



30144
P-12

George C. Marshall Space Flight Center

SPACE STATION FREEDOM
SECONDARY POWER WIRING
REQUIREMENTS

C. R. SAWYER
LEAD ENGINEER
INTERCONNECTING CABLING
SPACE STATION PROGRAM
WORK PACKAGE 1

BOEING AEROSPACE & ELECTRONICS COMPANY
HUNTSVILLE DIVISION
HUNTSVILLE, ALABAMA

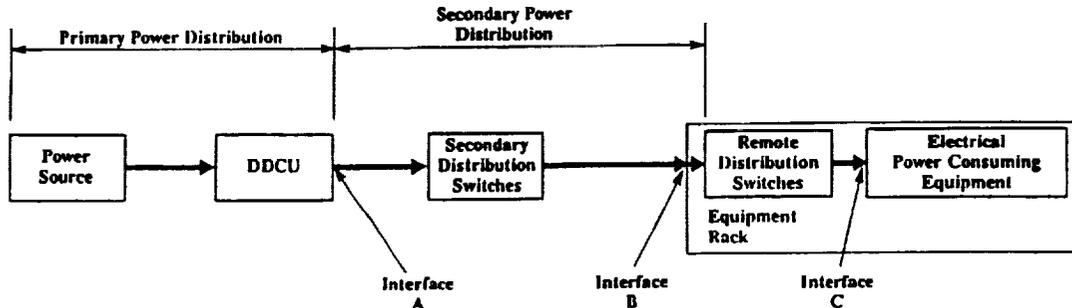
SECONDARY POWER -
WHAT IS IT?

