NATIONAL TRANSPORTATION SAFETY BOARD
OFFICE OF AVIATION SAFETY
WASHINGTON, D.C. 20594

September 15, 2008

Maintenance Records Factual Report

A. ACCIDENT: DCA-07-MA-310

LOCATION: St. Louis, Missouri

DATE: September 28, 2007

TIME: 1316 central daylight time

AIRCRAFT: American Airlines McDonnell Douglas DC-9-82 (MD-82), N454AA, Flight 1400

B. GROUP MEMBERS:

Group Lead: Ronald C. Price
National Transportation Safety Board
Washington, DC

Member: Brad Brugger
Transport Workers Union
Tulsa, Oklahoma

Member: Shannon Hankins
Allied Pilots Association
Fort Worth, Texas

Member: Barry Lederman
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C: SUMMARY

On September 28, 2007, at 1316 central daylight time, an American Airlines McDonnell Douglas DC-9-82 (MD-82), N454AA executed an emergency landing at Lambert-St Louis International Airport (STL), St. Louis, Missouri, after the flight crew received a "L ENGINE START VALVE" indication and a left engine (No. 1) fire warning during departure climb from the airport. The airplane sustained substantial damage. After landing, the 2 flight crew, 3 flight attendants, and 138 passengers deplaned via airstairs and no injuries were reported. The flight was operated under instrument flight rules as a 14CFR Part 121 regularly scheduled flight from STL to Chicago O'Hare International Airport (ORD).

The Maintenance Records Group comprised of persons from American Airlines (subsequently referred to as AA), the Allied Pilot's Association, the Transport Workers Union, and the Safety Board met at the AA maintenance facility in Tulsa, Oklahoma on May 6, 2008, and again on July 14, 2008, to review the maintenance records of the airplane.

D: DETAILS OF THE INVESTIGATION

1.0 Air Carrier Certificates

The Federal Aviation Administration (FAA) (New England Region) issued Air Carrier Operating Certificate Number AALA025A to AA on January 1, 1954. On March 6, 1980, AA was issued an Air Carrier Operating Certificate Part 25, by the FAA SW-33 Air Carrier District Office (ACDO), in Fort Worth, Texas

AA received the following Part 145 Repair Station Certificates:

Certificate AALR025A was issued on January 14, 1961, by the FAA's Oklahoma City Flight Standards District Office (FSDO). The repair station, which is located at the Tulsa International Airport, Tulsa, Oklahoma, was approved with the following ratings: Airframe Class 4 issued September 2, 1993; Limited Powerplant Class 3 issued September 2, 1993; Accessory Class 1, 2, and 3 issued September 2, 1993; Instrument Class 1, 2, 3, and 4; Radio Class 1, 2, and 3 issued September 2, 1993; Limited Nondestructive Inspection (NDI), Testing, and Processing for Radiographic, Magnetic Particle, Fluorescent Penetrant, Eddy Current, and Ultrasonic Testing issued January 11, 2005; and Limited Specialized Service for Bonded Metallic and Non-Metallic Components issued September 2, 1993.

Certificate A3AR112Y was issued on June 18, 1993, by FAA's Dallas-Fort Worth (DFW) FSDO. The repair station, which is located at the Alliance/Fort Worth Airport, Fort Worth, Texas, was approved with the following ratings: Limited Airframe issued June 4, 1999, for Boeing B-757-200, B-767-200, B-767-300, B-777-200, and B-777-300 aircraft and Limited Powerplant issued June 18, 1993 as described on its approved Capabilities List.

Certificate ZYUR969X was issued on September 14, 2004, by the FAA's American Airlines, Inc. (AMR) Certificate Management Office (CMO). The repair station, which is located at the Kansas City International Airport, Kansas City, Missouri, was approved with the following ratings: Limited Airframe; Limited Powerplant; Limited Accessory; Limited Emergency Equipment; and Limited Nondestructive Inspection, all issued September 14, 2004, as part of the original certification. All limited ratings are described on the Air Agency's approved Capabilities List.

2.0 Operations Specifications (OpSpecs)[1]

AA has a Part 121 Certificate, which included the standards, terms, conditions, and limitations contained in the FAA approved Operations Specifications (OpSpecs), Parts D and E. The OpSpecs, Parts D and E, include the following:

(a) Air carrier was authorized as a 14CFR Part 121 operation.

(b) Paragraph D072, the Continuous Airworthiness Maintenance Program, authorizes AA to use the maintenance program and limitations specified in this operations specification to maintain its airplanes.

(c) Paragraph D076, Maintenance Scheduling authorizes AA to use short-term escalations of certain maintenance intervals on their fleet. The MD-80 is not authorized short-term escalations on "B" or "C" checks. Similar limitations exist on other AA fleets.

(d) Paragraph D090, Use of Outside Sources, authorizes AA to utilize C.A.S.E.[2] as a means of qualifying a vendor for services, parts, and materials to satisfy the requirements of 14 CFR Section 121.373.

(e) Paragraph D091, Maintenance Program, authorizes AA to make arrangements with other organizations to perform substantial maintenance.

