# SSME FMEA/CIL
# REDUNDANCY SCREEN

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|---|---|
| Component Group: | Combustion Devices |
| CIL Item: | A340-02 |
| Part Number: | RS009168 |
| Component: | Nozzle Assembly |
| FMEA Item: | A340 |
| Failure Mode: | External rupture. |

| | |
|---|---|
| Prepared: | A. El-Ahmad |
| Approved: | T. Nguyen |
| Approval Date: | 9/9/99 |
| Change #: | 3 |
| Directive #: | CCBD ME3-01-5238 |
| Page: | 1 of 1 |

| Phase | Failure / Effect Description | Criticality Hazard Reference |
|---|---|---|
| SMC 4.1 | Leakage external to the nozzle and into the aft compartment will cause overpressurization. Fragmentation may cause damage to adjacent engines. Sudden loss of fuel causes LOX-rich operation. Loss of vehicle.<br><br>Redundancy Screens: SINGLE POINT FAILURE N/A | 1 ME-B7S ME-B7M, ME-B7A,C |

# SSME FMEA/CIL
# DESIGN

| | | | |
|---|---|---|---|
| Component Group: | Combustion Devices | Prepared: | A. El-Ahmad |
| CIL Item: | A340-02 | Approved: | T. Nguyen |
| Part Number: | RS009168 | Approval Date: | 9/9/99 |
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| Failure Mode: | External rupture. | Page: | 1 of 1 |

Design / Document Reference

FAILURE CAUSE: A: Structural failure of steerhorn, feedlines, mixer, diffuser, forward manifold, and aft manifold.

