



AEROSPACE INFORMATION REPORT

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ELECTROMAGNETIC INTERFERENCE ON AIRCRAFT FROM JET ENGINE CHARGING

Engine charging of aircraft has been observed for many years, with documentation dating back to the 1946 Army-Navy Precipitation Static Project reports in which it was noted that selective operation of either the inboard or outboard engines on a four-engine aircraft resulted in a slightly different discharge rate or discharge time constant. This was attributed to ion recombination in the exhaust stacks or, more properly, lack of it. This was considered primarily a curiosity of interest in relation to the basic discharge mechanisms of the aircraft, but for the earlier piston aircraft to be of no particular importance as a source of precipitation static radio interference. However, with the introduction of jet engines having large exhaust nozzles and high flow volumes at very high velocities, engine charging has become a significant problem requiring definite provisions for discharge. The basic mechanism is assumed to be charge separation occurring through the ionization disassociation, etc., of the molecules in the high temperature flame in which ions are selectively captured by the walls of the exhaust nozzle as determined by the individual exhaust nozzle geometry, the fuel types, and flow rate.

Charging as high as 800 microamps with water injection (Nanevicz, et al, AFAL-TR-65-239, p. 48, December 1965) has been observed with maximum takeoff power on the large jet engines of turbo-jet transport aircraft. In general, the effects on the aircraft communication system are similar to those from charging by frictional contact of the aircraft with atmospheric particles and as such can be handled by use of static wick dischargers.

Studies have been carried out as to possible methods of preventing engine charging by fuel additives. It was found that the charge rates were very sensitive to throttle and to some extent atmospheric conditions, and it was found that fuel additives could be used which greatly reduced charge rates. However, no practical fuel additives have been developed which do not have some severe disadvantages in the operation of the jet engines and no fuel additives are being used at the present time to prevent engine charging. It should be noted that conductive additives are being developed for dissipating static electrification in fuel tanks which should not be confused with additives to prevent engine charging.

Another alternative has been investigated, the use of conducting probes in the hot exhaust efflux for ion collection; however, it may be easily shown as verified in experimental studies that because of the extremely high flow rates, the large cross sectional area of the exhaust nozzle and the low mobility of the ions, that an extensive network of conductors would be required and these would be difficult to maintain in the high temperatures of the exhaust. Also, with a sufficient number of conductors for significant reduction in charge rates, engine performance would probably be adversely affected.

A third possibility, which has been employed in prototype experiments, is to actively discharge the aircraft through a special corona point assembly connected to a high voltage power supply. The aircraft potential is sensed continuously by an electrostatic field meter whose output controls the magnitude and polarity of the high voltage supplied to the corona point assembly.

The engine charging effects are greater at the lower flight altitudes and higher power setting. The actual charging process can be eliminated by after burner operation if available. The resultant flames provide a low impedance coupling of the aircraft to the ambient atmospheric potential. The small aircraft capacity of 500 pf's to 1500 pf's assures a rapid buildup in potential after the after burner is cut off.

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