

NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

August 8, 2008

Operational Factors/Human Performance Group Chairmans' Report

OPERATIONAL FACTORS / HUMAN PERFORMANCE

DCA07MA310

A. ACCIDENT

Operator: American Airlines
Location: Lambert - Saint Louis International Airport (STL), Saint Louis, Missouri
Date: September 28, 2007
Time: 1313 central daylight time¹
Airplane: MD-82², Registration Number: N454AA, Serial # 49559

B. OPERATIONS/ HUMAN PERFORMANCE GROUP

Captain B. David Tew – Co-Chairman Operational Factors Division (AS-30) National Transportation Safety Board 490 L'Enfant Plaza East, SW Washington, DC 20594-2000	Dr. Evan Byrne – Co-Chairman Human Performance Division – (AS-50) National Transportation Safety Board 490 L'Enfant Plaza East, SW Washington, DC 20594-2000
Captain Kevin G. Elmore Member Allied Pilots Association 14600 Trinity Boulevard Suite 500 Fort Worth, TX 76155	First Officer Mark L. Maestas - Member MD-80 Program Manager/Tech Pilot 4601 Highway 360 MD 843 Fort Worth, TX 76155

¹ All times are central daylight time based on a 24-hour clock, unless otherwise noted. Actual time of accident is approximate, determined by the Flight Data Recorder (FDR) and Air Traffic Control (ATC) transcripts.

² MD-80 is the FAA type designation used for the accident airplane. MD-82 is a version of the MD-80.

Mr. Tom J. Walsh - Member FAA – Supervisory Aviation Inspector 100 Hartsfield Centre Pkwy. Atlanta, GA 30354	
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1.0 HISTORY OF FLIGHT

On the day of the accident, the crew reported for duty about 1140 for a scheduled departure time of 1240. The airplane was late arriving from Chicago, Illinois. The actual departure time of the flight was 1302. Both the captain and F/O had ridden flights into STL prior to the accident flight. This was their first flight of their sequence. The captain and F/O had never previously flown together.

The airplane had a previous history of maintenance discrepancies concerning the start valve on the left engine and American Airlines’ maintenance personnel had previously performed corrective maintenance on the start valve. During their initial attempt to start the left engine for the accident flight, the crew did not observe indications of engine rotation on the cockpit gauges. Maintenance was alerted and manually opened the start valve to assist the crew in starting the left engine. The crew stated³ that during the second attempt to start the engines, both engines started and all engine indicators appeared normal after start.

The crew stated that during their taxi for takeoff, all required checklists were performed and all cockpit indications were normal with no alert lights illuminated.

The captain was the pilot-flying (PF) and he said the takeoff was uneventful until about 1,000 to 1,500 feet altitude above ground level when they received the first abnormal indication. At that time, the crew noticed that the Left Engine Start Valve light had illuminated. According to the captain, about 5-10 seconds after they noticed the Engine Start Valve light, the left engine fire warning bell sounded and the left engine fire warning light [ENG FIRE] illuminated. The F/O stated that he thought about 30 seconds after they noticed the Engine Start Valve light, the left engine fire warning bell sounded and the left engine fire warning light [ENG FIRE] illuminated. The captain said, “to the best of his knowledge”, he called for the Engine Fire / Damage / Separation emergency checklist⁴ after they received the engine fire warning and the first officer (F/O) began to perform the checklist. The F/O was also handling radio communications. The crew declared an emergency to the air traffic controller (ATC).

On the downwind leg, the captain said he transferred control of the airplane to the F/O so he could talk to the flight attendants. The engine fire indication was still illuminated and the F/O had not completed the Engine / Fire / Damage checklist when the captain interrupted the checklist and transferred control to the F/O. The F/O said the captain transferred control of the airplane after the autothrottles were disconnected⁵. The captain said his memory of the event was they went straight through the initial steps of the Engine / Fire / Damage / Separation checklist, but after listening to the

³ See attachment 1 –Interview summaries and crew statements
⁴ See attachment 2 – Engine Fire/ Damage/ Separation checklist
⁵ Autothrottles OFF was the first item on the Engine Fire/Damage/Separation checklist

cockpit voice recorder (CVR), he realized that he briefed the flight attendants (F/As) in the middle of the Engine / Fire / Damage checklist. There was still an indication warning of an engine fire when the captain interrupted the checklist to brief the F/As via interphone and the passengers via the public address (PA) system. The captain said he briefed the F/As and the passengers about the situation and informed them that they would return to STL. The captain said he felt like they only had a short time before they would be on the ground and that he needed to brief the flight attendants before the airplane was on short final. The captain said he briefed the #1 F/A that they had a fire indication in the left engine, they would be on the ground in less than ten minutes, and that he did not anticipate that an emergency evacuation would be required. The captain stated to the #1 F/A that if it was determined an emergency evacuation was needed, he would give her an “Easy Victor”⁶ signal three times over the public address system. While the captain was briefing the F/As and passengers, the procedures to fight an engine fire were not being completed. The captain then resumed control of the airplane after he had completed his briefing.

