation of the manufacturer to provide the technician with task card procedures to accomplish proper maintenance of the aircraft.
It is the technician's responsibility to properly perform the task per the instructions given on the task card.

Alaska Airlines management is responsible for "C" Check production flow and control.

TOOLING
Task card 24627000 (Acme Screw and Nut End Play Check) included tool part numbers as follows:
Tool: 0-1301-0-0169 horizontal stabilizer restraining fixture (4916750-1).
Tool: 0-1301-0-0689 tool number (0561) dial indicator
Tool: 0-1300-0-0172 (804605) go-no go gauge.

A horizontal stabilizer "restraining fixture" is attached to the lower surface of the horizontal stabilizer leading edge and the top web of the vertical stabilizer adjacent to the horizontal stabilizer actuator. A specified torque is applied to the restraining fixture changing the load on the acme screw from tension to compression. The resultant movement is measured with a dial indicator. This measurement is used to determine the end play between the acme nut and screw.

Alaska Airlines had one restraining fixture, which was located at their maintenance facility in Oakland, California (OAK). It was a tool that was manufactured in-house and not a tool manufactured by Douglas or Boeing. The tool had been tracked since June 30, 1984.
No initial inspection documentation was available.
The tool was tracked as ASA part number (P/N) 0-1301-0-0169 and serial number (S/N) 2018 and manufacturer's P/N 4916750-1.
The Douglas engineering drawing of the restraining fixture (4916750) dated May 25, 1965 indicates three different configurations of the tool as -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 line number 1995,therefore the tool should have been specified as 4916750-503 rather than the part number (-1) listed on task card 24627000.

On April 13, 2000, Boeing sent a message (M-7200-00-00975) to all DC-9, MD-80, MD-90, and 717 operators to ensure that horizontal stabilizer inspection tooling conforms to the use of a restraining fixture (tool P/N 4916750).
Any variation in the tooling thread quality, pitch, or amount of thread 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.
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 concerns, was the possibility that some of these tools could bottom out during the check, causing an inaccurate measurement.
On August 4, 2000, ASA purchased 15 Boeing manufactured restraining fixture tools, all which conformed to drawing requirements.

CONCLUSIONS:
ASA In-house manufactured tooling (restraining fixture) may not meet the "equivalent substitute" requirement as specified by McDonnell Douglas Engineering Drawing.

The ASA manufactured restraining fixture did not have the properly designated part number for the MD-80 N963AS line number.

The task card # 24627000 (Acme Screw and End Play Check) listed an incorrect horizontal stabilizer restraining fixture part number. (4916750-1)

LUBRICATION
On May 29, 1984,McDonnell Douglas issued AOL 9-1526 to all operators, recommending the horizontal stabilizer to be lubricated at approximately 600 flight hours, emphasizing the importance of maintaining a conscientious lubrication program to minimize acme nut thread wear.

A change was made and approved through the Alaska Airlines RAP control board and the FAA Principal Maintenance Inspector (PMI) involving "C" Check intervals. "C" checks, which were normally scheduled per flight hours, were more conveniently scheduled by Calendar months, which also effected lubrication intervals.

In 1991, after operators experienced problems with inadequate lubrication of the jackscrew assembly, McDonnell Douglas recommended the lubrication interval at 600 flight hours, issuing AOL 9-2120A to all DC-9 and MD80 operators.

In July 1996, the stabilizer lube at Alaska Airlines was placed on a time controlled, "stand alone" task card #28312000 with a maximum interval of 8 calendar months (approximately 2550 flight hours) to provide an approximate mid "C" Check interval lubrication.

In October 1996, the stabilizer lubrication was combined with the lubrication of the elevators and elevator tabs, with the interval remaining at 8 calendar months or 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).

In March 1985, stabilizer lubrication was accomplished at "2B" intervals, which were 700 flight hours (initial maintenance program, which incorporated "B" checks). By 1996 Alaska Airlines escalated the lubrication interval to 8 months, which was approximately 2550 flight hours.

On September 24, 1999, Task Card # 28312000 was accomplished at SFO. It was the last noted lubrication of the horizontal stabilizer acme nut/screw assembly on aircraft AS963. The specified lubricant grease was Aeroshell 33.

CONCLUSIONS:
Insufficient lubrication of the acme nut and screw assembly through the actions of the MSG-3 process, and the decisions of the Reliability Analysis Program, (RAP) in the unrealistic extension of maintenance intervals, without sufficient data, led to the accelerated wear rate of the horizontal stabilizer acme nut and screw assembly.[3]

The design and location of a single grease "zerk" fitting to lubricate the horizontal acme nut/screw assembly did not provide sufficient capability to fully lubricate the entire jackscrew. It required the Technician to brush or apply grease by hand to the remainder of the threads in addition to the use of a grease gun. Once the jackscrew assembly lubrication was completed, the stabilizer was operated in the full aircraft nose up, and full aircraft nose down positions, which left only a thin residual film in the threads to provide lubrication to the system.
The acme nut/screw assembly has **no reservoir** to provide further lubrication to the system.

[3] Lubrication Interval Escalation Graph

HORIZONTAL STABILIZER JACKSCREW ASSEMBLY

The horizontal stabilizer for the Douglas DC-9 series, McDonnell Douglas MD-80/90 series, and Boeing B-717 series airplane is located at the top of the *vertical* stabilizer. It is hinged forward of the rear spar so that the leading edge can be moved up and down to provide longitudinal trim for the airplane. Movement of the horizontal stabilizer is controlled from the cockpit by the longitudinal trim control system through a range of 12.2 degrees leading edge down to 2.1 degrees leading edge up. The system is electrically operated and consists of a primary system, an alternate system, the actuating mechanism, an indicating system, a takeoff warning system, and a motion warning system.

Movement of the primary or alternate longitudinal trim handle(s) or switch energizes the electrical circuit to the respective actuating mechanism to drive the horizontal stabilizer to the desired position. The indicating system shows the position of the horizontal stabilizer, and acts as a follow-up system to actuate the travel limit switches to de-energize the electrical circuit when the stabilizer reaches the travel limits. The indicating system also drives a sensing device that provides an audible signal in the cockpit when the stabilizer is in motion.

