

SSME / FA/CIL  
REDUNDANCY SCREEN

Component Group: Propellant Valves  
CIL Item: D140-06  
Component: Oxidizer Preburner Oxidizer Valve  
Part Number: RS008258  
Failure Mode: Fretting of internal parts.

Prepared: P. Lowrance  
Approved: T. Nguyen  
Approval Date: 6/30/99  
Change #: 1  
Directive #: CCBD ME3-01-5226  
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| Phase      | Failure / Effect Description   | Criticality<br>Hazard Reference     |
|------------|--|-------------------------------------|
| SMC<br>4.1 | Fire from ignition of internal parts. Loss of vehicle.<br>Redundancy Screens. SINGLE POINT FAILURE: N/A. | 1<br>ME-C3S,<br>ME-C3M,<br>ME-C3A,C |

**SSME FMEA/CIL  
DESIGN**

Component Group: Propellant Valves  
CIL Item: D140-06  
Component: Oxidizer Preburner Oxidizer Valve  
Part Number: RS008258  
Failure Mode: Fretting of internal parts.

Prepared: P. Lowrimore  
Approved: T. Nguyen  
Approval Date: 6/30/99  
Change #: 1  
Directive #: CCBD ME3-01-5225  
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Design / Document Reference

**FAILURE CAUSE:** A: Relative motion of: Bellows/Housing, Inlet sleeve/Bellows/Shim, Cam follower/Guide/Housing, Bellows/Guide/Cam follower, Shaft bearings/Retainer, Retainer/Shaft, Retainer/Wavewashers/Cap, Outlet sleeve/Housing/Shim.

THE BELLOWS (1) AND HOUSING (2) ARE FABRICATED FROM INCONEL 718. THE PILOT DIAMETER ON THE BELLOWS IS DRY-FILM LUBRICATED TO REDUCE FRICTION AND THE POTENTIAL OF FRETTING. THE BELLOWS IS INSTALLED WITH 6 SCREWS INTO LOCKING INSERTS IN THE HOUSING, SCREW RUNNING AND FINAL TORQUE ARE SPECIFIED (3). THE MATING DUCT FLANGE TRAPS THE SCREWS AND PROVIDES ADDITIONAL FLANGE LOADING TO PREVENT BELLOWS/HOUSING FRETTING. THE SLEEVE (4) IS INSTALLED IN THE BELLOWS (1) WITH A SHIM (5) BETWEEN THE TWO FLANGES. THE PILOT DIAMETER OF THE SLEEVE AND THE SHIM ARE DRY-FILM LUBRICATED TO REDUCE FRICTION AND THE POTENTIAL OF FRETTING. THE INLET SLEEVE IS INSTALLED WITH 6 SCREWS WHICH ARE LOCKED WITH DRY-LUBED CONICAL WASHERS (3). THE SLEEVE IS INCONEL 718, THE SCREWS ARE A-286 CRES, THE CONICAL WASHERS ARE 302 CRES, AND THE SHIM IS INCONEL 718. THE CAM FOLLOWER (6) CONTAINS A BE-CU GUIDE (7) WHICH OPERATES ON THE HOUSING (3). BE-CU WAS SELECTED FOR ITS WEAR RESISTANCE AND FRICTION CHARACTERISTICS (8). DRY-FILM LUBRICANT ON THE GUIDE REDUCES FRICTION, IMPROVES WEAR RESISTANCE, AND REDUCES THE POTENTIAL OF FRETTING. THE BELLOWS (1) CONTAINS A BE-CU GUIDE (9) WHICH OPERATES ON THE CAM FOLLOWER (6). THE GUIDE IS DRY-FILM LUBRICATED TO REDUCE FRICTION, IMPROVE WEAR RESISTANCE, AND TO REDUCE THE POTENTIAL OF FRETTING. THE INCONEL 718 RETAINER (10) IS SPRING-LOADED AGAINST THE 440C CRES SHAFT BEARING RACE (11) BY ELGILOY WAVEWASHERS (12). THE SPRING LOAD AND THE DIFFERENTIAL HARDNESS OF THE TWO MATERIALS PREVENTS WEAR AND FRETTING. THE RETAINER IS LUBRICATED WITH DRY-FILM LUBRICANT (9) FOR ADDITIONAL PROTECTION. THE RETAINER (9) IS INSTALLED ON THE INCONEL 718 SHAFT (13). THE DIFFERENT MATERIALS, DIFFERENTIAL HARDNESS, AND DRY-FILM LUBRICANT PROVIDE PROTECTION AGAINST FRETTING BETWEEN THESE PARTS. THE WAVEWASHERS (12) LOAD AGAINST THE HEAT TREATED INCONEL 718 CAP (14) AND THE HEAT TREATED A-286 WASHER (15). THE SPRING LOAD AND THE DIFFERENTIAL HARDNESS OF THE MATERIALS PROVIDES PROTECTION AGAINST FRETTING MOTION AND FRETTING. THE INCONEL 718 OUTLET SLEEVE (16) AND ANNEALED INCONEL 718 SHIM (5) ARE INSTALLED WITH 6 SCREWS WITH CUPWASHERS (3) FOR LOCKING. THE SHIM, CUPWASHERS, AND THE SLEEVE PILOT DIAMETER ARE DRY-FILM LUBRICATED TO PREVENT FRETTING. DRY-FILM LUBRICANT, INCONEL 718, ARMCO 21-8-9 CRES, A-286 CRES, 302 CRES, BE-CU, 440C CRES, AND ELGILOY ALL MEET THE STANDARD 10KG-M LOX COMPATIBILITY REQUIREMENTS (8). THE OXIDIZER PREBURNER OXIDIZER VALVE SUCCESSFULLY COMPLETED DVS TEST REQUIREMENTS (17), INCLUDING ENDURANCE (18), AND VIBRATION (19)