After the captain took control of the airplane, the F/O resumed performing the Engine Fire / Damage / Separation checklist. The F/O stated that both the fuel lever and the fire handle were harder than normal to move. The F/O discharged both fire agent bottles into the left engine because the ENG FIRE light remained illuminated after the first bottle had been discharged. The F/O said that after he discharged both fire agent bottles, they were approaching a base leg, so they began preparation for landing. The F/O said they did not complete the Engine / Fire / Damage / Separation checklist because there was not enough time. Items on the Engine Fire / Damage / Separation called for the crew to perform a One Engine Landing checklist⁷ and an Emergency Landing checklist⁸ prior to landing. These checklists were not performed. The captain said he was very familiar with the Single Engine Landing checklist⁹ so he informed the F/O that there was no need for him to perform it. The left engine fire indication light remained on after the fire agent was discharged and remained on after the airplane landed.

The captain stated that at about the time they were shutting off the fuel lever for the left engine, they began to experience some electrical malfunctions which resulted in losing displays on the captain’s primary flight display (PFD) and navigation (NAV) display panels. The captain said a lot of cockpit lights were not on that should have been on and he did not trust the lights that were on because the electrical system was “acting strange”. The autopilot without auto-throttles would have been useable if the digital flight guidance computer was selected to the number 2 system, but the captain elected to manually fly the airplane using the standby flight instruments and visual cues from outside the airplane.

As they maneuvered to land at STL, the nose gear failed to extend when they attempted to lower the landing gear. The F/O said he attempted three times to contact the tower controller for a visual confirmation of the position of the landing gear. The F/O said the controller was busy simultaneously working arrivals and departures. The captain said by the time communications were established and they were informed by the controller that the nose gear did not appear to be

⁶ “Easy Victor” was a standard code signal that the flight crew was trained to use to indicate that an evacuation was to begin.

⁷ See attachment 3 – One Engine Landing checklist

⁸ See Attachment 4 – Emergency Landing checklist

⁹ The single engine landing checklist was titled One Engine Landing checklist in the American Airlines manuals.

extended, they were too close to the airport to correct the situation before landing. The captain said he elected to go-around to allow time to trouble-shoot the landing gear problem. The captain said he thought he commanded a go-around. The F/O said he informed ATC that they would be performing a go-around. During this time, the left engine fire indications were still illuminated.

The captain asked for a company pilot, who was riding in the passenger cabin, to come to the cockpit jumpseat to assist in communications with the F/As and passengers and provide an extra “set of eyes” in the cockpit. According to the jumpseat pilot, when he entered the cockpit, he was given a brief 10 second “thumbnail sketch” of the situation and was asked if he had any ideas to help. He observed a lot of lights on in the cockpit at that time and told investigators that he could not figure out what the problem was by looking at the lights as most “everything was on”. He said they were about mid-field on a downwind leg at that time. Investigators asked the jumpseat pilot if he saw anything that the captain or F/O had missed. He said he noticed some hydraulic anomalies, but didn’t mention them because he thought the crew was already aware of them. He said the captain had his hands full flying the airplane and his priority was focused on flying the airplane. The captain asked him to assist the F/O and to coordinate with the F/As. He talked on the passenger address system and coordinated with the F/As. On the downwind leg, there was a short discussion of emergency gear extension and the F/O performed the Emergency Gear Extension checklist¹⁰. Upon completion of the Emergency Gear Extension checklist, all of the landing gear were extended.

The jumpseat pilot said things were happening fairly quickly as they turned base for a short approach. He did not recall at what point the nose gear was extended. His best recollection was that the nose gear was extended somewhere between the downwind and the base leg.

The captain landed the airplane and Aircraft Rescue and Fire Fighting (ARFF) vehicles followed the airplane on the runway during the landing rollout. After he had stopped the airplane, the captain said he immediately established contact with ARFF personnel and was informed that there was “still a little bit of fire”¹¹ in the engine. The captain said he was also informed that AARF was in the process of spraying foam on the remaining fire. The captain said he elected to keep the passengers on the airplane due to foam on the runway, the presence of the ARFF vehicles, and because there was no visible smoke or fire in the cabin.

The jumpseat pilot said there was no mention of any anomalies in the cabin from the F/As. He said that AARF was “right there” when they stopped and the captain opened his window and talked with the AARF chief. He did not know what conversation transpired between the captain and AARF. The jumpseat pilot said, after they landed, he initially talked to the #1 F/A seated on the F/A jumpseat. After a few minutes, the other F/As came forward because they wanted to get an idea of what had happened and what was going to happen. The jumpseat pilot conversed with the F/As face to face and passed along the information that he had and he recalled the topic of the conversation with the F/As was that everything was good. He tried to reassure them that they were not in any immediate danger. He took a look back into the cabin to see if there was any panic among the passengers. He said there was a lot of “looking around and conversation” but

¹⁰ See attachment 5 – Emergency Gear Extension checklist

¹¹ “Still a little bit of fire” was found on the ATC transcript of communications with the flight. It was described by AARF personnel as a small amount of fire on a piece of mesh hanging from the engine.

everyone remained seated and were relatively calm. He said the captain had made a decision not to evacuate immediately and his conversation with the fire chief confirmed that.

The F/O said the After Landing checklist was not performed. He said he “cleaned up” the airplane as he normally did after a landing but did not recall which items were “cleaned up”.

After a few minutes on the airplane, while the AARF crew performed their duties, the F/O elected to open the pneumatic crossfeed valves to provide air to the air-conditioning packs for passenger comfort. The movement of the left pneumatic crossfeed handle resulted in the left engine fire handle being retracted, which allowed fuel to be directed into the area of the left engine and out onto the ground. AARF personnel informed the crew of fuel spilling out of the engine and the crew responded saying that they had corrected the situation by pulling the left fire handle out again. As a result of the fuel spillage, the AARF incident commander decided he wanted the passengers to disembark from the airplane. The passengers were disembarked and transported by bus to the terminal. The crew shutdown the right engine and, at the suggestion of a mechanic, pulled the circuit breakers (CB) for the CVR and FDR.

