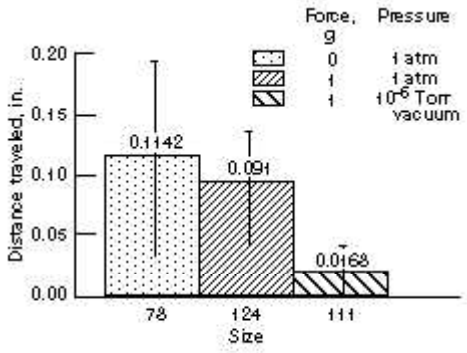
Environmental Influence of Gravity and Pressure on Arc Tracking of Insulated Wires Investigated

Momentary short-circuit arcs between a defective polyimide-insulated wire and another conductor may thermally char (pyrolize) the insulating material. The charred polyimide, being conductive, can sustain the short-circuit arc, which may propagate along the wire through continuous pyrolization of the polyimide insulation (arc tracking). If the arcing wire is part of a multiple-wire bundle, the polyimide insulation of other wires within the bundle may become thermally charred and start arc tracking also (flash over). Such arc tracking can lead to complete failure of an entire wire bundle, causing other critical spacecraft or aircraft failures.

Unfortunately, all tested candidate wire insulations for aerospace vehicles were susceptible to arc tracking. Therefore, a test procedure was designed at the NASA Lewis Research Center to select the insulation type least susceptible to arc tracking. This test procedure addresses the following three areas of concern: (1) probability of initiation, (2) probability of reinitiation (restrike), and (3) extent of arc tracking damage (propagation rate). Item 2 (restrike probability) is an issue if power can be terminated from and reapplied to the arcing wire (by a switch, fuse, or resettable circuit breaker). The degree of damage from an arcing event (item 3) refers to how easily the arc chars nearby insulation and propagates along the wire pair. Ease of nearby insulation charring can be determined by measuring the rate of arc propagation. Insulation that chars easily will propagate the arc faster than insulation that does not char very easily.

A popular polyimide insulated wire for aerospace vehicles, MIL-W-81381, was tested to determine a degree of damage from an arcing event (item 3) in the following three environments: (1) microgravity with air at 1-atm pressure, (2) 1g with air at 1 atm, and (3) 1g within a 10^-6 Torr vacuum.



Comparison of MIL-W-81381 insulated wire (20 AWG), in each environment of interest, with respect to the distance the arc travels in 16 sec.

The microgravity 1-atm air was the harshest environment, with respect to the rate of

damage of arc tracking, for the 20 AWG (American Wiring Gauge) MIL-W-81381 wire insulation type . The vacuum environment resulted in the least damage. Further testing is planned to determine if the environmental results are consistent between insulation types and to evaluate the other two parameters associated with arc tracking susceptibility.