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George C. Marshall Space Flight Center

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P-12

SPACE STATION FREEDOM SECONDARY POWER WIRING REQUIREMENTS

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SPACE STATION PROGRAM
WORK PACKAGE 1

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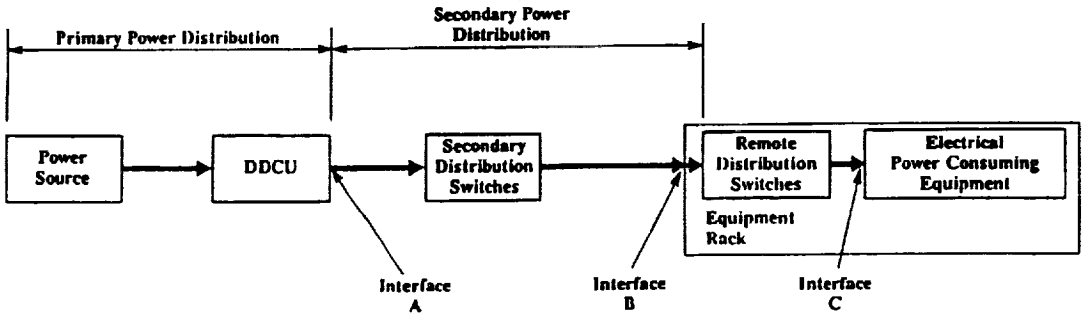
SECONDARY POWER - WHAT IS IT?

- SSF POWER TYPES
  - PRIMARY - POWER PRODUCED BY THE ARRAY & ROUTED TO DC-TO-DC POWER CONVERTER UNITS
  - SECONDARY - POWER PRODUCED BY DDCU'S & ROUTED TO THROUGH SPDA'S TO LOADS OR TERTIARY DISTRIBUTION ASSEMBLIES
  - TERTIARY - POWER ROUTED THROUGH TERTIARY POWER DISTRIBUTION ASSEMBLIES TO LOADS

FOR PRACTICAL PURPOSES SECONDARY & TERTIARY POWER ARE THE SAME, I.E. SECONDARY POWER

SPACE STATION FREEDOM
ELECTRICAL POWER
CATEGORIES



DIFFERENCES BETWEEN
SECONDARY & TERTIARY POWER

- ELECTRICALLY - NO DIFFERENCE
  - NO FURTHER CONDITIONING OF POWER IN TERTIARY POWER DISTRIBUTION ASSEMBLIES
  - SAME VOLTAGE LEVELS AT TERTIARY POWER DISTRIBUTION ASSEMBLY OUTPUTS AS SECONDARY POWER DISTRIBUTION ASSEMBLY OUTPUTS
- PHYSICALLY
  - SECONDARY POWER IS POWER DISTRIBUTED FROM DC-TO-DC POWER CONVERTER UNITS TO TERTIARY POWER DISTRIBUTION ASSEMBLIES THROUGH SECONDARY POWER DISTRIBUTION UNITS
  - TERTIARY POWER IS POWER DISTRIBUTED FROM TERTIARY POWER DISTRIBUTION ASSEMBLIES OR SECONDARY POWER DISTRIBUTION ASSEMBLIES TO LOADS

SPACE STATION FREEDOM
EEE PARTS WIRE SELECTION REQUIREMENTS

- SSP 30000, SECTION 9 SELECTION CRITERIA
  - SUITABILITY FOR APPLICATIONS
  - PROVEN QUALIFICATION
  - POTENTIAL USE IN MULTIPLE APPLICATIONS
  - PROVEN TECHNOLOGY
  - AVAILABILITY
  - APPROVAL STATUS

SPACE STATION FREEDOM
APPROVED ELECTRICAL WIRE & CABLE

- STANDARD WIRE & CABLE - GRADE 1 WIRE & CABLE LISTED IN MIL-STD-975 & SSP 30423
  - M22759/11, /12, /16, /23 & /3
  - M81381/7, /8, /9, /10 & /21
  - M27500 TYPES RC, RE, TE, TM, TN, MR, MS, MT, MV & NK
- NEW PROGRAM STANDARDS - BEING ADDED TO SSQ 30423
  - SSQ 21656
  - SSQ 21655