(1) RS008230; (2) RS008236; (3) RS008257; (4) RS008311; (5) RS010354; (6) RS008310; (7) RS008232; (8) RSS-8562; (9) RS008231; (10) RS008258; (11) RES1027; (12) RS008172; (13) RS008263; (14) RS008266; (15) RS008173; (16) RS010353; (17) DVS-SSME-515; (18) RSS-515-17; (19) RSS-515-24

**SSME FMF CIL  
INSPECTION AND TEST**

Component Group: Propellant Valves  
 CIL Item: D140-06  
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Prepared: P. Lawrence  
 Approved: T. Nguyen  
 Approval Date: 6/30/99  
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| Failure Causes | Significant Characteristics   | Inspection(s) / Test(s)                                  | Document Reference  |
|----------------|---|--|---|
| A              | BELLOWS<br>HOUSING<br>OPCV<br>SLEEVE, INLET<br>SHIM, INLET SLEEVE<br>CAM FOLLOWER<br>GUIDE, CAM FOLLOWER<br>GUIDE, BELLOWS<br>RETAINER, BEARING<br>BEARING ASSEMBLY<br>WAVEWASHER<br>SHAFT<br>CAP<br>RETAINER<br>SLEEVE |  | RS008230<br>RS008236<br>RS008258<br>RS008311<br>RS010354<br>RS008310<br>RS008232<br>RS008231<br>RS008268<br>RES1027<br>RS008172<br>RS008263<br>RS008266<br>RS008173<br>RS010353 |
|                | MATERIAL INTEGRITY  | MATERIAL INTEGRITY IS VERIFIED PER DRAWING REQUIREMENTS. | RS008230<br>RS008236<br>RS008311<br>RS010354<br>RS008310<br>RS008232<br>RS008231<br>RS008268<br>RES1027<br>RS008172<br>RS008263<br>RS008266<br>RS008173<br>RS010353             |
|                | HEAT TREAT  | HEAT TREAT IS VERIFIED PER DRAWING REQUIREMENTS.         | RS008230<br>RS008236<br>RS008310<br>RES1027<br>RS008172<br>RS008263   |
|                |   | PARTS ARE PENETRANT INSPECTED PER DRAWING REQUIREMENTS.  | RS008236<br>RS008311<br>RS008266  |

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Component Group: Propellant Valves  
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 Component: Oxidizer Preburner Oxidizer Valve  
 Part Number: RS008258  
 Failure Mode: Fretting of internal parts.

Prepared: P. Lowrimore  
 Approved: T. Nguyen  
 Approval Date: 8/30/99  
 Change #: 1  
 Directive #: CCBD ME3-01-5226  
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| Failure Causes | Significant Characteristics             | Inspection(s) / Test(s)   | Document Reference   |
|----------------|---|---|--|
| A              | HEAT TREAT                              | DRY-FILM LUBRICANT IS INSPECTED PER DRAWING REQUIREMENTS                                    | RS008231<br>RS008232<br>RS010353<br>RS008310<br>RS008311<br>RS008268<br>RS010354 |
|                | ASSEMBLY INTEGRITY                      | FASTENER RUNNING AND FINAL TORQUES ARE VERIFIED PER DRAWING REQUIREMENTS. (LAST INSPECTION) | RS008258   |
|                | HOT-FIRE ACCEPTANCE TESTING (GREEN RUN) | VALVE OPERATION IS VERIFIED THROUGH HOT-FIRE ACCEPTANCE TESTING. (LAST TEST)                | RL00461  |

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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.

**SSME TTA/CIL  
WELD JOINTS**

Component Group: Propellant Valves  
 CIL Item: D140  
 Component: Oxidizer Preburner Oxidizer Valve  
 Part Number: RS008258

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| Component | Basic Part Number | Weld Number | Weld Type | Class | Root<br>Side Not<br>Access | Critical Initial<br>Flaw Size Not<br>Detectable |     | Comments |
|-----------|-------------------|-------------|-----------|-------|----------------------------|---|-----|----------|
|           |                   |             |           |       |                            | HCF   | LCF |          |
| BELLOWS   | RS008230          | 3,4         | GTAW      | II    | X                          | X   |     |          |
| BELLOWS   | RS008230          | 5-7         | GTAW      | I     |                            |   |     |          |
| SHAFT     | RS008263          | 1,2         | EBWJ      | II    | X                          | X   |     |          |