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Electrical Power Relays Need Maintenance?

BY JIM LESLIE, VP COMPONENT OVERHAUL, NAASCO NORTHEAST. CORP.

Almost every aircraft configuration, from a four seat piston engine airplane to a 400+ seat, wide-body, commercial airliner, is fitted with electrical power interruption relays. At the flick of a switch, or in some cases automatically, electrical power relays open and close circuits to and from the electrical power generating unit, which can be anything from a 12 volt alternator to a 50 KVA three phase AC generator. Relays also control current to many high amperage accessories such as the battery, starter, fans, lights, electrical actuators, hydraulic pumps and air conditioning units, to name just a few. When all is working fine, the engine starts, the landing gear extends and retracts, passengers are comfortable, and pilots can see and be seen. Failure of these relays can cause any number of conditions ranging from delayed or cancelled flights, smoke in the cockpit or, in extreme cases, in-flight fires.

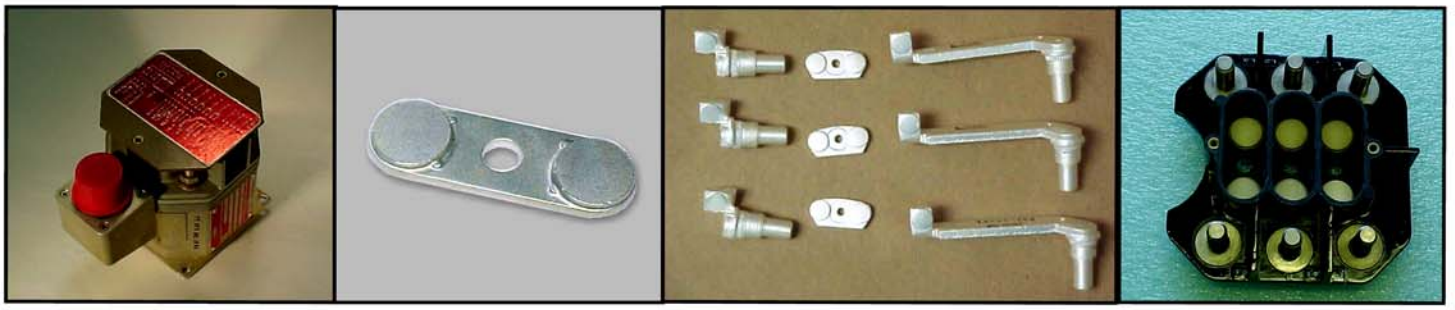
Typical Relay Operation

Most relays are electromechanically operated using a plunger type solenoid. When a "close" signal is applied to the relay close circuit, the plunger is pulled down with enough force to overcome the spring tension that holds the contacts in the open position and is held in the closed position by a permanent magnet latching circuit. The plunger movement pulls the moveable contacts to the stationary contacts closing the circuit and actuating any auxiliary switches which are incorporated into the unit. Relays can have as few as one auxiliary switch to as many as 10 or more. These low current switches can operate anything from the latching circuit to cock-pit annunciator lights. The movable contacts assemblies in the relay are usually made up of a conductor, composed of solid copper or bronze, fitted with a silver alloy button on one side that makes contact with a stationary bus bar. This bus bar usually consists of a contact button surface at one end and a threaded stud on the other end for fastening securely to the power or load source.

Causes of Relay Failure

Every time a relay opens or closes, an electrical arc is produced between the movable and stationary silver alloy contacts causing wear and pitting between the two contact mating surfaces. This continual opening and closing produces

far left: A-1077-Series fitted to Light Turbine Aircraft. below, left to right: Boeing 737 power relay, a movable contact from Boeing 727 relay, contact set from Hartman B-102F power relay, Terminal board with embedded stationary contacts.