SPACE STATION FREEDOM
PDRD LANGUAGE PROBLEMS

- PDRD STATES APPROVED PARTS ARE LISTED IN MIL-STD-975 & SSP 30423
  - INFERS TO DESIGNERS LISTED WIRE & CABLE MEET ALL OF THE REQUIREMENTS OF SPACE STATION
  - MIL-STD-975 DOES NOT DIFFERENTIATE BETWEEN WHAT IS ACCEPTABLE/NOT ACCEPTABLE BY PROJECT
  - MIL-STD-975 IS NOT UP TO DATE WITH CURRENT PART TECHNOLOGY
  - MIL-STD-975 SPECIFIES SUNSET WIRE & CABLE CONFIGURATIONS NECESSARY TO SUPPORT CURRENT, ONGOING PROJECTS

SPACE STATION FREEDOM
PDRD LANGUAGE PROBLEM RESOLUTION

- DIRECT USE OF SPECIFIC WIRE & CABLE TYPES IN ALL NEW DESIGN SPACE STATION EQUIPMENT BASED ON APPLICATION
  - JOINT WORK PACKAGE CONNECTOR GROUP HAS RECOMMENDED TEFLON, TEFZEL & SILICONE INSULATIONS BASED ON APPLICATION & PERCIEVED NASA DESIRES
- REVISE THE LANGUAGE IN THE PDRD FOR CLARITY
  - *"MIL-STD-975 lists standard EEE parts used in various NASA projects that have been found to be suitable for high reliability space applications and shall be used as a first order of precedance in selecting Space Station parts."*

PERCEIVED NASA REQUIREMENTS

- NO KAPTON (M81381) INSULATED WIRE OR CABLE DUE TO ARC TRACKING
- NO SILVER COATED CONDUCTOR DUE TO RED PLAGUE EXPERIENCE & POTENTIAL CORROSION PROBLEMS
- NO TEFZEL INSULATED WIRE OR CABLE IN INTERNAL MANNED VOLUMES DUE TO MARGINAL SELF-EXTINGUISHING PROPERTIES & CHAR BYPRODUCTS
- MARGINAL INSULATIONS VACUUM BAKED TO REDUCE OUTGASSING
- LITTLE-TO-NO DEVELOPMENT

CONTRACTUAL EEE PARTS WIRE & CABLE APPLICATION REQUIREMENTS

- ENSURE WIRE & CABLE WILL NEVER BE OVERSTRESSED DURING NORMAL OPERATION
- DERATE WIRE & CABLE IN ACCORDANCE WITH MIL-STD-975
- ENSURE ALL EXPECTED ENVIRONMENTAL CONDITIONS ARE CONSIDERED AND EVALUATED WHERE PRACTICAL
  - RADIATION
  - ATOMIC OXYGEN
  - PLASMA
  - VACUUM
  - VARYING THERMAL CONDITIONS

