SSME EA/CIL
REDUNDANCY SCREEN

Component Group:	Igniters and Sensors	Prepared:	M. Oliver
CIL Item:	J312-01	Approved:	T. Nguyen
Component:	HPOTP Boost Stage Discharge Temp Transducer (O11.1.2)	Approval Date:	3/30/99
Part Number:	RES7002	Change #:	1
Failure Mode:	Erroneous output signal.	Directive #:	CCBD ME3-01-4994
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Phase	Failure / Effect Description	Criticality Hazard Reference
S 4.2	Erroneous output signal(s) from one or both sensors(s) within integrity monitor limits results in loss of MCF protection. Loss of vehicle due to fire from LOX impact may result if sensor probe fails and is not detected.	1R ME-C3S
	Redundancy Screens: SENSOR SYSTEM (STRUCTURAL) - SENSOR SYSTEM (DETECTION): 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 FMEA/CIL
DESIGN

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Design / Document Reference

FAILURE CAUSE: A: Open circuit; broken platinum sensing element. Broken leadwire or leadwire connections.

ELECTRONIC, ELECTRICAL, AND ELECTROMECHANICAL PARTS FOR THE TRANSDUCERS INVOLVED IN THIS FUNCTION HAVE BEEN SELECTED FROM THE CLASS S OR EQUIVALENT APPROVED PARTS SELECTION (1). THE TRANSDUCER SENSOR ELEMENT IS MADE FROM REFERENCE PURITY PLATINUM WIRES MOUNTED ON A STRAIN FREE SUPPORT PROTECTED BY CERAMIC INSULATION. SENSING ELEMENT IS PROTECTED BY A PERFORATED STAINLESS STEEL SHIELD REDUCING MECHANICAL OR INSULATION DAMAGE PERFORATIONS IN THE SHIELD PROVIDES EXPOSURE TO CRYOGENIC LIQUIDS. PROCESS USED FOR BRAZING AND LEADWIRE CONNECTIONS ARE CONTROLLED BY SPECIFICATION (2). LEADWIRE CONNECTIONS ARE BRAZED IN A STRAIN FREE CONFIGURATION AND COVERED WITH AN INSULATING HEAT SHRINK TUBING. UPPER WIRING POTTING PREVENTS WIRE MOVEMENT AND SUBSEQUENT WIRING FAILURES (3)

(1) 85M03928; (2) RC7002, (3) RL10008

FAILURE CAUSE: B: Receptacle pin damage; shorting pin-to-pin or pin-to-shell.

CONNECTOR SELECTION OF THE ASSEMBLIES IS CONTROLLED BY ROCKETDYNE SPECIFICATION REQUIREMENTS (1). THE CONNECTOR DESIGN INCORPORATES FEATURES SUCH AS RUBBER SEALS, CORROSION RESISTANT PINS, LOCKING CONNECTORS, AND CONTROLLED ELECTRICAL CONNECTIONS TO PREVENT MALFUNCTION. THE CONNECTORS ARE IN ACCORDANCE WITH STANDARDS FOR USE ON ROCKET PROPELLED VEHICLES (2). THE PINS ARE NICKEL UNDERPLATED AND GOLD OVERPLATED TO PREVENT CORROSION AND MINIMIZE CONTACT RESISTANCE. THE PLATING IS CONTROLLED PER SPECIFICATION (2) THE CONNECTORS HAVE COMPLETED HARNESS DVS TESTING AND SENSOR DVS TESTING (3).

(1) RC7002; (2) RC1232; (3) DVS-SSME-202, DVS-SSME-203

FAILURE CAUSE: C: Change of internal resistance caused by moisture, corrosion, or contamination.

SENSORS ARE HERMETICALLY SEALED TO PROTECT FROM CONTAMINATION. A BACK FILL OF THE SENSOR CAVITY IS DONE TO INCORPORATE AN INERT PURGE, PREVENTING CORROSION OR CONDENSATION IN THE SENSOR (1). LEAK RATE REQUIREMENTS ARE CONTROLLED PER SPECIFICATION TO PREVENT INDUCTANCE OF FOREIGN SUBSTANCES AND PREVENT LOSS OF THE INERT GAS BACKFILL. INTERNAL POTTING PROTECTS FROM CORROSION (1).

(1) RC7002

FAILURE CAUSE: ALL CAUSES

SENSOR SYSTEM DESIGN PROVIDES REDUNDANCY TO THE ELECTRICAL COMPONENTS TO PRECLUDE ALL SINGLE POINT FAILURES OF THE CONTROL FUNCTIONS. THE SENSORS ARE A VENDOR ITEM, DRAWING SPECIFICATION AND MANUFACTURING PROCESSES ARE CONTROLLED BY ROCKETDYNE (1). ALL SENSOR DESIGNS ARE SUBJECTED TO A CRITICAL DESIGN REVIEW. ANY DESIGN CHANGES ARE RE-REVIEWED (1). THE RES7002-231 SENSORS HAVE COMPLETED DESIGN VERIFICATION TESTING (2), INCLUDING VIBRATION TESTING (3). THE -241 DESIGN IS IDENTICAL TO THE -231 WITH THE ADDITION OF A WORKMANSHIP SCREENING REQUIREMENT. THE RES7002-241 SENSOR HAS BEEN QUALIFIED BY SIMILARITY (4). THE MINIMUM FACTORS OF SAFETY MEET CEI REQUIREMENTS (5). THE SENSORS WERE ANALYZED FOR HIGH CYCLE FATIGUE AND LOW CYCLE FATIGUE LIFE AND MEET CEI REQUIREMENTS (6). TABLE J312 LISTS ALL THE FMEA/CIL WELDS AND IDENTIFIES THOSE WELDS IN WHICH THE CRITICAL INITIAL FLAW SIZE IS NOT DETECTABLE, AND THOSE WELDS IN WHICH THE ROOT SIDE IS NOT ACCESSIBLE FOR INSPECTION. THESE WELDS HAVE BEEN ASSESSED AS ACCEPTABLE FOR FLIGHT BY RISK ASSESSMENT (7). THE CONTROLLER MONITOR SYSTEM IS COMPRISED OF REDUNDANT SENSOR ELECTRONICS, REDUNDANT HARNESSES, AND REDUNDANT CONTROLLER CHANNELS (8).