(f) Paragraph D095, Use of Minimum Equipment Lists, authorizes AA to use an approved Minimum Equipment List (MEL).

(g) Paragraph D485, Aging Aircraft Inspection Program, requires AA to have an Aging Aircraft Inspection and Records Review program.

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[1] Operations Specifications contains the authorizations, limitations, and certain procedures under which each kind of operation, if applicable, is to be conducted by the certificate holder.

[2] The Air Carriers section of the Nonprofit Coordinating Agency for Supplier Evaluations (C.A.S.E.) was organized as a means of sharing non-prejudicial supplier quality approval data among the membership airlines. This increases surveillance coverage of suppliers and thereby upgrades their quality programs. It also has an economic impact on each C.A.S.E. member by decreasing the cost of supplier surveillance and making their surveillance programs more effective.

(h) Paragraph E096, Weight and Balance Program Requirements, requires AA to use an approved Weight and Balance Program.

3.0 Aircraft Information

The accident airplane, fuselage serial number (FSN) 49559, was manufactured by the McDonnell-Douglas (MD) Corporation was issued its airworthiness certificate on February 28, 1988. AA purchased the airplane from MD and put it on their Part 121 certificate on March 31, 1988. At the time of the accident, the airplane had accumulated 57,744 total flight hours and 30,254 total cycles. The airplane was equipped with two Pratt & Whitney (P&W) JT8D-219 turbofan engines and a Honeywell Auxiliary Power Unit (APU).

4.0 Maintenance and Inspection Programs

The AA's MD-80 Maintenance Program in effect on the day of the accident - September 28, 2007 – included a fixed interval inspection, a check program, and a repair assessment for pressurized fuselages program. AA's MD-82 Maintenance Inspection Program, revision **BU** dated **September 19, 2007,** and was approved by the FAA September 27, 2007. Each program is discussed in detail below.

AA's Maintenance Program utilizes Fixed Interval Scheduling. The fixed interval includes a window of 10 percent of the maintenance check interval for B, C, and HC-checks. A 0922 Tire Service Check (SC) is accomplished at Class 1 and 2 overnight stations when a Periodic Service (PS) or higher check is not accomplished. A PS is accomplished at intervals of 50 flight hours (FH) since the last PS, "A", "B", or "C"-check and having sufficient ground time of at least six hours. An "A" check is performed within 100 hours of aircraft time-in-service since the preceding "A", "B", or "C"-check. A PS is included in any higher check and is accomplished within this inspection. A "B"-check and inspection is conducted after the accumulation of 600 flight hours. The "C"-check and inspection is performed within 4,200 FH after the last "C"- check. All "A"- and "B"-checks and PS will also be accomplished with this inspection. A "Heavy C" (HC) inspection is performed at intervals not to exceed 12,600 FH since the previous HC in accordance with the AA Engineering Specification Maintenance manual (ESM Maintenance Inspection Program). Compliance with all applicable HC check task cards constitutes an airframe overhaul.

Airworthiness Directives (AD) and Manufacturer Service Bulletin (SB) compliance were written into the inspection program, and accomplished at the next appropriate check depending on the requirements of the notice.

Along with the Fixed Interval inspections and checks, AA also utilizes the MD-80 Supplemental Structural Inspection Document number **DM-IS-SID-80-2** Revision **D dated May 1, 2006**, as required by AD **2004-11-07**. This requires that Principal Structural Elements (PSE) to be inspected within the aircraft total time or total cycle criteria as required to meet the minimum DTR (Damage Tolerance Rating) established by **DM-IS-SID-80-2** Revision **D**.

All aircraft in the MD-80 fleet are subject to the provisions of the MSG-3 Material Review Board (MRB) Report. These requirements include external and internal inspections, corrosion prevention and control tasks, and additional supplemental structural inspections for fatigue related items.

The inspection Thresholds and Intervals shown in the Engineering Specification Maintenance (ESM) are as listed in the MD-80 MSG-3 MRB[3] for the applicable tasks, except as escalated by FAA approved practices. The thresholds shown in the MD-80 ESM apply to new aircraft delivered directly to American Airlines from the manufacturer, as well as to those aircraft formerly operated by TWA, LLC, that were fully transitioned to AA Maintenance Program, and any new aircraft deliveries in the future. AA heritage MD-80 aircraft originally operated to the requirements of the Corrosion Prevention and Control Program (CPCP) AD, (Reference AD 92-22-08 R1), have been superseded prior to September 19, 2006, when the airline transitioned from MSG-2 based maintenance program to the MSG-3 maintenance program. These aircraft had thresholds established at the time of the effective date of the AD (January 12, 1994) based on the aircraft age in accordance with the AD requirements. These thresholds establish the requirement for the date of the initial inspection of a given task on a given aircraft. AA heritage aircraft will continue to have their initial inspections of a given task accomplished at the existing AD thresholds for each aircraft. After the accomplishment of the initial inspection of a given task on a given aircraft, repeat inspections will be scheduled to the repeat inspection intervals as shown in the ESM.