Contacts fused together

carbon and metal particles, normal by-products created by this action, which cause resistance between the contact surfaces. Because of this accumulation of carbon and metal particles, resistance builds at or near the contact mating surfaces, thereby creating heat. The hotter the contacts become, the more susceptible they are to arcing, ultimately leading to melt down and failure. Damaged or shorted auxiliary switches, poor relay ground connection and loose or damaged terminal connections can also be reasons for replacement. Also, faulty components controlled by the relay such as a shorted motor or starter generator can draw more amps than the relay is rated for, causing premature failure.

There can also be false indications of a failed relay such as an opened or shorted circuit or component down stream such as frayed wire insulation, a shorted or open circuit or even an inoperative cockpit annunciator panel light.

The Ripple Effect

Relay failure can cause many problems. For example, if a 28 volt turbine engine starter generator relay fails in the open position, the starter will not turn the engine. If it fails in the closed position (contacts fused together due to melt down), the starter will turn as soon as the battery switch is turned on.

Worn and pitted contacts will create resistance in the circuit producing lower voltage under load. Low voltage will cause the load component to require more amperage to accomplish

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Worn and pitted contact must be repaired.

the same task and, in some cases, will overload the circuit or power source (battery or generator), melt wiring or ultimately damage the component. The same is true for AC three phase power relays and contactors except in this case, one or more phases can be faulty due to high resistance or an open phase. If a three phase component such as a fan, avionics component or even a de-icing system experiences an open phase during operation, failure of the system or component can occur.

Power Relay Maintenance

Most of the problems described above are due to extended unit time/cycles. Not more than just a few years ago, most relay maintenance was on an "on condition" basis but due to a number of recent incidents such as smoke in the cockpit, canceled flights, fires and burned out components, most major airlines and large corporate fleets are re-evaluating relay maintenance procedures. One major airline conducted a survey whereby their maintenance department disassembled and inspected their entire fleet of Boeing 737 power relays according to the component maintenance manual and found every one of the contacts, moveable and stationary, to be worn and pitted beyond useable limits. Due to the low cycles vs. flight hours, this airline

Need Maintenance?

Worn and pitted contacts will create resistance in the circuit...

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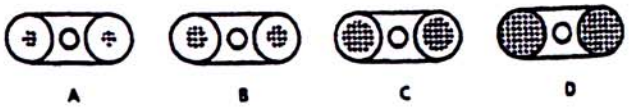
D. Check the contacts (14, IPL Figure 1) and the contacts of termial board (36). Figure 401 illustrates the desired characteristics and the point of replacement. For slightly pitted contacts, a fine file may be used to refinish the contacts. The contour of the contacts shall not be changed and the contact height shall be approximately the same. Wear will be uniform on both stationery and moving contacts. Therefore, the terminal board and moving contacts should always be replaced as a set.



A. Contact as shipped but after test has been completed.
B. After a period in service, acceptable.
C. Point of replacement, 50% of the area, 70% of the diameter pitted.
D. Unacceptable, destroyed.

Contact Check Diagram
Figure 401

above: Excerpt from Hamilton Sundstrand Manual 24-20-87 PN 9008D09 used on DC9/MD80.

left: Burnt (top) vs repaired (bottom) Hartman bus bar (various applications)

hard timed their relays to 6,000 hour TBO's. Commuter airlines, helicopter operators and corporate flight departments flying shorter legs should hard time their relays proportionately because most contact pitting is due to cycles.

Without proper test equipment, alignment tools and up to date maintenance manuals, field maintenance is basically restricted to basic inspections and cleaning. With some relays, the contact cover can be removed for visual inspection and carbon particle clean out. Others are hermetically sealed and not intended for field maintenance. A good maintenance practice is to perform a milivolt drop test on mission critical relays during the aircraft's annual or 100 hour inspection. A quick glance at the recorded history of each relay should give you forewarning of imminent failure. So, to avoid delays at the gate, canceled flights or being stuck somewhere in the boondocks, start a preventive maintenance program for the forgotten critical components of your aircraft. ■

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