THE STEERHORN, FEEDLINES, DIFFUSER BODY, BYPASS DUCT, FORWARD MANIFOLD, AND AFT MANIFOLD ARE MADE FROM INCONEL 718. IT IS READILY SOLUTION TREATED DURING THE BRAZE CYCLE REQUIRED FOR THE NOZZLE FABRICATION AND HEAT TREAT PROPERTIES ARE DEVELOPED AFTER PRECIPITATION HARDENING (1). THE ENTIRE INLET SYSTEM OF THE NOZZLE OPERATES AT -350 DEGREES F WHICH IS BELOW THE -100 DEGREES F THRESHOLD WHERE INCONEL 718 BECOMES SUSCEPTIBLE TO HYDROGEN EMBRITTLEMENT, THEREFORE NO PROTECTION FOR HYDROGEN ENVIRONMENT EMBRITTLEMENT OF INCONEL 718 IS NEEDED. THE NOZZLE COOLANT INLET MANIFOLD DESIGN INCORPORATES THIRTY-SIX MACHINED HOLES LOCATED AT THE AFT MANIFOLD LIP. THE MACHINED HOLES ACCOMODATE THE TEST STAND SIDE LOAD ARRESTOR MECHANISM (SLAM). EIGHT ADDITIONAL HOLES ARE USED TO SECURE THE NOZZLE DRAIN LINE TO THE NOZZLE AFT MANIFOLD. INCONEL 718 FATIGUE ARRESTOR BOLTS ARE INSTALLED IN EACH OF THE SLAM AND NOZZLE DRAIN LINE HOLES. THE FATIGUE ARRESTOR BOLTS ARE DESIGNED TO PROVIDE A MAXIMUM AMOUNT OF PRELOAD TO THE AFT MANIFOLD LIP AND AN IMPROVED LOAD PATH ACROSS THE SLAM AND DRAIN LINE HOLES DURING ENGINE START AND CUTOFF RESULTING IN INCREASED FATIGUE LIFE (15). THE OUTLET SYSTEM OF THE NOZZLE WHICH OPERATES NEAR AMBIENT TEMPERATURE IS PROTECTED FROM HYDROGEN ENVIRONMENT EMBRITTLEMENT BY ELECTRODEPOSITED COPPER ON CRITICAL INCONEL 718 PARENT MATERIAL AND INCOLOY 903 OVERLAY WELDS ON ALL INCONEL 718 WELDMENTS (1). THE MIXER IS MADE FROM INCOLOY 903 WHICH WAS CHOSEN FOR ITS RESISTANCE TO HYDROGEN EMBRITTLEMENT AND STRENGTH. THE MIXER ELEMENTS ARE MADE FROM 347 CRES AND ITS MATERIAL PROPERTIES ARE NOT AFFECTED BY HIGH PRESSURE HYDROGEN (1). THESE ELEMENTS HELP ELIMINATE TURBULENT FLOW AND PROVIDES FOR THE MIXING OF THE HOT AND COLD HYDROGEN (2). THE FEED LINES INCORPORATE STEAM LOOPS AND SLIDE BRACKETS WHICH ALLOW THE NOZZLE TO EXPAND AND CONTRACT WITHOUT INDUCING STRESSES ON THE LINES. CRITICAL WELD BEADS ARE MACHINED FLUSH TO REDUCE STRESS CONCENTRATIONS (3). THE PRIMARY FACTORS OF SAFETY MEET CEI REQUIREMENTS (4), EXCEPT THOSE WHICH ARE LIFE LIMITED BY MAJOR WAIVER (16). THE ANALYSIS FOR HIGH CYCLE FATIGUE AND LOW CYCLE FATIGUE LIFE FOR PRODUCTION NOZZLES WITH SLAM AND DRAIN LINE FATIGUE ARRESTOR BOLTS INSTALLED MEETS CEI REQUIREMENTS (5). NOZZLES WITH FATIGUE DAMAGE AT THE AFT MANIFOLD SLAM AND DRAIN LINE BRACKET ATTACHMENT HOLES ARE REPAIRED PER SPECIFICATION REQUIREMENTS (13), AND ARE LIFE LIMITED BY MAJOR WAIVER (14). THE NOZZLE ASSEMBLY WAS DVS STRUCTURAL TESTED (6). THE NOZZLE HIGH PRESSURE FUEL FEED SYSTEM PARENT MATERIALS WERE CLEARED FOR FRACTURE MECHANICS/NDE FLAW GROWTH SINCE THEY CONTAIN NO FRACTURE CRITICAL PARTS (7). THE FMEA/CIL WELDS ARE CLEARED FOR FRACTURE MECHANICS/NDE FLAW GROWTH BY THE WELD ASSESSMENT (8). TABLE A340 LISTS ALL 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. THOSE WELDS IN WHICH THE CRITICAL INITIAL FLAW SIZE IS NOT DETECTABLE ARE ACCEPTABLE FOR FLIGHT BY RISK ASSESSMENT (8). THE NOZZLE WELDS IN CRITICAL AREAS, STEERHORN AND STUBOUTS HAVE BEEN STRAIN GAUGED TO VERIFY STRUCTURAL LOADS (9). PULL TESTS TO VERIFY OFFSET LIMITING FACTOR ON STUBOUTS HAVE BEEN PERFORMED (10). TEST SAMPLES OF AFT MANIFOLD HAVE BEEN PRESSURE CYCLED TO VERIFY LIMITED DAMAGE FACTOR OF TPS SPOTWELDS (11). THE DIFFUSER WAS BURST TESTED TO FAILURE TO VERIFY DESIGN AND STRUCTURAL PARAMETERS (12).

(1) RSS-8573-10; (2) RS009158, RSS-303-5; (3) RS009168; (4) RSS-8546, CP320R0003B; (5) RL00532, CP320R0003B; (6) RSS-303-33, TCA28; (7) NASA TASK I-17; (8) RSS-8756; (9) SSE 47-01-107, SSE 47-01-101, SSE 47-01-102; (10) SSE 47-16-047; (11) SSE 47-06-091, SSE 47-06-092; (12) SSE 47-07-059; (13) RL01051; (14) DAR 2161R3 DAR 1949R1 DAR 2297 DAR 2196 DAR 2352; (15) SSE 47-16-028; (16) DAR 2724 DAR 2661 DAR 2608R2 DAR 2648R1 DAR 2651 DAR 2654 DAR 2729 DAR 2714 DAR 2727

FAILURE CAUSE: B: Tube failure, jacket fatigue.

