



National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: October 7, 1998

In reply refer to: A-98-111

Honorable Jane F. Garvey
Administrator
Federal Aviation Administration
Washington, D.C. 20591

On February 20, 1997, at 0645 central standard time, a Douglas DC-9-15, N93S, operated as Northwest Airlines (NWA) flight 219 under Title 14 Code of Federal Regulations Part 121, from Minneapolis, Minnesota, to Kansas City, Missouri, experienced an in-flight electrical fire, which filled the cockpit with smoke and fumes. The crew donned their oxygen masks and turned off both generators and the battery switch. They flew with a flashlight for 1 minute and then turned the emergency power switch on after the flames had distinguished themselves. The flightcrew declared an emergency, and the flight was diverted to the Des Moines International Airport, Des Moines, Iowa, and landed without further incident. None of the 4 crewmembers or the 32 passengers on board were injured, and the airplane sustained minor damage.

Examination of the airplane indicated that the electrical fire originated within the power distribution system's cross-tie relay, Westinghouse¹ part number (P/N) 914F567-4. The cross-tie relay allows either the left or right three-phase² alternating current (AC) generator to supply electrical power to all AC buses. Seven relays of this type are used in each DC-9 series airplane to provide electrical power source switching, including the cross-tie relay, left and right (L&R) generator relays (GR), L&R auxiliary power relays (APR), and L&R external power relays (EPR). These seven relays are mounted in the electrical power center (EPC) distribution panel in the cockpit.

Examination of the cross-tie relay from N93S revealed that the failure resulted from a phase-to-phase short,³ which was caused by the presence of main contact wear products

¹ Now Sundstrand Corporation.

² Comprises three single-phase windings that each produce a continuously alternating voltage/current.

³ Low resistance connection between two conductors normally insulated from each other (i.e. short circuit).

(debris) throughout the contact housing (arc box). NWA's records indicated that the relay had 35,160 hours total time and 7,775 hours since the last overhaul.

An examination of Douglas Aircraft Company⁴ (DAC) incident summary reports indicated that on November 5, 1974, a DC-9-31 experienced a similar cross-tie failure, during an approach for landing, in which smoke and sparks emitting from the EPC panel caused an emergency evacuation after landing. On June 5, 1975, another cross-tie relay caught fire on a DC-9-15 during taxi for takeoff. The smoke reportedly was so thick aft of the cockpit that the flight attendant was unable to locate the cockpit call button; she had to go to the rear of the aircraft to use the call button to inform the crew about the fire. Westinghouse concluded the most likely cause of these failures was a phase-to-phase short within the relay.

As a result of this finding, on July 9, 1975, DAC notified all operators⁵ that all cross-tie relays with more than 7,000 hours service should be removed within 3,000 hours to be cleaned and inspected per Westinghouse Overhaul Manual 24-20-46, dated May 1, 1975. On July 1, 1975, Westinghouse issued Service Bulletin (SB) 75-701 to incorporate a more flame-resistant Lexan relay cover and improve the relay's internal wiring clearances. In March 1976, Westinghouse issued SB 75-703 to add a gasket seal to each of the interphase barriers of the contact housing and change the power relay assembly P/N from 914F567-3 to 914F567-4. The P/N 914F567-4 relay incorporates the changes recommended in SBs 75-701 and 75-703. Westinghouse informed operators that the reason for the change was to prevent phase-to-phase shorts resulting from the migration of main contact wear products through the contact housing interphase barriers. This modification was specifically recommended for all cross-tie relays. In June 1977, Westinghouse revised SB 75-703 to recommend, for the advantages of interchangeability, that this modification also be accomplished on all GRs, APRs, and EPRs.

On May 5, 1976, DAC issued All Operators Letter (AOL) 9-977 to recommend that all model DC-9, C-9A, and C-9B aircraft cross-tie relays be modified, in accordance with the two Westinghouse SBs, within 6,000 flight hours. The letter also informed operators that beginning with aircraft fuselage No. 850, subsequent production would have the improved power relay (P/N 914F567-4) installed in all seven relay positions.

On June 25, 1985, McDonnell Douglas⁶ (MD) issued AOL 9-1120A to advise operators that Westinghouse had developed an improved hybrid power relay, P/N 9008D09, which incorporated a deep cavity arc box and utilized magnetically held contacts, in lieu of the mechanically latched type formerly used by DAC. The design increased the recommended time between overhaul (TBO) to 12,000 flight hours, compared to the recommended TBO of 7,000 flight hours for the P/N 914F567-3 and -4 relays. On November 12, 1991, MD issued AOL 9-1120B to clarify the interchangeability between the old and new relay P/Ns. The operators were advised that the new relay, P/N 9008D09-X, was interchangeable with relay P/N 914F567-X, in all seven power relay positions on all DC-9 and MD-80 aircraft. The

⁴ Now Boeing, Douglas Products Division.

⁵ Telex DC-9-COM-31/HRG, dated July 9, 1975.

⁶ Now Boeing, Douglas Products Division

letter also informed operators that the improved power relays would be installed at all seven relay positions during production for MD-80 aircraft, beginning with fuselage No. 909, and for all other DC-9 aircraft, beginning with fuselage No. 930.

A review of FAA service difficulty report (SDR) data for the period between January 1, 1974, and June 1, 1998, for Westinghouse relay P/Ns 914F567-3 and 914F567-4, indicated 21 reported failures. Numerous failures of the relay resulted in electrical power loss, smoke and unscheduled landings. Many of the failures occurred in relays installed in positions other than the cross-tie location. The SDR data further revealed that several of the -3 and -4 relays had accumulated more than 7,000 flight hours at the time of failure, thereby exceeding the recommended TBO of 7,000 flight hours specified for these relays. One SDR, submitted in 1988, revealed that the operator had continued to utilize the P/N 914F567-3 relay in the cross-tie position subsequent to the 1976 issuance of DAC AOL 9-977.

Based on the February 20, 1997, NWA incident and the continued reports of AC power relay failures, the Safety Board is concerned about the ongoing potential for an electrical fire in the DC-9 series aircraft. This potential can be reduced by the modification of all existing P/N 914F567-3 relays to the -4 configuration and overhaul of the relays every 7,000 flight hours, before contaminants build to a level that will cause shorting between the main contacts of the power relay, or by their replacement with P/N 9008D09 relays. Therefore, the Safety Board believes that the FAA should issue an airworthiness directive to require that DC-9 operators modify all existing Westinghouse P/N 914F567-3 AC power relays (i.e. cross-tie relays, GRs, APRs, and EPRs) to the -4 configuration, in accordance with DAC AOL 9-977, dated May 5, 1976, and overhaul the relays every 7,000 flight hours thereafter or replace these relays with the improved power relay, P/N 9008D09.

Therefore, the National Transportation Safety Board recommends that the Federal Aviation Administration:

Issue an airworthiness directive to require that DC-9 operators modify all existing Westinghouse part number (P/N) 914F567-3 alternating current power relays (i.e. cross-tie relays, generator relays, auxiliary power relays, and external power relays) to the -4 configuration, in accordance with Douglas Aircraft Company All Operators Letter 9-977, dated May 5, 1976, and overhaul the relays every 7,000 flight hours thereafter or replace these relays with the improved power relay, P/N 9008D09. (A-98-111)

Chairman HALL, Vice Chairman FRANCIS, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in these recommendations.

[Original Signed]

By: Jim Hall
Chairman

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