Application Note

1864 Megohmmeter used in Aircraft Fuel Pump Inspection

Another aerospace application for the GenRad 1864 Megohmmeter is inspection of fuel boost and override/jettison pumps. Reports of fuel leaks on eight 747 aircraft fuel pumps have prompted inspection and test of those pumps having 34,000-67,000 use hours since new or previously overhauled (Boeing Service Bulletin 747-28A2194). Still, where does the 1864 Megohmmeter come into play? It is used to test the resistance at the pump/wire bundle interface at the top of the fuel pump. One of the features of the 1864 is that the voltage can be set to 10 V first to check for shorts and then to the required voltage of 500 V to minimize the possibility of generating an arc during testing.

On a 747 aircraft there are multiple fuel tanks: several in each wing section, one in the center of the fuselage between the wings and one at the rear tail section. Refer to Figure 1.0. The fuel jettison override pumps are located at the center of the aircraft next to the wing section. The fuel boost pumps are located on the wing and there may be auxiliary jettison pumps in the tip section of the wing. Transfer pumps are located at the center and tail tanks.

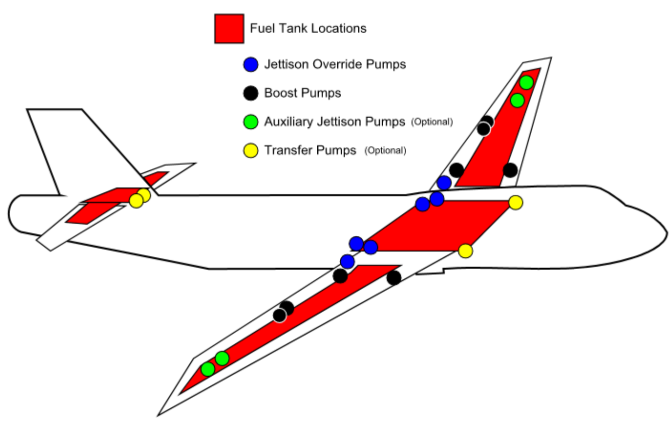

Figure 1.0 Fuel Pump Locations

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Before we get into the fuel pump, let's step back and draw out the basics of how an aircraft flies and how the fuel system serves this purpose. There are four engines on a 747, two on each wing. The pilot controls the engines via computer signals. A jet engine takes in air at the front and pulls it through a series of compressor blades. The fuel is added (aided by the fuel pump) to the hot compressed air and the mixture ignites in the combustion chamber of the engine. This explosion of very hot gases out the rear of the engine creates the thrust that propels the aircraft forward.
Refer to Figure 2.0 for aerodynamic forces acting upon and aircraft. Lift is created by the differential of air moving over and under the wings. The air going over the top moves faster than air going under. The faster the wing moves through the air, the greater the lift, eventually enabling the aircraft to overcome the force of gravity and take off. The engines provide the thrust and the fuel pumps keep the fuel supplied to the engine.

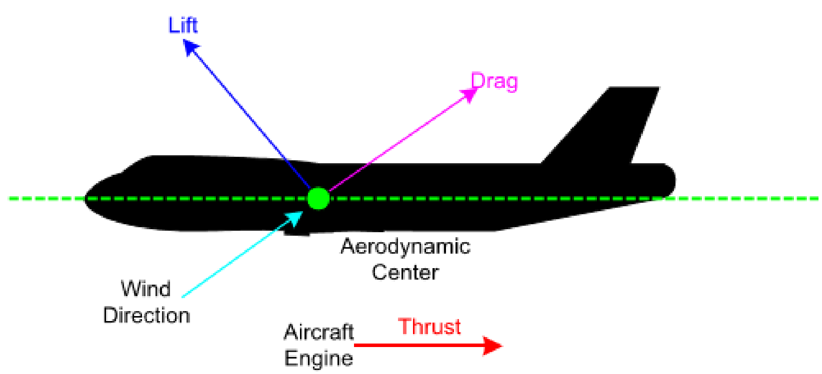

Figure 2.0: Aerodynamic Forces acting on an Aircraft

Definitions*

Aerodynamic Force: (Fluid Mechanics) The force between a body and a gaseous fluid caused by their relative motion. (Also known as aerodynamic load).

Aerodynamic Lift: (Fluid Mechanics) That component of the total aerodynamic force acting on a body perpendicular to the undisturbed airflow relative to the body.

Aerodynamic Drag: (Fluid Mechanics) A retarding force that acts upon a body moving through a gaseous fluid and that is parallel to the direction of the motion of the body. (Also known as aerodynamic resistance).

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Thrust: (Aeronautical Engineering) The pushing or pulling force developed by an aircraft engine or a rocket engine.

* McGraw Hill Dictionary of Scientific and Technical Terms © 1974

What Does a Fuel Pump Do?

Figure 3.0: Fuel Pump

Figure 3.0 illustrates a generic fuel pump. The fuel pump, driven by the engine controls, provides a source of high-pressure fuel to the combustion chamber to obtain the required level of thrust. High pressure also powers the engine actuation systems. Fuel pumps are labeled ‘booster’ pumps when they provide motive flow (force) for ejector pumps located inside the fuel tanks. A fuel-metering unit provides fuel flow based on the current signal generated by the engine electronic control.

