F-35 "ALIS" Limitations of Aircraft Repair Scenarios: "Divide & Conquer" Technique for Troubleshooting Light Flicker

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When attempting to troubleshoot a discrepancy without the aid of a troubleshooting chart, the first technician action step is to decide where to begin the process of examination. When experience does not suggest the point at which the troubleshooting should begin, the technician should consider the “Divide & Conquer” Technique.

The important aspect of this simple example is not the use of this particular schematic for this particular discrepancy, but rather to illustrate the advantages of the “Divide & Conquer” Technique as opposed to a “Hit & Miss” approach to troubleshooting.

In the “Divide & Conquer” Technique, the technician separates the system into two equal parts, either in regard to the number of components or in terms of a linear measurement, then testing the operation of each half of the system to that point.

Based on the results of the test, the technician knows whether the discrepancy lies in the first or second half of the system under investigation that is being tested. The discrepant half of the system is then divided into two equal parts and the system is again tested.

This process is repeated until the discrepancy is discovered. The use of the “Divide & Conquer” Technique offers, in the long run, the quickest way to identify a discrepancy & its possible cause.

When coupled with experience, the “Divide & Conquer” Technique is hard to beat. The technician may, after previous troubleshooting, note that one portion of the system rarely experiences failure. In such cases, troubleshooting may begin at another, more likely point.

Testing at any point in the system requires knowledge of the specific system involved in the investigation. The technician must be able to determine the inputs & outputs of the system at the test point.

Generally, it is best for the technician to determine what is to be expected at any point prior to making the test. Determining the acceptable test result criteria before testing lessens the tendency of the technician to accept invalid results.

The selection of the appropriate corrective action is the next step in the returning the aircraft to an airworthy condition. A description of corrective action techniques is beyond the scope of this report. The technician should remember that the repair is not complete until the cause & symptom are corrected.

The following example is designed to demonstrate the utility of "Divide & Conquer" Techniques on a Simple Aircraft Repair Scenario:

Assume the pilot reports that a left-hand low pressure warning light flickers. Also assume that all valves are in the position represented in operational instructions. The obvious things are checked first: Fuel supply & warning light bulb, and both are functional.

Assume the troubleshooting charts do not provide any direction for flickering problems. From the system schematics, it is determined that there are four locations from which troubleshooting may be accomplished: engine compartment, cockpit and either of the two fuel tank areas.

"Divide & Conquer" by selecting the cockpit as the middle location. Since the difficulty appears on the left-hand system, the right hand emergency shutoff valve is closed & tagged. Tagging of all switches and manual valves placed in non-operational positions during the troubleshooting process is accomplished to ensure that they are returned to operational positions before the aircraft is released for service. When the fuel-boost pumps are activated, the discrepancy is not duplicated.

When the left-hand emergency shut-off valve is also closed [not likely to be done in flight] the low pressure light illuminates but does not flicker. Chances are now good that the fault does not exist in the engine compartment. The emergency shut-off valve is opened.

Since no master warning of fuel bypass was reported, fuel bypass systems are assumed to be operational. The discrepancy may now be assumed to be in either of the fuel tank systems.

Each system may be checked separately by use of the cross-feed valve. With the cross-free valve open, the left-hand boost pumps are turned on with right hand boost pumps off. The discrepancy is not duplicated. From this, the left-hand system and the right-tank check valve may be considered operational.

Turning off left-hand pumps and turning on the right hand pumps results in the problem being duplicated. The problem lies in either the right-hand or left-had check valve. Closing the left-hand manual shutoff, the discrepancy continues, so the left-hand check valve is probably operational.

Closing the cross-feed valve and opening the right-hand emergency shutoff valve moves the discrepancy from the left-hand low-pressure light to the right hand light. The discrepancy is definitely in the right hand tank system.

Since the tank boost pumps do not indicate failure, the boost pumps are probably all right. The two remaining potential problems are the two check valves, either the fuel-ejector unit check valve or the check valve between the boost-pump check valves.

By dividing the system in half at the emergency shut-off valve, the portion of the system beyond the emergency shutoff was eliminated from consideration.

By dividing the faulty portion of the system in half again, the right hand tank system was identified as the culprit.

A cross-check verified this fact. After dividing the system in half twice and doing some investigation, the technician was able to limit the fault to one of two components from a potential of a few dozen components.