The longitudinal trim actuating mechanism is located within the vertical stabilizer forward of the horizontal stabilizer front spar. The actuating mechanism consists of an acme screw and acme nut, drive torque tube ("Quill Shaft") located inside the acme screw. It also includes a main gearbox, a sandwich gearbox, primary longitudinal trim actuator motor, alternate longitudinal trim actuator motor, and support. The main gearbox and the acme screw and acme nut assembly are common to both primary and alternate systems. The acme nut is attached to the empennage structure by a gimbal ring and retaining pins, and the acme screw is installed in the nut and attached to the support, which is installed at the stabilizer front spar center section. The main gearbox is a dual planetary gear assembly and is installed on the support directly above the acme screw.

The acme screw and nut assembly incorporates two independent serpentine threads, which the Boeing Commercial Airplane Group maintains are intended to provide a redundant load path in the event of a failure in one of the thread spirals. Evidence showed, however, that the two thread patterns of the acme nut, in the case of the accident aircraft, N963AS, wore evenly, thus any redundancy in the dual load path of the acme screw and nut assembly design became questionable. Also noted in the course of investigation was the lack of contingency in the event of excessive wear or stripped acme nut threads for the stabilizer trim system which allows the possibility of the acme screw to disengage from the acme nut.

Boeing testified at the Alaska Airlines flight 261 public hearing in December 2000, that wear is taken into account by the very nature of the acme nut's robust design. In addition, they further pointed out that the acme nut thread wear design could be compromised without regular maintenance intervention, and the results could be catastrophic.

In reference to an All Operators Letter 9-2120A (AOL) from McDonnell Douglas, dated September 5, 1991, the average in-service wear rate for the MD-80 airplane was 0.0013 inches per 1,000 flight hours.

This AOL concluded that McDonnell Douglas recommended, for increased service life, that operators lubricate the jackscrew assembly repetitively at a 600 hour interval called out in the On Aircraft Maintenance Planning (OAMP) document, if not sooner.

CONCLUSIONS:

The wear of the acme screw/nut was designed to be periodically measured by the operator so that appropriate repair or replacement of the assembly could be performed, based on specified wear limits. AMFA believes that the Alaska Airlines maintenance program was deficient, in that it failed to address a safety of flight condition through the extension of maintenance intervals.

PRIMARY LONGITUDINAL TRIM CONTROL SYSTEM

The primary longitudinal trim control system consists of two control wheel switches (commonly referred to as "Pickle Switches") in the outboard horn of each aileron control wheel, *and* dual control handles (commonly referred to as the "Suitcase Handle") located on the left side of the control pedestal.

The "Pickle Switch" provides **electric** control for the trim system to operate.

The "Suitcase Handle" provides **Mechanical** control for the trim system to energize the *same* electric relay by means of a two-way cable system, which actuates a contact and completes the circuit to the primary actuator motor.

In the event the "Pickle Switch" became inoperative, the "Suitcase Handle" could be used to mechanically operate the primary actuator motor.

When the dual trim control (Suitcase) handles are moved together, the manual override control actuates a contactor to complete the circuit to the motor section of the primary actuator motor to drive the actuating mechanism and move the horizontal stabilizer.

As the primary motor is a major draw of electrical current, it is expected to cause a rapid rise in load across the left generator circuit during motor spin up. This will result in a significant movement in the left generator load meter. Once the motor reaches full speed, the amount of current required to sustain the motor at this speed drops significantly. This will result in an indicated drop on the load meter. Activation of primary trim generates a momentary spike to approximately 1.0 units. Activation of the primary motor, while it's brake remains engaged, will result in a sudden rise that will remain steady until power is removed by releasing the "Pickle Switch" or "Suitcase Handle," tripping the associated circuit breaker, or activation of the thermal protection switch of the motor.

Operation of the "Pickle Switch" and the "Suitcase Handle" *simultaneously,* energizes the *same* relay for the *same* primary trim motor.[1]

[1] Reference attachments:

The result would be no different than operating each control individually.
The primary and alternate trim motors have speed-versus-torque characteristics with significant torque capability.
The primary motor rotates the acme screw at approximately 35 rpm and has a maximum torque of 18,850 inch lbs. The primary motor addresses the design condition that primary trim *must* function without stalling during a high-speed dive pullout.
The alternate motor rotates the acme screw at approximately 10 rpm with a stall torque of 4,400 inch lbs.
The differential gearbox, to which both motors are attached, is a speed sum device. *Not* a torque sum device.
In the event both alternate and primary motors run together in the same trim direction, the two *speeds* sum together resulting in a higher trim rate.
This sum, however, applies only up to the point where resisting air loads (or mechanical jam) provide a reaction torque at the acme screw equal to, or greater than the capability of the alternate motor. At this point, the stronger primary motor will begin to back drive the alternate motor. The acme screw will stop rotating and act as a grounding point.
Each motor is protected from excessive overheating by a thermal cutout unit that interrupts 3-phase electrical power during an overheat condition. The alternate actuator motor thermal unit will open after approximately 60 seconds of overheating. The primary motor thermal unit will open after 15 to 30 seconds of overheating. Continued operation of the primary and alternate motors are protected from excessive overheating by a thermal cutout unit that interrupts 3-phase electrical power during an overheat condition.

On February 10, 2000, Boeing issued Flight Operations Bulletin Number MD-80-00-02, in regards to Stabilizer Trim Inoperative/Malfunction with the following recommendations: "If a horizontal stabilizer trim system malfunction is encountered, complete the Flight Crew Operating Manual (FCOM) checklist(s). Do not attempt additional actions beyond that contained in the checklist(s). If completing the checklist procedures does not result in an operable trim system, consider landing at the nearest suitable airport. If an operable trim system is restored, the captain should consider proceeding to an airport where suitable maintenance is available, or to the original destination based on such factors as distance, weather, etc.
The Primary and Alternate trim motors are each equipped with a thermal cut-off device which interrupts electrical current to the motor if that trim motor overheats. Repeated or continuous use of the trim motor may cause a thermal cutoff. After the motor cools, it will automatically restore trim function when the thermal cutoff resets."