2.0 FLIGHT CREW INFORMATION

Both crewmembers were current and qualified under American Airlines and FAA requirements.

Tests for drug and alcohol were not administered post-accident.

American Airlines provided the following information on company policy when asked why tests for drug and alcohol were not administered to the pilots:

“The policy allows judgment on the part of the Chief Pilot in these type of situations, and states: “Testing is required if with the best information available at the time, the crewmember’s performance could not be completely discounted as a contributing factor to the accident”. There was no accident and no one was hurt, and there was no evidence whatsoever to question the crew’s sobriety as a contributing factor. “Probable cause” was not a factor, since every piece of evidence pointed to the crew handling a mechanical malfunction of the aircraft.”

2.1 Captain Steven Earle Garbe

Date of hire with American Airlines, Inc.: August 6, 1990

First class medical certificate dated March 5, 2007 –limitation –must wear corrective lenses; possess glasses for near/intermediate vision

Captain Garbe was wearing his glasses during the flight.

Training and Proficiency Checks:

Upgraded to captain on MD-80¹² on July 25, 2001
 Last recurrent training: January 27, 2007
 Last Proficiency check on MD-80 airplane: August 19, 2007

Flight Times: provided by American Airlines.

Total pilot flight time	14,000 hours
Total Pilot-In-Command (PIC) flight time	6,000 hours
Total MD-80 flight time	883 hours
Total MD-80 PIC flight time	831 hours
Total flight time last 24 hours	Prior to the accident flight, 0 hours
Total flight time last 30 days	71 hours
Total flight time last 90 days	103 hours
Total flight time last 12 months	497 hours

Captain Garbe flew a total of 711 hours as PIC on the MD-80 prior to being displaced to F/O on the B-777. He flew for five years as F/O on the B-777 then was requalified back onto the MD-80 as captain. He had been back on the MD-80 as captain for two months prior to the incident. During that two month period, he flew about 103 hours as PIC.

A review of FAA records found no prior accident, incident or enforcement actions for Captain Garbe.

2.2 First Officer Kevin May

Date of hire with American Airlines, Inc.: January, 1999
 First class medical certificate dated March 19, 2007 –no limitation

Training and Proficiency Checks:

Last recurrent training: May 16, 2007
 Last Proficiency check on MD-80 airplane: May 15, 2007

Flight Times: provided by American Airlines.

Total pilot flight time	7,000 hours
Total PIC flight time	1,500 hours
Total MD-80 second-in-command (SIC) flight time	3,004 hours
Total flight time in MD-80	3,004 hours
Total flight time last 24 hours	Prior to the accident flight, 0 hours
Total flight time last 30 days	69 hours

Total flight time last 90 days	116 hours
Total flight time last 12 months	Approximately 700 hours

A review of FAA records found no prior accident, incident or enforcement actions for First Officer May.

3.0 WEIGHT AND BALANCE

The following information was provided by the company post-accident:

	Weight
Basic Operating Weight	84,198 lbs.
Passenger Weight	24,581 lbs.
Baggage & Cargo	3,400 lbs.
Zero Fuel Weight	112,179 lbs.
Maximum Zero Fuel Weight	122,000 lbs.
Fuel	23,500 lbs.
Ramp Weight	135,679 lbs.
Taxi Fuel Burn	448 lbs.
Takeoff Weight	135,231 lbs.
Maximum Ramp Weight	150,500 lbs.
Maximum Takeoff Weight	149,500 lbs.
Maximum Landing Weight	130,000 lbs.

The airplane was within approved weight and balance limits for takeoff, but the landing weight could not be determined during the Operations/ Human Performance investigation.

4.0 AERODROME INFORMATION

At the time of the accident, Lambert – St Louis International airport elevation was 618 feet above mean sea level (MSL), and was located 10 miles northwest of St Louis, Missouri. The airport had four grooved runways. Three runways including the landing runway were 150 feet wide and runway 12R/30R was 200 feet wide. The landing runway 12L/30R was 9,003 feet long, runway 12R/30L was 11,019 feet long, runway 11/29 was 9,001 feet long, and runway 6/24 was 7,602 feet long.

Runway 12L/30R had high intensity runway lights (HIRL), centerline lights (CL), Approach Light, System with Sequenced Flashing Lights with ILS Cat-II Modification (ALSF - II), Touchdown Zone Landing lights (TDZ), and a precision approach path indicator (PAPI) on both ends of the runway. Runway 12L had Runway End Identification Lights (REIL).

12R/30L had HIRL, CL, medium intensity approach lighting system with runway alignment indicator lights (MALSR), TDZ, and PAPI lights on both ends of the runway. Runway 30L had REIL lights.

Runway 11/29 had HIRL, CL, ALSF - II, TDZ and PAPI lights on both ends of the runway.

Runway 6/24 had HIRL, MALSR, and PAPI lights on both ends of the runway.

5.0 COMPANY INFORMATION

American Airlines was a global Part 121 airline operating about 4,000 flights daily to 250 cities in over 40 countries. American was the second largest airline in the world based on operating revenues. The company's corporate office was in Fort Worth, Texas adjacent to the Dallas / Fort Worth International Airport. At the time of the accident, American operated a fleet of about 664 airplanes consisting of Airbus 300s; Boeing 737s, 757s, 767s, 777s; and about 335 McDonnell Douglas MD-80s. The airline had about 10 crew bases located throughout the United States.