The AA maintenance organization chart was reviewed and revealed that the Vice President for Maintenance is responsible for a large fleet of airplanes with a defined group of personnel handling the MD-80 series maintenance program.

AA assigns supervisors for all of the MD-80 maintenance bases, with lines of responsibility throughout the maintenance organization. Included are responsibilities for fleet support from engineering, maintenance control, and logistical support. (**Attachment 1**)

The following is a listing of the previous inspections accomplished on the accident aircraft N454AA:

Aircraft	Check	Station	Date	Flight Hours	Cycles
454	**0922**	**ORD**	**17 Sep 07**	**57,660**	**30,182**
454	**0922**	**PHX**	**22 Sep 07**	**57,704**	**30,202**
454	**0922**	**DFW**	**26 Sep 07**	**57,734**	**30,217**
454		**-END-**			
Aircraft	**Check**	**Station**	**Date**	**Flight Hours**	**Cycles**
454	**PS**	**ORD**	**17 Sep 07**	**57,660**	**30,182**
454	**PS**	**PHX**	**22 Sep 07**	**57,704**	**30,202**
454	**PS**	**LGA**	**23 Sep 07**	**57,711**	**30,206**

[3] Computer based maintenance program developed by the operator and manufacturer.

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Aircraft	**Check**	**Station**	**Date**	**Flight Hours**	**Cycles**
454	**AC**	**LAX**	**10 Sep 07**	**57,613**	**30,157**
454	**AC**	**PHX**	**22 Sep 07**	**57,704**	**30,202**
454	**AC**	**LGA**	**23 Sep 07**	**57,711**	**30,206**
454		**-END-**			

Aircraft	**Check**	**Station**	**Date**	**Flight Hours**	**Cycles**
454	**BC**	**LGA**	**17 Apr 07**	**56,507**	**29,562**
454	**BC**	**LGA**	**29 Jun 07**	**57,101**	**29,868**
454	**BC**	**LGA**	**23 Sep 07**	**57,711**	**30,206**
454		**-END-**			
Aircraft	**Check**	**Station**	**Date**	**Flight Hours**	**Cycles**
454	**CC**	**3 TUL**	**30 Sep 91**	**10,710**	**6,573**
454	**CC**	**4 TUL**	**8 Apr 92**	**12,194**	**7,474**
454	**CC**	**5 TUL**	**14 Jun 93**	**15,505**	**9,488**
454	**CC**	**6 TUL**	**26 Jun 94**	**18,544**	**11,135**
454	**CC**	**7 TUL**	**10 Oct 95**	**22,629**	**13,176**
454	**CC**	**8 TUL**	**25 Jan 97**	**26,546**	**14,985**
454	**CC**	**9 TUL**	**14 Apr 98**	**30,436**	**16,798**
454	**CC**	**10 TUL**	**22 Jun 99**	**34,199**	**18,530**
454	**CC**	**11 TUL**	**29 Aug 00**	**37,814**	**20,198**
454	**CC**	**12 TUL**	**1 Nov 01**	**41,387**	**21,914**
454	**CC**	**13 TUL**	**14 Nov 02**	**44,414**	**23,417**
454	**CC**	**14 TUL**	**5 Mar 04**	**47,514**	**24,931**
454	**CC**	**15 TUL**	**26 May 05**	**51,238**	**26,794**
454	**CC**	**16 TUL**	**22 Nov 06**	**55,355**	**28,947**
454		**-END-**			
Aircraft	**Check**	**Station**	**Date**	**Flight Hours**	**Cycles**
454	**HC**	**1 TUL**	**8 Apr 92**	**12,194**	**7,474**
454	**HC**	**2 TUL**	**10 Oct 95**	**22,629**	**13,176**
454	**HC**	**3 TUL**	**22 Jun 99**	**34,199**	**18,530**
454	**HC**	**4 TUL**	**14 Nov 02**	**44,414**	**23,417**
454	**HC**	**5 TUL**	**22 Nov 06**	**55,355**	**28,947**

The Corrosion Prevention and Control Program is mandated by AD 92-22-08R1 with an effective date of January 12, 1994. The purpose of the MD-80 Corrosion Prevention and Control Program is to maintain the MD-80 fleet in such a manner as to prevent occurrence of corrosion findings in excess of Level 1 (minor corrosion with no structural degradation) after the initial inspection of each area of an airplane. The basis for the establishment of inspection tasks and repeat inspection intervals, and

determination of corrosion levels within this program, is provided in MD/Boeing Document D6-36022, **Aging Airplane Corrosion Prevention and Control Program**, Revision E, dated June 11, 1997. AA's Corrosion Prevention and Control Program status list was reviewed for the accident aircraft and was found to comply with the program with no significant corrosion found.

The Repair Assessment for Pressurized Fuselages Program describes the AA procedures for compliance with 14CFR Part 121.370 "Repair Assessment" for pressurized fuselages. The AA procedures were based on the guidelines in MD/Boeing Document MSG-3 MRB Report.

