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

December 5, 2008

Systems Group Chairman's Factual Report – Addendum 1

DCA-07-MA-310

A. ACCIDENT

Operator:	American Airlines
Location:	Lambert – St. Louis International Airport, St. Louis, MO
Date:	September 28, 2007
Time:	1:16 PM Central Daylight Time
Airplane:	McDonnell Douglas DC-9-82 (MD-82), N454AA

B. SYSTEMS GROUP

Chairman: Scott Warren
National Transportation Safety Board
Washington, D.C.

Member: Greg Magnuson
American Airlines
Tulsa, OK

Member: Ken Sujishi
Federal Aviation Administration
Los Angeles, CA

Member: William Mutz
The Boeing Company
Long Beach, CA

Member: Dave Stewart
Allied Pilots Association
Fort Worth, TX

C. SUMMARY

On September 28, 2007, at 1316 central daylight time, a McDonnell Douglas DC-9-82 (MD-82), N454AA, operated by American Airlines as flight 1400, executed an emergency landing at Lambert-St Louis International Airport (STL), St. Louis, Missouri, after the flight crew received a left engine fire warning during departure climb from the airport. The airplane sustained substantial damage. Visual meteorological conditions prevailed and an instrument flight rules flight plan was filed for the 14 CFR Part 121 scheduled domestic flight. After landing, the 2 flight crew, 3 flight attendants, and 138 passengers deplaned via airstairs and no occupant injuries were reported. The intended destination of the flight was Chicago O'Hare International Airport (ORD), Chicago, Illinois.

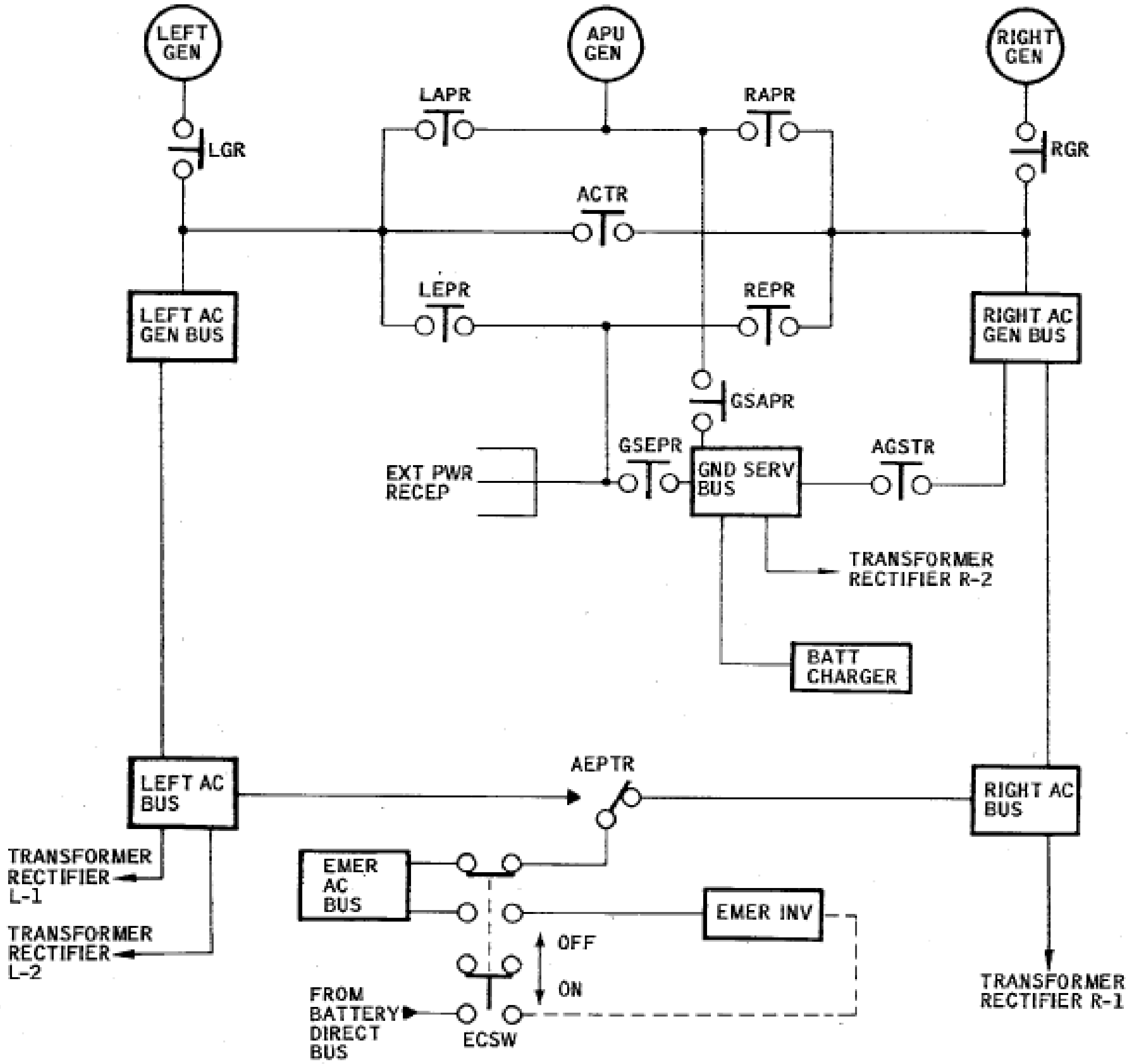
Upon receiving the left engine fire warning during climb, the flight crew discharged the aircraft engine fire bottles into the affected engine. During the visual return and single-engine approach to the airport, the nose landing gear did not extend. The flight crew then extended the nose landing gear using the emergency landing gear extension procedure. The airplane returned and then landed on runway 30L (11,019 feet by 200 feet, grooved concrete) and was met by STL Airport Rescue and Fire Fighting Vehicles.

