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NASA WIRING FOR SPACE APPLICATIONS PROGRAM TEST RESULTS

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Presentation Outline

- Objective
- Atomic Oxygen System Description
- Results of Wire Insulation Exposure to 5 eV Atomic Oxygen Atoms
- Discussion of Ultraviolet Radiation Test Procedure
- Results of Ultraviolet Radiation Exposure on Materials

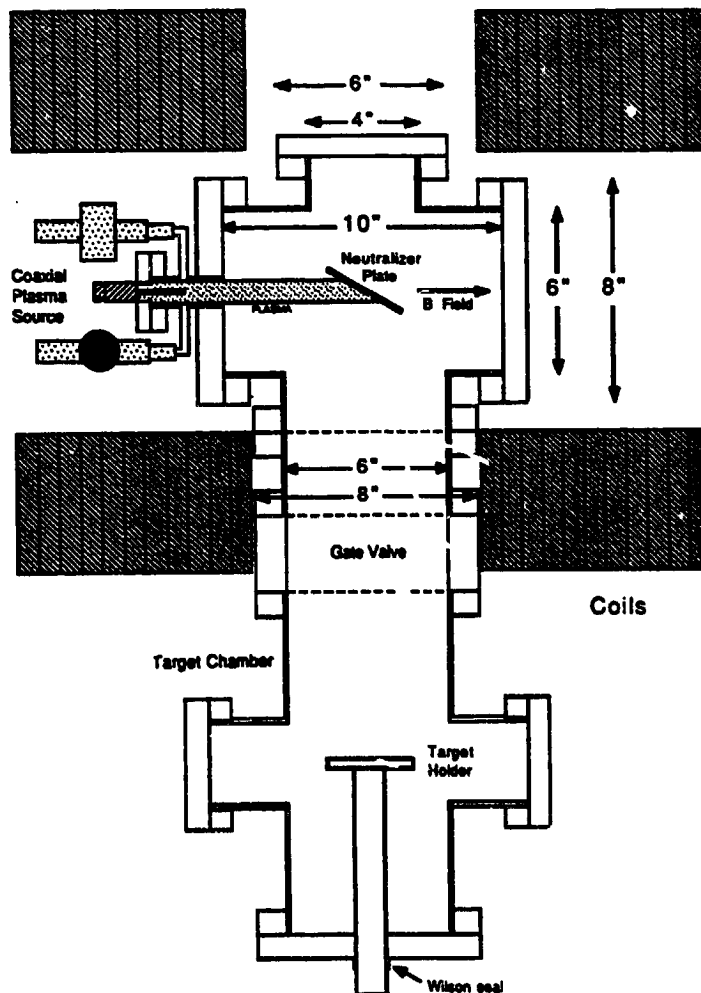
Objective

Investigate the effects of AO, UV and AO with UV synergistic effects on wire insulation materials. Atomic oxygen exposure to be on the order of 10^{21} atoms/cm² and VUV radiation to be on the order of 10,000 ESH.

PPPL 5 eV Atomic Oxygen System Characteristics

- Developed under contract with MSFC (H-83097B)
- Produces 5 eV atomic oxygen neutral atoms at a flux of 10^{16} atoms/cm²
- Fluence Levels of 10^{21} atoms/cm² require exposure times of approximately 40 hrs.
- Simultaneously produces Vacuum Ultraviolet radiation at 130 nm 200 times as intense as the equivalent solar VUV dose.

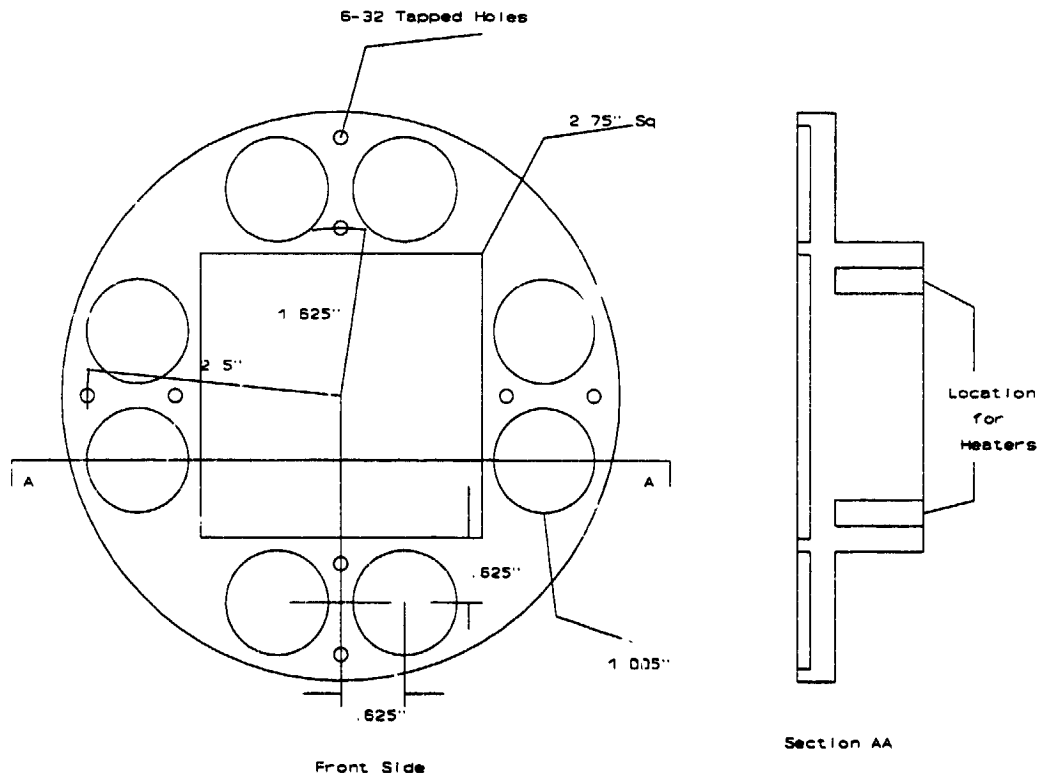
PPPL 5 eV Atomic Oxygen System Schematic