5.0 Continuing Analysis and Surveillance (CASS)[4]

AA has a Continuing Analysis and Surveillance (CASS) program that calls for daily meetings to review the previous days maintenance discrepancies of their fleet to ensure the adequacy of the maintenance programs and to confirm the programs are properly followed, controlled, and effective. The AA CASS program was approved the FAA.

In addition to the daily AA meetings, AA conducts monthly CASS/reliability meetings held on the last Thursday of every month, in which the FAA's Principal Maintenance Inspector (PMI) for AA or his/her representative often attends. A monthly reliability report is furnished to the FAA and covers the preceding month's activity and is a statistical analysis of maintenance data collected from the following sources: (1) Departure delays; (2) Flight cancellations; (3) Pilot reports; (4) Component removals and (5) Engine data.

6.0 Minimum Equipment List (MEL)[5]

AA was authorized to use an approved MEL on its MD-80 airplane fleet per its OP Specs. At the time of the accident, there were 6 open MEL items in the airplane logbook including the No. 1 engine start valve (ATA Code 8000).

7.0 Supplemental Type Certificates (STC)[6]

MD-80 Supplemental Type Certificates (STC) used by AA were reviewed and the majority of the 12 MD-80 STCs were avionics related. None were related to the engine start system.

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[4] As established by 14 CFR Part 121.373, each certificate holder shall establish and maintain a system for the continuing analysis and surveillance of the performance and effectiveness of its inspection program and the program covering other maintenance, preventative maintenance and alterations and for the correction of any deficiency in those programs, regardless of whether those programs are carried out by the certificate holder or by another person.

[5] The FAA approved Minimum Equipment List contains a list of equipment and instruments that may be inoperative on a specific aircraft for continuing flight beyond a terminal point.

[6] The FAA issues Supplement Type Certificates, which authorize a major change or alteration to an aircraft, engine or component that has been built under an approved Type Certificate.

8.0 Airworthiness Directive (AD)[7] and Service Bulletin (SB) Summary

AA provided an AD summary sheet that included a list of applicable SBs. AA does not have a separate sheet that tracks SB compliance alone. A review of the status of applicable P&W JT8D-200 series engine ADs revealed that all the ADs had been complied with. The records indicated that there were no ADs due at the time of the engine fire and subsequent emergency landing.

9.0 Aircraft Maintenance Logbook

The Airplane Maintenance Logbooks contain daily flight and maintenance information. The logbooks pages for the accident airplane, dated July 2007, through September 28, 2007 were reviewed and revealed that all the required maintenance checks were up-to-date and complete.

10.0 Weight and Balance Summary

According to the AA OpSpecs, the MD-80 airplanes are required to be weighed every forty-two (42) calendar months. The last documented weight and balance summary for the accident airplane was accomplished on August 29, 2006, in Tulsa, Oklahoma.

11.0 Service Difficulty Reports (SDR)[8]

From April 2004 through October 2007, AA Maintenance submitted approximately 20 SDRs to the FAA for aircraft N454AA. The breakdown of the SDRs was as follows: Structural (6), Electrical (10), Lights (2), and Engines (2).

12.0 Major Repairs and Alterations

The airplane major repair and alternations records were reviewed. None of the recorded major repairs included the left engine, left pylon, or engine start system. A review of the airplanes alterations revealed that no engine start systems were altered in any way in the past five years.

13.0 Time Limit Control Components

Time limited component status for the airplane and the two installed P&W JT8D-219 powerplant engines and the Honeywell APU were reviewed. No items were found that exceeded the time limit on this airplane.

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[7] Airworthiness Directive (AD) is a regulatory notice sent out by the FAA informing the operator of an action that must be taken for the aircraft to maintain its airworthiness status.

[8] A Service Difficulty Report (SDR) is a report of the occurrence or detection of each failure, malfunction, or defect as required by 14 CFR 121.703.

14.0 Vendors

The Maintenance Records Group reviewed the Approved Vendor List provided by AA. All substantial maintenance vendors are listed in the AA OpSpecs section D091. On average, AA conducts audits of their approved vendors every two years; however, they also utilize the C.A.S.E program for which they are approved to use.

15.0 Method of Record Keeping

All routine and non-routine work forms, log books, serviceable part tags from components installed, deferred items records, engine records, etc., are entered into the aircraft computer records (Management Information Systems for Aviation) on a daily basis. A computer file history is maintained so that all inspections and checks can be monitored for time limitations. The computer files are backed up daily to prevent total loss of history files and hard copies of the maintenance work is kept at AA at their Tulsa facility.

16.0 Manuals

AA uses the following manuals to maintain the airworthiness of its fleet and management of the airline.

AA General Procedures Manual (GPM) – A guide to company polices and procedures to be followed by all persons performing maintenance and inspection services on company aircraft.