This addendum provides additional details concerning the aircraft's electrical system, the results of a series of tests conducted on a hydraulic system check valve, and the fire sleeves for the hydraulic lines located in the engine nacelle.

D. DETAILS OF THE INVESTIGATION

1.0 Electrical System

The AC and DC electrical power systems used on the airplane are similar in design. Referred to as a split-bus system, both the AC and DC electrical power systems are divided into two independent systems, the left side and the right side. Normally, each side operates independently from the other, each having a power source and bus system supplying power to the various load demands throughout the airplane. In the event of a power loss on the load buses of either side, a crosstie relay is provided so that the dead buses can be connected to the buses of the opposite side. Figure 1 provides an overview of the AC power system architecture.



TR	TRANSFORMER RECTIFIER
LGR	LEFT GENERATOR RELAY
RGR	RIGHT GENERATOR RELAY
ACTR	AC CROSS TIE RELAY
ECSW	EMERGENCY CONTROL SWITCH
LAPR	LEFT AUXILIARY POWER RELAY
RAPR	RIGHT AUXILIARY POWER RELAY
LEPR	LEFT EXTERNAL POWER RELAY
REPR	RIGHT EXTERNAL POWER RELAY
AEPTR	AC EMERGENCY POWER TRANSFER RELAY
AGSTR	AC GROUND SERVICE TIE RELAY
GSAPR	GROUND SERVICE AUXILIARY POWER RELAY
GSEPR	GROUND SERVICE EXTERNAL POWER RELAY

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Figure 1
AC Power System – Block Diagram

If an AC generator bus should lose power, the AC crosstie relay is designed to operate automatically to tie the two generator buses together if the AC bus crosstie switch is in the automatic position, unless a bus fault lockout occurs.

Auxiliary AC electrical power is provided by a generator of the same type as the engine driven generators to supply AC power to the corresponding dead buses if an engine driven generator fails during flight. The generator is driven by a constant-speed, gas turbine auxiliary power unit (APU) installed in the aft accessory compartment of the airplane. Through the use of control switches and relays, auxiliary power can be supplied to all AC load buses at the same time, or to only the left or right AC buses provided the bus selected is not receiving power from an engine driven generator.

1.1 AC Crosstie Relay

The function of the AC crosstie relay (ACTR) is to connect the left and right AC generator buses together under certain conditions, thereby permitting both buses to be fed by a single generator.

During normal operation each generator supplies its own load bus and the AC Bus Crosstie switch is in the automatic (AUTO) position. The ACTR is prevented from closing by the presence of voltage on both buses.

If power is lost on one bus, the ACTR is designed to automatically close when the associated dead bus sensing circuit senses a loss of power on the bus. Once the ACTR is closed, it can be tripped open by several means, including power returning to the dead bus or if various signals from the airplane's generator control units are received.

The ACTR can be locked out (prevented from closing) by several means including:

a. A signal is supplied by a normally open differential protection circuit. A fault sensed by a differential protection circuit or a bus fault sensed by the undervoltage protection circuit will lock out the ACTR.

b. If an undervoltage condition appears on the powered bus after the ACTR closes, the ACTR is opened. If the voltage then recovers, the fault is considered to be on the dead bus, and the ACTR is locked out.

This locked out condition is indicated in the flight deck by illuminating the "AC CROSSTIE LOCKOUT" annunciator on the overhead annunciator panel, and cannot be reset until the aircraft is on the ground.

2.0 Left Pressure Filter Module Check Valve Test Results

The left pressure filter module check valve located near the left hydraulic pump outlet was removed from the airplane and tested at the operator's facility in Tulsa, OK. The nomenclature for the unit was:

American Airlines P/N: 5734450
Manufacturer's P/N: 2C6580
S/N: No serial number is used on these units
Manufacturer: Crissair, Inc

The tests were designed to determine whether or not the unit met the requirements specified on the unit's engineering drawing. The tests and test results are included in table 1 below:

Table 1
Left Hydraulic System Check Valve Tests and Test Results

Test	Test Results
Check Valve Internal Leakage	At 5 psig – 0 drops/minute (Allowed leakage is 1 drop/minute) At 1500 psig – 0 drops/minute (Allowed leakage is 0 drop/minute) At 3000 psig – 0 drops/minute (Allowed leakage is 0 drop/minute)
Flow Check	8 psig pressure drop at 6.0 gallons/minute (max pressure drop allowed = 10 psig)
Cracking Pressure	7 psig (cracking pressure requirement is between 2 and 10 psig)

3.0 Fire Sleeve

The hydraulic lines in the engine nacelle are protected in some areas by fire sleeves. The fire sleeves are designed to provide additional fire protection to those areas of the hydraulic lines in the event of a nacelle fire. American Airlines identified the fire sleeves used on the hydraulic lines for the accident aircraft as the AE102 fire sleeve manufactured by Eaton. According to the fire sleeve manufacturer, the fire sleeve and hose combination are subjected to the fire resistance certification conditions[1] as a combined assembly. The manufacturer also stated that they do not conduct any follow-on certification type testing on the fire sleeve/hose combination using fire sleeves that have been removed from in-service aircraft.

Scott Warren
Lead Aerospace Engineer

[1] See TSO-C75 – this document contains many certification requirements, for this investigation, the most relevant certification condition is to withstand a 2000 deg F flame for 5 minutes