● 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

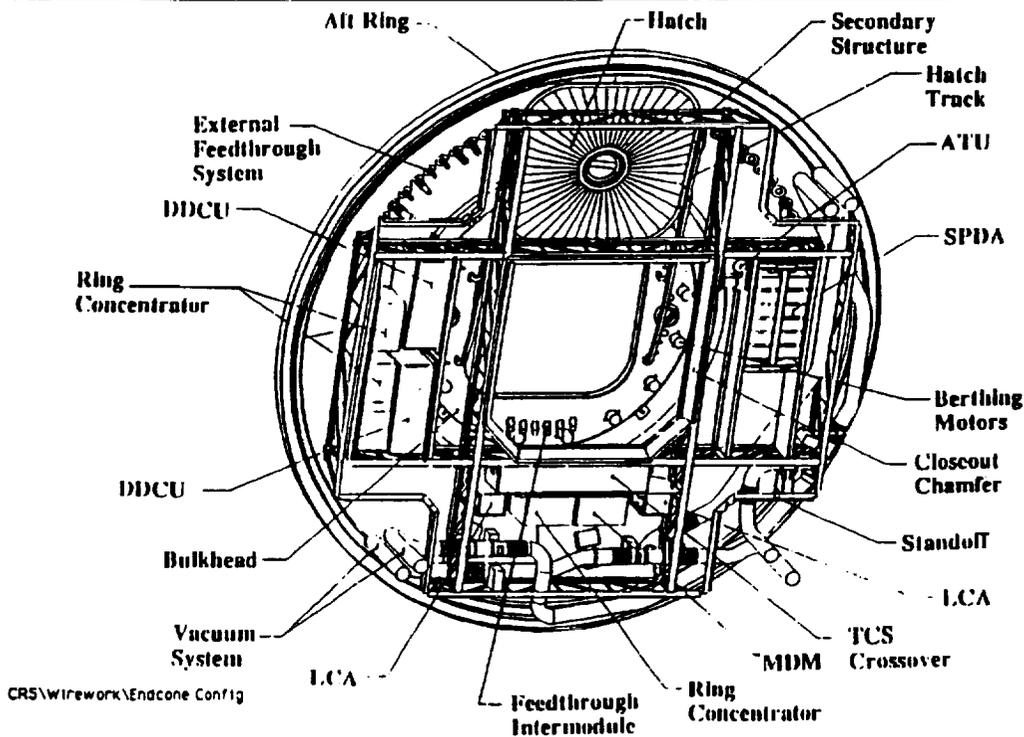
WIRE DERATING CRITERIA

- 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

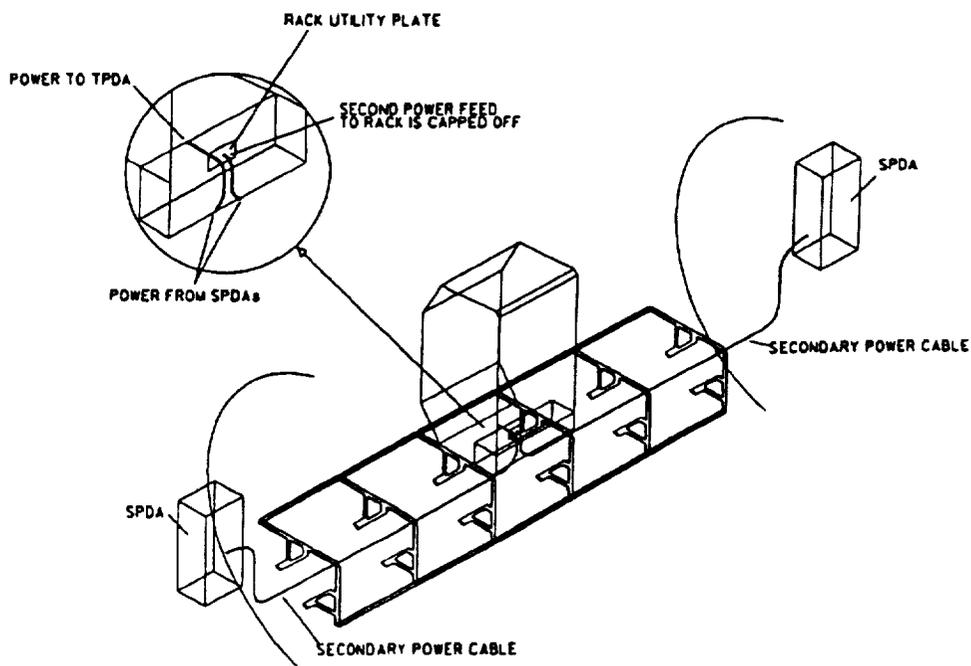
INTERNAL MODULE SECONDARY POWER APPLICATIONS

- 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

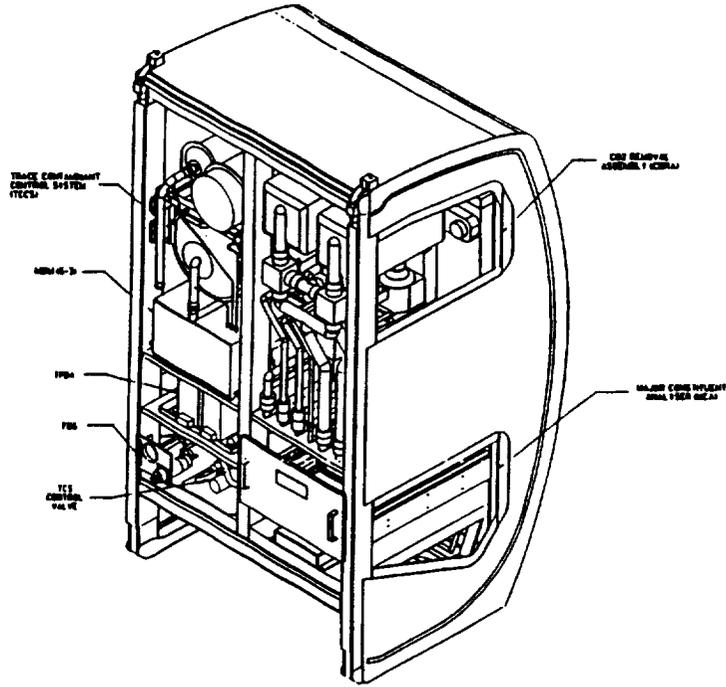
GENERAL CONFIGURATION -
U. S. LABORATORY MODULE
ENDCONE