AA Maintenance Procedures Manual (MPM) – This manual contains the Maintenance Procedures required to dispatch the aircraft per the minimum equipment list (MEL) manual and is supplemented by the Aircraft Maintenance Manual (AMM), Standard Practices Manual, and Adequate Safety Precautions Manual

AA Engineering Specifications Manual (ESM) – FAA approved time limits for the accomplishment of the overhaul, replacement, periodic inspection and routine checks of the aircraft, and its component parts, accessories, and appliances. The most current version of this document is ESM S80 **Revision CC** dated 9/3/08.

AA Supplemental Maintenance Manual – Provides a supplement to the manufacture maintenance manual.

Supplemental Illustrated Parts Catalog – Provides a supplement to the manufacturer Illustrated Parts Catalog.

Minimum Equipment List (MEL) – List of equipment and instruments that may be inoperative on a specific aircraft.

Weight and Balance Manual – Weight and balance procedures to be followed by maintenance and flight operations personnel on all aircraft operated by AA.

Powerplant Maintenance Specification 9000 - Contains the complete specifications for the detailed shop inspection and repair requirements for the Pratt & Whitney JT8D series engines operated by AA. This specification is to be applied to the complete engine as well as to the individual modules of the engine.

Manufacture Supplied Manuals - Aircraft/Engine Maintenance Manuals, Structural Repair Manuals, Wiring Diagrams, Overhaul Manuals, Illustrated Parts Catalog, Corrosion Program Manual, Non-Destructive Testing (NDT) Manual, Significant Structure Items Manual, SBs and Engine Manuals.

17.0 No. 1 Engine Start Valve Discrepancy History

A review of the maintenance log records for the accident airplane for the between September 1, 2007, and September 30, 2007, for start valve discrepancies or engine start problems revealed the following (**Attachment 1**):

September 16, 2007, KTPA (Tampa), Log Page: 45480E650

Discrepancy:[9]	"LH start Valve Will Not Open"
Maintenance Action:	"Replaced Left Eng start Valve- OPS Normal"

September 16, 2007, KORD (Chicago) Log Page 45480E651

Repeat Write up:	"Repeat Write Up #79 Left Start Valve Will Not Open"
Maintenance Action:	"Removed And Replaced #1 ENG start Valve Per M/M Start Valve Operation Normal"

September 17, 2007, KORD (Chicago), Log Page 45480E659

Discrepancy:[10]	"Left engine start Valve Will Not Open."
Maintenance Action	"MEL Entered In MIC Sheet. Placarded Left Engine Start Valve Auth 9-1455C-C."

September 17, 2007, KDFW (Dallas-Ft Worth), Log Page 45480E659

Info:[11]	"MEL Continued"
Maintenance Action:	"Replaced Start Valve, Found Air Filter Not Allowing Air Flow To Valve. Part NIS At DFW. Continue Deferral. Tulsa Tech Notified."

[9] Pilot report #79.
[10] Pilot report #86.
[11] Information from Line Maintenance.

September 17, 2007, KORD (Chicago), Log Page: 45480E659

Maintenance Action:	"Removed and Replaced 8th Stage Check Valve And Air Filter For Start Valve. On Initial Start Sequence W/ APU Air On. Start Valve Wont Open. After Cycling Start Switch The Second time, Start Valve Opens And Engine Starts Turning. Only Happens When APU Air Switch Is Initially Turned On W/O Duct Pressure."

September 17, 2007, KORD (Chicago), Log Page: 45480E658

Maintenance Action:	"MEL 09-1455C-C Engine Start valve"
INFO Entry	ATBT accomplished. No Help. Needs Further T/S

September 17, 2007, KDFW (Dallas-Ft. Worth), Log Page: 45480E658

Maintenance Action:	"Replaced Start Valve, No Help, Found Air Filter (CPN 5463619) Not Allowing Air Flow To Valve. Part NIS At DFW. Continue Deferral. Tulsa Tech Notified."

September 18, 2007, KTUL (Tulsa), Log Page: 45480E658

ATBT Entry:[12]	"Field Reports LT ENG start Switch Requires Engagement Twice To Open Start Valve Even Though APU Air Ramps Up To 40 PSI. Ref WDM 74-11-00 PG 557 and WDM 49-31-01 PG 516 SHT 3. Remove APU ECU and Disc Starter Plug P1-838 and MEG Wiring From CB B1-1 To Pin A Of Plug P1-838 and Pin B10 Of ECU Plug R5-604A. The Start Signal Splits From Terminal Block S3-48 and Goes To Both Starter And ECU.2."
FACT:[13]	"Started L/H ENG Several Times, Could Not Duplicate. Start Valve Operated Normally. OK For Service. RMVD Placard And Cleared MIC Sheet."

September 19, 2007, KORD (Chicago), Log Page: 45480E65F

Discrepancy:[14]	"Left Engine Start Valve would Not Open Until The Fourth Attempt."
Maintenance Action:	"Deferred Left engine starter shut Off Valve Maint PER MEL Entered on MIC Sheet. MPM 80-2 Accomplished.

[12] ATBT is an abbreviation for "Action To Be Taken". It is an instruction given to maintenance by Tech Services, Maintenance Operations Control (MOC) department of American Airlines in Tulsa, Oklahoma. Tech Services executes part of the airline's CASS program.
[13] Maintenance action listed as "FACT" for final action taken.
[14] Pilot report #89.

