

NASA WIRING FOR SPACE APPLICATIONS PROGRAM TEST RESULTS

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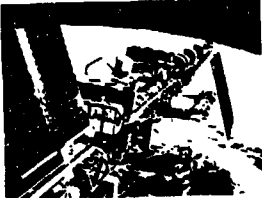
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ELECTRICAL POWER WIRING PROGRAM

GOAL: TO PROVIDE A TECHNOLOGY BASE FOR THE DEVELOPMENT OF LIGHTWEIGHT, ARC TRACK-RESISTANT AND RELIABLE WIRING SYSTEMS FOR AEROSPACE APPLICATIONS.

APPROACH

- IDENTIFY MISSION REQUIREMENTS AND APPLICATION ENVIRONMENTS
- EVALUATE POTENTIAL WIRING SYSTEMS AND ESTABLISH A DATABASE
- INVESTIGATE ADVANCED TECHNOLOGIES RELEVANT TO WIRING FAILURE PREVENTION, DETECTION, AND ISOLATION.
- ESTABLISH GUIDELINES AND RECOMMENDATIONS







TECHNOLOGICAL DEVELOPMENTS

- NEW INSULATING MATERIALS
- NEW WIRING CONSTRUCTIONS
- IMPROVED SYSTEM DESIGN
- ADVANCED CIRCUIT PROTECTION

APPLICATIONS

- PRESSURIZED MODULES
- TRANS-ATMOSPHERIC VEHICLES
- LEO/GEO ENVIRONMENTS
- LUNAR AND MARTIAN ENVIRONMENTS

NASA Wiring for Space Applications Program

- **Test Program:** Evaluate potential wiring constructions and establish a database of testing information.
 - Identify and prioritize NASA wiring requirements
 - Select candidate wiring constructions
 - Develop test matrix and formulate test program
 - Coordinate and conduct tests
 - Establish guidelines and recommendations

NASA Wiring for Space Applications Program

- **NASA Mission Environments:**

- Pressurized Module
- LEO/GEO Applications
- Trans-Atmospheric Vehicles
- Lunar Surface
- Martian Surface

OPERATIONAL ENVIRONMENTS

	Pressurized Modules	Low Earth Orbit	GEO	Trans-atmospheric	Lunar Surface	Martian Surface	Military Aircraft
Electrical							
Voltage	28 - 120 V	28 - 180 V		28 - 270 V		28 - 180 V	28 V
Frequency	DC				DC - 20 kHz		DC - 400 Hz
Mechanical							
Vibration	1 - 10 g 137 - 145 dB SPL						25 μ m amplitude 400 Hz
Impacts	N/A	11 - 26 impacts/m ² /yr (Function of Altitude)	< LEO	LEO \rightarrow GEO (Function of Altitude)	0.01 - 0.5 impacts/m ² /yr	Very Low Probability	N/A
Environmental							
Temperature	18.3 C - 28.7 C	-85 C \rightarrow 120 C 60.3 cycles/yr	-186 C \rightarrow 124 C 90 cycles/yr	-200 C \rightarrow 280 C Cycles Altitude Dependent	-171 C \rightarrow 111 C 13 cycles/yr	-143 C - 27 C 358 cycles/yr	-85 C \rightarrow 230 C
Atmosphere	Earth \rightarrow 37% O ₂	Earth \rightarrow Very Low O ₂				Earth \rightarrow 0.13% O ₂ 93.3% CO ₂	Earth Atmosphere
Gas/Fluid Comp.	25 \rightarrow 75% RH 100% RH Salt Fog Space Fluids	100% RH Salt Fog Space Fluids					25 - 75% RH 100% RH Salt Fog Aerospace Fluids
Pressure	517 - 760 Torr	10 ⁻⁶ \rightarrow 10 ⁻¹⁶ Torr	7.5 x 10 ⁻¹⁴ Torr	760 \rightarrow 7.5x10 ⁻¹⁴ Torr	10 ⁻⁶ \rightarrow 10 ⁻¹² Torr	4.4 \rightarrow 11.4 Torr	49 - 760 Torr
EM Radiation	N/A	2220 \rightarrow 6800 EBH/yr (Altitude Dependent)	8780 EBH/yr	8780 EBH/yr (Altitude Dependent)	8780 EBH/yr	1884 EBH/yr	Earth UV
Particulate Radiation	N/A	Protons, α particles, and electrons				N/A	N/A
Atomic Oxygen	N/A	10 ¹⁹ atoms/cm ² /yr (Altitude Dependent)	< LEO	LEO \rightarrow GEO (Altitude Dependent)	N/A	N/A	N/A
Reduced Gravity	10 ⁻³ \rightarrow 10 ⁻⁴ g	10 ⁻³ \rightarrow 10 ⁻⁴ g		1 \rightarrow 10 ⁻⁴ g	0.165 g	0.38 g	N/A
Charged Plasma	N/A	0.3 \rightarrow 45x10 ¹⁴ atoms/m ² 0.1 \rightarrow 0.2 eV	0.34 \rightarrow 1.12 atoms/m ² 120 \rightarrow 200 keV	LEO \rightarrow GEO	N/A	10 ¹⁰ \rightarrow 10 ¹¹ atoms/m ²	N/A