(1) RC7002; (2) DVS-SSME-203, RSS-8560; (3) RSS-203-11; (4) RSS-8660; (5) RSS-8546, CP320R0003B; (6) RL00532, CP320R0003B; (7) RSS-8756, CP406R0008 3.2 3.5

SSME FM CIL
INSPECTION AND TEST

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CIL Item: J312-01
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Part Number: RES7002
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Failure Causes	Significant Characteristics	Inspection(s) / Test(s)	Document Reference
A	TEMPERATURE TRANSDUCER		RES7002
	COMPONENT INTEGRITY	THE ELEMENT MATERIAL IS INSPECTED PER SPECIFICATION REQUIREMENTS.	RC7002
		PROCESSES USED IN THE TRANSDUCER MANUFACTURE AND ASSEMBLY ARE VERIFIED PER SPECIFICATION AND INCLUDE: • ELECTRICAL CONNECTIONS MADE BY BRAZING. • ENCAPSULATION OF COMPONENTS.	RC7002 RL10006
B	TEMPERATURE TRANSDUCER CONNECTOR RECEPTACLE		RES7002 RES1232
	CONNECTOR INTEGRITY	THE PLATING ON THE CONNECTOR PINS IS INSPECTED PER SPECIFICATION REQUIREMENTS.	RC1232
		THE FOLLOWING TESTS ARE PERFORMED DURING MANUFACTURING AND SENSOR ACCEPTANCE: - TRANSDUCERS ARE CALIBRATED. - INSULATION RESISTANCE BETWEEN PINS AND THE CASE IS VERIFIED TO BE WITHIN SPECIFICATION. - DIELECTRIC VOLTAGE TESTS MEASURE THE CURRENT LEAKAGE BETWEEN PINS AND CASE AND VERIFY THEM TO BE WITHIN SPECIFICATION	RC7002 RC7002 RC7002
C	TEMPERATURE TRANSDUCER		RES7002
	INTERNAL CLEANLINESS	CLEANLINESS REQUIREMENTS ARE VERIFIED PER SPECIFICATION DURING MANUFACTURING OF THE TRANSDUCERS.	RC7002
		INSULATION RESISTANCE BETWEEN CONNECTOR PINS AND CASE IS VERIFIED TO MEET SPECIFICATION REQUIREMENTS.	
	WELD INTEGRITY	ALL WELDS ARE INSPECTED TO DRAWING AND SPECIFICATION REQUIREMENTS PER WELD CLASS. INSPECTIONS INCLUDE: VISUAL, DIMENSIONAL, PENETRANT, RADIOGRAPHIC, ULTRASONIC, AND FILLER MATERIAL, AS APPLICABLE	
	ASSEMBLY INTEGRITY	AFTER THE CASE IS WELDED, HELIUM LEAK TESTS ARE PERFORMED TO VERIFY HERMETIC SEAL.	
ALL CAUSES	TEMPERATURE TRANSDUCER		RES7002
	ASSEMBLY INTEGRITY	ALL VENDOR INSPECTION AND TEST CRITERIA IS UNDER ROCKETDYNE APPROVAL AND CONTROL.	RC7002
		TRANSDUCERS ARE SUBJECTED TO A WORKMANSHIP SCREENING ACCEPTANCE TEST INCLUDING VIBRATION AND THERMAL CYCLE.	
		TRANSDUCERS ARE CALIBRATED.	
	HOT FIRE ACCEPTANCE TESTING (GREEN RUN)	SENSOR OPERATION IS VERIFIED THROUGH HOT FIRE ACCEPTANCE TESTING.	RL00461

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Failure Causes	Significant Characteristics	Inspection(s) / Test(s)	Document Reference
ALL CAUSES	PRE-FLIGHT CHECKOUT	SENSOR OPERATION IS VERIFIED EVERY MISSION FLOW BY SUCCESSFUL COMPLETION OF THE CONTROLLER SENSOR ELECTRICAL CHECKOUT. (LAST TEST)	OMRSD V41AQ0.010 OMRSD S00FA0.213

Failure History: Comprehensive failure history data is maintained in the Problem Reporting database (PRAMS/PRACA)
Reference: NASA letter SA21/98/308 and Rocketdyne letter 98RC09761.

Operational Use: Not Applicable.

SSME [illegible]EA/CIL
WELD JOINTS

Component Group: Igniters and Sensors
CIL Item: J312
Component: HPOTP Boost Stage Discharge Temp Transducer (O11.1.2)
Part Number: RES7002

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Component	Basic Part Number	Weld Number	Weld Type	Class	Root Side Not Access	Critical Initial Flaw Size Not Detectable HCF	Critical Initial Flaw Size Not Detectable LCF	Comments
TEMPERATURE TRANSDUCER	RES7002	R2	GTAW	II	X			
TEMPERATURE TRANSDUCER	RES7002	R2A	GTAW	II	X			