6.0 Crew Procedures

6.1 Engine Start Valve checklist

The American Airlines DC-9 Operating Manual –QRH, ENG section, page 12, dated 3/31/06, L or R START VALVE OPEN light checklist provided guidance for crews to use if an engine start valve open light appeared during airplane operations. The guidance for a Start Valve Open occurrence in-flight stated in part:

In Flight

Accomplish QRH 2.1 – Engine Failure / Inflight Shutdown procedure.

The crew said that the left engine fire warning indication appeared shortly after the engine start valve open light appeared and they did not perform the L or R START VALVE OPEN checklist, but started to perform the Engine Fire / Damage / Separation checklist.

6.2 Emergency Procedures Accomplishment

The American Airlines DC-9 Operating Manual –QRH¹³, EMER/ABNORM PREFACE section, page 2, dated 3/31/06, paragraph Emergency Procedures Accomplishment stated in part:

Per FAR 121.557(a) – “In an emergency situation that requires immediate decision and action, the pilot in command may take any action he considers necessary under the circumstances. In such a case, he may deviate from prescribed operations, procedures and methods, weather minimums, and this chapter to the extent required in the interest of safety.”

The order of accomplishment for emergency procedures is as follows:

- 4. The pilot-monitoring (PM) will read from the QRH. Both challenge and response should be read aloud.*

¹³ QRH – quick reference handbook

5. *Upon completion of the checklist, the pilot-monitoring (PM) will announce, “----- checklist complete.”*
6. *After completing a procedure in the QRH, ensure that all other procedures and checklists are completed as appropriate for the phase of flight.*

6.3 Engine Fire / Damage / Separation checklist

During post-accident interviews, the captain stated that he initially thought that several items on the Engine Fire / Damage / Separation checklist were completed prior to his briefing to the F/As, but after listening to the CVR, he knew that they weren't. The captain was asked if the Engine Fire /Damage /Separation checklist was normally supposed to be performed without any interruptions. He said that would depend on the circumstances. He said he did not think that it was stated anywhere that you must do a certain number of steps before you could do anything else. The F/O stated “whether they should finish the engine fire damage checklist before talking to F/As probably depended on the situation”. An American captain, who was part of the company's team who provided Human Factors and Safety Training (HFST) and was also a checkairman who had instructed and performed checkrides on pilots in the simulator, was asked by investigators, if there was a fire indication in the cockpit, what portion of the Engine Fire / Damage / Separation should be completed once it was started. He said that, 95 percent of the time, he expected that if he gave an engine fire that the checklist would be run through to completion without stopping. He replied that if there was an engine fire, it would make sense that “you would at least close the fuel control lever, pull the fire handle, and shoot a bottle at a minimum”. Investigators could find no guidance in American Airlines manuals on when it was acceptable to interrupt the Engine Fire / Damage / Separation checklist or if necessary to interrupt the checklist, which items should be accomplished at a minimum.

Before the Engine Fire / Damage / Separation checklist was completed, the captain said he transferred control of the airplane to the F/O and briefed the passengers and the F/As. The captain said he felt like they only had a short time before they were on the ground and he needed to give the F/As a briefing before they turned onto the final approach. The captain briefed the F/As that he did not expect there would be a need for an emergency evacuation, but he did discuss the signals to be used if an emergency evacuation was needed. The captain then resumed control of the airplane and the F/O resumed the Engine Fire / Damage / Separation checklist.

The F/O stated that after he had pulled the left engine fire handle and discharged both fire agent bottles, he began preparations for landing and did not complete the Engine Fire / Damage / Separation checklist.

The Engine Fire / Damage / Separation checklist directed the crew to perform several items if an “immediate landing” was planned. The APU was to be started, the fuel crossfeed was to be on, and the hydraulic system was to be set “as required”. The captain said he started the APU. The F/O said he did not perform the FUEL X-FEED or the HYDRAULIC SYSTEM items on the “immediate landing” portion of the Engine Fire / Damage / Separation checklist

If an immediate landing was planned, that portion of the Engine Fire / Damage / Separation checklist directed the crew to perform the One Engine Landing checklist¹⁴ and the Emergency Landing checklist¹⁵. These checklists were not performed. During post-accident interviews, the captain stated that he informed the first officer that it was not necessary to perform the One Engine Landing checklist as he was very familiar with it.

The left engine fire indication light remained on after the fire agent was discharged and remained on after the airplane landed.

The American Airlines MD-80 Program Manager / Technical pilot stated that: American Airlines training emphasized the importance of working together to optimally handle an emergency situation and that pilots should enlist the help of all resources available even including dead-heading crewmembers if necessary. American training emphasized the importance of maintaining situation awareness throughout the emergency as the best method of achieving a successful outcome. Although it was not specifically written that the captain would ensure he or she did everything possible to extinguish an engine fire [complete the checklist] before handing the airplane to the F/O and proceeding to brief the Flight Attendants, this was considered part of our prioritization training and basic aviation. This was trained in the simulator and if a pilot had not prioritized properly and attempted to brief the flight attendants prior to completing critical items on a checklist then he would be corrected by the checkairman or simulator proficiency pilot. The American Airlines QRH procedure for Engine Fire / Damage / Separation actually included the step “Notify Flight Attendants” on the second page of the procedure after all of the critical items had been accomplished.

