

SSME FMEA/CIL
REDUNDANCY SCREEN

Component Group: **Electrical Harnesses**
 CIL Item: **H123-01, H124-01**
 Part Number: **R0019505, R0019506**
 Component: **Armored - 28V DC Power 1W100, 1W101**
 FMEA Item: **H123, H124**
 Failure Mode: **Open or short circuit in harness. Loss of connector.**

Prepared: **P. Ho**
 Approved: **T. Nguyen**
 Approval Date: **5/3/00**
 Change #: **1**
 Directive #: **CCBD ME3-01-5287**

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Phase	Failure / Effect Description	Criticality
		Hazard Reference
M 4.2	<p>Failure of both harnesses causing loss or degradation of both 28 VDC supplies will negate both DCU channels from a normally recoverable primary power transients, controller halt. Mission abort.</p> <p>Redundancy Screens: HARNESS SYSTEM: LIKE REDUNDANCY</p> <p>A: Pass - Redundant hardware items are capable of checkout during normal ground turnaround. B: Fail - Loss of a redundant hardware items is not detectable during flight. C: Pass - Loss of redundant hardware items could not result from a single credible event.</p>	<p>1R ME-G9P,S,M,A,C,D, ME-G4M</p>

**SSME EA/CIL
DESIGN**

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Design / Document Reference

FAILURE CAUSE: A: Conductor or insulation damage caused by vibration flexure, routing, or clamping.

MATERIAL SELECTION OF THE WIRES, INSULATORS, CONNECTORS, AND ASSEMBLY TECHNIQUES ARE CONTROLLED BY SPECIFICATION (1) TO GUARD AGAINST THE FAILURE OF THE HARNESS IN THE ENVIRONMENTS IT IS EXPOSED TO. THESE CONTROLS ARE ESTABLISHED BY GOVERNMENT SPECIFICATIONS FOR CONNECTORS (2) AND WIRE SELECTION (3), AND ARE KEYED TO THE FUNCTION AND USAGE OF THE HARDWARE. TO PREVENT DETERIORATION OF THE CONDUCTOR OR INSULATOR, WIRES ARE OF SUCH CROSS SECTION AS TO PROVIDE AMPLE AND SAFE CURRENT CARRYING CAPACITY. THE MAXIMUM DESIGN CURRENT IN ANY WIRE IS LIMITED SO THAT "WIRE TOTAL TEMPERATURE" WILL NEVER EXCEED THE RATED WIRE TEMPERATURE (1). HARNESS ASSEMBLIES INCORPORATE A FLEXIBLE GLASS FILLER CORD TO ENHANCE CABLE ROUNDING (1). THE CORD HELPS IN ELIMINATING EXCESSIVE BEND RADII THAT MAY CAUSE WIRE DAMAGE. TEFLON FILM WRAP AND TEFLON TAPE COVER THE WIRE BUNDLES TO PROTECT THE INSULATION FROM ABRASIVE DAMAGE. A WIRE MESH SHEATH PROTECTS THE ENTIRE WRAP FROM SHARP IMPACTS, HANDLING DAMAGE, AND PROVIDES EMI PROTECTION (4). BRAID WIRE TYPE, SIZE, AND COVERAGE ARE CONTROLLED BY SPECIFICATION (5). CABLE ROUTING IS CONTROLLED BY THE ASSEMBLY DRAWINGS (6) THAT ESTABLISH THE RETAINING CLAMPS AND RESTRAINING TIES. THE SECURING CLAMPS (7) INCORPORATE RUBBER GROMMETS THAT PREVENT PINCHING OR CUTTING OF THE INSTALLED HARNESS.

(1) RL10014; (2) 40M39569; (3) 40M50577, 40M50578; (4) RL00249; (5) RA1613-004; (6) RS007007; (7) RE127-2018

FAILURE CAUSE: B: Loose, worn, or damaged pin or pins.
C: Damaged contact or crimp.
E: Connector shell failure.
F: Torque lock damage.

CONNECTOR SELECTION OF THE ASSEMBLIES IS CONTROLLED BY SPECIFICATION REQUIREMENTS (1). THE REQUIREMENTS INCORPORATE CONTROLS (2) THAT ARE KEYED TO GUARD AGAINST THE ENVIRONMENTS THEY ARE EXPOSED TO. THE CONNECTORS MEET CEI REQUIREMENTS FOR HIGH CYCLE FATIGUE, LOW CYCLE FATIGUE, AND MINIMUM FACTORS OF SAFETY (3). THE CONNECTORS ARE SELECTED IN ACCORDANCE WITH MSFC STANDARDS FOR USE ON ROCKET PROPELLED VEHICLES (4). BENT OR WORN PINS ARE REMOVABLE AND REPLACEABLE. BAYONET LOCKING RINGS ARE PROVIDED TO PREVENT CONNECTORS FROM BACKING OFF (2).