Primary Trim Horizontal Stabilizer LLAMM System Schematic 27-41-0
Primary Longitudinal Trim Wiring Diagram 27-41-01

CONCLUSIONS:
There is no *visual* means available to the flight crew to indicate that the thermal cutoff device of the primary and/or alternate trim motors has been activated.

Other than operation of the primary and/or alternate trim motor controls, and observation of the generator load meter, there is no *visual* reference to indicate to the flight crew that the thermal cutoff feature has reset electrical power to the primary and/or alternate trim motors.

GREASE
Mobile Grease 28 (MIL-G-81322) Visually identified with a red tint.
Manufactured using a lithium base.
Aeroshell Grease 33 (MIL-G-23827) Visually identified with green tint.
Manufactured using a clay base.

In January 1996, a request was made by ASA through the Douglas Field Service Representative (SEA) to substitute Aeroshell 33 grease in lieu of Mobil 28 grease. Since air carriers such as ASA operate both Douglas and Boeing aircraft in their fleet, the standardization of lubricants would be an economical benefit.

In January 1997, Douglas stated that laboratory testing of Aeroshell 33 was in progress, however, completion was probably a year away.

On June 9, 1997, Alaska Airlines issued Maintenance Information Letter (MIL) #20-30-97-27 in regards to a new general-purpose aircraft grease BMS 3-33. It states that BMS 3-33 grease is fully interchangeable and intermixable with MIL-G-23827 (Aeroshell 7), MIL-G-21164 (Aeroshell 17) and BMS 3-24 (Aeroshell 16) greases, and that "Lube cards are being revised to use the new BMS 3-33 grease. It also states that "Alternate greases can be used if BMS 3-33 is not available (Ref. GMM 6-1-0 page 2 or MM 20-30-21).
The General Maintenance Manual (GMM) 6-1-0 grease section chart lists Mobil 28 grease as a second alternative to meet the MIL-G-23827 grease specification for flight controls on both McDonnell Douglas and Boeing aircraft.[2]

Boeing Service Letter, 777-SL-20-006-B, dated June 30, 1997, states that MIL-G-23827 is a synthetic diester oil-base product, and has long been the favorite lubricant for general use on Boeing airplanes. "This grease is incompatible with MIL-G-81322." The Boeing Letter also states that "In some cases..., MIL-G-81322 is incompatible with MIL-G-23827 grease and therefore the two greases should not be intermixed."

[2] Reference Attachment:
Alaska Airlines Maintenance Information Letter MIL #20-30-97-27

On June 19, 1997, Douglas offered the possibility of a "no technical objection" (NTO) letter if ASA was interested in conducting an in-service evaluation of the Aeroshell 33 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.

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

In September 1997 Douglas issued action # 332808 stating that they had "no technical objection" to the use of Aeroshell 33 (BMS 3-33) grease in place of Mobile Grease 28 for the lubrication of ASA MD-80 airplanes, with one known restriction. Aeroshell 33 grease was not to be used in areas subjected to temperatures in excess of 250 degrees Fahrenheit, including landing gear wheel bearings. The Douglas NTO was issued before the completion of the laboratory study, and the performance of the grease could not be verified. The NTO stated that ASA had the responsibility to monitor lubrication areas for any reactions and that it was also the responsibility of ASA to obtain FAA approval for the use of Aeroshell 33 on their MD-80 airplanes.

The incompatibility of mixing different greases is a well known, and tested for, phenomenon.

In April 2000, the National Transportation Safety Board commissioned the U.S. Navy's Aerospace Materials Laboratory to evaluate the compatibility of Mobilgrease 28 and Aeroshell Grease 33 using the American Society for Testing and Materials (ASTM) test method D-6185. ASTM D-6185 is used to evaluate combinations of two different types of lubricating greases. According to ASTM D-6185, "compatibility is the characteristic of lubricating greases to be mixed together without significant degradation of properties of performance." Incompatibility is most often manifested by degradation in physical properties. Results of the testing indicated that Mobilgrease 28 and Aeroshell Grease 33 are incompatible at the 90/10 and 10/90 ratios, but not at the 50/50 ratio.

The mixture of 90/10% or 10/90% of the two greases indicated a tendency for the clay based Aeroshell 33 (green tint) to cause a "washout" of the Mobil grease 28 (red tint) lithium (soap) based grease. This anomaly degrades the lubricating properties of both greases.

During the Alaska Airlines' transition from Mobile grease 28 to Aeroshell Grease 33 on MD-80 aircraft, there were no written instructions for flushing out the old grease, or for accomplishing the grease change.

It was further determined by the investigation that purging the jackscrew assembly would require disassembly of the acme nut assembly to completely remove residual grease from the thread paths.

At the time of the accident, Alaska Airlines called out for *three* different grease types and/or specifications in *three* different maintenance documents.

1. The MD-80 Maintenance Manual (MM) lists MIL-G-81322 as the wide temperature range (WTR) grease specification for the Horizontal Stabilizer/Elevator. The Maintenance Manual also recommended Mobilgrease 28 and Aeroshell Grease 22 as products for MIL-G-81322.

2. The Alaska Airlines General Maintenance Manual (GMM) lists MIL-G-23827 as the grease specification for flight controls. Section 6-1-0 of the GMM states under preferred greases, "Table 1 specifies particular products to be used where "MIL SPEC" greases are specified in the applicable maintenance manual. Alternates are specified for use *only* when the preferred grease is not available." In the GMM, Aeroshell 33 (BMS-33) is not listed as a preferred, or alternate grease for "MIL SPEC" MIL-G-81322 in either the Douglas or Boeing grease chart.

3. The Alaska Airlines Task Card # 28312000, for lubrication of the Horizontal Stabilizer/Elevator, lists Aeroshell 33 (BMS 3-33) as the grease specification.

Moreover, task card # 28312000, Revision Date 01/06/98, did not list a "MIL SPEC" number for Aeroshell 33 grease. Under the "lubricate elevator" section of task card # 28312000, reference is made to an available graphic of the elevator and elevator tabs. A notation is included stating, " If Graphic not available Refer to MM12-21-02, Figure 306 and 307." Under the Horizontal Stabilizer Lubrication section of the same task card there is no reference made to a Graphic, nor is there any reference to the Maintenance Manual.
Technicians are required to comply with the grease specification(s) listed on the work card used to perform a given task, in the lubrication of a given component.