6.4 Electrical Abnormal Indications

The captain stated that about the time they shutoff the fuel lever, they started getting some “strange electrical problems” that he did not expect to see in that circumstance. His digital flight guidance panel went blank. His primary flight display and his navigation display went blank momentarily. He said there were so many lights on the annunciator panel that he felt the information on that panel was completely useless. He speculated that about two thirds of the annunciator panel lights were on. He said he could not even trust what the lights were telling him based on all the electrical indications.

6.5 Nose Gear Extension

During their initial approach to land at STL, the crew extended the landing gear while on final approach. Normally, gear position and main gear door status were indicated by annunciator lights on the upper instrument panel. Normally, the gear position lights illuminated green to indicate that the gear and gear handle were in the down-and-locked position and the gear position lights illuminated red when the gear was in any

¹⁴ See attachment 3 – One Engine Landing checklist

¹⁵ See attachment 4 – Emergency Landing checklist

intermediate position. There was also a gear warning horn that would alert an unsafe condition. The normal green and red annunciator lights for the gear were not working due to the loss of electrical power to gear indication systems. The crew subsequently used the nose gear down lock indicator¹⁶ to determine that the nose gear had not extended. The only backup to check for main gear extension was a main gear latch visual position indicator located in the aisle floor above the main gear. The F/O contacted the STL tower for confirmation of their landing gear position. The tower controller replied that he could see that the main gear appeared to be extended but he did not believe that the nose gear was extended. The F/O informed the controller that they would have to perform a go-around. The captain said he “believed” he called for a go-around. He “thought” he said to leave the gear down and called for flaps 11.

The captain said he called for the Emergency Gear Extension checklist after the go-around was performed. The F/O said he used the Emergency Gear Extension checklist procedures to extend the nose gear.

6.6 Go-Around Decision

During post-accident interviews, the captain was asked why he elected to perform a go-around on one engine with an engine fire indication light still illuminated. The captain replied that by the time they received confirmation from the controller that the nose gear was still up [retracted], their altitude was too low and they were too close to the airport to perform an emergency gear extension. He said he had no thought about landing with the nose gear up. He said he did not want to attempt a nose gear up landing for a couple of reasons. He said if he did a nose gear up landing, he would most likely have some passengers hurt and also he had no time to brief the F/As that they would do a gear up or partial gear up landing. He said the F/As would not have been prepared for a gear up landing. He said the airplane was flying and he felt it was safer to go around and extend the gear in a controlled situation. The captain said they had done what they could to fight the fire and that since the fire was on a pod engine, it was contained and “less of a problem”. The captain also said he could not trust what the lights in the cockpit were telling him because of all the electrical system indications they were experiencing.

6.7 Go-Around Procedure

The American Airlines DC-9 Operating Manual - QRH, ENG section, pages ENG-5 and ENG-6, dated 3/31/08, contained the One Engine Landing checklist which, contained the procedures for a go-around on one engine.

American Airlines procedures called for several items to be done during a go-around¹⁷:

- (1) The pilot flying was to call for go-around EPR¹⁸ / thrust on the remaining engine.
- (2) The pilot flying was to press the TO/GA button¹⁹.

¹⁶ Nose gear down lock indicator – This was a pin indicator in the cockpit that had mechanical linkage to the nose gear.

¹⁷ See attachment 3 – One Engine Landing checklist.

¹⁸ EPR – engine pressure ratio – is an indication of what thrust is being provided by the engine.

- (3) The flaps were to be retracted to 11 degrees.
- (4) Airspeed was to be maintained at a minimum of V_{ref}^{20} plus 5 knots.
- (5) The landing gear was to be retracted.
- (6) The spoilers were to be disarmed.

The captain said he elected to leave the gear extended during the go-around due to the problem they had with extending the nose gear.

6.8 Loss of Hydraulic Fluid

The systems group determined that the left hydraulic system lost fluid at about the time the left engine was being shutdown. This loss of fluid would normally have illuminated the left hydraulic pressure low indicator light [L HYD PRESS LOW] and have indicated an abnormal hydraulic quantity indication on the hydraulic fluid quantity gauge.

During post-accident interviews, the captain and F/O indicated that they were unaware of any abnormal hydraulic indications until they were on the ground. The captain indicated that the multiple electrical systems indications caused concern and that he could not trust some indications in the cockpit.

The American Airlines DC-9 Operating Manual – QRH, Tab 1, page 1.2, Engine /Fire / Damage checklist had an item that indicated that if an immediate landing was planned, the hydraulic system was to be set “as required”²¹. The F/O said he did not get to the hydraulic system item on the Engine Fire / Damage / Separation checklist as the hydraulics were not addressed if planning an immediate landing. The F/O said he never touched the hydraulic panel as it was left in the takeoff configuration.

American Airlines personnel were asked what were American pilots trained to check on the hydraulic indicators before responding to the hydraulics item on the Engine Fire / Damage / Separation checklist. They responded that pilots were trained to check the hydraulic pressure indications, the hydraulic quantity indications, and the position of the hydraulic switches.

When the jumpseat pilot was brought into the cockpit from the cabin, he said he noticed an indication of a loss of all hydraulic pressure in the left system and an indication of “some” pressure in the right system. He thought the accident pilots were already aware of the hydraulic indications and that he was not the first to notice a hydraulic problem. The captain and the F/O did not recall being aware of any hydraulic abnormality until they were on the ground and said they did not recall the jumpseat pilot mentioned anything about a hydraulic abnormality.