(1) RL10014; (2) RES1235; (3) RL00532, RSS-8546, CP320R0003B; (4) 40M39569, 40M38277

FAILURE CAUSE: D: Corrosion or moisture.

THE ELECTRICAL COMPONENTS OF THE WIRE HARNESS ARE PROTECTED FROM CORROSION BY INHERENT MATERIAL DESIGN AND PROTECTIVE EXTERNAL COVERING OF THE CABLE. THE WIRE INSULATION IS COMPOSED OF TEFLON (1). TEFLON HAS RESISTANCE TO FLUIDS AND ATMOSPHERIC VAPORS. THE CONNECTOR CONTACTS ARE PLATED WITH GOLD OVER NICKEL UNDERPLATE (2). GOLD IS RESISTANT TO WATER CORROSION AND HUMIDITY. EXCEPT FOR POTTED CONNECTORS, THE CONNECTOR BACKSHELL IS PROTECTED BY SILICON RUBBER (3) TO PROTECT THE CONNECTOR FROM THE MAXIMUM SPECIFIED OPERATIONAL ENVIRONMENTS. PIN INSERT INTERFACIAL SEALS (4) ARE PROVIDED TO REDUCE CORROSION. CONNECTORS ARE MAINTAINED IN THEIR SEALED BAGS UNTIL READY FOR ASSEMBLY. CONNECTORS ARE PROTECTED TO PREVENT DAMAGE OR CONTAMINATION RESULTING FROM CONTACT WITH EACH OTHER OR ADJACENT OBJECTS (5).

(1) 40M50577; (2) MSFC-SPEC-250; (3) RL10014; (4) RC1235; (5) RL00249

FAILURE CAUSE: ALL CAUSES

28VDC POWER IS PROVIDED FROM REDUNDANT HARNESSES. THE HARNESS DESIGN IS TESTED PER HARNESS DESIGN VERIFICATION TESTING (1), INCLUDING VIBRATION TESTING (2), SAFETY FACTOR CRITERIA TESTING (3), AND DURING ENGINE CERTIFICATION TESTING (4).