Wire Insulation Materials Exposed to 5 eV Atomic Oxygen

- TRW PFPI--Partially Fluorinated Polyimide
- MIL-W-22759/12-TFE Teflon Outer Material
- MIL-W-22759/34-XL-ETFE (TFE Teflon Material)

Wire Insulation Sample Fixture for AO Exposure



Atomic Oxygen Testing Visual Observations

- After completion of tests all wire materials showed no signs of eroding to the conductor or discoloration of the wire material.
- All wire samples had a powdery residue left on the surface.

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Mass Loss Summary of Wire Exposed to 8.5×10^{24} atoms/cm² Fluence AO and 8200 ESH VUV

	Average Δ mass (mg)	Average Δ thickness (μ m)	Computed Re (cm ³ /atom)
TRW-PFPI (awg #20)	6.26	47.2	5.6×10^{-24}
MIL-W-22759/12 (awg #20)	7.47	34.8	4.1×10^{-24}
MIL-W-22759/34 (awg #12)	3.12	14.5	1.7×10^{-24}

Ultraviolet Test Set-Up

- Four Samples of Each Wire Were Used For Statistical Average.
- Samples Exposed in 10^{-7} Torr Vacuum for a Period of 1033 hrs.
- Samples were controlled at Temperature of 120°C
- An Enhanced Ultraviolet Radiation Lamp with a Mercury-Xenon Bulb was used to radiate the samples.
- Source Produce Four (4) UV suns over the wavelength region of 200 nm to 400 nm per hour.
- Total Sample Exposure 4132 Equivalent Sun Hours.

Ultraviolet Radiation Test Materials

- Teledyne Thermantics (awg #20 and #12)--TFE/FEP Co-Polymer
- Tensolite (awg #20 and #12)-- TFE teflon outer material
- Champlain (awg #20)--FEP/TFE Co-polymer
- Barcel M81381-7 (awg #20)--Kapton
- HSCR Gore (awg #20 and #12)--TFE Teflon material Outercoat
- M81381-11 (awg #20 and #12)--Kapton Outer Material
- Filotex (awg #20 and #12)--TFE Teflon Outer Material

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Mass Loss Summary of Wire to 4000 ESH UV Radiation

	Average ΔMass (mg)	Percent Average ΔMass (%)
Filotex (awg #20)	0.327	0.069
Filotex (awg #12)	0.517	0.023
Teledyne Therm. (awg #20)	0.153	0.033
Teledyne Therm. (awg #12)	0.530	0.025
Tensolite (awg #20)	0.197	0.041
Tensolite (awg #12)	0.443	0.021
Champlain (awg #20)	0.233	0.048
HSCR Gore (awg #20)	0.267	0.057
HSCR Gore (awg #12)	0.510	0.023
M81381-11 (awg #20)	-0.180	-0.035
M81381-11 (awg #12)	-0.720	-0.034
Barcel M81381-7 (awg #20)	-0.044	-0.010

Summary of Atomic Oxygen and VUV Exposure of Wire Insulation Material

- **TRW - Partially Fluorinated Polyimide (PFPI) has higher AO reactivity. Uncertain to cause.**
- **Fluorinated Polymers have a high Synergistic VUV and Atomic Oxygen reactivity.**
- **The True Reason for the Increased Fluorocarbon Reactivity Is Not Known But is Believed to be Caused by the Increased VUV Radiation Rate.**
- **VUV Exposure Alone on Fluorocarbon Materials Causes Them to Lose Mass.**