6.9 Emergency Evacuation Guidance

¹⁹ TO/GA button – this was pressed so the engine power would automatically advance to go-around power and so the flight director would present go-around guidance.

²⁰ V_{ref} – This was the approach and landing reference speed.

²¹ See attachment 2 - Engine Fire/ Damage/ Separation checklist

The American Airlines Flight Manual Part 1, Section 19 – Abnormal and Emergency, EMERGENCY EVACUATION paragraph, page 8, dated 3/4/05, stated in part:

2.1 General Guidance

- A. *In an emergency evacuation, it is likely that certain passengers and crewmembers will suffer injury. The Captain should consider the relative risks of remaining aboard the aircraft against the risks of evacuation.*
- B. *Although indications of fire must be regarded with the utmost seriousness, in some cases such as a fire warning light, torching, or external smoke, the Captain should seek further information or confirmation from other sources such as the tower, other aircraft, or emergency response crews*
- C. *If an irregularity or emergency develops during ground operations and it is not feasible to return or continue to the terminal / gate area, the Captain should consider the use of emergency exits and evacuation slides to deplane passengers and crew only if their safety is in question. Otherwise internal or remote stairs or an eventual return to the terminal / gate should be used for deplaning.*

2.2 Flight Attendant Initiated Evacuation

When an aircraft has come to a stop in an obvious life-threatening situation (fire, black smoke in the cabin, crash), Flight Attendants are authorized to initiate an evacuation without awaiting instructions from the cockpit. Flight Attendants will attempt to communicate with the cockpit if at all possible. If contact with the cockpit is not possible, or time is of critical importance, Flight Attendants will make an independent decision and operate all usable exits.

American Airlines issued a Flight Operations Technical Information Bulletin²² [Number 97-02] in February 1997, which discussed Emergency Evacuations. The Bulletin was signed by the Managing Director – Flight Operations Technical. The bulletin discussed the fact that “it is not feasible for the Flight Department to establish a rigid set of rules regarding evacuation since there are many situational variables that can occur”. The Bulletin stated that the captain must evaluate the situation and make an appropriate decision. The Bulletin discussed the possibility of injury during egress in an emergency evacuation. It also discussed the risks to passengers in remaining aboard the airplane. The Bulletin stated that “fire or smoke originating in the cabin or cargo compartment is the most dangerous condition that can face an airplane and its occupants”. The Bulletin also discussed fire or smoke in the engines. It stated that “engines were built to handle high temperatures” and that “nothing in these areas will normally support combustion except fuel which can be cut off with the fire handle”.

²² See attachment 6 – Flight Operations Technical Information Bulletin

The Flight Operations Technical Information Bulletin on Emergency Evacuations provided the following guidelines that were suggested for consideration by crews:

1. *The decision to evacuate should be deliberate and carefully considered weighing the risks against evacuating against the risks of remaining aboard.*
2. *The most hazardous event is fire or smoke within the pressurized area of the airplane (cabin or cargo compartment).*
3. *Smoke, or some flames, in the engines, APU²³, or wheel assembly areas will normally burn out quickly and not endanger the cabin. Request airport fire equipment, pull the fire handle, discharge fire suppression agent as appropriate, carefully monitor the area and communicate with crash vehicle crews and tower. Time and situation permitting, clear the active runway. Evacuate the passengers if the fire does not extinguish in a reasonable time or appears to be spreading.*

American pilots were required to read the quick reference handbook on ground evacuations during day 6 of ground school training. On day 8 of ground school, they discussed the ground evacuation procedure in the classroom and later practiced it in the simulator during the flight training device (FTD) day 6. The focus was on covering the procedure step by step to ensure pilots understood each step as they performed the action. During recurrent training, ground evacuation was a variable maneuver during several periods. The MD-80 Program Manager estimated that 90% or more of the pilots got to practice an emergency evacuation during recurrent training.

The American Airlines Chief Pilot for the Dallas / Fort Worth base was interviewed post-accident and was asked about American Airlines guidance and training on the decision to conduct an emergency evacuation. The Chief Pilot said that an engine fire indication while the airplane was on the ground did not necessarily require an immediate ground evacuation. American Airlines policy and teaching for fire events was to gather as much information as you could and assess the situation before initiating a ground evacuation. The pilots should determine if they are able to put the fire out with the fire extinguishing system. The pilots should talk to the flight attendants to determine what do they see and also ask AARF personnel what they see. He said he would ask the ATC tower personnel if they saw a fire on the airplane. To help assess what the situation was, he might also ask pilots in other airplanes what they saw. Ultimately he would not make a decision based on just a fire indication if he thought he could get more information from inside or outside the airplane. He said an evacuation decision might be airplane specific. He said the MD-80 airplane with the engines on the back of the tail was different than an airplane with engines under the wing.

Post-accident, American Airlines instructors were interviewed and stated that a crew should make an evacuation decision based on the information they had supplemented with any input from AARF personnel, any input from tower personnel, and any input from the F/As. The instructors agreed with the accident captain's decision.

²³ APU – Auxiliary Power Unit, which is used to provide electrical power and air to the airplane systems.

During his in-flight briefing to the F/As, the captain told the F/As that he did not think they would have to emergency evacuate the passengers. At the time the captain made this statement to the F/As, the left engine fire indication was still illuminated in the cockpit indicating an engine fire. The captain did brief the evacuation signals to be used if it was determined that an emergency evacuation was needed.

