

**SSME FMEA/CIL
REDUNDANCY SCREEN**

Component Group: Igniters and Sensors
 CIL Item: J701-01
 Component: Fuel Flowmeter
 Part Number: R0014001
 Failure Mode: Erroneous flowmeter turbine speed.

Prepared: M. Oliver
 Approved: T. Nguyen
 Approval Date: 3/30/99
 Change #: 1
 Directive #: CGBD ME3-01-4994
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Phase	Failure / Effect Description	Criticality Hazard Reference
S 4.2	Erroneous flowmeter rotation produces off-nominal mixture ratio operation which will result in an SLE indication and controller initiated shutdown. Mission scrub. Loss of vehicle due to turbine or heat exchanger failure may result if turbine over-temperature condition occurs and is not detected. Redundancy Screens: SENSOR SYSTEM - ENGINE 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.	1R ME-G6S,A
M 4.1	Erroneous flowmeter rotation causing all sensors to be outside qualification limits results in sensor disqualification, a MCF indication, and electrical lockup response. Mission abort may result if lockup occurs during Max Q throttling. Redundancy Screens: SENSOR SYSTEM - SENSOR SYSTEM: UNLIKE 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
M 4.2	Erroneous flowmeter rotation produces off-nominal mixture ratio operation which will result in SLE indication and controller initiated shutdown. Mission abort. Loss of vehicle due to turbine or heat exchanger failure may result if turbine over-temperature condition occurs and is not detected. Redundancy Screens: SENSOR SYSTEM - ENGINE SYSTEM: UNLIKE 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
M 4.3	Off-nominal mixture ratio operation within the engine redline limits produces off-nominal propellant consumption. Mission abort. Redundancy Screens: SINGLE POINT FAILURE: N/A	1R ME-G4M

J - 201

**SSME EA/CIL
DESIGN**

Component Group: Igniters and Sensors
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Part Number: R0014001
Failure Mode: Erroneous flowmeter turbine speed.

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Design / Document Reference

FAILURE CAUSE: A: Flowmeter drag caused by contamination in bearings.
B: Blade damage after calibration.

ORBITER SYSTEM DESIGN INCORPORATES A FILTER IN THE FUEL FEED SYSTEM ELIMINATING PROPELLANT CONTAMINATION SOURCES (1). THE FLOWMETER DESIGN INCORPORATES UPSTREAM FLOW STRAIGHTENING SECTIONS (2) MANUFACTURED OF 21-6-9 CRES BAR WITH HEXAGONAL PASSAGES. THE ROTOR IS MACHINED FROM NICKEL 200. THIS MATERIAL WAS SELECTED FOR ITS MAGNETIC PERMEABILITY AND CRYOGENIC TOUGHNESS (3). THE FLOWMETER BEARING ASSEMBLY IS CONTROLLED BY SPECIFICATION AND IS OF THE TYPE USED TO SERVICE LIQUID HYDROGEN AT THE PROPER OPERATING TEMPERATURES AND PRESSURES (3). THE CONTROLLER MONITOR SYSTEM IS COMPRISED OF REDUNDANT SENSOR ELECTRONICS, REDUNDANT HARNESSSES, AND REDUNDANT CONTROLLER CHANNELS (4).

(1) ICD 13M15000; (2) R0014003; (3) RSS-8582; (4) CP406R0003 3.2.3

**SSME FMEA/CIL
INSPECTION AND TEST**

Component Group: Igniters and Sensors
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Failure Causes	Significant Characteristics	Inspection(s) / Test(s)	Document Reference
A, B	FUEL FLOWMETER		R0014001
	DRYNESS	FLOWMETER IS CLEANED PER SPECIFICATION REQUIREMENTS.	RL10001
		THE ENGINE IS DRIED POST GREEN RUN	RL00050-04
	FUEL FLOWMETER ASSY FUEL FLOWMETER HOUSING FUEL FLOWMETER STRAIGHTENER FLOWMETER SHAFT FLOWMETER ROTOR FLOWMETER BEARING ASSEMBLY		R0014001 R0014002 R0014003 RS006246 RS006247 RES1011
	CLEANLINESS REQUIREMENTS	THE FUEL FLOWMETER IS CLEANED FOR FUEL SERVICE PER SPECIFICATION REQUIREMENTS.	R0014001
		UPSTREAM COMPONENTS ARE CLEANED FOR FUEL SERVICE PER SPECIFICATION REQUIREMENTS.	RL10001
	HOT FIRE ACCEPTANCE TESTING (GREEN RUN)	THE LPFT DISCHARGE DUCT ASSEMBLY IS HOT FIRE ACCEPTANCE TESTED. SCREENING REQUIREMENTS VERIFY ABSENCE OF BI-STABLE OPERATING MODE.	RL00461
		FLOWMETER OPERATION IS VERIFIED BY DATA REVIEW FROM THE PREVIOUS FLIGHT OR GREEN RUN. (LAST TEST)	MSFC PLN 1228

J-203

Component: Igniters and Sensors
 CIL Item: J701-01
 Component: Fuel Flowmeter
 Part Number: R0014001
 Failure Mode: Erroneous flowmeter turbine speed.

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 Approved: T. Nguya
 Approval Date: 3/30/99
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Failure Causes	Significant Characteristics	Inspection(s) / Test(s)	Document Reference
Failure History:	Comprehensive failure history data is maintained in the Problem Reporting database (PRAMS/PRACA) Reference: NASA letter SA2188/308 and Rocketdyne letter 88RC09761		
Operational Use:	FAILURE MODE CAN BE DETECTED IN REALTIME BY THE FLIGHT CONTROL TEAM WHO WILL EVALUATE EFFECTS UPON VEHICLE PERFORMANCE AND ABORT CAPABILITY. BASED ON THIS EVALUATION THE APPROPRIATE ABORT MODE OR SYSTEM CONFIGURATION WILL BE SELECTED. FAILURE DETECTION CUES AND ASSOCIATED SSME PERFORMANCE DATA HAVE BEEN COORDINATED BETWEEN THE ENGINEERING AND FLIGHT OPERATIONS ORGANIZATIONS WITH THE RESPONSES DOCUMENTED IN MISSION FLIGHT RULES.		