On October 16, 2001, the NTSB Systems Group convened in Oxnard, California to extract and examine samplings of grease from the aircraft wreckage in an attempt to examine all fittings on the horizontal stabilizer, the elevator, and rudder. A NTSB metallurgist was included to provide expertise and standardization of observations.
The group noted that the grease fittings examined were attached to components that had already undergone an impact with the ocean, a salvage operation that included two fresh water rinses, storage in a building for 20 months, and a high pressure washing in December 2000.
The group defined the following standards for observations of the conditions of the grease.

- **Fresh** – Oily sheen visible; Smooth consistency
- **Semi-Fresh** – No oily sheen visible; Smooth consistency
- **Semi-Dry** – No oily sheen visible; Consistency is not completely smooth and some clumps are present

- **Dry** – No oily sheen is visible; Consistency is mostly solid with clumps
- **No Grease** – The fitting is void of grease.

A witness' account regarding the "Jackscrew conditional observation upon retrieval" by one of three NTSB representatives aboard the MV Independence, commissioned for salvage of aircraft N963AS, made in part, the following written statement:
"Once on deck, the stabilizer was rinsed with a low-pressure freshwater hose. The instructions were to not disturb (the material) nor to handle or touch the threads.
Visually, I could see that the threads were covered in what appeared to be a grease-like substance and a mixture of mud and sand. The heaviest concentration was at the upper end, continuing down the threads it would be better characterized as a film or sheen, but there was a coating."

CONCLUSIONS:
Alaska Airlines submitted ME-01 change request form (97-002974) which was not filled out completely or correctly, contrary to their own written procedures.

Alaska Airlines did not obtain approval for the grease changes from the FAA, prior to it use on ASA MD-80 airplanes.[3]

There was a thin film coating of grease present on the jackscrew threads at the time it was first retrieved from the ocean.

During an interview conducted by the NTSB, the Managing Director of Engineering stated that he did not know of any ASA field-testing concerning the use of Aeroshell 33 grease.

The Manager Systems Engineering quoted, in reference to the NTO, "I don't believe we specifically felt that FAA approval was required at the time."

Alaska Airlines did not provide written procedures for the mixing of the two grease types pertaining to purging Mobile 28 from the system when lubricating with Aeroshell 33.

[3] Reference Attachment MIL # 20-30-97-27

HUMAN PERFORMANCE

It should be noted that AMFA did not participate in the NTSB Cockpit Voice Recorder (CVR) Group.

AMFA submitted a written request to reconvene the CVR group for the purpose of gaining pertinent information regarding identification of audible content and for the purpose of obtaining insight as to the flight crews' radio communication with Alaska Airlines Maintenance Control, and Line Maintenance personnel. The group was never reconvened.

All CVR information concerning the time line from the initial upset of flight 261 was acquired from the edited, transcribed reports made available by the NTSB.

Every indication in the troubleshooting of the jammed stabilizer points to the belief that the problem was of an electrical nature as indicated by the flight crew to Alaska Airlines Maintenance Control, LAX Maintenance, and Operations.

Although transponder code 7700 was activated and received by ATC, there was no verbal declaration received by ground support which would indicate the severity of the problem encountered by the flight crew until the final upset, at which time a "Mayday" call was transmitted.

The actions of the flight crew, in their attempts to control the aircraft, in a condition considered to that point, "Fail Safe," were consistent with the training and experience encountered in abnormal situations of the horizontal stabilizer trim system.

The actions of the ground personnel, including ATC, Dispatch, Maintenance Control, and LAX maintenance, were in accordance to the information and training available to them at that time.

CONCLUSIONS:

The Abnormal Procedures Checklist and/or the Quick Reference Handbook (QRH) related only to electrical malfunctions of the Horizontal Stabilizer Inoperative, or Runaway Stabilizer conditions.

There was inadequate staffing of ground support personnel with knowledge of aircraft in-flight system abnormalities to aid in troubleshooting the problems encountered by the flight crew. Prescribed training of ground support personnel did not address horizontal stabilizer *mechanical* failure.

The flight crew was unable to make radio communication with Seattle Maintenance Control (SEAMC) early on in the flight to report any abnormal flight conditions, due to inoperable Dual Tone Multiple Frequency (DTMF) sites in Mexico. Additional time may have allowed ground support the opportunity to provide more specific information.

LAX Line Maintenance, with reference to all ASA Line Maintenance Aircraft Maintenance Technicians (AMT) respectively, are not trained by Alaska Airlines for in-flight troubleshooting procedures.
The inquiry by LAX Maintenance as to the nature of flight 261's horizontal stabilizer problem was a concerned response to overhearing the conversation between the flight crew and LAX Operations. Verbal communication with the flight crew comprised of suggestions, in the form of questions, about the existing problem, which AMFA considers commendable and appropriate action.

There were not written procedures, policies, or training to address in the event of mechanical failure of the horizontal stabilizer trim system.

Under the introduction section of Alaska Airlines MD-80 Quick Reference Handbook (QRH) Rev-11/15/99 states "The procedures established in this handbook represent the best known available facts about these subjects. Flight Crews should follow these procedures as long as they fit the Emergency/Abnormal situation. However, at any time if they are not adequate or do not apply, the Captain's best judgement should prevail. Only the Flight Crew operating the aircraft can evaluate the situation sufficiently to make the proper decision."

PROBABLE CAUSE

The Aircraft Mechanics Fraternal Association determines that the probable cause of the Alaska Airlines Flight 261 accident was the horizontal stabilizer acme nut wearing to the point of failure, due to inadequate lubrication of the jackscrew assembly.

Subsequently, the torque tube stop nut sheared under stress, due to the loads applied to the trim system, and longitudinal control of the aircraft was lost.