Of concern in fuel tanks is heating of the fuel pump, heating of the fuel in the tank, capacity (level) of fuel in the tank and behavior of associated wiring. The level of the fuel in the tank is directly proportional to the amount of fuel vapor. The fuel tanks sit across the main portion of the fuselage with the landing gear in close proximity. Fuel tanks are inspected regularly and do not pose any immediate danger to passengers. Fuel tank explosions are extremely rare. Current safety measures recommended by the NTSB include: foam insertion systems; flying with full center fuel tanks; insulating the tanks from components that could heat up the vapor and using colder fuel (i.e.: re-fueling from ground tanks in lieu of in-flight refueling).

Getting back to the role of the 1864 Megohmmeter in the testing of the wire pump bundles of the override/jettison fuel pumps per Service Bulletin 747-28A2194. Figure 4.0 illustrates the wire bundle at the top of the fuel pump and the cap where the insulation resistance testing is performed.

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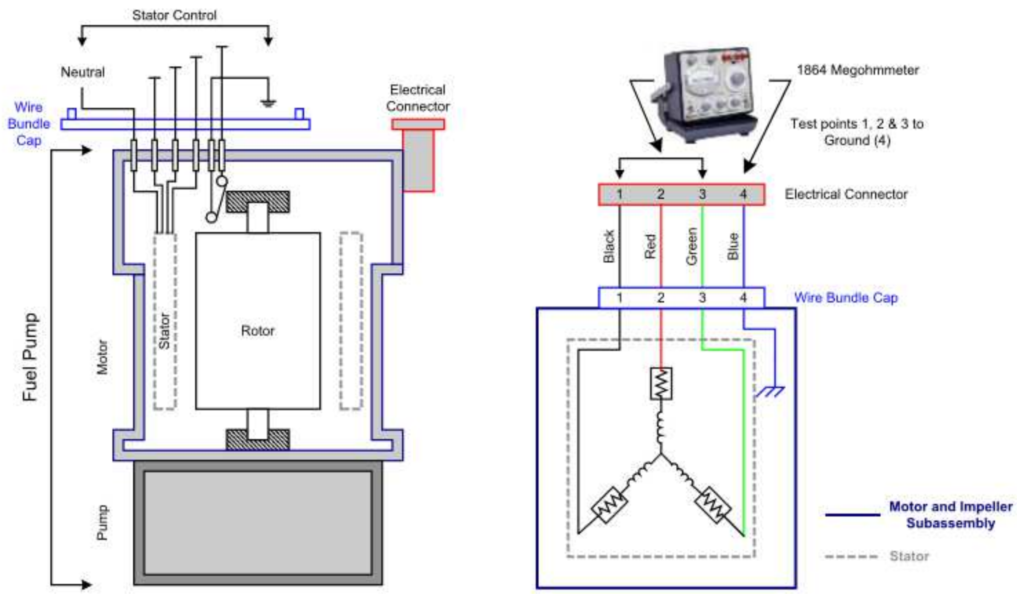

Figure 4.0: Fuel Pump Inspection Site-Wire Bundle Cap

A visual inspection of the fuel pump wire terminal assembly is performed to make sure no fuel has leaked on the wire assembly, that there is no breakage, corrosion or discoloration of the wires and that there are no broken screws. The electrical connector mounted on the side of the fuel pump is disconnected from the pump.

The 1864 Megohmmeter is connected to the electrical connector. The resistance between pin 4 (chassis ground) and pins 1, 2 and 3 (individually) is measured at 10V DC then again at 500V DC.

The 10V DC test is done first to prevent arcing or overheat in a flammable leakage zone when high voltage is applied to a pump with low insulation resistance.

If the insulation resistance is greater than 1MΩ at 10VDC then the wire assembly is tested at 500V DC. The insulation resistance at 500V DC must be greater than 5MΩ. If the resistance is < 1MΩ at 10V DC or < 5MΩ at 500V DC, the pump is replaced. This simple test and straightforward specification belie the immense importance of this electrical safety test.

The 1864 Megohmmeter used to test the insulation resistance of the fuel pump wire assembly, verifies that the resistance is in compliance with the 747 aircraft maintenance specifications. The 1864 Megohmmeter is a portable, steel encased high resistance tester capable of supplying 200 test voltages from 10V-1090V DC and measure resistance up to 200TΩ (2 x 10^{14} ohms). Besides aircraft wiring, the 1864 Megohmmeter has been employed in insulation resistance (IR) tests on wire & cable (cable reels), capacitors, rectifiers and solid-state diodes plus a wide variety of electronic components.

For complete product specifications on the 1863/1864 or any of IET's products, visit us at https://www.ietlabs.com/genrad-1864-megohmmeter.html

Do you have an application specific testing need? Call us at 516-334-5959 or email engineering at sales@ietlabs.com and we'll work with you on a custom solution.

Put IET to the test because we're committed to solving your testing requirements.

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