THE NOZZLE TUBES ARE HYDROFORMED FROM A-286 PRIMARILY FOR ITS FORMABILITY, AND ITS RESISTANCE TO HIGH PRESSURE HYDROGEN EMBRITTLEMENT (1). A NOZZLE JACKET IS BRAZED TO THE OUTER DIAMETER OF THE NOZZLE TUBE STACK. THE JACKET IS CONSTRUCTED OF INCONEL 718 PANELS WELDED ON CIRCUMFERENTIAL HATBANDS TO FORM A REINFORCED OUTER SHELL FOR THE STACK NOZZLE TUBES. THIS FORMS AN INTEGRAL PRESSURE VESSEL WITH THE BRAZED TUBES TO CONTAIN THE EXHAUST GAS. THE TUBES ARE NICKEL PLATED TO ASSIST BRAZE FLOW AND ADHESION (2). THE BRAZE ALLOY WAS DEVELOPED FOR THE SSME NOZZLE, IT PROVIDES STRENGTH, DUCTILITY, LIGHTWEIGHT, AND GOOD BRAZING CHARACTERISTICS (1). BRAZING OPERATIONS ARE CONTROLLED PER SPECIFICATION TO INSURE UNIFORM FLOW AND PROPER ADHESION (3). PRIMARY STRESS FACTORS OF SAFETY FOR THE STACKED TUBE ASSEMBLY MEET CEI REQUIREMENTS (4). TUBE FAILURE UNDER THE NOZZLE JACKETS CAN BE ATTRIBUTED TO BUCKLING AND SUBSEQUENT CRACKING OF THE JACKET OVER SEVERAL HOT FIRE CYCLES (5). JACKET BUCKLING IS DETECTABLE PRIOR TO JACKET FAILURE (CRACKING) AND TUBE RUPTURE. THESE NOZZLES WILL BE ALLOCATED FOR GROUND TEST ONLY. HIGH CYCLE AND LOW CYCLE FATIGUE LIFE OF THE JACKET, MANIFOLDS, AND TUBES MEET CEI REQUIREMENTS (6). THE JACKET, MANIFOLDS, AND TUBES PARENT MATERIALS WERE CLEARED FOR FRACTURE MECHANICS/NDE FLAW GROWTH SINCE THEY CONTAIN NO FRACTURE CRITICAL PARTS (7). THE JACKET AND TUBES HAVE BEEN STRUCTURALLY DESIGN VERIFICATION TESTED (8). COOLANT TUBES HAVE BEEN BURST TESTED BOTH WITH AND WITHOUT DEFECTS (9).

(1) RSS-8573-10; (2) RA1609-027, RA1109-036; (3) RA1507-014; (4) RSS-8546, CP320R0003B, I.L. 7127-405, SSME 87-0054; (5) UCR A005220; (6) RL00532 CP320R0003B; (7) NASA TASK 1-17; (8) RSS-303-33, TCA28; (9) I.L. 6127-4001, SSME 86-0043

SSME FMEA
# INSPECTION AND TEST

| | | | |
|---|---|---|---|
| Component Group: | Combustion Devices | Prepared: | A. El-Ahmad |
| CIL Item: | A340-02 | Approved: | T. Nguyen |
| Part Number: | RS009168 | Approval Date: | 9/9/99 |
| Component: | Nozzle Assembly | Change #: | 3 |
| FMEA Item: | A340 | Directive #: | CCBD ME3-01-5238 |
| Failure Mode: | External rupture. | Page: | 1 of 4 |