Contributing factors to the accident were:

1) The design and certification of the MD-83 horizontal stabilizer trim system was not redundant, in that a single failure resulted in the total loss of the longitudinal control of the aircraft.
2) Alaska Airlines' escalation of increased maintenance intervals over a continued period of time, leaving the acme nut/screw threads without adequate lubrication.
3) The FAA's Air Transport Oversight System (ATOS) did not provide adequate surveillance to ensure that a recommended maintenance program met the requirements, as per FAR Parts 21.50, and Appendix H of FAR Part 25.

AMFA RECOMMENDATIONS

All Maintenance Program changes should be approved in writing by the air carriers' FAA PMI before the change becomes effective.

Air Carriers should submit with those specific Maintenance Program changes, sufficient, pertinent and relevant documentation or testing data to support such change before the Maintenance Program change becomes effective.

The air carriers and the FAA must not rely on "Tacit" or assumed approval for Maintenance Program changes such as escalations for inspections, task cards or lubrication as well as material specification changes such as lubricants and other fluid type changes.

Require all Maintenance Program changes such as task card changes to be numbered for tracking purposes when received by the FAA. This would aid in tracking changes and would eliminate the possibility that changes are missed.

Provide additional FAA staffing to support the PMI in reviewing Maintenance Program changes.

Change FAA Flight Standards Service policy to ensure that every task card change or Maintenance Program change notification is thoroughly reviewed before approving or accepting that change.

Amend the End Play check procedure to apply only one specific torque value, rather than a value *range* such as 250-300 inch lbs. This would help in constant readings during the End Play check.

Devise new End Play check procedures that will ensure accurate readings with minimal chance of human error.

Use new non destructive testing (NDT) technologies for inspection of critical wear components, such as the jackscrew acme nut and jackscrew threads, which could determine the wear of *all* of the threads and not just the threads with the least amount of wear.

The FAA should require operators to track jackscrew wear and apply that information to MSG considerations.

Record and track all wear rate information for all flight critical components.

Alaska Airlines Engineering Department should verify that all tools and materials meet the specifications called out for by the manufacturer. Ensure that tooling that is not obtained from the manufacturer is an "Equivalent Substitute," which fully conforms to the manufacturer's tool specification requirements.

When changing a grease specification, all documents containing a reference to that grease specification must be changed at the same time. This will eliminate the different grease specifications called out for in different maintenance documents for the same task, where the possibility of intermixing different types of greases could occur.

Improve the tracking and approval process of the Maintenance Programs/Technical Publications Change Request form (ME-01).
Ensure that the forms are not lost or delayed when going though the approval process.

Implement a check procedure to ensure that all of the required signatures and approvals are in place before a Maintenance Programs/Technical Publications Change Request gets processed.

Ensure that the Alaska Airlines Manager of Maintenance Programs/Technical Publications is knowledgeable about the requirements of the Maintenance Program including the MRB/RAP approval process.

The FAA should require Alaska Airlines to reinstate the "C1" Check "3,600 Flight Hour or 15 Month (Which ever comes first)" interval requirement of the MSG-3 MRB and MSG-3 OAMP to it's Maintenance Program for the MD-80 aircraft.

Eliminate the FAA's ATOS system. Adopt a new system of surveillance, regulatory compliance and oversight.
Despite ATOS being in place since October 1, 1998, the ATOS program failed to find and correct the issues surrounding the Alaska Airlines Flight 261 accident.

The FAA's ATOS program, if retained, should be modified to include more inspectors and increased surveillance in addition to the basic ATOS model concept. A reduction in the number of airlines participating in the ATOS program should be adopted until changes such as policies and procedures, staffing and training, are put into place and are proven to be effective. Training requirements should be revised so it states that the PMI, PAI, and POI assigned to the CMT have aircraft type specific training completed prior to assignment.

The FAA should revise the Position Classification Guide as it applies to fleet size and number of inspector's required.

The FAA should sanction the local CMO a training budget. (The FAA local CMO has the best knowledge on who needs the training and in what areas).

The FAA should revise the FARs to require Part 121 air carriers to provide a specific number of training hours per year for Aircraft Technicians. The vague reference that outlines the Maintenance Training Program requirements listed in FAR 121.375 is subjective.
There is no hourly requirement to train the technicians who are responsible to maintain the aircraft in airworthy condition.
Aircraft Technicians carry a FAA issued Airman's Certificate and are a critical component to the Safety of Flight.
Flight Crew and Flight Attendants are required to have a specific number of training hours annually, yet there is **no requirement** for a specific number of training hours required per year for Aircraft Maintenance Technicians.
Aircraft are continually becoming more complex and technologically advanced. Therefore a specific required number of training hours for Aircraft Technicians should be made mandatory by the FAA for air carriers operating under Part 121, and included in the FARs.

"Hard time"[4] flight critical components, such as the horizontal jackscrew assembly.

AMFA appointed Aircraft Maintenance Technicians should be allowed to participate in the maintenance evaluation and program development process.

The FAA should evaluate aircraft certified as Derivative models against existing FAR requirements, for the purpose of modification, to be in compliance with current FAR regulations.

A visual warning device should be incorporated into the horizontal stabilizer primary and alternate trim motor thermal cutoff system to indicate it's operation.

AMFA is in concurrence with the National Transportation Safety Board's Safety Recommendations, A-01-41 through -48, dated Oct 1, 2001 to the FAA as follows:

Require the Boeing Commercial Airplane Group to revise the lubrication procedure for the horizontal stabilizer trim system of Douglas DC-9, McDonnell Douglas MD-80/90, and Boeing 717 series airplanes to minimize the probability of inadequate lubrication. (A-01-41)

Require the Boeing Commercial Airplane Group to revise the end play check procedure for the horizontal stabilizer trim system of Douglas DC-9, McDonnell Douglas MD-80/90, and Boeing 717 series airplanes to minimize measurement error. Conduct a study to validate the revised procedure against an appropriate physical standard of actual acme screw and acme nut wear.

