Scavenge Pump Relay
(Failure Analysis)

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Evaluation Report
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TABLE OF CONTENTS

000034

LIST OF FIGURES

Figure Page

Scavenge Pump Relay

PURPOSE

Determine the condition of the scavenge pump relay following its recovery.

FACTUAL DATA

The relay, as received, is shown in Figure 1. The case of the relay was deformed on the top and sides. The case had a white film covering it. There was also a reddish brown corrosion in various locations on the case of the relay (Figure 2). Radiographs of the relay indicated the coil was tilting at approximately a 10 degree angle (Figure 3). The radiographs also revealed the normally open (N.O.) and normally closed (N.C.) contacts were all open (Figures 4 and 5).

Electrical measurements were made between the terminals of the coil. Measurements were also made between the N.O. and N.C. contacts to their common and the N.O. and N.C. contacts to the case of the relay. The measurements were made with a HP E2378A multimeter. The resistance of the coil was 109 ohms. The resistance measurement of the N.O. and N.C. contacts to common indicated they were all electrically open (greater than 20 M ohms). The resistance measurement of the N.O. and N.C. contacts to the case of the relay indicated they were also electrically open except N.O. contact A1. It had a resistance to the case of the relay of approximately 800 K ohms.

The socket of the relay was removed so the inner surfaces, pins, and glass to metal seals underneath the red environmental seal could be examined. White and reddish brown residues were present on the environmental seal, inner surfaces of the relay, and socket. These residues were also present on the mating male and female contacts of the socket and relay (Figures 6 and 7). The glass to metal seals were examined, no cracks were observed. The base of the pins for N.O. contact A1 and N.C. contacts B3, C3, and D3 had a reddish brown corrosion.

The solder seal at the base of the relay was carefully thinned with a file until it fractured. The case was removed. The N.O. and N.C. contacts were in the same position as previously shown by the radiographs. The coil and mechanics of the relay were separated from the base of the relay. The internal base of the relay was relatively bright and shiny

except for the area surrounding N.O. contact A1. The area surrounding its glass to metal seal had a white residue (Figure 8). Analysis in the SEM by energy dispersive spectroscopy (EDS) suggests the area is composed primarily of the elements sodium, chlorine, and tin. Minor amounts of iron, nickel, copper, and zinc are also present (Figure 9). The glass to metal seal of A1 had a red, yellow, white, and green residue surrounding approximately one-third of the seal (Figure 8). Analysis of the area in the SEM found it to consist of the elements sodium, chlorine, tin, iron, nickel, copper, and zinc (Figure 10).

Electrical measurements were made again between the N.O. contact A1 and the case of the relay. The resistance was as before. The residue was removed and the electrical resistance measurement was repeated. The resistance increased and A1 to the case of the relay could now be considered as electrically open (greater than 20 M ohms). The area between the pin of A1 and the case of the relay was examined in the SEM for evidence an electrical short could have existed before the area had become corroded. The evidence would consist of melting of the pin or case material; no evidence of melting was found (Figures 11, 12, and 13).

The mating surfaces of the stationary and moving N.O. and N.C. contacts were examined in the SEM, see Figures 14 and 15 for examples of A1 and A2. The mating surfaces of the contacts were generally free of residue except for the surface of stationary contact A1. Analysis in the SEM by EDS suggests the residue is composed primarily of the elements sodium, chlorine, and silver. The mating surfaces of the contacts did not exhibit arc erosion or excessive wear. The mating surfaces of the contacts did not exhibit signs of witness marks which could be distinguished from their normal making or breaking action.

SUMMARY OF FINDINGS

A summary of the significant findings is offered as a result of the examination of the scavenge pump relay.

External

The relay has impact damage as indicated by the deformed case and the tilted actuator coil inside the relay.

The N.C. closed contacts are in the open position.

The case of the relay as well as the mating surfaces of the electrical connector exhibit signs of being in a corrosive environment (white and reddish brown residues).

The N.O. contact (A1) had a resistance of 800 K ohms to the case of the relay.

Internal

The base of the relay was bright and shiny except for the area surrounding N.O. contact A1.

Analysis of the white residue suggests it is primarily a compound of tin(chloride).

A multicolored residue lying on the glass to metal seal of A1 suggests it consists of compounds of iron, copper, and tin(chloride).

The resistance of the N.O. contact A1 increased once the residue on the glass to metal seal was removed.

Evidence that an electrical short could have been present before the formation of the multicolored residue was not found.

The mating surfaces of the N.O. and N.C. contacts did not exhibit signs of witness marks.

The mating surfaces of the N.O. contacts did not exhibit arc erosion or excessive wear.

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PUBLICATION REVIEW: This report has been reviewed and approved.

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000040