SPACE STATION FREEDOM
SECONDARY POWER WIRING
REQUIREMENTS

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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**

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**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

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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 TEFLOK, TEFZEL & SILICONE INSULATIONS BASED ON APPLICATION & PERCEIVED 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 precedence 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
  - DISTIBUTE POWER TO INDIVIDUAL HOUSEKEEPING & PAYLOAD RACKS
  - DISTIBUTE POWER TO EXORACK MOUNTED COMPONENTS REQUIRING ELECTRICAL POWER

- TERTIARY POWER DISTRIBUTION ASSEMBLY OUTPUT
  - DISTIBUTE POWER TO RACK MOUNTED EQUIPMENT
GENERAL CONFIGURATION -
U.S. LABORATORY MODULE
ENDCONE

CABLE ROUTING -
SPDA TO RACK INTERFACE
INTERNAL RACK
EQUIPMENT CONFIGURATION
(OPEN LOOP ARS RACK)

CABLE ROUTING -
STANDOFF TO RACK INTERFACE
(HOUSEKEEPING 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 TEFLOL 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)

<table>
<thead>
<tr>
<th>Configuration</th>
<th>Insulation</th>
<th>Conductor coating</th>
<th>Size AWG</th>
<th>Temperature rating (°C)</th>
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### 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 TEFLOON INSULATION**
  - Requires care in forming, securing and installation

- **M22759/3 DOES NOT COVER SIZES LARGER THAN 8 AWG**

**ORIGINAL PAGE #8 OF POOR QUALITY**
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) - MEDIUM TFE AND POLYIMIDE FILM
SPACE SHUTTLE MAIN ENGINE (SSME) - THICK WALL EXTRUDED TFE
EXTERNAL TANK (ET) - MEDIUM TFE INSIDE AND POLYIMIDE FILM OUTSIDE

CONDUCTORS
PREDOMINANTLY NICKEL PLATED COPPER

FE - POLYTETRAFLUROETHYLENE
EP - FLUORINATED ETHYLENE PROPYLENE

SPACE LAUNCHED PROPULSION VEHICLES

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

SPACELAB, ORBITAL PAYLOADS AND EXPERIMENTS

- PREDOMINANTLY POLYIMIDE FILM
- SOME TFE, FEP, POLYALKENE, AND HYBRID CONSTRUCTIONS
- CONDUCTORS - MIXTURE TIN, SILVER, NICKEL PLATED
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°C INTERNAL EQUIPMENT AND BOXES
   -200 TO 200 OR 260°C INTERCONNECTING CABLES
   -255 TO 200°C INSIDE CRYOGENIC FUEL & OXIDIZER TANKS

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
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)