| Failure Causes | Significant Characteristics | Inspection(s) / Test(s) | Document Reference |
|---|---|---|---|
| A | MIXER ASSEMBLY | | RS009159 |
| | MATERIAL INTEGRITY | MATERIAL INTEGRITY IS VERIFIED PER SPECIFICATION REQUIREMENTS. | RB0170-186<br>RB0170-153 |
| | | THE MIXER MANIFOLD BASE, BOWL, AND OUTLET FLANGE ARE MAGNETIC PARTICLE AND PENETRANT INSPECTED AFTER ROUGH MACHINING. INLET ELBOW FROM CCV IS ULTRASONIC INSPECTED PRIOR TO MACHINING | RS009293<br>RS009152<br>RS009158<br>RS009174 |
| | 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. | RL10011<br>RA0607-094<br>RA0115-116<br>RA0115-006<br>RA0115-127<br>RA1115-001 |
| | | SPECIAL INSPECTIONS ARE PERFORMED TO VERIFY MISMATCH AND PART DISTORTION ARE ACCEPTABLE AT WELDS 2 AND 3 (RS009169). | RS009159 |
| | | A SURFACE FINISH INSPECTION IS PERFORMED ON WELD 7. | RS009156 |
| | CCV DUCT | | RS008161 |
| | MATERIAL INTEGRITY | MATERIAL INTEGRITY IS VERIFIED PER SPECIFICATION REQUIREMENTS. | |
| | | DUCT ASSEMBLY IS PENETRANT INSPECTED PER SPECIFICATION REQUIREMENTS. | RA0115-116 |
| | HEAT TREATMENT | HARDNESS TEST VERIFIES ADEQUATE HEAT TREAT PER SPECIFICATION REQUIREMENTS. | RA0611-020 |
| | DIFFUSER ASSEMBLY | | RS009156-101 |
| | MATERIAL INTEGRITY | MATERIAL INTEGRITY IS VERIFIED PER SPECIFICATION REQUIREMENTS. | RB0170-153 |
| | | FORGINGS ARE PENETRANT INSPECTED PER SPECIFICATION REQUIREMENTS. | RA0115-116 |
| | | FORGINGS ARE ULTRASONIC INSPECTED PER SPECIFICATION REQUIREMENTS. | RA0115-012 |
| | HEAT TREAT | HEAT TREAT IS VERIFIED PER SPECIFICATION REQUIREMENTS. | RA1607-014<br>RA0611-020 |
| | FORWARD MANIFOLD ASSEMBLY | | RS009155 |
| | MATERIAL INTEGRITY | MATERIAL INTEGRITY IS VERIFIED PER SPECIFICATION REQUIREMENTS. | RB0170-153 |
| | | PENETRANT AND ULTRASONIC INSPECTION IS PERFORMED ON SUBASSEMBLIES PER SPECIFICATION REQUIREMENTS. | RA0115-116<br>RA0115-012 |
| | DUCTILE NICKEL PLATE | PLATING INSPECTION IS PERFORMED PER SPECIFICATION REQUIREMENTS | RA1109-005 |
| | COPPER PLATING COVERAGE AND BOND | THE METALURGICAL ADHESION TESTS CHECK PLATING AND COVERAGE. | RA1109-002 |

