

**SSME FMEA/CIL
REDUNDANCY SCREEN**

Component Group: Propellant Valves
 CIL Item: D15D-01
 Component: Chamber Coolant Valve
 Part Number: RS008259
 Failure Mode: Fails to move or moves slowly.

Prepared: P. Lowrimore
 Approved: T. Nguyen
 Approval Date: 6/30/99
 Change #: 2
 Directive #: CCBD ME3-01-5226
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Phase	Failure / Effect Description	Criticality Hazard Reference
M 4.1	<p>Controller switches to channel B; and valve position remains out-of-limits, controller commands hydraulic actuator lockup of all actuators. Mission abort may result when hydraulic lockup occurs during Max Q throttling.</p> <p>Redundancy Screens: VALVE SYSTEM - ACTUATORS SYSTEM: UNLIKE REDUNDANCY</p> <p>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.</p>	<p>1R ME-B2M, ME-G6M</p>
M 4.2	<p>When not detectable by SEI, CCV failure results in excessive preburner temperatures. Controller detects excessive temperature and initiates engine shutdown. Mission abort.</p> <p>Redundancy Screens: VALVE SYSTEM - SENSOR SYSTEM: UNLIKE REDUNDANCY</p> <p>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.</p>	<p>1R ME-B2M, ME-G6M</p>

D-91

SSME FA/CIL
DESIGN

Component Group: Propellant Valves
CIL Item: D150-01
Component: Chamber Coolant Valve
Part Number: RS008269
Failure Mode: Fails to move or moves slowly.

Prepared: P. Lovrimore
Approved: T. Nguyen
Approval Date: 8/30/99
Change #: 2
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Design / Document Reference

FAILURE CAUSE: A: Seizure of CCV shaft/bearings.

THE CCV (1), THRUST (2), AND SHAFT BEARINGS (3) ARE ROLLER BEARINGS. THEY ARE USED FOR THEIR FRICTION AND LOAD CAPACITY CHARACTERISTICS. THE ROLLERS AND RACES ARE 440C (2) (3), WHICH WAS SELECTED FOR ITS HARDNESS, STRENGTH, AND CORROSION RESISTANCE (4). THE ROLLERS ARE SEPERATED BY A BE-CU RETAINER (2) (3). THE SHAFT BEARING RETAINERS ARE DRY-FILM LUBRICATED (4) TO REDUCE ROLLER-TO-RETAINER FRICTION (3). THE RETAINER PREVENTS ROLLER-TO-ROLLER CONTACT AND MINIMIZES THE ROLLER RUBBING VELOCITY. THE RETAINER PREVENTS SEIZURE CAUSED BY ROLLER SKEWING. THE LOW ROTATIONAL VELOCITY WITH LESS THAN 90 DEGREES TRAVEL PRECLUDES SEIZURE CAUSED BY WEAR OR SPALLING. THE VALVE COMPONENTS ARE CLEANED PRIOR TO ASSEMBLY (5). THE VALVE IS ASSEMBLED IN A CONTAMINATION CONTROLLED ENVIRONMENT (6). THE FUEL SUPPLY TO THE ENGINE IS FILTERED TO 800-MICRONS (7). BINDING OR SEIZURE OF THE CCV WILL BE DETECTED BY THE ACTUATOR RVDT CONTROLLER MONITOR AND WILL RESULT IN A VEHICLE COMMANDED SHUTDOWN (8). THE MONITOR SYSTEM IS COMPRISED OF REDUNDANT SENSOR ELECTRONICS, REDUNDANT HARNESS, AND REDUNDANT CONTROLLER CHANNELS

(1) RS008259; (2) RES1032; (3) RES1027; (4) RSS-8582; (5) RL10301; (6) RQ0711-600; (7) ICD 13M15000; (8) CP406R0002 PT 1 3.2.3.6.1

FAILURE CAUSE: B: Broken shaft or coupling.

THE 3 PIECE COUPLING TRANSFERS TORQUE FROM THE ACTUATOR TO THE CCV SHAFT (1) (2). THE COUPLING PREVENTS SIDE LOADS CAUSED BY ACTUATOR/VALVE CENTERLINE MISALIGNMENT. THE SHAFT IS MADE FROM A-286. A-286 WAS SELECTED FOR ITS DUCTILITY, ELASTIC MODULUS, CRYOGENIC PROPERTIES, RESISTANCE TO CORROSION AND STRESS CORROSION, AND RESISTANCE TO HEE (3). THE UPPER AND LOWER COUPLINGS (4) ARE INCONEL 718 WHICH WAS CHOSEN FOR ITS CRYOGENIC STRENGTH, DUCTILITY, AND CORROSION RESISTANCE (3). THE INTERMEDIATE COUPLING (5) IS HEAT TREATED NITRIDING STEEL. THIS PROVIDES CORE STRENGTH AND DUCTILITY TO TRANSMIT TORQUE AND SURFACE HARDNESS TO RESIST WEAR (3). THE INTERMEDIATE COUPLING IS DRY-FILM LUBRICATED TO REDUCE FRICTION AND WEAR (5).