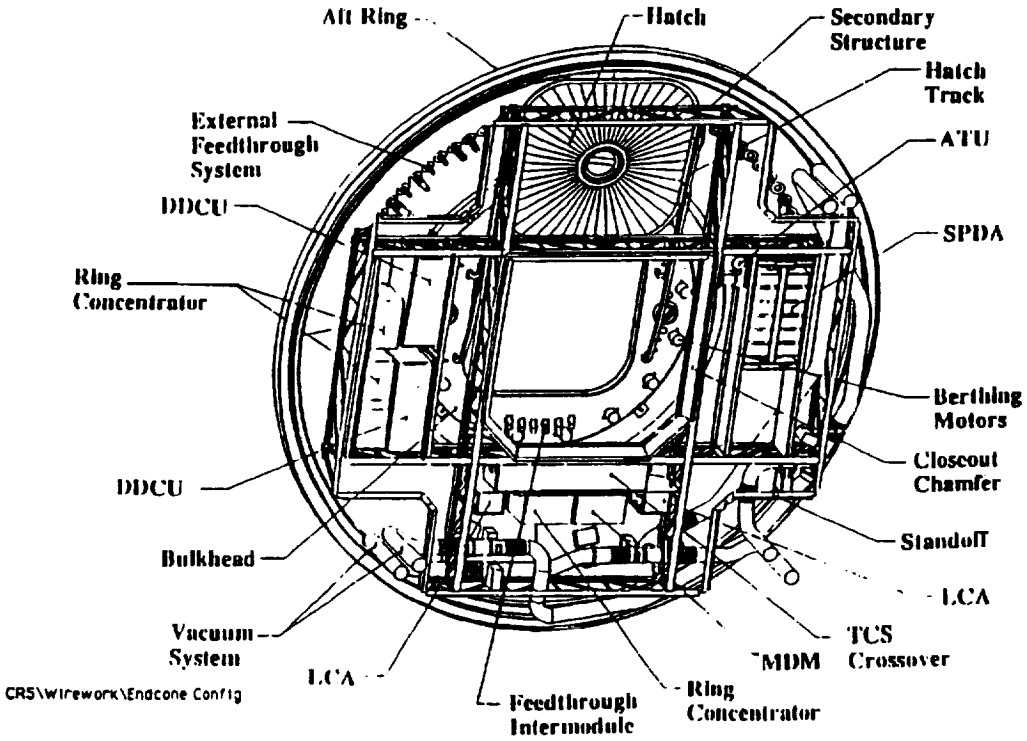
WIRE DERATING CRITERIA

- SSP 30000 SPECIFIES WIRE DERATING IN ACCORDANCE WITH MIL-STD-975
  - CURRENT DERATING BASED ON 200 DEGREE C WIRE OPERATING IN 70 DEGREE C IN HARD VACUUM
  - DERATED CURRENT VALUES ARE APPROXIMATELY ONE HALF OF THE CURRENT THAT WILL RAISE THE INSULATION TEMPERATURE FROM 70 DEGREES C TO 200 DEGREES C
- CONTRACTUAL DERATING IS REASONABLE BASED ON FOLLOWING CRITERIA
  - SCHEDULED MAINTENANCE PERFORMED IN PROXIMITY OF "HOT" WIRES
  - OPERATION IN EVACUATED MODULES AT FULL LOAD

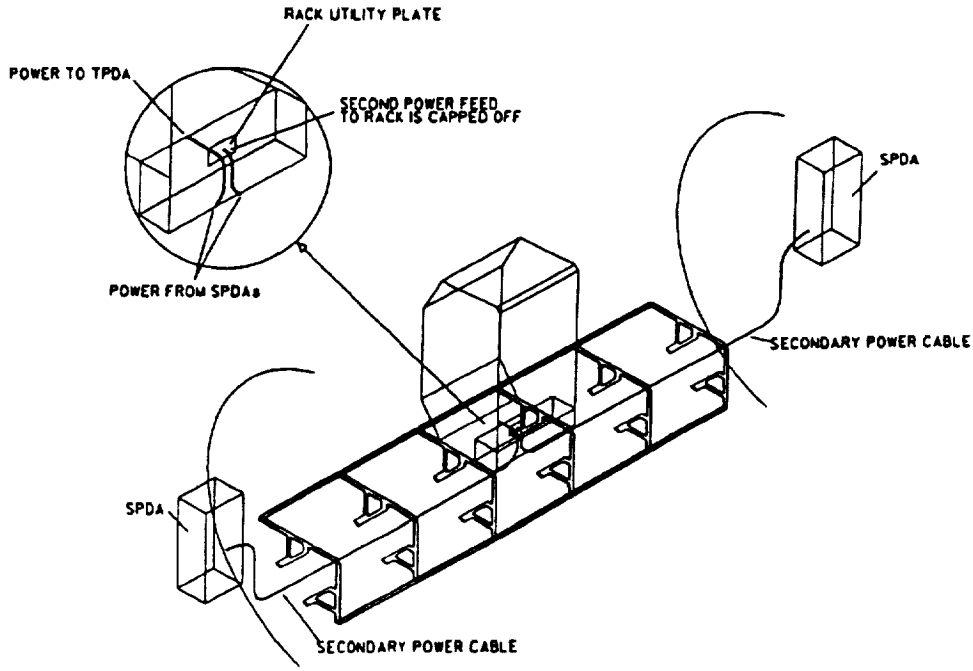
INTERNAL MODULE SECONDARY POWER APPLICATIONS

- SECONDARY POWER DISTRIBUTION ASSEMBLY OUTPUT
  - DISTRIBUTE POWER TO INDIVIDUAL HOUSEKEEPING & PAYLOAD RACKS
  - DISTRIBUTE POWER TO EXORACK MOUNTED COMPONENTS REQUIRING ELECTRICAL POWER
- TERTIARY POWER DISTRIBUTION ASSEMBLY OUTPUT
  - DISTRIBUTE POWER TO RACK MOUNTED EQUIPMENT

