ANALYSIS OF FA 10264 REIL AND DME WATER PROBLEM

STATEMENT OF PROBLEM:

Several REIL's and a number of DME control units have been identified to have a major water problem that contributes to failures of the electronics and out of service calls on the systems. This problem is reported nation wide.

OBSERVATIONS:

Mark Tracy took me out to runway 5 at Lawrence Massachusetts to witness the REIL installation that had a recurring problem with water being observed in the control box when opened (most noticeable early in the morning according to Mark). The system consisted of two independent sets each consisting of a stand alone control box coupled to an individual flasher and each set is mounted on a small concrete pad. Separated by approximately 120 feet the two installations are in effectively identical environments. However, the two installations have different historic failure rates. Looking out from the runway, the installation on the left has a much greater problem than the installation on the right and it was noted that the ground around this vulnerable installation is 'swampy'. Many deep ruts attest to trucks getting mired down in the spongy soil.

We opened the left control box and it was out of service. Several resistors were burned out - one had exploded and particles were resident on the surfaces. Water stains were evident on the inside of the aluminum cover and rust was evident on the sides of relays in the unit. The cover had been allowed to flip over backwards (the support arm provided may not have been connected) and the rear hinge shows damage. A heater was added to this unit as an experiment to try to get rid of the moisture - a good approach but the results indicated it didn't succeed. Too much moisture got into the unit even after the heater installation.

A comparison was made of the other installation but the second unit was obviously in much better condition. No damage was evident at this unit (which didn't have a heater) but water stains were also evident on the inside of its cover.

The control box resembles an 18 inch by 18 inch by 8 inch high aluminum suitcase mounted horizontally on two pipe supports. The aluminum cover is hinged at the back and is about eight inches high. When the control box is opened, the electronics which are stacked six inches high are visible. They are mounted on a single horizontal aluminum sheet about 18 by 18 inches which sits inside the enclosure. This plate in turn is mounted by means of screws and one inch spacers to a cast aluminum base plate which is the bottom of the unit.

Two three inch diameter pipes which are screwed into the base are the structural supports holding the control box about 24 inches off the ground. See attached sketch in Excel 4.0 (Figure 1). The pipes also function as conduit, routing cables from the control box to the adjacent flasher (about 3 feet to the side of the control box) and bringing power into the location through trenched access.

Gaskets surround the aluminum lip to act as a seal against water entry. The design requires that the gasket material initially protrude above the aluminum lip so the flexible material can be compressed and act as a good seal. See attached sketch in Excel 4.0 (Figure 2). Unfortunately in the out of service unit, the gasket is mounted below the lip so it is ineffective for a good deal of the circumference. This is not a good design as there is no positive compression of the gasket under all conditions.

The cause of the electrical failure observed is quite evident. Water gets into the box. When the REIL is exercised to land aircraft, the control box heats up and the water inside the enclosure turns to vapor. Then the box turns off and the inside cools quickly. When the outside temperature drops,(winter or night time in spring and summer) the moisture deposits itself on the inside surface of the aluminum cover (the aluminum transmits the low temperature into the enclosure; the moisture deposits itself onto the cold surface similar to the effect seen inside on a car's windows in winter). Since the electronics board is mounted in a horizontal position immediately under the large horizontal cover, the water droplets fall on the unprotected board (the board is NOT conformal coated - another poor design feature). Since the board is mounted horizontally, the moisture can't run off - it puddles on the board. Moisture seeps into the components and when energized, the components literally explode from the steam generated.

The main question is how does the moisture enter the enclosure in the first place? Several points of entry were observed.

- First the inoperable gasket identified above will allow moisture to be drawn into the box when the REIL turns on and off causing alternate heating and cooling (the box 'breathes' - heat expands the air driving it out of the box; cooling causes a drop in pressure drawing air into the box). This will draw in moisture during heavy fog or rain conditions or if there is a lot of standing water on the surface.