	MEL 09-1672C-C."
ATBT (TUL) Entry:	"Previous History. 2 Valves Replaced, No Help…Troubleshoot wiring PER WDM 74-11-00. Repair As Required."

September 19, 2007, KAUS (Austin), Log 45480E65F

FACT:[15]	"Replaced #1 Engine Start Switch And Start Valve. OPS CKS OK. LK CK OK. Removed Placard Cleared MIC"

September 27, 2007, KDFW (Dallas-Ft. Worth), Log Page: 45480E673

Discrepancy:[16]	"Left Start Valve Did Not Open On Engine Start"
INFO:	"Replaced LT ENG Start Valve No Help Placarded LT ENG Start Valve Inop PER MEL VLV Opened And Verified Closing PER MPM."
ATBT Entry:	"Suggest Troubleshooting Wiring. REF WDM 74-11-00 Start Valve Has Been Replaced REF MM 80-10-02-2. Check Operation Of Valve Repair Per Your Finding.***Note Start Valve Replace In DFW 27/SEPT/07 And In ORD 16/SEPT/07 Start Valve Switch Replace In SEPT/19/07"

18.0 No. 1 Engine Start Valve Maintenance Actions

Review of the air start valve change history for the No. 1 engine revealed that the start valve (designated VAL6256)[17] was changed six times within 12 days (See section 17.0 for details). According to the Field Maintenance Report (FMR) print out for N454AA, there were no ATA 8000 (start system) faults for the 60 days prior September16, 2007, which was the first reported start problem (**Attachment 2**). The left engine start switch was changed once and the left engine start valve operation was deferred four times and each time, entered on the MEL list. After arriving at a suitable maintenance base (Class 1 or 2)[18] the start valve was removed and replaced, an operational check was performed on the start system, and the deferred item was removed from the MEL list. Review of the Action To Be Taken (ATBT) entries to the Field Maintenance Report (FMR) revealed that on three separate occasions (September 18, 19, and 27, 2007), technical services (maintenance control located at Tulsa) sent ATBT to the line mechanic for further air start valve troubleshooting guidance to address the problems.

[15] Maintenance action listed as final action taken.
[16] Listed as MDIS for maintenance discrepancy.
[17] AA designated the No. 1 (left) engine start valve as VAL6256 in their parts inventory and tracking programs. The No. 2 (right) engine start valve is designated VAL6257.
[18] Class 1 is a lightly staffed maintenance base and a Class 2 is a fully staffed AA maintenance facility.

18.1 Boeing Engine Start Maintenance Procedures

Review of the DC-9/MD-80 Maintenance Manual (Boeing) recommended maintenance practices, section 80-10-00 **Cranking – Description and Operation**, revealed two methods to manually start an engine (**Attachment 3**). The first method assumes that the shutoff valve solenoid valve is inoperative and allows the mechanic to depress the solenoid manual override button. Depressing the button accomplishes the same function as normal electrical activation of the valve. The Boeing instruction provides a CAUTION to only use hand pressure. The CAUTION reads as follows:

> "Use only hand pressure to depress the override button. Use of screwdriver or other type of prying device to depress override button can deform slender pin mechanism inside valve. A deformed override bottom pin can hold solenoid switcher ball off its seat which allows valve to open uncommanded when air pressure is available to engine start valve. If undetected or uncorrected, this condition will result in significant damage to engine starter."

The second method to manually activate the valve is to use a special tool (WRE 9550) to engage the hex fitting located on the other side of the butterfly valve. The hex fitting is marked with a notch to point to labels "OPEN" or "CLOSED" on the switch cover.

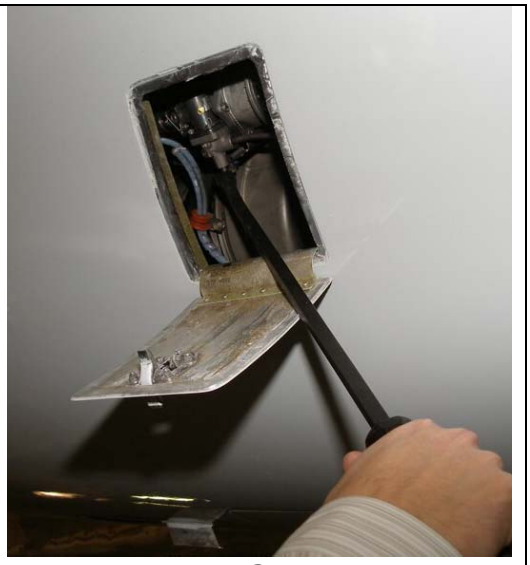
On December 16, 1997 Boeing Product Support department issued an All Operators Letter (AOL), number 9-2549 to all DC-9 and MD-80 airplane operators to clarify procedures for start valve failures. In the AOL, Boeing related information about a failed start valve, clarified proper maintenance dispatching action when the annunciator system malfunctions, provided additional information and cautions relating to possibility of deforming the manual override pin, and informed operators that temporary revisions to DC9/MD-80 MM Chapters 80-10-0 and 80-10-2 would be issued to include cautions and notes to prevent deformation of the pin (**Attachment 4**).