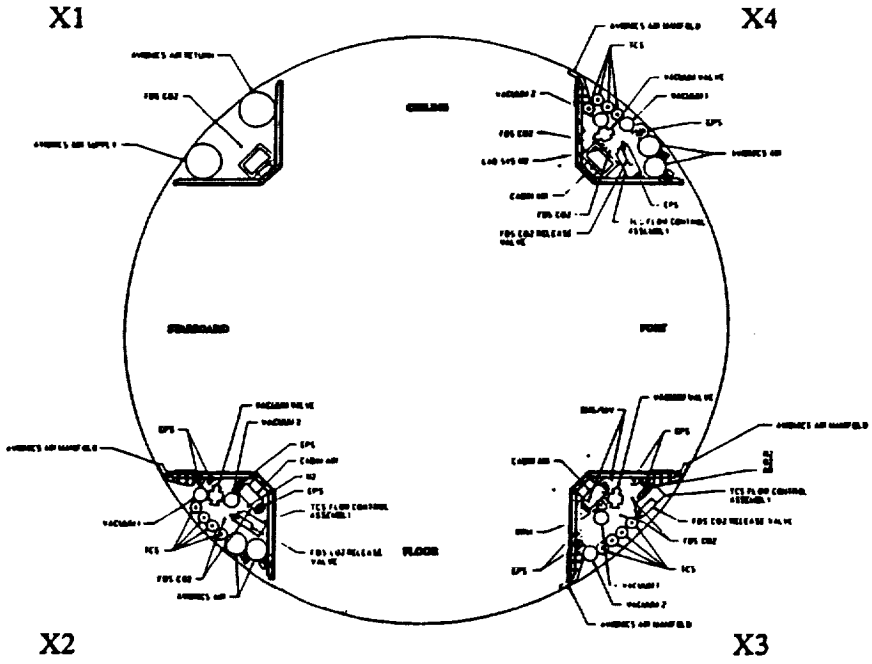
GENERAL CONFIGURATION - U. S. LABORATORY MODULE ENDCONE



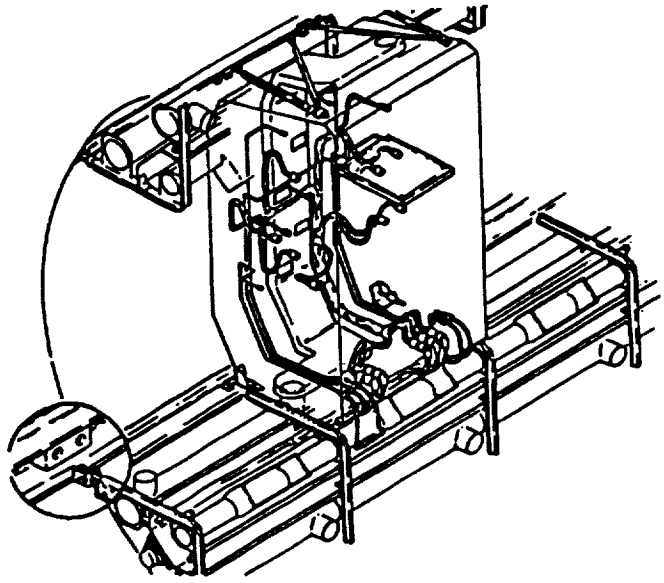
CABLE ROUTING - SPDA TO RACK INTERFACE



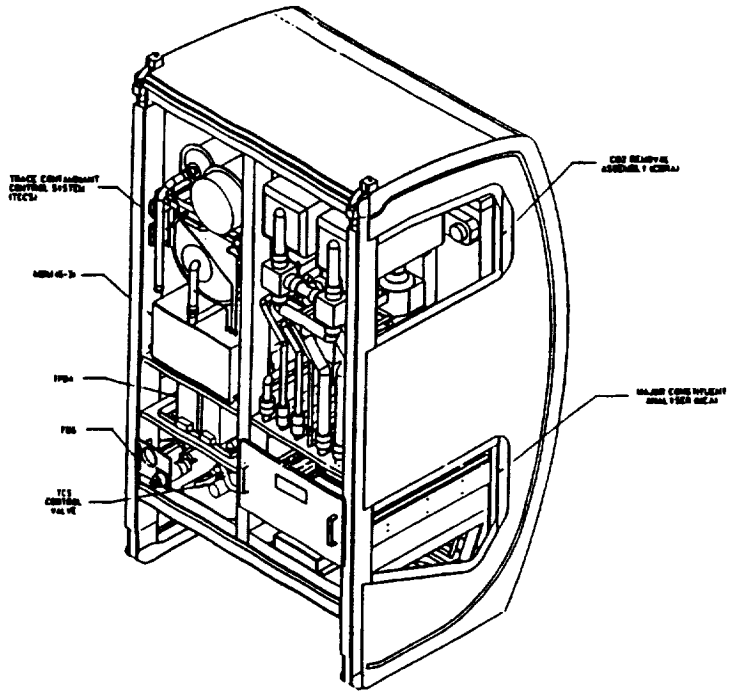
CABLE ROUTING - DENSITY IN STANDOFFS (U. S. LABORATORY MODULE)



