SSME EA/CIL
REDUNDANCY SCREEN

Component Group:	Electrical Harnesses	Prepared:	P. Ho
CIL Item:	H101-01, H102-01	Approved:	T. Nguyen
Part Number:	R0018401, R0018402	Approval Date:	5/3/00
Component:	Extended Life - Armored - 115V AC Power 1W1, 1W2	Change #:	1
FMEA Item:	H101, H102	Directive #:	CCBD ME3-01-5287
Failure Mode:	Open or short circuit in harness. Loss of connector.	Page:	1 of 1

Phase	Failure / Effect Description	Criticality Hazard Reference
M 4.2	Failure of both harnesses causing a loss of AC power results in disqualification of both controller channels and a MCF indication. Mission abort. Redundancy Screens: HARNESS SYSTEM: LIKE REDUNDANCY A: Pass - Redundant hardware items are capable of checkout during normal ground turnaround. B: Pass - Loss of a redundant hardware items is detectable during flight. C: Pass - Loss of redundant hardware items could not result from a single credible event.	1R ME-G4M, ME-G9P,S,A,M,C,D

SSME FMEA/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 PRECLUDE SINGLE POINT ELECTRICAL FAILURES, REDUNDANT FUNCTIONS ARE IMPLEMENTED IN SEPARATE HARNESSES, ROUTED THROUGH DIFFERENT PATHWAYS. 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. THE ABLATIVE SILICONE TUBING AND WIRE MESH SHEATH PROTECTS THE WRAP FROM SHARP IMPACTS OR HANDLING DAMAGE (4). A HEAT SHRINKABLE POLYOLEFIN SIMI-RIGID OVERMOLD IS USED TO PROVIDE HARNESS SUPPORT (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; (4) RL00996; (5) RL00996, RL00995; (6) RS007007; (7) RE127-2018

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

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

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, 40M39569; (5) RL00996

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Design / Document Reference

FAILURE CAUSE: ALL CAUSES

THE POWER HARNESSES IN EACH ENGINE CONTROLLER ARE REDUNDANT (1). A FAILURE OF BOTH POWER SUPPLY HARNESSES (MULTIPLE FAILURE) WOULD RESULT IN A CONTROLLER INITIATED PNEUMATIC SHUTDOWN (2). THE ORBITER 400 Hz POWER SYSTEM IS COMPRISED OF THREE BUSSES (3). THE A CHANNEL OF EACH CONTROLLER CONNECTS TO A DIFFERENT ORBITER BUS (3). THE B CHANNEL OF EACH CONTROLLER CONNECTS TO THE SAME BUS AS THE A CHANNEL ON THE NEXT ENGINE, (I.E., BUS 1 - ME1 DCU A & ME3 DCU B; BUS 2 - ME2 DCU A & ME1 DCU B; BUS 3 - ME3 DCU A & ME2 DCU B). THE POWER DISTRIBUTION IS SET UP IN THIS WAY TO PRECLUDE A SINGLE BUS FAILURE FROM REMOVING ALL POWER FROM ONE ENGINE CONTROLLER. HOWEVER, SHOULD A CONTROLLER POWER SUPPLY FAIL AND SHORT THE BUS, THE CONTROLLER CHANNEL (ON ANOTHER ENGINE) THAT SHARES THE SAME BUS MIGHT DETECT THE POWER FAILURE AND HALT DUE TO A POWER FAILURE INTERRUPT. THE CONTROLLER CHANNELS (ALL ENGINES) THAT ARE ON DIFFERENT BUSSES WOULD BE UNAFFECTED. THE CONTROLLER SOFTWARE IS CONFIGURED TO DETECT AND RESPOND PROPERLY TO THE FAILURES IDENTIFIED, IMPLEMENT THE NECESSARY REDUNDANT CONTROLLER CHANNEL SWITCHING, AND COMMAND A SAFE ENGINE STATE WHEN REDUNDANCY IS LOST (2). THE BASIC HARNESS DESIGN IS TESTED PER HARNESS DESIGN VERIFICATION TESTING (4), INCLUDING VIBRATION TESTING (5), SAFETY FACTOR CRITERIA TESTING (6), AND DURING ENGINE DVS TESTING (7). EXTENDED LIFE HARNESS DESIGN CHANGES WERE CERTIFIED BY HOT-FIRE TESTING, LABORATORY TESTING, ANALYSIS AND SIMILARITY (8).