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

This study should also establish that the procedure produces a measurement that is reliable when conducted on-wing. (A-01-42)

Require maintenance personnel who lubricate the horizontal stabilizer trim system of Douglas DC-9, McDonnell Douglas MD-80/90, and Boeing 717 series airplanes to undergo specialized training for this task. (A-01-43)

Require maintenance personnel who inspect the horizontal stabilizer trim system of Douglas DC-9, McDonnell Douglas MD-80/90, and Boeing 717 series airplanes to undergo specialized training for this task. This training should include familiarization with the selection, inspection, and proper use of the tooling to perform the end play check. (A-01-44)

Require operators supply to the FAA, technical data including performance information and test results, demonstrating that proposed changes will not present any potential hazards.
Obtain approval of the proposed changes from the principal maintenance inspector (PMI) and concurrence from the FAA applicable aircraft certification office before the implementation of any proposed changes in allowable lubrication applications for critical aircraft systems. (A-01-45)

Issue guidance to Principal Maintenance Inspectors to notify all operators concerning the potential hazards of using inappropriate grease types and mixing incompatible grease types. (A-01-46)

Survey all operators to identify any lubrication practices that deviate from those specified in the manufacturer's airplane maintenance manual.
Determine whether any of those deviations involve the current use of inappropriate grease types or incompatible grease mixtures on critical aircraft systems and, if so, eliminate the use of any such inappropriate grease types or incompatible mixtures. (A-01-47)

Convene an industry-wide forum to disseminate information about and discuss issues pertaining to the lubrication of aircraft components, including the qualification, selection, application methods, performance, inspection, testing, and incompatibility of grease types used on aircraft components. (A-01-48)

AMFA ACCIDENT OVERVIEW

Maintenance Practices include many aspects to be considered in the reliability of an aircraft and it's components.

A Boeing study of commercial jet airplane accidents from 1988 through 1997 cited only 6% maintenance attributed accidents.

The majority of *these* accidents were the result of deficiencies in maintenance procedures and requirements.

The current method of establishing and changing maintenance programs allows for significant differences in operator and manufacturer recommended procedures and intervals. This often results in major differences in maintenance practices between operators of the same type aircraft.

Design of the DC-9 horizontal stabilizer trim system and the evolution to the MD-83 series aircraft involved significant increases in horizontal stabilizer size, and gross weight of the aircraft.

The FAA deemed that the systems design philosophy for the MD-81 and MD-83 trim system was essentially the same as the DC-9 trim system. According to FAA Order 8110.4A, entitled "Type Certification": "Components of the same design as the original which have exhibited a satisfactory service history need not demonstrate further compliance to later regulations."

AMFA believes, that unlike most critical safety of flight components, the horizontal stabilizer acme nut/screw assembly on the MD-83, is not sufficiently redundant, in that a single failure, in this case the loss of the jackscrew acme nut, can result in catastrophic loss of control.

In a letter to Alaska Airlines dated July 10, 2001, AMFA expressed concern regarding the company's selection of the MSG-3 maintenance process for the MD-80 fleet.

The horizontal stabilizer jackscrew assembly installed on aircraft N963AS, which was involved in the flight 261 accident, was maintained under the guidelines of this program. Unanticipated failure of this critical component imposes serious questions regarding the entire MSG-3 process.

The steward of the MSG-3 process, the ATA, clearly specifies that the operator is solely responsible and accountable for the suitable implementation of this program. Therefore, a cautious approach and careful consideration should preclude any decision by Alaska Airlines to implement this process into the MD-80 fleet. Particularly in light of the results this process may have played in the case of flight 261.

The ATA describes MSG-3 logic as a "from the top down, or consequence of failure approach." The logic is considerably flawed in its application to the MD-80 jackscrew, especially in understanding the consequence of failure.

Like most accidents, the loss of Alaska Airlines flight 261 was not the result of a single individual in the performance of their assigned tasks.

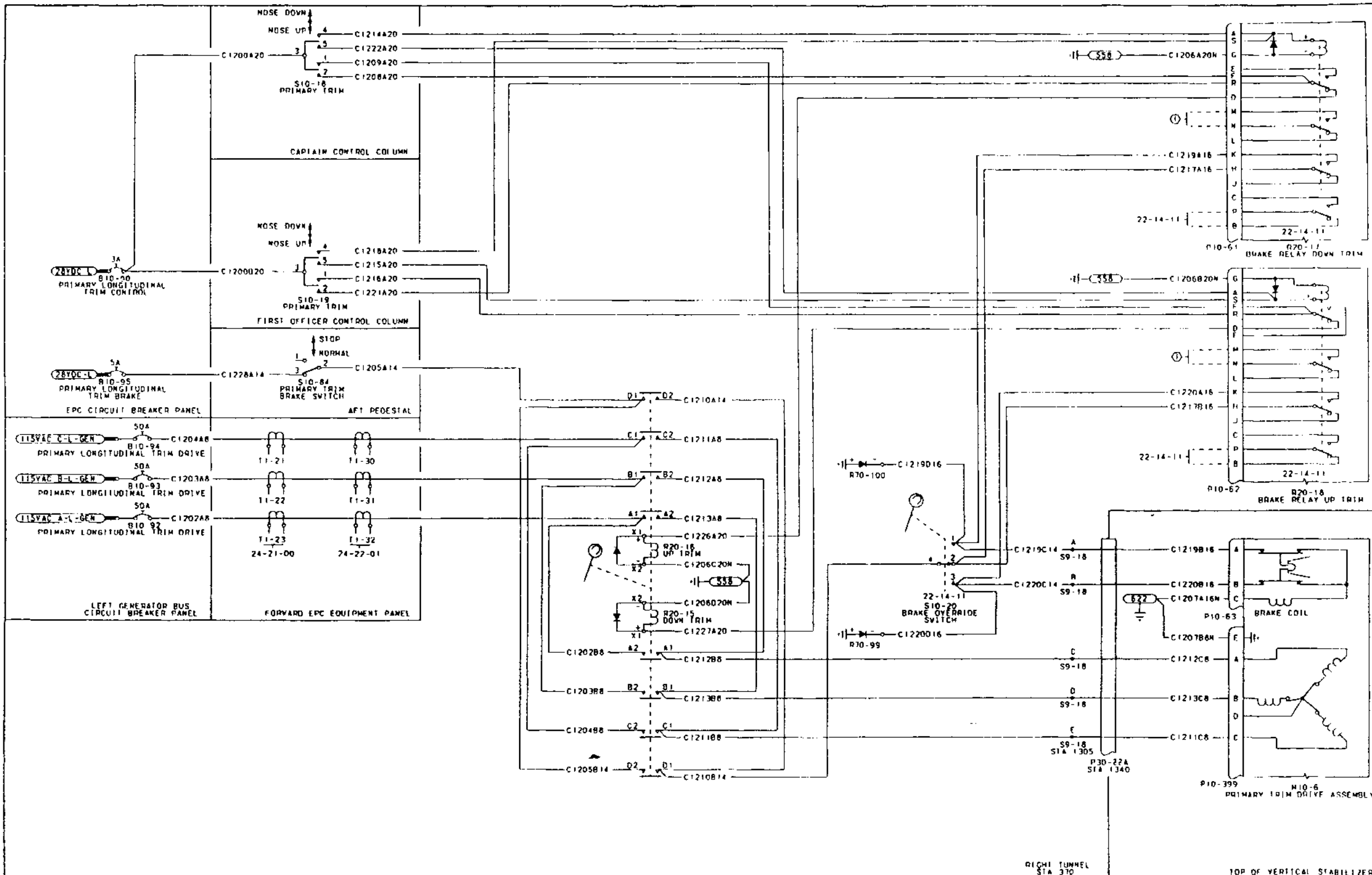
Rather, the cause is related to the failure of a "system" that allowed an airplane to be certified as airworthy without sufficient redundancy and a maintenance program that was deficient in detecting a safety of flight condition.