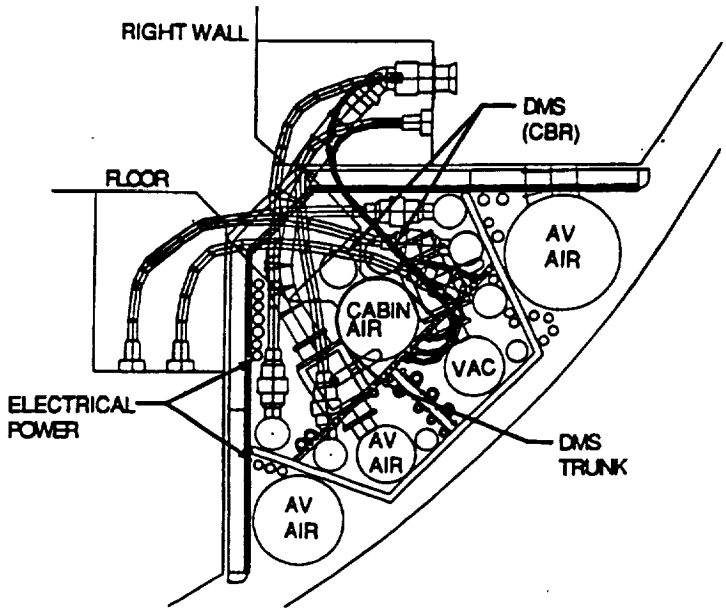
INTERNAL RACK CABLE ROUTING



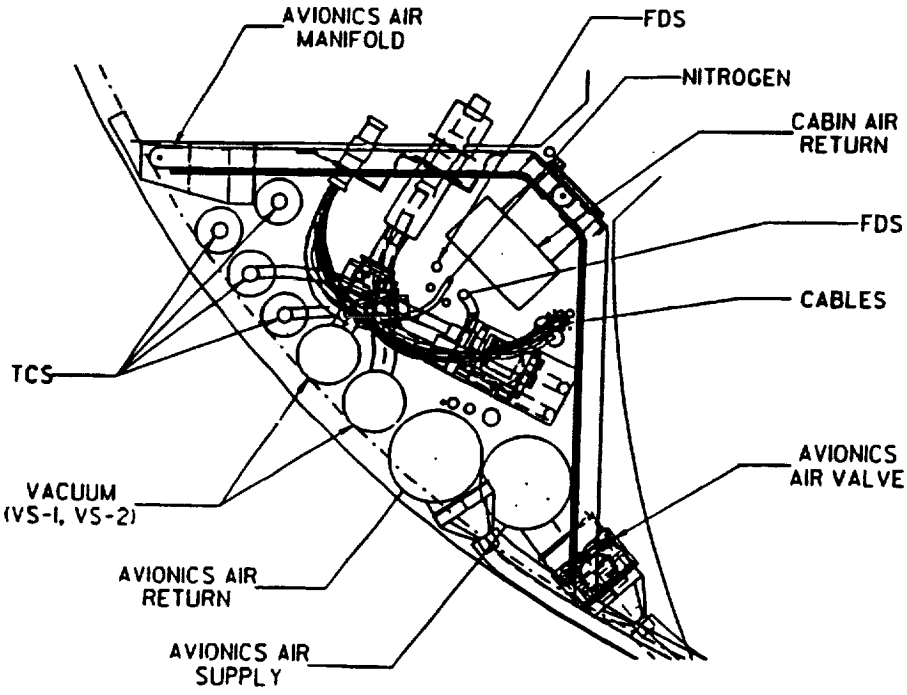
INTERNAL RACK EQUIPMENT CONFIGURATION (OPEN LOOP ARS RACK)



