

SSME FMEA/CIL
REDUNDANCY SCREEN

Component Group: Propellant Valves
 CIL Item: D120-02
 Component: Main Oxidizer Valve
 Part Number: RSD08255
 Failure Mode: Fails to move or moves slowly.

Prepared: P. Lowrmore
 Approved: T. Nguyen
 Approval Date: 6/30/89
 Change #: 2
 Directive #: CCBD ME3-01-5228
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| Phase | Failure / Effect Description | Criticality Hazard Reference |
|----------|---|---------------------------------|
| S 4.2 | When not detectable by SEII, MOV failure results in failure to establish ignition or in excessive preburner temperatures. Mission scrub Loss of vehicle due to LOX duct rupture or overtemperature may result if not detected. Redundancy Screens: VALVE 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-B2S, ME-C3S |
| S 4.3 | When failure occurs during MOV opening and not detected by SEII, hydraulic flow forces close MOV causing high HPOTP speeds and oxidizer duct overpressure and rupture. Loss of vehicle. Redundancy Screens: SINGLE POINT FAILURE: N/A. | 1 ME-C3S |
| C 4.1 | When detected by SEI, controller switches to channel B; if valve position remains out-of-limits, controller initiates pneumatic shutdown; failure continues, oxidizer flow continues until vehicle pre valve closure. LOX-rich cutoff. Loss of vehicle Redundancy Screens: SINGLE POINT FAILURE: N/A | 1 ME-B4A,C ME-C3A,C |

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DESIGN

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Design / Document Reference

FAILURE CAUSE: A: Broken shaft or coupling.

THE 3 PIECE COUPLING TRANSFERS TORQUE FROM THE ACTUATOR TO THE MOV SHAFT (1) (2). THE COUPLING PREVENTS SIDE LOADS CAUSED BY ACTUATOR/VALVE CENTERLINE MISALIGNMENT. THE SHAFT, UPPER COUPLING (3), AND LOWER COUPLING (4) ARE INCONEL 718 WHICH WAS CHOSEN FOR ITS CRYOGENIC STRENGTH, DUCTILITY, AND CORROSION RESISTANCE (5). THE INTERMEDIATE COUPLING (6) IS HEAT TREATED NITRIDING STEEL. THIS PROVIDES CORE STRENGTH AND DUCTILITY TO TRANSMIT TORQUE AND SURFACE HARDNESS TO RESIST WEAR (5). THE INTERMEDIATE COUPLING IS DRY-FILM LUBRICATED TO REDUCE FRICTION AND WEAR (6).

(1) RS008255; (2) RS008271; (3) RS008084; (4) RS008083; (5) RSS-8575; (6) RS008160

FAILURE CAUSE: B: Seizure of MOV shaft/bearings.

THE MOV (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 SEPARATED 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 AND ONE OPEN/CLOSE CYCLE PER TEST PRECLUDES SEIZURE CAUSED BY WEAR OR SPALLING. THE VALVE COMPONENTS ARE CLEANED PRIOR TO ASSEMBLY (5). THE VALVE IS ASSEMBLED IN A CONTAMINATION CONTROLLED AREA (6). THE OXIDIZER SUPPLY TO THE ENGINE IS FILTERED TO 800 MICRONS (7). SHOWED NO DETRIMENTAL WEAR OR DAMAGE. THIS VALVE HAD 131 TESTS AND 26,671 SECONDS OF HOT FIRE TIME (6). BINDING OR SEIZURE OF THE MAIN OXIDIZER VALVE WILL BE DETECTED BY THE ACTUATOR RVDT CONTROLLER MONITOR, AND RESULT IN A VEHICLE COMMANDED SHUTDOWN (8). THE MONITOR SYSTEM IS COMPRISED OF REDUNDANT SENSOR ELECTRONICS, REDUNDANT HARNESSSES, AND REDUNDANT CONTROLLER CHANNELS.