- Second the 2 each 3 inch diameter pipes entering the box from below will allow entry of moisture from below. Again the temperature cycling will 'wick' moisture into the enclosure. These were examined in detail to see how they influenced the system. The far left pipe goes deep into the ground and routes the power to the complex. It is assumed that it consists of cable directly in contact with the soil below ground level - no PCV pipe. Both the two remaining pipes - the other support for the control box and the support for the flasher are mounted to the concrete pad using frangible couplings. It is assumed that they don't enter the ground. Moisture can enter through the pipe - to - concrete surfaces - no gaskets visible, through the armored cable and through various access ports - all have intact gaskets. Any moisture drawn into the flasher collage can be drawn into the enclosure through the right hand 3 inch pipe.
- To evaluate the relative importance of each of these entry mechanisms a quick set of calculations were performed. Assuming the seal on the cover to be left out entirely and estimating an 80 inch circumference coupled with a .01 inch gap between the casting and the cover, the effective open area is 0.8 square inches. The open area contributed by the 3 inch pipe (assume 2.75 inside diameter) is 5.94 square inches. Therefore each pipe is 7.5 times more of a problem than the seal around the case. This would appear to be the culprit. Of the two pipes, the one entering the ground is more likely to be the major contributor. The spongy soil acts as a reservoir of , continually replenishing the supply, and the pipe in conjunction with the temperature cycling in the box 'wicks' the moisture into the enclosure resulting in all the above mentioned events.

RECOMMENDED SOLUTION

First the gasket for the cover on the failed unit should be replaced so that the gasket rises above the aluminum lip.

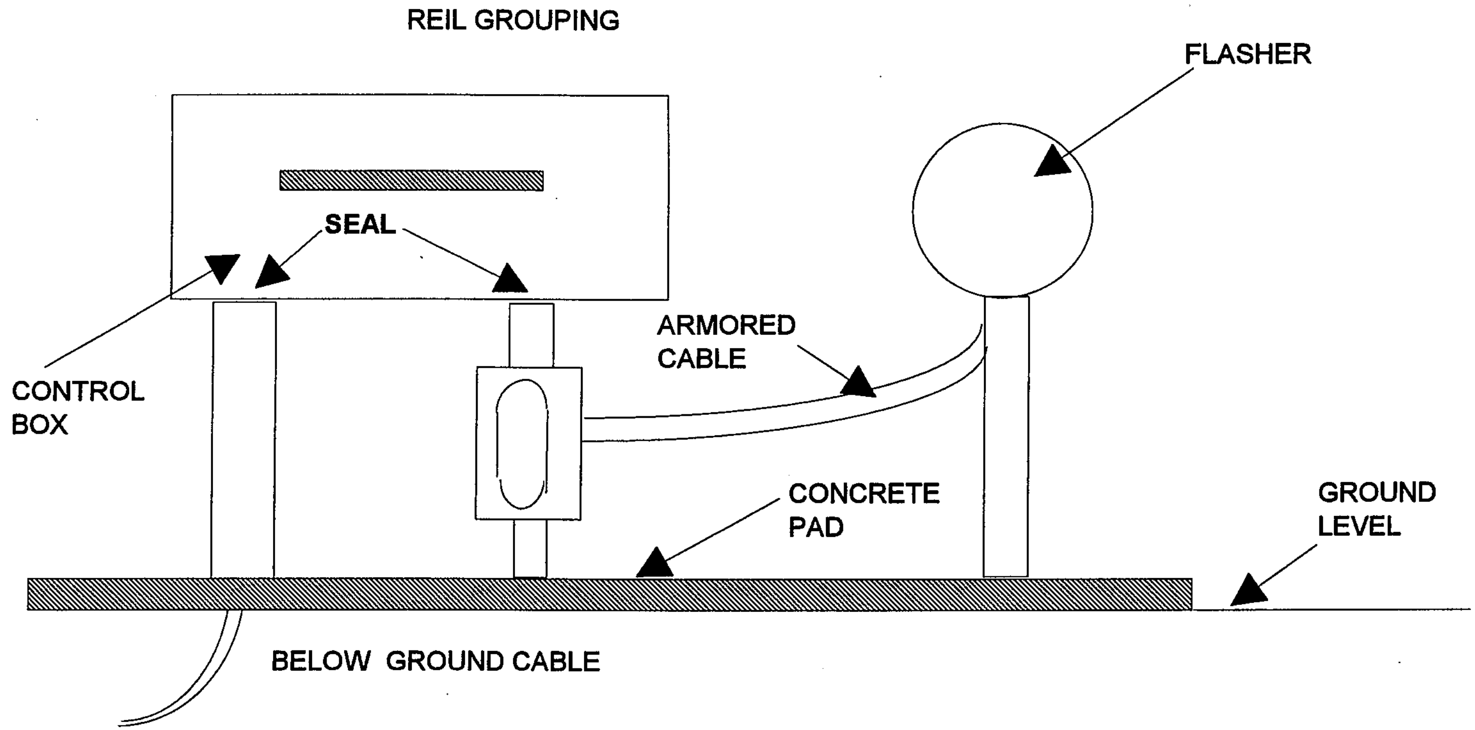
Next the two 3 inch pipes have to be sealed so they don't act as a viaduct for bringing moisture into the enclosure. DUCT SEAL a commercial product which the technicians have in the repair van is the recommended fix. This compound is similar to modeling clay, it is used in most of the commercial environmental labs to seal entry to a wide range of environmental tests. It is flexible and can be readily removed in a matter of minutes. Silicone rubber was considered but the cables coming through these pipes have to be accessed so silicone rubber is not a viable solution. The technician indicated that if the flasher fails the assembly comes with the cable as an 'umbilical cord' and the cable and the flasher have to be replaced - not a good design (a possible opportunity to put in an ECP for cost saving).