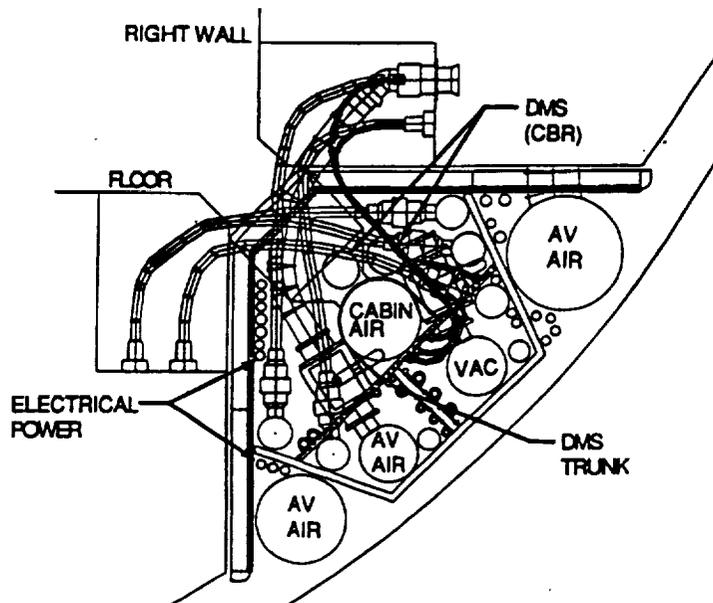
CABLE ROUTING -
SPDA TO RACK INTERFACE



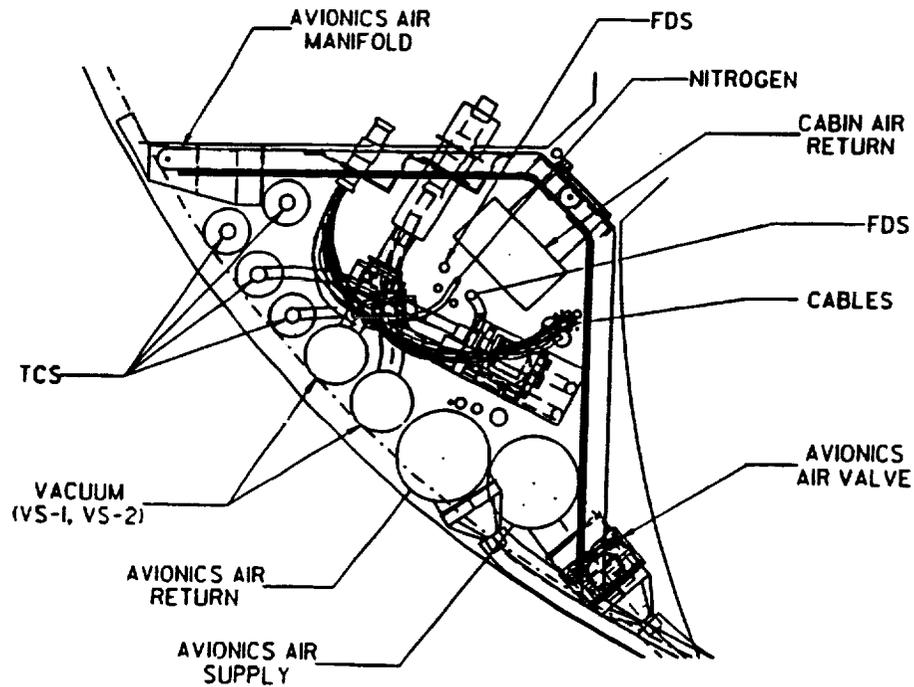
**INTERNAL RACK
EQUIPMENT CONFIGURATION
(OPEN LOOP ARS RACK)**



**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	260	COPPER
M22759/12	TEFLON	NICKEL	28-8	260	COPPER
M22759/16	TEFLON	TIN	24-2/0	150	COPPER
M22759/22	TEFLON	SILVER	28-20	260	HSCA
M22759/23	TEFLON	NICKEL	28-20	260	HSCA
M81381/7	KAPTON	SILVER	26-10	200	COPPER
M81381/8	KAPTON	NICKEL	26-10	200	COPPER
M81381/9	KAPTON	SILVER	30-20	200	HSCA
M81381/10	KAPTON	NICKEL	30-20	200	HSCA
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

omit

ORGANIZATION MSFC/NASA	MARSHALL SPACE FLIGHT CENTER SPACE WIRING WORKSHOP ELV REQUIREMENTS	NAME: 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 MSFC/NASA	MARSHALL SPACE FLIGHT CENTER SPACE WIRING WORKSHOP ELV REQUIREMENTS	NAME: 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 MSFC/NASA	MARSHALL SPACE FLIGHT CENTER SPACE WIRING WORKSHOP ELV REQUIREMENTS	NAME: BILL McPEAK
CHART NO 3		DATE: 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 150⁰C INTERNAL EQUIPMENT AND BOXES
 - 200 TO 200 OR 260⁰C INTERCONNECTING CABLES
 - 255 TO 200⁰C INSIDE CRYOGENIC FUEL & OXIDIZER TANKS

ORGANIZATION MSFC/NASA	MARSHALL SPACE FLIGHT CENTER SPACE WIRING WORKSHOP ELV REQUIREMENTS	NAME: BILL McPEAK
CHART NO 4		DATE: 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 MSFC/NASA	MARSHALL SPACE FLIGHT CENTER SPACE WIRING WORKSHOP ELV REQUIREMENTS	NAME: BILL McPEAK
CHART NO 5		DATE: 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)