(1) RS008255; (2) RES1096; (3) RES1092, RES1097; (4) RSS-8575; (5) RL10001; (6) RQ0711-600; (7) ICD 13M15000; (8) CP406R0002 PT 1 3.2.3:6.1

FAILURE CAUSE: ALL CAUSES

HIGH CYCLE AND LOW CYCLE FATIGUE AS WELL AS MINIMUM FACTORS OF SAFETY FOR THE MAIN OXIDIZER VALVE MEET OEI REQUIREMENTS (1). THE MOV WAS CLEARED FOR FRACTURE MECHANICS/INDE FLAW GROWTH, SINCE IT CONTAINS NO FRACTURE CRITICAL PARTS (2). THE MAIN OXIDIZER VALVE SUCCESSFULLY COMPLETED DVS TEST REQUIREMENTS (3), INCLUDING ENDURANCE (4), AND VIBRATION (5).

(1) RL00532, CP320R0003B, RSS-8546; (2) NASA TASK 117; (3) DVS-SSME-515; (4) RSS-515-17; (5) RSS-515-24

**SSME FMEA/CIL
INSPECTION AND TEST**

Component Group: Propellant Valves
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 Component: Main Oxidizer Valve
 Part Number: RS008255
 Failure Mode: Fails to move or moves slowly.

Prepared: P. Lowrmore
 Approved: T. Nguyen
 Approval Date: 8/30/99
 Change #: 2
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| Failure Causes | Significant Characteristics | Inspection(s) / Test(s) | Document Reference |
|----------------|--|--|---|
| A | SHAFT UPPER COUPLING LOWER COUPLING INTERMEDIATE COUPLING | | RS008271 RS008084 RS008083 RS008180 |
| | MATERIAL INTEGRITY | MATERIAL INTEGRITY IS VERIFIED PER DRAWING REQUIREMENTS. HEAT TREAT IS VERIFIED PER DRAWING REQUIREMENTS. MACHINED PARTS ARE PENETRANT INSPECTED PER DRAWING REQUIREMENTS. | |
| | LUBRICATION | DRY-FILM COATING IS VERIFIED PER DRAWING REQUIREMENTS. | RS008180 |
| | MAIN OXIDIZER VALVE SHAFT SHAFT BEARING SHAFT BEARING THRUST BEARING | | RS008255 RS008271 RES1092 RES1097 RES1096 |
| B | MATERIAL INTEGRITY | MATERIAL INTEGRITY IS VERIFIED PER DRAWING REQUIREMENTS. | RS008271 RES1092 RES1097 RES1096 |
| | LUBRICATION | DRY-FILM COATING IS VERIFIED PER DRAWING REQUIREMENTS. | RES1092 RES1097 |
| | ASSEMBLY INTEGRITY | DURING ASSEMBLY AND FUNCTIONAL TEST OF THE MAIN OXIDIZER VALVE TORQUE IS VERIFIED. VALVE IS ACTUATED AND RESPONSE TIME IS VERIFIED DURING CONTROLLER FLIGHT READINESS CHECKOUT, AND DURING ACTUATOR CHECKOUT PRIOR TO EACH FLIGHT. VALVE IS ACTUATED 10 TIMES DURING HYDRAULIC CONDITIONING. (LAST TEST) | RL00435 OMRSD V41AS0 030 OMRSD V41AS0 010 OMRSD SOCFA0.211 |
| | ALL CAUSES | FINISHED PARTS ARE VERIFIED CLEAN PER SPECIFICATION REQUIREMENTS. VALVE IS ASSEMBLED IN A CONTAMINATION CONTROLLED AREA. VALVE IS ASSEMBLED AND FUNCTIONALLY TESTED PER SPECIFICATION REQUIREMENTS. VALVE OPERATION IS VERIFIED THROUGH HOT-FIRE ACCEPTANCE TESTING. | RS008255 RL10001 RQ0711-600 RL00435 RL00461 |
| | HOT-FIRE ACCEPTANCE TESTING (GREEN RUN) | | |

D-17

Component up: Propellant Valves
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Approved: T. Nguyen
Approval Date: 6/30/99
Change #: 2
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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 86RC09761. | | |
| Operational Use: | Not Applicable. | | |

**SSME / FA/CIL
WELD JOINTS**

Component Group: Propellant Valves
 CIL Kent: D120
 Component: Main Oxidizer Valve
 Part Number: RS008255

Prepared: P. Lowrimore
 Approved: T. Nguyen
 Approval Date: 6/30/99
 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 | |
| BELLOWS | RS008211 | 3,4 | EBW | II | X | X | X | |
| BELLOWS | RS008211 | 5-8 | GTAW | I | | | | |
| SHAFT | RS008271 | 1,2 | EBW | II | X | X | | |