



National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: December 20, 2007

In reply refer to: A-07-113 through -116

The Honorable Robert A. Sturgell
Acting Administrator
Federal Aviation Administration
Washington, D.C. 20591

On November 15, 2004, a fire occurred in the electrical/electronic equipment center compartment of a Boeing 777-200ER airplane (operated by British Airways as flight BA239) shortly after arrival at Boston-Logan International Airport, Boston, Massachusetts. Ground maintenance personnel observed smoke coming from the airplane after a ground electrical power unit was plugged into the airplane's external power panel. Maintenance personnel notified the flight crew of the smoke and helped deplane all passengers and crew from the aircraft. No injuries to any passengers or flight crewmembers were reported.

Postincident examination of the airplane revealed that the fire resulted from a combination of electrical arcing between the lower terminal studs at the primary power receptacle¹ and misting hydraulic fluid from a ruptured nose landing gear (NLG) hydraulic line, which is located about 3 inches from the primary and secondary external power receptacles. The primary power receptacle, its protective cover guard, attached wiring, adjacent wire bundles, and the NLG hydraulic line all sustained extensive thermal damage (see figure 1).

Following the incident, British Airways conducted a fleetwide visual inspection on its model 777 airplanes (43 total aircraft). Fifty-five percent of the receptacles that were inspected contained contact pins that exhibited signs of overheating; 12 percent contained contact pins that were loose and had evidence of melting at the base of the pins. A secondary external power receptacle that showed signs of electrical arcing and extensive thermal damage to its protective cover was sent to Boeing for analysis.

¹ The primary external power receptacle was installed after the incident airplane was manufactured and had been on the airplane since September 28, 2002.

