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Suggested Topic Area: Condition Based Maintenance

The mission capable status of the C-141 depends on many systems, one of which is the fuel delivery system. Fuel is delivered to the C-141 aircraft engines from the wing fuel tanks by means of twenty fuel boost pumps, one primary and one secondary in each tank [four main tanks, four auxiliary tanks, and two extended range (ER) tanks]. The primary and secondary fuel boost pumps are submerged inside the wing fuel tanks.

During the past year, failure of fuel system boost pumps have accounted for over 4000 hours of aircraft unscheduled downtime. This equates to one aircraft being unavailable for nearly half a year. On average, the loss of airlift for this many days has a potential multi-million dollar negative impact annually on the Air Mobility Command's Transportation Working Capital Fund (TWCF) revenue. If the progress of these failures or malfunctions could be predicted or monitored in advance, their maintenance could be appropriately scheduled and their impact on operations minimized.

Oak Ridge National Laboratory is teaming with the Warner Robins ALC, Georgia to reduce the loss of availability of the C-141 due to unplanned repair or replacement of the fuel boost pump.

WR-ALC and ORNL personnel are defining the scope of an improved maintenance approach for the twenty fuel boost pumps of the C-141. The goal of these studies is to demonstrate the effectiveness of electrical signature analysis (ESA) as a diagnostic maintenance technique for detecting the highest consequence fuel pump failure modes. The ESA technique has the advantage that it is sensitive to both electrical and mechanical pump failure modes. Preliminary work will isolate and identify the electrical signatures of the various failure modes.

WR-ALC and ORNL personnel will define the scope of an improved maintenance approach for the twenty fuel boost pumps of the C-141. The initial studies will focus on C-141 aircraft assigned to Wright-Patterson Air Force Base (AFB). ORNL will be the technical lead in all tasks in this phase of the project.

The goal of the first phase of the project, now complete, was to demonstrate the effectiveness of the electrical signature analysis technique on C-141 electric fuel booster pumps.

The goal of the second phase of the project is to develop a prototype electrical signature analysis (ESA) diagnostic instrument for the C-141 electric fuel boost pumps, and to demonstrate/validate it against the fleet of C-141s maintained by the 445th Air Reserve Wing (ARW) at Wright-Patterson AFB.

The ESA technique has the advantage that it is sensitive to both electrical and mechanical pump failure modes. Work in Phase II will isolate and identify the electrical signatures of a representative sample of pumps supplied by the Air Force.

In Phase II, a group of defective fuel boost pumps returned from field use are being examined at ORNL to determine their physical and functional condition. The pumps are being subjected to an operational test and their electrical signatures are being recorded. Following the operational test, the pumps are being disassembled to determine the type and degree of faults that they contain. The results of these examinations are being cross-correlated and entered into the project database. A ranking of the type of defects that are most prevalent are being developed. The electrical signature characteristics of these defective pumps are being compared to a set of baseline pump signatures and correlated with data from the physical and functional evaluations.

The Phase II test program will also include testing of a group of fuel boost pumps obtained from C-141 aircraft stored at the AMARC facility. These pumps are being tested both before and after implanting a series of different types of progressively more severe defects. Changes in the electrical signatures of these pumps are being correlated with the type and level of defects inserted.

A horizontal test stand for testing both main and auxiliary fuel boost pumps has been constructed to support Phase II testing. The fuel to be used is the current JP-8 fuel.

A database of electrical signatures and their associated defect types is being developed.

A prototype diagnostics recognition algorithm is being developed and tested/validated using field electrical signature measurements and forensics from fuel pumps on aircraft maintained at the 445th ARW at Wright Patterson AFB.