Once the airplane was stopped on the ground, contact was made with AARF personnel and the captain was informed that he still had a small residual fire. The captain asked AARF if they were going to spray it and was told that they were “putting a line on it”. He was then told everything was “good” by AARF. During post-accident interviews, the captain said he elected to not perform an emergency evacuation because they were stopped under control, there was no hull breach, there was no evidence of smoke or fumes in the passenger cabin, and there were several emergency vehicles all around the airplane. The captain said he decided the passengers were safer on the airplane and there was no reason to evacuate.

During training, American Airlines showed their crews an AARF²⁴ training film. On the training film, an AARF representative indicated that if they were on-scene, they were capable of handling a situation.

6.10 Retraction of the Fire Handle

While still sitting on the runway after AARF had sprayed and put out the residual fire, the F/O opened the left pneumatic crossfeed valve that caused the left engine fire handle to be retracted. Normal after landing procedures²⁵ called for the F/O to open the pneumatic crossfeeds. When the F/O opened the left pneumatic crossfeed, this resulted in the retraction of the left engine fire handle. When the left engine fire handle retracted, fuel was introduced back into the damaged engine area and spilled onto the ground. After he realized that the left fire handle had retracted, the F/O again pulled the left engine fire handle out. As a result of this fuel spillage, the AARF commander decided that the passengers should be removed from the airplane. Passengers were deplaned using external stairs and transported by bus to the terminal.

The Boeing MD-80 Flight Crew Operating Manual contained information that stated in part:

If ENG FIRE handle is pulled, placing respective PNEU X-FEED VALVE lever to OPEN will retract ENG FIRE handle.

A review of American Airlines Flight and Operating Manuals did not reveal any information or guidance that indicated that opening a pneumatic crossfeed valve would result in a fire

²⁴ AARF personnel in the film were from the AARF unit at Dallas / Fort Worth International Airport (DFW), Dallas, Texas.

²⁵ These after landing procedures were part of a “flow pattern” that was normally performed by the F/O after landing and clearing the runway. There were several items, including opening the pneumatic crossfeed valve, which the F/O normally did as part of this clean-up flow prior to reading the After Landing checklist.

handle being retracted thus reversing a shutoff of fuel. Retraction of a fire handle by opening the pneumatic crossfeed valve was not taught in American Airline's training modules. The American Airlines Operating Manual did provide information that when a fire handle was pulled, fuel was shutoff and the pneumatic crossfeed valve was closed. The fire handle shutting the pneumatic crossfeed valve was taught during training. During post-accident interviews, the American Airlines MD-80 Fleet Captain Flight Operations and the MD-80 Fleet Captain Training stated that American pilots were trained that there was a direct mechanical linkage between the fire handle and the pneumatic crossfeed lever and should be aware that opening the pneumatic crossfeed lever would retract the engine fire handle.

6.11 Checklists

To sum up the information provided in the accident report, this section identifies the checklists applicable during the flight after the start valve light open indication illuminated. The crew stated that they performed all required checklists prior to that time.

- L or R START VALVE OPEN light – this checklist was not performed.
- Engine Fire / Damage / Separation – this checklist was performed in part but was also interrupted at one point.
- One Engine Landing – this checklist was not performed.
- Emergency Landing – this checklist was not performed.
- L or R HYD PRESS LOW light – this checklist was not performed.
- L or R Hydraulic Quantity Low or Decreasing – this checklist was not performed.
- Before Landing – this was a mechanical checklist. This checklist was performed.
- After Landing – this checklist was not performed.
- Parking – unknown if this was performed.
- Ground Evacuation – this checklist was not performed.

6.12 Cockpit Voice Recorder

The American Airlines DC-9 Operating Manual - QRH, EMER / ABNORM PREFACE page 7, Cockpit Voice Recorder paragraph, dated 8-16-04, stated in part:

The COCKPIT VOICE RECORDER c-b (Upper EPC – F6) must be pulled during the Parking checklist following any of these occurrences:

- *Airplane accident*
- *In flight fire*

The American Airlines DC-9 Operating Manual - QRH, section 14, page 14.1, ground Evacuation checklist, dated 12-16-02, indicated that the CVR circuit breaker was to be pulled during an emergency evacuation.

The American Airlines Flight Manual Part I, Section 19 – Abnormal and Emergency section pages 17 & 18, sub-section 5. VOICE RECORDER stated in part:

5.2 Deactivation of the recorder

- B. The voice recorder circuit breaker must be pulled during accomplishment of the parking checklist following any of these occurrences:*
- 1. Aircraft accident*
 - 5. In-flight fire*

5.3 NTSB Investigation

- A. In the event of an accident or occurrence requiring immediate notification to the National Transportation Safety Board and which results in the termination of flight, the NTSB may request AA retain the recorded information. Information obtained from the voice recorder may be used to assist in the determination of the cause of the accident or occurrence. To accomplish this, it is necessary for the Captain to pull the voice recorder circuit breaker prior to leaving the aircraft.*

About 30-40 minutes after the airplane had stopped; the F/O pulled the CVR and FDR circuit breakers when a mechanic came on-board the airplane and advised him to pull the circuit breakers.

7.0 Crew Training

7.1 Multiple Simultaneous Failures during Training

American Airlines management personnel stated that they were currently under the Advanced Qualification Program (AQP). They stated that the AQP program had specific guidance on what training was to be provided and at that time there was no multiple emergencies training at American. The management personnel indicated that they were in discussions with the FAA to determine whether multiple emergencies training should be included in future training.