KEY: N/A = Not Applicable

TESTING PROGRAM APPROACH

- **Determine Required Test Matrix**
 - NASA Operational Environments
 - NASA Unique Test Requirements

- **Leverage Existing Testing Database**
 - Air Force Programs
 - Navy Programs
 - NASA Programs

- **Identify and Evaluate Candidate Wiring Constructions**
 - Military Standard Wires
 - Hybrid Insulation Constructions

- **Utilize (Inter)National Expertise**
 - External Review of All Plans
 - Experienced Testing Organizations

NASA Wiring for Space Applications Program

- **Candidate Systems:**
 - Filotex (PTFE/PI/FEP)
 - Thermatics (PTFE/PI/PTFE)
 - Tensolite (PTFE/PI/PTFE)
 - Gore (PTFE/HSCR PTFE/PTFE)
 - MIL-W-81381/7 (FEP/PI)
 - MIL-W-22759/12 (TFE)
 - MIL-W-22759/34 (XL-ETFE)
 - New Insulation (PFPI)

- **Configuration:**
 - MIL-W-81381/7 constructions
 - AWG: # 12, # 20
 - Single wire
 - Twisted pair

NASA Wiring for Space Applications Program

- **Summary of Results Reported in 2nd NASA Workshop on Wiring for Space Applications:**
 - Arc tracking, mechanical, electrical, flammability, fluid reactivity, thermal vacuum stability, atomic oxygen, and ultra-violet radiation performed on 8 candidate samples of both # 12 and # 20.
 - Candidate constructions down-selected to 3 most promising candidates, single wire gauge (# 20), and further tests were defined.
 - New insulation materials were identified and will be investigated

(Information reported in NASA Conference Publication 3244 - "Second NASA Workshop on Wiring for Space Applications")

NASA Wiring for Space Applications Program

FY '94 - '95 Testing Activities

- **Down-selected Samples:**
 - Gauge:*
 - AWG # 20
 - Constructions:*
 - Tensolite (PTFE/PI/PTFE)
 - Thermatics (PTFE/PI/PTFE)
 - Filotex (PTFE/PI/FEP)
 - MIL-W-81381/7 (FEP/PI)
 - MIL-W-22759/12 (TFE)
 - MIL-W-22759/34 (XL-ETFE)
 - New Insulation (PFPI)

NASA Wiring for Space Applications Program

FY '94 - '95 Testing Activities

- **Participating Organizations:**

- NASA
 - LeRC
 - MSFC
 - JSC
- McDonnell Douglas/TRW
- University of Buffalo

NASA Wiring for Space Applications Program

FY '94 - '95 Testing Activities
NASA LeRC

- **Objective:** Perform comparative analysis of arc-tracking of the candidate constructions under atmospheric, vacuum, and μ gravity conditions.
- **Tests:** Arc-tracking
 - Ambient conditions
 - 5×10^{-6} torr
 - 10^2 g
- **Principal Investigator:** Thomas J. Stueber
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NASA Wiring for Space Applications Program

FY '94 - '95 Testing Activities
NASA MSFC

- **Objective:** Investigate the effects of AO, UV, and AO with UV synergistic effects on wire insulation materials.
- **Tests:** AO: $\sim 10^{21}$ atoms/cm²
UV: $\sim 10,000$ ESH
- **Principal Investigator:** Jason A. Vaughn
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