18.2 American Airlines Manual Engine Start Procedures

Review of AA's manual engine start procedure in the AA Maintenance Procedures Manual, MEL/CDL, chapter 80, **Starter Shutoff Valve – Maintenance Practices AA MEL 80-2**, dated October 27, 2006, revealed that only one method of manual starting was approved and authorized for use. The approved method required opening the start valve by using the manual hex head feature and no mention was made of using the override button. Unlike the Boeing procedure that specifically calls out the use of wrench PN WRE 9550 to activate the butterfly valve, the AA procedure at the time of the accident did not specify any particular tool. Since then, AA had made changes to their manual engine start procedures to include deactivating the start valve by disconnecting the air line and capping exposed lines and by specifying the tool to be used – PN WRE 9550 (**Attachment 5**).

Although the written procedures to use the specialized tool were well known, according to interviews with line mechanics, it was customary and the most expeditious method to use the manual override button. Typically, a prying device, such as a screwdriver would be used to depress the override button in the event that a start valve failed to open and a manual start was necessary (**Photos 1 and 2**). Furthermore, according to line mechanics statements, AA maintenance supervisors were aware of the use of the override button to manually start the engine and did not take any action to prevent or dissuade its use (**Attachment 6**). Since the use of the override button was not an authorized procedure in the AA maintenance manual, no written CAUTIONS or WARNINGS statements, similar to those in the Boeing procedure, existed to warn the mechanic that prying the override button could result in a bent pin and a stuck override shaft.

1



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Photos 1 and 2: Typical AA Method for Manual Engine Start

Discussions with AA engineering revealed that changes to the maintenance procedures can by requested by any AA employee by submitting a Form E63 "Request for Services" (**Attachment 7**). Guidance and the Form E63 are located in the GPM which is a guide to AA polices and procedures to be followed by all persons performing maintenance and inspection services on company aircraft. A review of the AA change requests did not reveal any requests for changes in the for manual start procedures. The MD-80 engineering section of AA in Tulsa stated that, had a request been submitted, action to review and revise the maintenance procedures would have been accomplished (**Attachment 8**). Review of the maintenance deferral procedures revealed that start valve failures could be deferred by maintenance personnel, the logbook entry completed, the start switch placarded, then the manual start could be attempted. The manual start procedures included coordination with the flightcrew such that the butterfly valve was manually held open, the flightcrew activated the start switch and completed the start normally, after which the maintenance person would close the butterfly valve and verify that the valve index was in the closed position.

19.0 Other Aircraft Start Valves

Review of AA's maintenance write-ups for the MD-80 series fleet for reported engine start problems during the same period as the reported engine start problems for the accident airplane (September 16 – 28, 2007) revealed 27 different airplanes had also had engine start problems. Of the 27 maintenance write-ups, 18 were deferred and the item entered into MEL. All start valve records indicated the start valve issue was resolved but none of the corrective actions indicated changing the air starter valve filter. In each of the 27 cases, once the start problem was resolved, none had repeat discrepancies within the few days that followed (**Attachment 9)**. After the accident AA had additional start valve (ATA 8000) annunciator light (illumination on take off) failures. See Addendum 1 to Powerplant Factual Report.

20.0 Repeat Maintenance Items

In Chapter 23 **Surveillance** in the GPM, Sections 23-01 **Reliability/Performance Analysis** and Section 23-21 **Data Analysis** provide the procedures for providing long-term monitoring relating to the mechanical reliability of an aircraft system, structure, engine and components by collecting and analyzing mechanical performance data (**Attachments 10 and 11**). Along with the procedures, this guidance also provides areas of responsibility. According to AA, during each technical services shift at the Tulsa Maintenance facility, two technical services personnel were assigned to review and act on "alert" items that were reported by the field mechanics. An "alert" is a preset item within the AA computer maintenance system that automatically flags repeat discrepancies, deferred items placed on MEL status, and other safety related reports from the line mechanics.

The "alert" list was reviewed by Tech Services to offer aid for troubleshooting by line mechanics and track logistics fleet-wide issues. A review of the engine start valve (ATA 8000) "alert" items for aircraft N454AA revealed that the first "alert" that the system produced by computer printout for the accident airplane occurred on September 16, 2007. The "alert" had the listed discrepancy and the mechanics action. No comment was made by the technical services representative. The second "alert" occurred on September 17, 2007, and had the discrepancy, the maintenance action, and a request (ATBT) by technical services to conduct extensive troubleshooting. After accomplishing the ATBT, the start valve would not operate properly, no further action was taken; the start valve remained on the MEL until the next maintenance base. At the next maintenance base, the mechanic reported that the start valve was replaced but the filter was not allowing control air through the air line. The records show that there was not a part in stock (NIS), the deferral was continued, and Tulsa Tech notified. The maintenance action ended on September 18, 2007, at the Tulsa maintenance base, when the mechanic reported "could not duplicate" and removed the start valve from the MEL. The third "alert" occurred on September 27, 2007, and the discrepancy, the actions, and the comment (ATBT) to troubleshoot more extensively the wiring were recorded.