The control box has to be opened and the interior plate holding all the components has to be removed. 4 screws hold the plate, 4 hold the large transformer and another 4 hold another assembly. Other screws may be involved in this removal. Then the two 3 inch pipe mouths are accessible. DUCT SEAL is to be pushed into the opening to make sure it is sealed (removal is easy; fingers can extract the material which doesn't harden even after years of service - a tool can be designed to hasten removal if deemed appropriate). It was originally thought to access only the pipe entering the ground but that approach is more trouble than it is worth. Sealing both is much smarter.

Reassembly of the unit is the reverse of the steps outlined above. Estimated time to install is 1 hour.

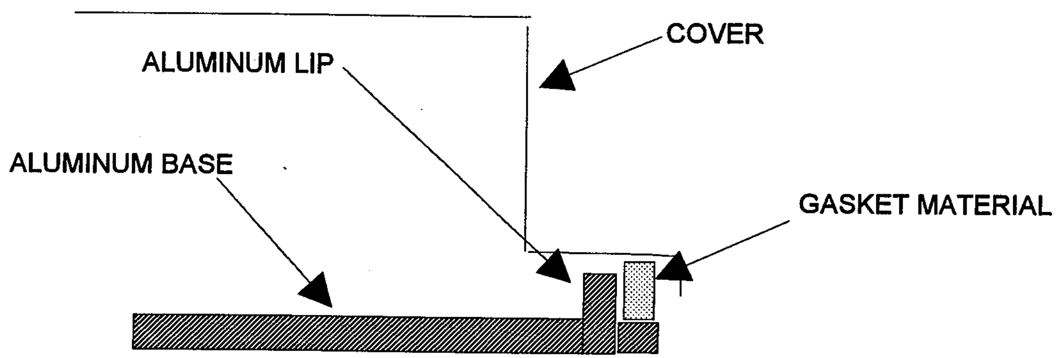
It is further recommended that two units that are exhibiting this problem at two different sites be used as a test bed to verify the accuracy of the diagnosis and the solution. Wait two to four weeks and examine the units to see if there was an improvement. If positive, put the "fix" in throughout the Region.

REIL SKETCH - CONTROL BOX FLASHER   REILHWA.XLS 9:03 AM 5/24/95



J COLLINS ANE403 NISC (ARTHUR D. LITTLE)

FIGURE 1



COVER SEALING CONCEPT GASKET TO BE HIGHER THAN BASE LIP