CABLE ROUTING - STANDOFF TO RACK INTERFACE (HOUSEKEEPING RACKS)



CABLE ROUTING - STANDOFF TO RACK INTERFACE (PAYLOAD RACKS)



SECONDARY POWER WIRE SIZES

- WIRE SIZES ARE BASED ON CONTRACTUAL DERATING CRITERIA, NUMBER OF WIRES IN BUNDLES EXITING RPCM'S AND RPCM RATING
  - 50 A RPCM = 4 AWG
  - 25 A RPCM = 8 AWG
  - 12 A RPCM = 12 AWG
- WITH 8 12 A RPC'S IN A 12 A RPCM 12 AWG IS MARGINAL
  - ACTUAL ALLOWABLE CURRENT WITH ALL RPC'S "HOT" IS 11.5 A

JOINT WORK PACKAGE CONNECTOR GROUP RECOMMENDATIONS

- LARGE POWER FEEDERS (8 AWG & LARGER) REQUIRING FLEXIBILITY/FORMABILITY
  - SSQ 21652 SILICONE INSULATED WIRE
    - HIGH PICK COUNT ROPE LAY
    - HIGH SHORE SILICONE JACKET
- SMALL POWER FEEDERS (12 AWG & SMALLER) INTERNAL TO MODULES
  - SSQ 21656 TEFLON INSULATED WIRE
- SMALL POWER FEEDERS EXTERNAL TO MODULE
  - SSQ 21656 TEFZEL INSULATED WIRE

SECONDARY POWER WIRE & CABLE DESIRED INSULATION CHARACTERISTICS

- 200 DEGREE C RATING MINIMUM
- EXTREMELY DURABLE
- SELF EXTINGUISHING
- NON TOXIC CHAR BYPRODUCTS
- FLEXIBLE
- LOW OFFGASSING
- MINIMAL OUTGASSING
- EASY TO STRIP

POTENTIAL WIRE CONFIGURATIONS (BASED ON NASA DESIRES)

Configuration	Insulation	Conductor coating	Size AWG	Temperature rating (C)	Conductor material
M22759/3	TEFLON	NICKEL	22-2/0	260	COPPER
~~M22759/11~~	~~TEFLON~~	~~SILVER~~	~~28-8~~	~~200~~	~~COPPER~~
M22759/12	TEFLON	NICKEL	28-8	260	COPPER
~~M22759/16~~	~~TEFZEL~~	~~TIN~~	~~24-2/0~~	~~150~~	~~COPPER~~
~~M22759/22~~	~~TEFLON~~	~~SILVER~~	~~28-20~~	~~200~~	~~NICKEL~~
~~M22759/23~~	~~TEFZEL~~	~~NICKEL~~	~~28-20~~	~~260~~	~~NICKEL~~
~~M81381/7~~	~~KAPTON~~	~~SILVER~~	~~26-10~~	~~200~~	~~COPPER~~
~~M81381/8~~	~~KAPTON~~	~~NICKEL~~	~~26-10~~	~~200~~	~~COPPER~~
~~M81381/9~~	~~KAPTON~~	~~SILVER~~	~~30-20~~	~~200~~	~~NICKEL~~
~~M81381/10~~	~~KAPTON~~	~~NICKEL~~	~~30-20~~	~~200~~	~~NICKEL~~
~~M81381/21~~	~~KAPTON~~	~~TIN~~	~~26-10~~	~~150~~	~~COPPER~~

M22759/3 & /12 CAVEATS

- M22759/3 WIRE IS EXTREMELY STIFF
  - TEFLON JACKET OVER FIBERGLASS BRAID OVER TEFLON
  - STANDARD MULTI STRAND CONDUCTOR CONSTRUCTION
- M22759/12 WIRE HAS LIGHTWEIGHT TEFLON INSULATION
  - REQUIRES CARE IN FORMING, SECURING AND INSTALLATION
- M22759/3 DOES NOT COVER SIZES LARGER THAN 8 AWG

ORIGINAL PAGE IS OF POOR QUALITY

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ORGANIZATION	MARSHALL SPACE FLIGHT CENTER	NAME:
MSFC/NASA	SPACE WIRING WORKSHOP ELV REQUIREMENTS	BILL McPEAK
CHART NO. 1		DATE: JULY 1991