The Aircraft Mechanics Fraternal Association expresses sincere thanks and gratitude to the National Transportation Safety Board for allowing our participation in this aircraft accident investigation. May the outcome of this investigation bring resolution and closure to the many people this accident has touched, with the continued awareness of the importance of flight safety.
May the NTSB consider our recommendations, that they will contribute to the prevention of future such accidents.

Sincerely,

David Patrick
AMFA Party Coordinator Flight 261

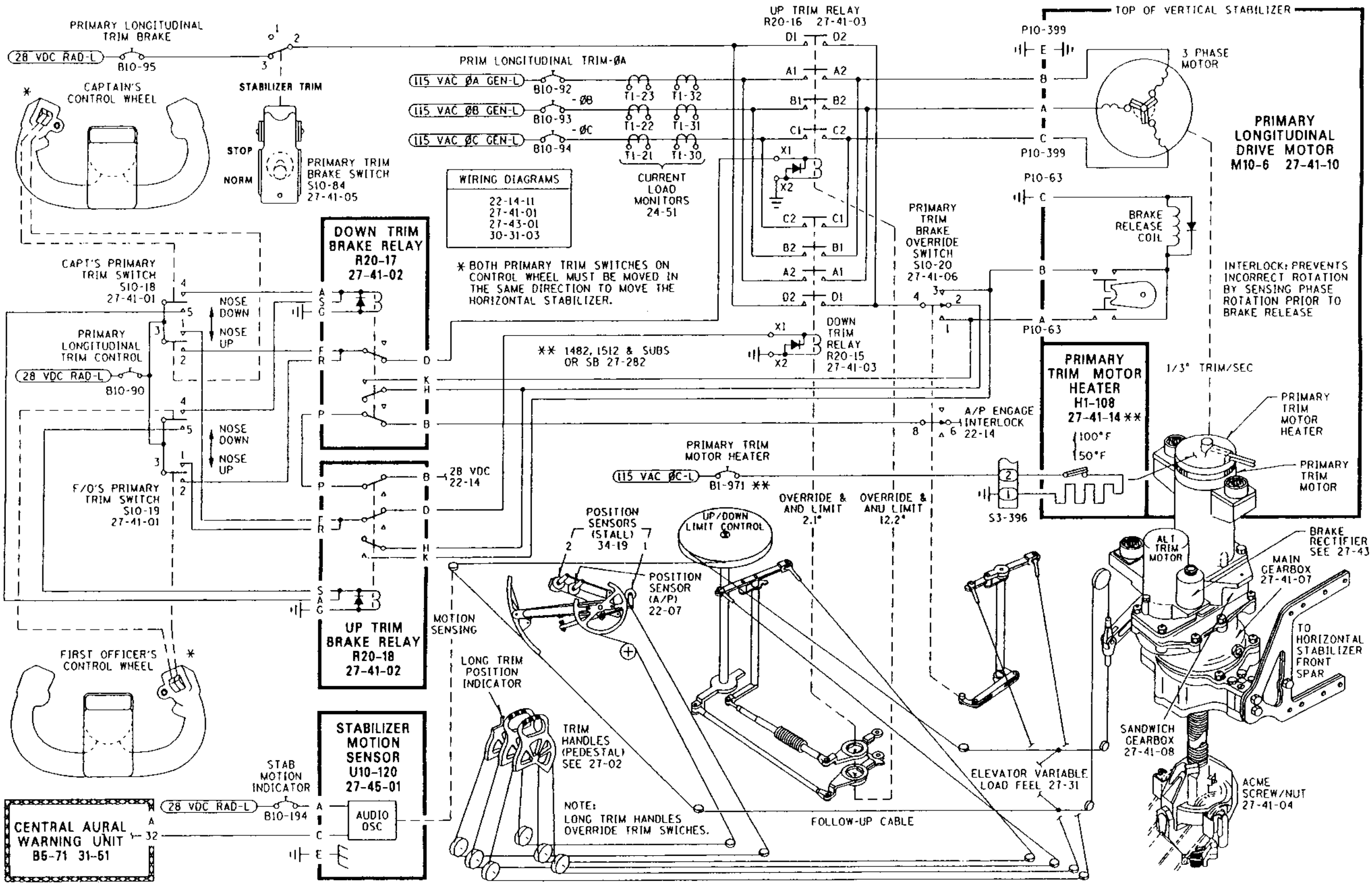
CC: Airline Pilots Association
Alaska Airlines
Association of Flight Attendants
Boeing Commercial Airplane Company
Federal Aviation Administration
Equilon Enterprises LLC



① 27-43-01 IF APPLICABLE

EFFECTIVITY	TITLE	
AS	PRIMARY LONGITUDINAL TRIM	

SYSTEM SCHEMATIC **MDC PROPRIETARY**



CUSTOMER: MD-80 (1345-2183) OR SB 27-272 EXCEPT MD-87	APPROVAL & CHANGE RECORD	TITLE: PRIMARY TRIM HORIZONTAL STABILIZER	DOUGLAS	CHG AA	CODE IDENT NO. 88277	MD-80	27-41-0
			APPR BY: G. BEEDON	ENGR: G. BEEDON	DRAWN BY: P. TRUONG	DATE: 2-10-97	CODE: 1008

ALASKA AIRLINES

MAINTENANCE INFORMATION LETTER

June 9, 1997 Category: MIL #20- 30-97-27

NEW GENERAL PURPOSE AIRCRAFT GREASE

Background: Boeing has worked with several grease manufacturers and airlines with the objective of developing a new general purpose grease with improved corrosion and wear protection and the potential of consolidation of several greases. The new grease will be under BMS 3-33 specification.

