AEROSPACE INFORMATION REPORT	AIR5128™	REV. A
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(R) Electrical Bonding of Aircraft Fuel Systems

RATIONALE

An industry committee has reviewed documents relative to description of proper electrical bonding of aircraft fuel systems. While there are many references that include partial discussion, there has been no single document dedicated to just this subject. This AIR has addressed the subject but the previous version lacked useful detail. The intent of the current version of this AIR is to add more detail relevant to this subject. This includes expanding the outline (table of contents) and adding a higher level of detail in the way of numerical values to guide the designers with electrical bonding of aircraft fuel systems.

AIR5128A has been reaffirmed to comply with the SAE Five-Year Review policy.

FOREWORD

In early aircraft, the fuel system was relatively simple. Fuel flows were low and rubber hoses were normally used to provide for flexibility and ease of alignment within the system. It was in the 1950 era, with the advent of jet engines, when significant changes in the aircraft plumbing systems began to change some of the factors related to electrical bonding considerations. The use of conventional hose and hose clamp connections were creating leakage problems as a result in changes in fuels and their effects on the rubber. New style couplings were being developed for use with rigid tubing to resolve the leakage problems with rubber hoses. Electrical bonding was not a direct consideration in these efforts but MIL-B-5087, first issued in November 1949, was the reference document in the fuel system specifications to cover all forms of electrical bonding. Electrical bonding of the tubes and across the joints was a requirement if the linear dimension exceeded 3 in but the electrical connection to structure included a resistance requirement "less than one-half megohm" to prevent the accumulation of static charge.

Aircraft and their fuel systems became more complex with high fueling rates becoming the norm under most conditions, including In-Flight-Refueling. With greater recognition of the effects and dangers of electrical discharges within the system, design changes were being requested. Some system designers for military aircraft expressed concerns that the use of safety wire on threaded fasteners and couplings within the system resulted in potential sources of discharges within the fuel tanks. The use of bonding clamps and cables to provide for electrical bonding added significant weight and costs. Other forms of locking threaded fasteners were requested along with simpler methods of maintaining electrical continuity throughout the system.

One of the results was various designs for self-locking fuel line couplings to eliminate the use of safety wire plus the incorporation of various types of integral electrical bonding connections. At that time, the request was only to provide for the requirements of MIL-B-5087B, Class S (1 Ω maximum resistance). The concern that was expressed at that time still related only to static electric charges that could develop during fuel flow within the system. During the 1970s, these types of connectors became common in aircraft fuel system plumbing. In military aircraft, the external points of the system, such as the vent tubes, were generally electrically isolated from the external structure to prevent the entry of lightning charges into the plumbing system. A flame arrestor was often installed within the vent line to prevent the entry of the flame front into the system as a result of the ignition of fuel vapors externally.

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FOREWORD (Continued)

With the development of new high performance aircraft such as the F16, the question was raised concerning the possible effect on the fuel system when the aircraft was subjected to lightning strikes in flight. This included the possibility of high currents passing through the plumbing system including the connectors and other components used within the system. Tests were performed on the existing system components to satisfy the USAF that the system was safe. No significant changes were required as a result of this testing.

In recent years, the question of adequate electrical bonding has been raised more often and with some strict and questionable criteria. Very low resistance values are requested in many cases with values ranging from a low of 2.5 mΩ, to 100 mΩ, and to a high of the old standard, 1 Ω (Class S). The basis for these requirements with respect to aircraft fuel systems has never been clearly defined and has created considerable concern for the suppliers and users of the various components within these systems. It appears that the limits were selected for lack of any other well defined criteria resulting from test data or other analysis. The very low resistance values are difficult to achieve while complying with other requirements such as corrosion resistance at the interface of materials/components.

A significant amount of effort has been and is being expended in the area of Electromagnetic Interference (EMI) and Lightning effects on some aircraft systems. Some of the documents relating to these tests and analyses are referenced within the body of this report. In the Reference Section, a more complete list of existing documents that are referenced elsewhere in this report and/or may be of general interest are included.

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