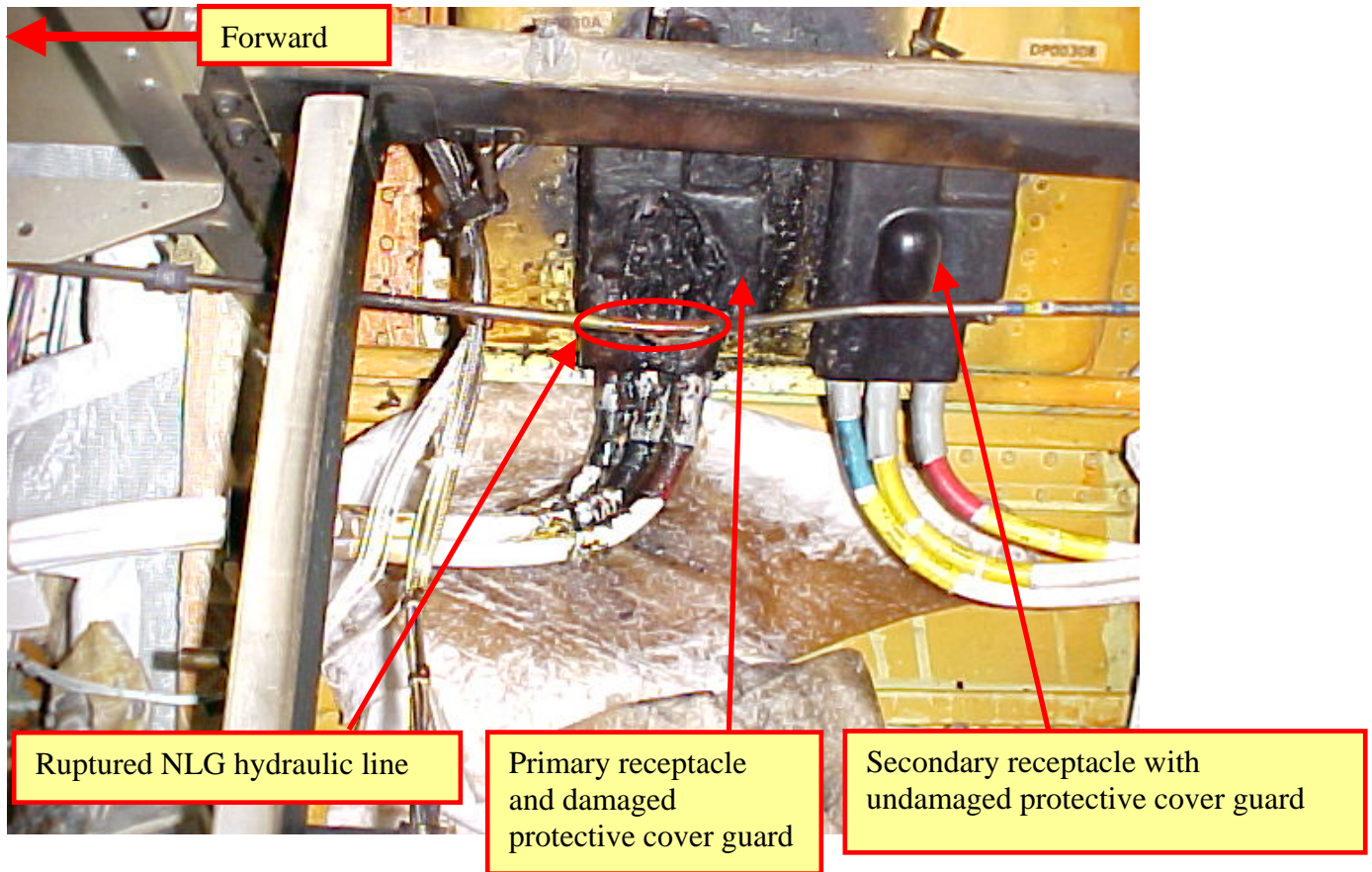


Figure 1. Damaged external power connector receptacles and the surrounding compartment.

National Transportation Safety Board investigators queried the Federal Aviation Administration's (FAA) service difficulty report (SDR) database and identified two additional Boeing 777-200 airplanes in which the external power receptacles exhibited signs of electrical arcing and overheating. Both events occurred while connecting ground power to the airplane. During the first reported event, which occurred on July 19, 2003, arcing was observed coming from the power receptacle. The second reported event occurred on July 6, 2004. According to the operator, a postincident inspection performed by a maintenance technician revealed evidence of overheating on the secondary external power receptacle and thermal damage to an adjacent insulation blanket. This secondary power receptacle was also submitted to Boeing for analysis.

Examination of the primary power receptacle terminal block from the airplane involved in the November 15, 2004, event identified evidence of electrical arc damage between three of the phase studs (A, B, and C in figure 2) installed on the back of the terminal block, as well as melted inner surfaces due to the arcing. Additionally, the terminal lug that connects to the phase C stud showed evidence of oxidation and electrical arc erosion. Several of the contact pins exhibited overheating damage, extensive pitting, and considerable corrosion. Metallurgical analysis of the ruptured NLG hydraulic line revealed that it failed due to exposure to molten copper plasma. Examination of the protective cover guard revealed that a portion of its surface had melted as a result of exposure to plasma.

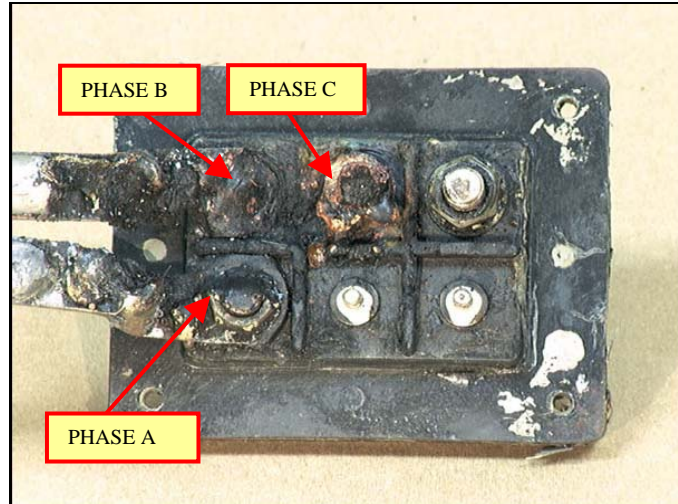


Figure 2. Primary power receptacle (internal to the aircraft) from the incident airplane showing evidence of electrical arc erosion between phase studs A, B, and C.

Examination of one of the damaged secondary external power receptacles identified during British Airways' fleetwide inspection yielded similar findings to those from the incident airplane. The examination confirmed the presence of electrical arcing at the terminal studs on the power receptacle and identified one spherical bead of copper imbedded on the inside surface of the protective cover guard. If British Airways had not identified this damaged power receptacle during its visual inspection, the electrical arcing likely would have continued, possibly resulting in a fire.

Metallurgical examinations performed on the components from the airplane involved in the July 2004 event noted in the SDR database could not conclusively determine an initiating cause of the observed overheating at the secondary external power receptacle. However, a large mass of melted metal was observed between the terminal studs of phases A and B, which likely caused a direct phase-to-phase short circuit that led to arcing.