21.0 Start Valve Filters

The AA maintenance program for the filters was based on MRB 80-001-02 and listed in AA ESM, which recommends cleaning of the filter elements at 1C intervals. The MRB does not recommend an inspection or "hard time" replacement of the filters. The MRB does not recommend tracking filter changes or tracking filters by S/N. AA developed separate work cards with identical instructions for cleaning and replacing fuel and air filters for the left engine, work card 7751 and for the right engine, work card 7752. According to work cards 7751 (**Attachment 12**) and 7752 (**Attachment 13**), both dated March 16, 2006, Step 4, the start valve filter inspection in effect at the time of the accident was to clean the screen with solvent, dry it with compressed air and reinstall it. Neither work card provided a requirement or criteria for visual inspection of the filter screen. On May 28, 2008, AA revised Step 4 for work cards 7751 and 7752 to state that "N/A all of Step 4 if ECO K3338 is accomplished"[19] (**Attachments 14 and 15, respectively**). Step 6 was added that requires a filter inspection for breaks, tears, cracks or other degradation. As part of step 6, blanks were added to note inspection results, and a column was added to require Quality Assurance personnel sign-off.

A review of the Boeing maintenance troubleshooting and testing for start valves did not include the possibility of a failed filter. An air line that did not allow airflow was assumed to be a dirty filter and cleaning procedures would have been applicable.

Review of the filter manufacturer, PTI, Technologies, Inc., sales revealed that 72 filters were sold to distributors in 2007 for the entire fleet of aircraft worldwide. The filter manufacturer indicated that the filter model used on all MD-80 series aircraft is also used on several other DC-9 model aircraft. According to PTI, no previous malfunctions had been reported to them concerning filter failures before the accident date. Furthermore, according to PTI, they did not establish a service life or inspection interval for the filter. According to Boeing, the Boeing MD-80 MSG-3 Maintenance Program Work Cards recommend that the Start Valve Line Filter should be cleaned at a "1C" interval in accordance with Task Card No. 801C-097. The Starter Shut Off Valve Inline Filter is not a life limited part as it is not found in the Safe Life Limits (SLL) report for the MD-80 as defined in Report No. MDC-J0005.

22.0 Corrective Actions

AA made numerous changes following the accident. All of the start valve filters have been replaced with new filters and new inspection and cleaning criteria has been implemented. The engine start valve MEL procedures have been changed to disconnect the air supply line from the valve to avoid inadvertent activation and any of the disconnected lines are capped.

[19] ECO K3338 is the engineering change order that specifies a new filter.

AA engineering has informed Safety Board staff that an Engineering Modification has been submitted to Boeing, Honeywell, and the FAA for approval to shorten the bottom manual override pin on the start valve solenoid to prevent the possibility of bending during manual starts, even if a prying device is used. The approval and modifications are expected in the next six months.

AA provided a computer print out, sorted and in numerical sequence by ATA code, for all the discrepancies due to the engine fire and corrective actions taken to return airplane N454AA back to service (**Attachment 16**). In order to bring back the airplane to service, AA removed and replaced the No. 1 engine (left), pylon, cowls, engine pylon apron, engine mounts, cone bolts and inspected the structural area for fire damage in accordance with the maintenance manual and structural repair manual. According to AA, the aircraft has not experienced any further start valve problems or any significant structural problems.

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ATTACHMENTS:

1	AA Line Maintenance Organization Chart
2	Field Maintenance Report (FMR) print out for N454AA
3	DC-9/MD-80 Maintenance Manual (Boeing) recommended maintenance practices, section 80-10-00 **Cranking – Description and Operation** (Boeing Procedure)
4	Boeing All Operators Letter, Number 9-2549,dated December 16, 1997
5	AA Maintenance Procedures Manual, MEL/CDL, chapter 80, **Starter Shutoff Valve – Maintenance Practices AA MEL 80-2**, dated October 27, 2006
6	Line Mechanic Interview Statements
7	GPM Chapter 02-23 Request for Services/Form E63
8	MD Engineering Comments on Procedural Changes
9	Other Aircraft Start Valve Write-up between September 16 - 28, 2007
10	GPM Chapter 23 Surveillance 23-01 Reliability/Performance Analysis
11	GPM Chapter 23 Surveillance 23-21 Data Analysis
12	Left Engine Fuel & Filter – Clean/Replace Work Card 7751, dated 3/16/2006
13	Right Engine Fuel & Filter – Clean/Replace Work Card 7752, dated 3/16/2006
14	Left Engine Fuel & Filter – Clean/Replace Work Card 7751, dated 5/28/2008
15	Right Engine Fuel & Filter – Clean/Replace Work Card 7752, dated 5/28/2008
16	Computer print out for return to service for airplane N454AA