SSME FMEA/CIL
REDUNDANCY SCREEN

Component Group:	Electrical Harnesses	Prepared:	P. Ho
CIL Item:	H162-01, H163-01	Approved:	T. Nguyen
Part Number:	R0014028, R0015969	Approval Date:	5/3/00
Component:	Conventional - MFV/OPOV/AFV Skin Temperature 1W315, 1W317	Change #:	1
FMEA Item:	H162, H163	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
PS 4.1	Single harness failure causing erroneous signals from one sensor within LCC limits results in loss of sensor ability to detect MFV/OPOV/AFV leakage. Loss of vehicle due to heat exchanger failure may result if AFV leakage exists and is not detected.	1R ME-B3S
	Redundancy Screens: HARNESS SYSTEM - VALVE SYSTEM: UNLIKE REDUNDANCY	
	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.	

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.**
F: Open splices.

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 DETERIORIATION 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). CABLE ROUTING IS CONTROLLED BY THE ASSEMBLY DRAWINGS (4) THAT ESTABLISH THE RETAINING CLAMPS AND RESTRAINING TIES. THE SECURING CLAMPS (5) INCORPORATE RUBBER GROMMETS THAT PREVENT PINCHING OR CUTTING OF THE INSTALLED HARNESS. SPLICING OF CONDUCTORS IS CONTROLLED BY SPECIFICATION REQUIREMENTS (6).

(1) RL10014; (2) 40M39569; (3) 40M50577, 40M50578; (4) RS007007; (5) RE127-2018; (6) RA1613-003

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, RE1761, RE1229; (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 INHERANT 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 PINS ARE CONSTRUCTED FROM NICKEL UNDERPLATE AND GOLD OVERPLATE (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) RL00113

FAILURE CAUSE: **ALL CAUSES**

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) ECP 763

SSME FMEA/CIL
INSPECTION AND TEST

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Failure Causes	Significant Characteristics	Inspection(s) / Test(s)	Document Reference
A, F	ELECTRICAL HARNESS ELECTRICAL HARNESS		R0014028 R0015969
	ASSEMBLY INTEGRITY	THE FOLLOWING TESTS ARE PERFORMED DURING MANUFACTURING AND ASSEMBLY ACCEPTANCE: - ALL WIRES ARE SUBJECTED TO SPARK AND DIELECTRIC TESTING. - ALL CRIMPED CONTACTS IN THE CONNECTORS AND CABLE SPLICES ARE SUBJECTED TO A PULL TEST. - 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. - INSULATION RESISTANCE OF THE ASSEMBLY.	RB0150-044, 40M50577 RA1613-005 RA1613-003 RL00128 RL00128 RL00128 RL00457
	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. - RE-TEST OF HARNESS FOLLOWING SPLICE.	RL00039 RS007007 RS007007 RL00039 RL00039 RA1613-003
B, C, E	CONNECTOR CONNECTOR CONNECTOR		RES1235 RE1761 RES1229
	ASSEMBLY INTEGRITY	HARNESS/CONNECTOR ASSEMBLY IS CONTROLLED PER SPECIFICATIONS WHICH INCLUDE: - CRIMPING OF ELECTRICAL CONNECTOR CONTACTS. - INSTALLATION OF HEAT SHRINKABLE, SILICON RUBBER, STRAIGHT TUBING, AND MOLDED PARTS. - SELECTION AND USAGE OF PROTECTIVE CLOSURES.	RA1613-005 R0014028 R0015969 RA0116-054
		COMPLETED ASSEMBLY IS INSPECTED FOR PROTECTIVE BRAID FRAYING AT THE CONNECTOR JUNCTION, CONTACT PIN RETENTION, MISSING PARTS, AND DAMAGE OR DEFECTS TO SHELL OR PINS PER SPECIFICATION REQUIREMENTS.	RL00113
D	CONNECTOR CONNECTOR CONNECTOR		RES1235 RE1761 RES1229
	CLEANLINESS OF COMPONENTS	CLEANLINESS REQUIREMENTS ARE VERIFIED PER SPECIFICATION DURING MANUFACTURING AND SPLICING OF THE HARNESS ASSEMBLY.	RL00113 RA1613-003

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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 VERIFIED INSTALLED ON THE CONNECTOR WHEN NOT IN USE.	RL00113
	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.	RL00113
ALL CAUSES	ELECTRICAL HARNESS ELECTRICAL HARNESS		R0014028 R0015969
	ASSEMBLY INTEGRITY	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 AND SKIN TEMP SENSOR OPERATION AND CHANNELIZATION IS VERIFIED AFTER ANY REPAIR OR REPLACEMENT.	OMRSD V41AU0.020
		HARNESS AND SKIN TEMPERATURE SENSORS ARE VERIFIED OPERATIONAL PRIOR TO EACH FLIGHT AND AFTER REPAIR OR REPLACMENT.	OMRSD V41AU0.013
		ALL SKIN TEMP DATA FROM THE PREVIOUS FLIGHT IS REVIEWED. ANY ANOMALOUS CONDITION NOTED REQUIRES FURTHER TESTING OR HARDWARE REPLACEMENT PRIOR TO THE NEXT FLIGHT. IN THE EVENT OF MAINTENANCE OR REPAIR, THE ABOVE CHECKOUTS ARE APPLICABLE. (LAST TEST)	MSFC PLN 1228

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.