(1) DVS-SSME-202; (2) RSS-202-6; (3) RSS-202-20; (4) VCR RSS-ECP-676, VCR RSS-ECP-893

SSME FMEA/CIL
INSPECTION AND TEST

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Failure Causes	Significant Characteristics	Inspection(s) / Test(s)	Document Reference
A	28VDC POWER ELECTRICAL HARNESS		R0019505
	28VDC POWER ELECTRICAL HARNESS		R0019506
	ASSEMBLY INTEGRITY	<p>THE FOLLOWING TESTS AND INSPECTIONS ARE PERFORMED DURING MANUFACTURING AND ASSEMBLY ACCEPTANCE:</p> <ul style="list-style-type: none"> - LIGHTNING BRAID IS INSPECTED FOR ACCEPTABILITY - ALL WIRES ARE SUBJECTED TO SPARK AND DIELECTRIC TESTING - ALL CONTACTS IN THE CONNECTORS ARE SUBJECTED TO A RETENTION TEST - A RESISTANCE TEST BETWEEN THE BRAID AND MATING CONNECTOR FLANGE IS PERFORMED ON THE LIGHTNING BRAID/CONNECTOR AND VERIFIED TO BE WITHIN SPECIFICATION - EACH WIRE RUN IS VERIFIED FOR END TO END CONTINUITY - INSULATION RESISTANCE BETWEEN EACH CONDUCTOR AND EVERY OTHER CONDUCTOR IS VERIFIED TO BE WITHIN SPECIFICATION - A DIELECTRIC WITHSTANDING VOLTAGE TEST BETWEEN EACH CONDUCTOR AND EVERY OTHER CONDUCTOR, SHELL, OR SHIELD VERIFIES THE LEAKAGE CURRENT TO BE WITHIN SPECIFICATION 	RL00249 RB0150-044 RB0150-045 RL00249 RL00249 RL00128 RL00128 RL00128
	INSTALLATION INTEGRITY	<p>INSTALLATION OF THE HARNESSES IS VERIFIED PER SPECIFICATIONS DEFINING THE:</p> <ul style="list-style-type: none"> - INSPECTION OF HARNESSES PRE AND POST INSTALLATION - ROUTING REQUIREMENTS WHICH INCLUDE: <ul style="list-style-type: none"> INSTALLATION PATH, CLAMP LOCATIONS AND SIZES SEPARATION DISTANCE REQUIREMENTS FROM OBJECTS WHICH COULD CAUSE CABLE OR CONNECTOR DAMAGE MINIMUM BEND RADII - INSPECTION OF CONNECTORS PRIOR TO MATING. THIS INCLUDES BACKSHELL, PINS AND GROMMET INSPECTIONS. 	RL00039 RL00039 RS007007 RS007007 RL10014 RL00039
B, C, E, F	CONNECTOR		RES1235
	ASSEMBLY INTEGRITY	<p>HARNESS/CONNECTOR ASSEMBLY IS CONTROLLED PER SPECIFICATIONS WHICH INCLUDE:</p> <ul style="list-style-type: none"> - CRIMPING OF ELECTRICAL CONNECTOR CONTACTS - USE OF FLEXIBLE INSULATION SLEEVING - INSTALLATION OF HEAT SHRINKABLE, SILICON RUBBER, STRAIGHT TUBING AND MOLDED PARTS - SELECTION AND USAGE OF PROTECTIVE CLOSURES <p>COMPLETED ASSEMBLY IS INSPECTED FOR PROTECTIVE BRAID FRAYING AT THE CONNECTOR JUNCTION, CONTACT PIN RETENTION, MISSING PARTS, DAMAGE, OR DEFECTS TO SHELL OR PINS PER SPECIFICATION REQUIREMENTS.</p> <p>FOLLOWING INSTALLATION, THE CONNECTOR TORQUE STRIP IS VERIFIED PER SPECIFICATION REQUIREMENTS.</p>	RL00081 RB0150-009 RA0605-018 RA0116-054 RL00249 RS007007 RA1606-018
D	CONNECTOR		RES1235
	CLEANLINESS OF COMPONENTS	CLEANLINESS REQUIREMENTS ARE VERIFIED PER SPECIFICATION DURING MANUFACTURING OF THE HARNESS ASSEMBLY.	RL00249

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Failure Causes	Significant Characteristics	Inspection(s) / Test(s)	Document Reference
D	CLEANLINESS OF COMPONENTS	METAL TYPE DUST AND MOISTURE PROOF CAPS ARE INSTALLED ON THE CONNECTOR WHEN NOT IN USE.	RL00249
	SURFACE FINISH	THE PLATING ON THE CONNECTOR PINS IS INSPECTED PER SPECIFICATION REQUIREMENTS.	RC1235
	ASSEMBLY INTEGRITY	PRIOR TO CONNECTOR MATING, THE CONNECTOR IS INSPECTED FOR ANY CORROSION OR DAMAGE WHICH WOULD ALLOW MOISTURE TO ENTER THE CONNECTOR.	RL00039
ALL CAUSES	28VDC POWER ELECTRICAL HARNESS		R0019505
	28VDC POWER ELECTRICAL HARNESS		R0019506
	ASSEMBLY INTEGRITY	ALL CONTROLLER DATA FROM THE PREVIOUS FLIGHT OR HOT FIRE IS REVIEWED. ANY ANOMALOUS CONDITION NOTED REQUIRES FURTHER TESTING OR HARDWARE REPLACEMENT PRIOR TO THE NEXT FLIGHT.	MSFC PLN 1228
		RETEST REQUIREMENTS AFTER HARNESS REPLACEMENT OR CONNECTOR DEMATE VERIFY THAT THE PROPER CONTROLLER ELECTRICAL CHECKOUTS ARE PERFORMED TO RE-VALIDATE THE HARNESS ASSEMBLY.	OMRSD V41ZA0.010
	HARNESSES ARE INSPECTED FOR DAMAGE AND PROPER ROUTING DURING POST FLIGHT EXTERNAL INSPECTION.	OMRSD V41BU0.030	
	HARNESS OPERATION IS VERIFIED EVERY MISSION FLOW BY THE FOLLOWING CONTROLLER ELECTRICAL CHECKOUTS: (LAST TEST) - PRE-CRYO LOAD TESTING - CONTROLLER POWER APPLICATION	OMRSD S00FA0.213 OMRSD V41AN0.010	

Failure History: Comprehensive failure history data is maintained in the Problem Reporting database (PRAMS/PRACA)
 Reference: NASA letter SA21/88/308 and Rocketdyne letter 88RC09761.

Operational Use: Not Applicable.

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