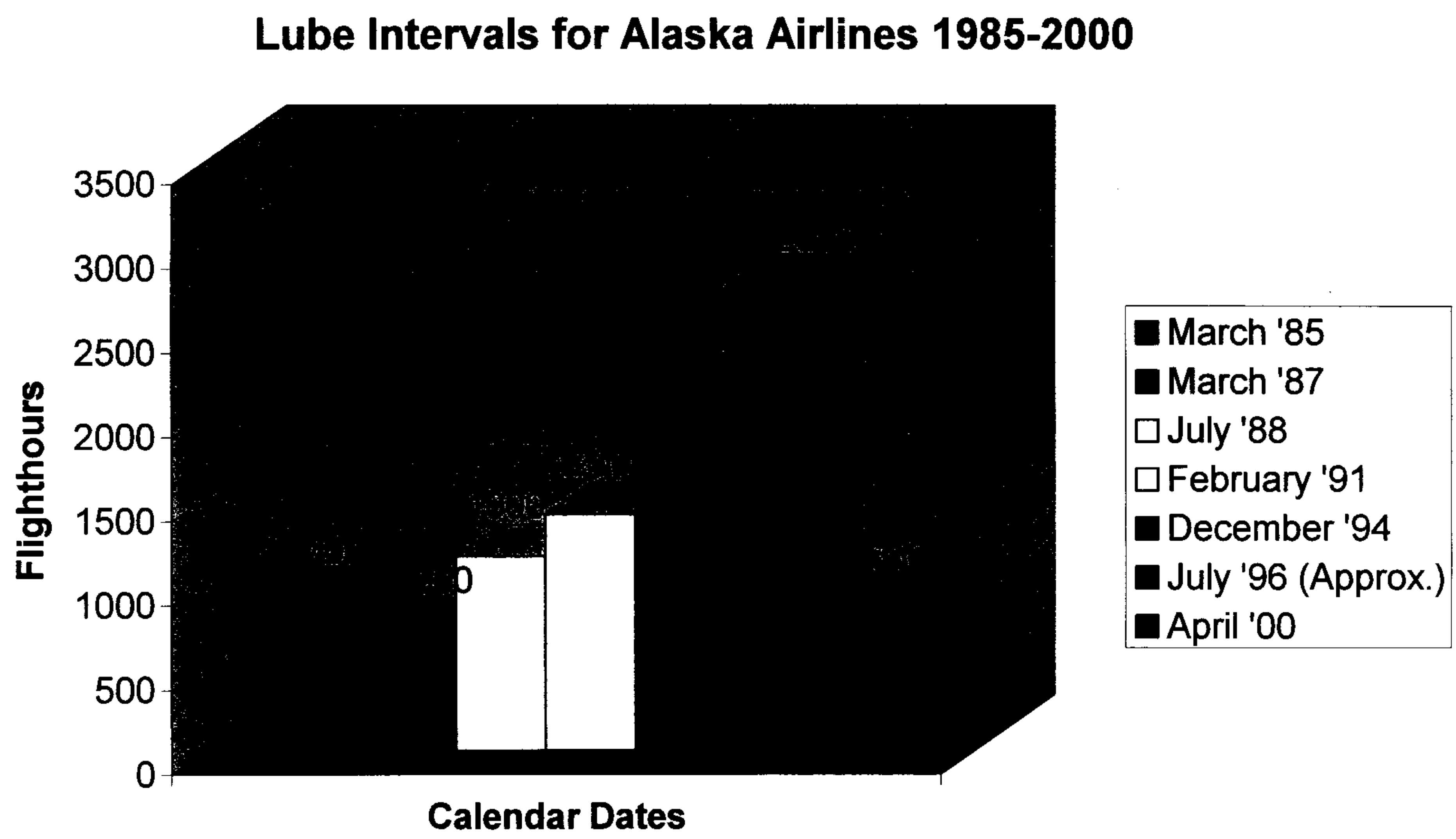
Problem: There are many different grease types to lubricate a wide range of components on an aircraft. This can be both confusing and expensive. So many greases, so little time.

Solution: Alaska Airlines will eliminate several greases and will consolidate to the new BMS 3-33 grease. BMS 3-33 will replace MIL-G-23827 (Aeroshell 7), MIL-G-21164 (Aeroshell 17) and BMS 3-24 (Aeroshell 16) greases. Lube cards are being revised to use the new BMS 3-33 grease.

Currently, only Aeroshell 33 grease is qualified to BMS 3-33 specification. It is stocked in 14 oz tubes (ASA P/N 0-0340-3-0118) and 35 pound pails (0-0340-3-0110). Aeroshell 33 is translucent green with the consistency of cake frosting and the smell of machine oil.

BMS 3-33 is fully interchangeable and intermixable with the previous greases. For the Boeing fleet, BMS 3-33 is the preferred grease. Alternative greases can be used if BMS 3-33 is not available (Ref. GMM 6-1-0 page 2 or MM 20-30-21).

Above material for information only, shall not be used to replace Aircraft Maintenance Manual or General Maintenance Manual as a basis for sign off of an aircraft discrepancy.


Lube Intervals for Alaska Airlines 1985-2000
Flighthours
3500
3000
2500
2000
1500
1000
500
0
Calendar Dates
March '85
March '87
July '88
February '91
December '94
July '96 (Approx.)
April '00