The Boeing Chief Pilot Flight Operations-Safety indicated that Boeing did away with multiple emergency training in the mid 1980s. He said the decision was driven by the introduction of the integrated crew advisory system (ICAS) which prioritized non-normal occurrences. He said that ICAS created an environment where the airplane handled multiple emergencies.

The Boeing representative said that the earlier multiple emergencies training was subject to abuse as an instructor would increase the load on a student until he could not handle any more. He said it was considered negative training and felt it was not realistic to go back to multiple emergencies training.

Guidance in the Boeing 737 NG Flight Crew Training Manual, Non-Normal Operations section, page 8.31, dated October 31, 2007 indicated that it was rare to encounter in-flight events which were beyond the scope of non-normal checklists (NNC). The Boeing training manual said that in those situations, “the flight crew may be required to accomplish multiple NNCs, selected elements of several different NNCs applied as

necessary to fit the situation, or be faced with little or no specific guidance except their own judgment and experience.” The Boeing training manual also stated that “Because of the highly infrequent nature of these occurrences, it is not practical or possible to create definitive flight crew NNCs to cover all events.”

The FAA Director of Flight Standards Service, AFS-1 responded to questions from NTSB investigators concerning multiple emergencies training²⁶ in a letter that stated in part:

The FAA supports realistic flight crew training. It would be impossible to train for every combination of in-flight emergencies. Over loading a student with unrelated combinations of emergencies is counterproductive and generally considered negative training. On the other hand, if the student should fail to accomplish a task or procedure satisfactorily, it is realistic to introduce an additional problem that would logically result from the unsatisfactory accomplishment of the earlier task. The FAA supports training scenarios designed to do that. In general, this guideline confines the compounding of problems/emergencies to a particular aircraft system or related systems.....

In all cases, the primary objective of flight training is to provide an opportunity for flight crewmembers to acquire the skills and knowledge necessary to perform to a desired standard.....

Multiple, unrelated emergencies strung together as a training event are unrealistic training scenarios. In pursuit of realistic line-oriented training, airlines create Line Operational Simulations (LOS) by developing Line Oriented Flight Training (LOFT) and Line Operational Evaluation (LOE) scenarios from actual line experiences.....Scenarios designed from these sources are operationally relevant, believable, and a test of the flight crew’s skills and capabilities.

Advanced Qualification Program (AQP) participants use lesson plans for training events. AQP training curriculums are based on a job task analysis, qualification standards, and proficiency objectives developed for each duty position. The curriculums are translated into a course footprint, and then documented in the curriculum outline. These curriculums are expanded in more detail in the student and instructor syllabus and in individual lessons and evaluations. The LOE is the primary means of proficiency evaluation under an AQP. This evaluation addresses the individual’s ability to demonstrate technical and Crew Resource Management (CRM) skills appropriate to fulfilling job requirements in a full mission scenario environment. A typical LOE scenario is divided into a series of segments, called event sets. A scenario might have six or eight event sets relating to the phases of operations (ground operations, takeoff, climb, cruise, descent, approach, landing, and after landing). Each event set consists of a series of

²⁶ See Attachment 7 – FAA response to NTSB Information Request 08-087

evaluation tasks, which include both technical and CRM objectives. The intent of an LOE is to evaluate and verify that an individual's job knowledge, technical skills, and CRM skills are commensurate with AQP qualification standards. An LOE is not designed to saturate a flight crew or impose an unrealistic level of difficulty or complexity. On the other hand, the LOE must provide enough difficulty and complexity to adequately test the flight crew's technical and CRM skills, and for that purpose, should the flight crew compound an emergency by failing to accomplish a task or procedure satisfactorily, all additional problems that would logically result from the unsatisfactory accomplishment of the earlier task are allowed to progress.

Complex events have ongoing consequences that must be dealt with in flight and cannot be solved by simply selecting and executing an abnormal checklist. LOE scenarios require the coordinated actions of all crewmembers for successful completion. The properly designed LOE does not necessarily have a single solution. Rather, it may have a number of possible and reasonable solutions. Thus, the well-designed LOE promotes the management of a complex situation.

8.0 HUMAN FACTORS SAFETY TRAINING

According to company records the captain attended Human Factors Safety Training (HFST) Pilot Recurrent on January 27, 2006 and the first officer last attended this training on May 16, 2007. The HFST pilot recurrent course duration was 2 hours and 45 minutes. Attendees were organized into small groups to encourage participation and discussion. The class used facilitated discussion, and review of video taped scenarios depicting events that happened at the company. The module effective at the time the captain attended training addressed multiple topics including leadership styles, decision making, conflict resolution strategies, professionalism, FOQA, partnership for safety, and fuel use and computations. The module effective at the time the first officer attended the course addressed multiple topics including, unstabilized approaches, EAP, FOQA, and Flight 1740, and ARFF. Flight 1740 was a discussion of an American Airlines event and according to the briefing slides discussion topics centered on issues of checklist usage, emergency landing procedures, evacuation issues, team work, and the use of all resources in an emergency situation. During the ARFF segment fire events in 121 air carrier service were discussed and a video from the DFW Department of Public Safety addressing ARFF resources was played. The ARFF video consisted of an American Airlines representative interviewing DFW ARFF personnel regarding flight crew communication with AARF and evacuation decisions²⁷. This video was also used during flight attendant recurrent HFST in 2007.

Submitted by:

²⁷ See Attachment 8 – Transcript of AARF Training Video

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