HISTORICAL

GROUND LAUNCHED PROPULSION VEHICLES

SATURN

SIC AND SIVB STAGES - THICK WALL EXTRUDED TFE
SII STAGE - MEDIUM WALL EXTRUDED TFE
INSTRUMENT UNIT - THIN WALL EXTRUDED TFE AND FEP W/POLYIMIDE COATING

SHUTTLE

SOLID ROCKET BOOSTER (SRB) - MEDIUM WALL EXTRUDED TFE
SOLID ROCKET MOTOR (SRM) - MED TFE AND POLYIMIDE FILM
SPACE SHUTTLE MAIN ENGINE (SSME) - THICK WALL EXTRUDED TFE
EXTERNAL TANK (ET) - MED TFE INSIDE AND POLYIMIDE FILM OUTSIDE

CONDUCTORS

PREDOMINANTLY NICKEL PLATED COPPER

FE - POLYTETRAFLUOROETHYLENE
EP - FLUORINATED ETHYLENE PROPYLENE

ORGANIZATION	MARSHALL SPACE FLIGHT CENTER	NAME:
MSFC/NASA	SPACE WIRING WORKSHOP ELV REQUIREMENTS	BILL McPEAK
CHART NO. 2		DATE: JULY 1991

HISTORICAL

SPACE LAUNCHED PROPULSION VEHICLES

- o INERTIAL UPPER STAGE (IUS) - POLYALKENE INTERNAL & POLYIMIDE FILM EXT.
- o TRANS ORBITAL STAGE (TOS) - POLYIMIDE FILM
- o CONDUCTORS - MIXTURE TIN, SILVER, NICKEL PLATED.

SPACELAB, ORBITAL PAYLOADS AND EXPERIMENTS

- o PREDOMINANTLY POLYIMIDE FILM
- o SOME TFE, FEP, POLYALKENE, AND HYBRID CONSTRUCTIONS
- o CONDUCTORS - MIXTURE TIN, SILVER, NICKEL PLATED

ORGANIZATION	MARSHALL SPACE FLIGHT CENTER	NAME:
MSFC/NASA	SPACE WIRING WORKSHOP	BILL McPEAK
CHART NO	ELV REQUIREMENTS	DATE:
3		JULY 1991

LAUNCH AND PROPULSION VEHICLES REQUIREMENTS

RANKING

1 ARC TRACKING PROOF WIRING (NO PROPAGATION)

2 270 Vdc OPERATION AT CRITICAL PRESSURE
2500 Vdc/rms MINIMUM AT ONE ATMOSPHERE

3 ABRASION/CUT-THRU/NOTCH RESISTANT

4 TEMPERATURE

-85 TO 150^{0}C INTERNAL EQUIPMENT AND BOXES

-200 TO 200 OR 260^{0}C INTERCONNECTING CABLES

-255 TO 200^{0}C INSIDE CRYOGENIC FUEL & OXIDIZER TANKS

ORGANIZATION	MARSHALL SPACE FLIGHT CENTER	NAME:
MSFC/NASA	SPACE WIRING WORKSHOP	BILL McPEAK
CHART NO	ELV REQUIREMENTS	DATE:
4		JULY 1991

LAUNCH AND PROPULSION VEHICLE REQUIREMENTS

RANKING

5 RESISTANT TO AND COMPATIBLE WITH:

WATER/SALT WATER/HUMIDITY

LIQUID OXYGEN

LIQUID HYDROGEN AND HYDRAZENE

CHEMICALS

6 CONDUCTOR SIZES 30 THRU 0 OR EQUIVALENT

DATA BUS, RF, & FIBER OPTIC VERSIONS

ORGANIZATION	MARSHALL SPACE FLIGHT CENTER	NAME:
MSFC/NASA	SPACE WIRING WORKSHOP	BILL McPEAK
CHART NO	ELV REQUIREMENTS	DATE:
5		JULY 1991

LAUNCH AND PROPULSION VEHICLE REQUIREMENTS

RANKING

7 FLAMMABILITY, ETC REQUIREMENTS OF NHB 8060.1C

8 NO MATERIAL FLAKING, CRACKING, OR DELAMINATION

9 VIBRATION 200 G'S
ORDNANCE SHOCK 30,000 G'S

10 BASIC REQUIREMENTS (MIL-W-22759, MIL-W-81381)

11 FLEXIBLE

12 WEIGHT/SPACE (LAST ITEM)