Examination and analysis by the Safety Board of the three submitted receptacles and protective cover guards revealed that electrical arcing within the power receptacles results in copper material eroding from the receptacle's terminal studs and splattering on the back of the protective cover guard, melting the material and creating a hole in the cover. In this condition, the molten copper plasma is free to splatter into the airplane's electrical/electronic compartment, introducing the potential for damage to critical aircraft components located in this compartment, such as a hydraulic line or electrical wiring. Alternately, molten splatter could result in ignition of nearby materials such as dust, lint, or insulation blankets. Such damage could potentially compromise critical aircraft functions. An initial inspection to establish a baseline followed by scheduled inspections would allow maintenance personnel to assess the condition of the primary and secondary external electrical power receptacles and their associated hardware, reducing the potential for arcing or fire.

The Safety Board notes that the design of the receptacles on the Boeing 777 is not substantially different from the receptacles used on other transport-category airplanes. However, although most other models of airplanes include regular inspections of the external power

receptacles as part of their maintenance program, the Boeing 777 does not require such inspections. Therefore, the Safety Board believes that the FAA should require operators of Boeing 777 airplanes to perform regular inspections of the primary and secondary external power receptacles and their protective cover guards to detect signs of worn or overheated pins and thermal damage and repair or replace any damage found. The Safety Board also believes that the FAA should require Boeing to add a new maintenance task that requires operators to perform scheduled visual inspections of the primary and secondary external power receptacles and their protective cover guards to detect signs of worn or overheated pins and thermal damage before the condition results in electrical arcing and fire.

The Safety Board is also concerned that the proximity of the NLG hydraulic line to the primary and secondary power receptacles makes it susceptible to damage resulting from uncontained electrical arcing that may occur. On August 9, 2007, Boeing issued Service Bulletin (SB) 777-29-0032, which recommends wrapping a fire-resistant tape around the portion of the hydraulic line that is adjacent to the receptacles to protect the line from the effects of electrical arcing. The Safety Board fully supports this modification and believes that, to ensure it is implemented on all applicable airplanes, the FAA should issue an airworthiness directive requiring operators of Boeing 777 airplanes to comply with Boeing SB 777-29-0032 to protect the NLG hydraulic line from the effects of electrical arcing from the primary and secondary external power receptacles.

The protective cover guard installed over the external power receptacles is currently designed with a 1-inch hole on the top that is intended as an outlet for a wire from the power panel. However, without the wire installed, this hole also allows for the possibility of conductive debris to enter and collect in the area of the terminal studs, which could cause electrical shorting and arcing like that observed on one of the three receptacles examined from the overheating events. The Safety Board is aware that Boeing has initiated a set of design modifications to the installation of the protective cover guard to minimize the amount of debris that could enter through the hole in the top of the cover guard. However, these design enhancements only apply to new production airplanes; they do not apply to in-service airplanes. Therefore, the Safety Board believes that the FAA should require Boeing to modify and air carriers to install the protective cover guard for primary and secondary external power receptacles for all model 777 airplanes to eliminate the possibility of debris entering the receptacles and causing electrical shorting and arcing between the receptacle studs.

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

Require operators of Boeing 777 airplanes to perform regular inspections of the primary and secondary external power receptacles and their protective cover guards to detect signs of worn or overheated pins and thermal damage and repair or replace any damage found. (A-07-113)

Require Boeing to add a new maintenance task that requires operators to perform scheduled visual inspections of the primary and secondary external power receptacles and their protective cover guards to detect signs of worn or overheated pins and thermal damage before the condition results in electrical arcing and fire. (A-07-114)

Issue an airworthiness directive requiring operators of Boeing 777 airplanes to comply with Boeing Service Bulletin 777-29-0032 to protect the nose landing gear hydraulic line from the effects of electrical arcing from the primary and secondary external power receptacles. (A-07-115)

Require Boeing to modify and air carriers to install the protective cover guard for primary and secondary external power receptacles for all model 777 airplanes to eliminate the possibility of debris entering the receptacles and causing electrical shorting and arcing between the receptacle studs. (A-07-116)

Chairman ROSENKER, Vice Chairman SUMWALT, and Members HERSMAN, HIGGINS, and CHEALANDER concurred with these recommendations.

[Original Signed]

By: Mark V. Rosenker
Chairman