(1) RS008259; (2) RS008162; (3) RSS-8582; (4) RS008318; (5) RS008320

FAILURE CAUSE: ALL CAUSES

HIGH CYCLE AND LOW CYCLE FATIGUE AS WELL AS MINIMUM FACTORS OF SAFETY FOR THE CHAMBER COOLANT VALVE MEET CEI REQUIREMENTS (1). THE CCV WAS CLEARED FOR FRACTURE MECHANICS/NDE FLAW GROWTH, SINCE IT CONTAINS NO FRACTURE CRITICAL PARTS (2). THE CCV SUCCESSFULLY COMPLETED DVS TEST REQUIREMENTS (3), INCLUDING ENDURANCE (4), AND VIBRATION (5). FAILURE CRITICALITY WILL BE REDUCED BY TURBINE TEMPERATURE REDLINE CLIT-OFF (6).

(1) RL00532, CP320R00038, RSS-8546; (2) NASA TASK 117; (3) DVS-SSME-515; (4) RSS-515-17; (5) RSS-515-24; (6) CP406R0002 PT 1 3.2.3.5.3

**SSME FMEA/CIL
INSPECTION AND TEST**

Component Group: Propellant Valves
 CIL Item: D15D-01
 Component: Chamber Coolant Valve
 Part Number: RS008259
 Failure Mode: Fails to move or moves slowly.

Prepared: P. Lowrimore
 Approved: T. Nguyen
 Approval Date: 6/30/99
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Failure Causes	Significant Characteristics	Inspection(s) / Test(s)	Document Reference
A	CHAMBER COOLANT VALVE SHAFT SHAFT BEARING THRUST BEARING		RS008259 RS008182 RES1027 RES1032
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER DRAWING REQUIREMENTS.	RS008162 RES1037 RES1032
		HEAT TREAT IS VERIFIED PER DRAWING REQUIREMENTS.	
	LUBRICATION	DRY-FILM COATING OF SHAFT BEARINGS IS VERIFIED PER DRAWING REQUIREMENTS.	RES1027
	ASSEMBLY INTEGRITY	DURING ASSEMBLY AND FUNCTIONAL TEST OF THE CHAMBER COOLANT VALVE, ACTUATION TORQUE IS VERIFIED.	RL00155
		VALVE IS ACTUATED AND RESPONSE TIME IS VERIFIED DURING CONTROLLER FLIGHT READINESS CHECKOUT AND DURING ACTUATOR CHECKOUT.	OMRSD V41AS0.030 OMRSD V41AS0.010
		VALVE IS ACTUATED 10 TIMES DURING HYDRAULIC CONDITIONING (LAST TEST)	OMRSD S00FA0.211
B	SHAFT COUPLING SLIDER		RS008162 RS008318 RS008320
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER DRAWING REQUIREMENTS. HEAT TREAT IS VERIFIED PER DRAWING REQUIREMENTS	
		MACHINED PARTS ARE PENETRANT INSPECTED PER DRAWING REQUIREMENTS.	RS008320
	LUBRICATION	DRY-FILM LUBRICANT IS VERIFIED PER DRAWING REQUIREMENTS.	
ALL CAUSES	CHAMBER COOLANT VALVE		RS008259
	ASSEMBLY INTEGRITY	FINISHED PARTS ARE VERIFIED CLEAN PER SPECIFICATION REQUIREMENTS. VALVE IS ASSEMBLED IN A CONTAMINATION CONTROLLED AREA.	RL10001 RQ0711-600
		VALVE IS ASSEMBLED AND FUNCTIONALLY TESTED PER SPECIFICATION.	RL00155

D-03

CIL Item: D150-01
 Component: Chamber Coolant Valve
 Part Number: RS008259
 Failure Mode: Falls to move or moves slowly.

Prepared: R. L. Williams
 Approved: T. Nguyen
 Approval Date: 8/30/99
 Change #: 2
 Directive #: CCBD ME3-01-5218
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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 SA21/88/308 and Rocketdyne letter 08RC09761.		
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.		

SSME FA/CIL
WELD JOINTS

Component Group: Propellant Valves
CIL Item: D150
Component: Chamber Coolant Valve
Part Number: RS008259

Prepared: P. Lowmore
Approved: T. Nguyen
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Change #: 1
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Component	Basic Part Number	Weld Number	Weld Type	Class	Root Side Not Access	Critical Initial Flaw Size Not Detectable		Comments
						HCF	LCF	
SHAFT	RS008162	3	GTAW	II	X	X		