(1) DS25401; (2) CP406R0008, 3.2.6.9.5; (3) ICD 13M15000; (4) DVS-SSME-202; (5) RSS-202-6; (6) RSS-202-20; (7) DVS-SSME-101; (8) VRS344

SSME FMEA/CIL
INSPECTION AND TEST

Component Group: Electrical Harnesses
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Part Number: R0018401, R0018402
Component: Extended Life - Armored - 115V AC Power 1W1, 1W2
FMEA Item: H101, H102
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

Failure Causes	Significant Characteristics	Inspection(s) / Test(s)	Document Reference
A	1W1 EXTENDED LIFE HARNESS 1W2 EXTENDED LIFE HARNESS		R0018401 R0018402
	ASSEMBLY INTEGRITY	THE FOLLOWING TESTS ARE PERFORMED DURING MANUFACTURING AND ASSEMBLY ACCEPTANCE: - 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 ARMOR BRAID AND MATING CONNECTOR FLANGE IS PERFORMED ON THE 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.	RB0150-044, 40M50577 RL00995, RL00996 RL00995, RL00996 RL00128 RL00128 RL00128
	INSTALLATION INTEGRITY	INSTALLATION OF THE HARNESSES IS VERIFIED PER SPECIFICATIONS DEFINING THE: - INSPECTION OF HARNESSES PRE- AND POST-INSTALLATION. - ROUTING REQUIREMENTS WHICH INCLUDE: 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, RS007007 RS007007 RS007007 RL00039 RL00039
B, C, E	CONNECTOR		RES1235
	ASSEMBLY INTEGRITY	HARNESS/CONNECTOR ASSEMBLY PROCESSES ARE VERIFIED PER SPECIFICATIONS WHICH INCLUDE: - 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.	RA1613-005 RB0130-109 RA0605-018 RA0116-054
		COMPLETED ASSEMBLY IS INSPECTED FOR CONTACT PIN RETENTION AND PROTECTIVE BRAID DAMAGE.	RL00995, RL00996
D	CONNECTOR		RES1235
	CLEANLINESS OF COMPONENTS	CLEANLINESS REQUIREMENTS ARE VERIFIED PER SPECIFICATION DURING MANUFACTURING OF THE HARNESS ASSEMBLY.	RL00995 RL00996
		METAL TYPE DUST AND MOISTURE PROOF CAPS ARE VERIFIED INSTALLED ON THE CONNECTOR WHEN NOT IN USE.	RL00995 RL00996

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FMEA Item:	**H101, H102**	**Directive #:**	**CCBD ME3-01-5287**
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Failure Causes	Significant Characteristics	Inspection(s) / Test(s)	Document Reference
D	SURFACE FINISH	THE PLATING ON THE CONNECTOR CONTACTS ARE 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	1W1 EXTENDED LIFE HARNESS 1W2 EXTENDED LIFE HARNESS		R0018401 R0018402
	ASSEMBLY INTEGRITY	ALL CONTROLLER DATA FROM THE PREVIOUS FLIGHT IS REVIEWED. ANY ANOMALOUS CONDITION NOTED REQUIRES FURTHER TESTING OR HARDWARE REPLACEMENT PRIOR TO THE NEXT FLIGHT.	MSFC PLN 1228
		RE-TEST 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 AND AFTER ANY REPAIR OR REPLACEMENT BY THE FOLLOWING CONTROLLER ELECTRICAL CHECKOUTS: (LAST TEST) - CONTROLLER POWER APPLICATION AND COMMAND ACCEPTANCE. - SENSOR AND IGNITER CHECKOUT. - FLIGHT READINESS TEST. - ACTUATOR CHECKOUT. - PNEUMATIC CHECKOUT.	OMRSD V41AN0.010 OMRSD V41AQ0.010 OMRSD V41AS0.030 OMRSD V41AS0.010 OMRSD V41AS0.020

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.