| Failure Causes | Significant Characteristics | Inspection(s) / Test(s) | Document Reference |
|---|---|---|---|
| A | HEAT TREAT | HEAT TREAT IS VERIFIED PER SPECIFICATION REQUIREMENTS. | RA1507-014<br>RA0611-020 |
| | STEERHORN ASSEMBLY<br>DUCT SUBASSEMBLIES | | R0012279<br>RS009168<br>R055620<br>R0012273 |
| | MATERIAL INTEGRITY | MATERIAL INTEGRITY IS VERIFIED PER SPECIFICATION REQUIREMENTS. | RS0170-211<br>RA1602-009 |
| | | WELDED STEERHORN ASSEMBLY IS PENETRANT INSPECTED. ALL FEEDING TUBING AND END RINGS ARE PENETRANT INSPECTED | RA0116-116 |
| | | STEERHORN ASSEMBLY DETAILS ARE ULTRASONIC INSPECTED PER DRAWING AND SPECIFICATION REQUIREMENTS. | RA0116-124 |
| | HEAT TREAT | HEAT TREAT IS VERIFIED BY SPECIFICATION REQUIREMENTS. | RA0611-020 |
| | | NOZZLE WELDS ARE PENETRANT INSPECTED AFTER PROOF TEST. | RA0116-116 |
| | AFT MANIFOLD<br>CAP<br>SLAM BOLT<br>SLAM WASHER<br>SLAM WASHER<br>SLAM NUT<br>DRAIN LINE BOLT<br>DRAIN LINE SHIM<br>DRAIN LINE WASHER<br>DRAIN LINE NUT | | RS009286<br>RS009169<br>R036710<br>R036711<br>R036712<br>MS21043-3<br>R036720<br>R036737<br>R036722<br>R036739 |
| | MATERIAL INTEGRITY | MATERIAL INTEGRITY IS VERIFIED PER SPECIFICATION REQUIREMENTS. | RS0170-154<br>RS0170-153<br>RS0170-211 |
| | | R036710 AND R036720 FATIGUE ARRESTOR BOLTS ARE PENETRANT INSPECTED PER DRAWING AND SPECIFICATION REQUIREMENTS. | RA0116-116 |
| | | THE RS009286 AFT MANIFOLD AND DETAILS ARE PENETRANT INSPECTED AFTER MACHINING | |
| | HEAT TREAT | R036710 AND R036720 FATIGUE ARRESTOR BOLTS ARE HEAT TREATED PER DRAWING AND SPECIFICATION REQUIREMENTS. | R036710<br>R036720<br>RA0611-020 |
| | 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. | RL10011<br>RA0607-034<br>RA0116-116<br>RA0116-036<br>RA0116-127<br>RA1116-001 |
| | ASSEMBLY INTEGRITY | R036710 AND R036720 FATIGUE ARRESTOR BOLT INTERFACE DIAMETERS ARE VERIFIED PER DRAWING REQUIREMENTS. | R036710<br>R036720 |

Component: Combustion Devices
CIL Item: A340-02
Part Number: RS009168
Component: Nozzle Assembly
FMEA Item: A340
Failure Mode: External rupture.

Prepared:
Approved: T. Nguyen
Approval Date: 9/9/99
Change #: 3
Directive #: CCBD MF3-01-5238



| Failure Causes | Significant Characteristics | Inspection(s) / Test(s) | Document Reference |
|---|---|---|---|
| A | ASSEMBLY INTEGRITY | AFT MANIFOLD SLAM AND DRAIN LINE BRACKET HOLE INTERFACE DIAMETERS ARE VERIFIED AND INSPECTED PER DRAWING REQUIREMENTS | RS009168<br>RE000285 |
| | | FATIGUE ARRESTOR BOLTS ARE INSTALLED PER DRAWING AND SPECIFICATION REQUIREMENTS. | RL01351 |
| | CLOSEOUT CAP WALL THICKNESS AND CONTOUR | A SPECIAL CONTOUR AND MISMATCH INSPECTION IS PERFORMED AFTER WELDING. | RS009285 |
| B | JACKET<br>TUBES | | RS009150<br>RS009172 |
| | MATERIAL INTEGRITY | MATERIAL INTEGRITY IS VERIFIED PER SPECIFICATION REQUIREMENTS. | RB0160-047<br>RB0170-154<br>RB0170-153 |
| | 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. | RL10011<br>RA0507-034<br>RA0115-115<br>RA0115-035<br>RA0115-127<br>RA1115-001 |
| | | ASSEMBLY IS STRESS RELIEVED AFTER WELDING OPERATION. | RS009150 |
| | HEAT TREAT | HEAT TREAT IS INSPECTED AFTER POST BRAZING OPERATIONS PER SPECIFICATION REQUIREMENTS. | RAC511-020 |
| | BRAZE INTEGRITY | FOLLOWING BRAZING OPERATIONS THE SHELL ASSEMBLY IS VISUALLY AND RADIOGRAPHICALLY INSPECTED FOR BRAZING DEFECTS. | RS009169<br>RA0115-009 |
| ALL CAUSES | NOZZLE ASSEMBLY | | RS009169 |
| | ASSEMBLY INTEGRITY | ENTIRE NOZZLE ASSEMBLY IS PROOF PRESSURE TESTED PER SPECIFICATION REQUIREMENTS. | RL00209 |
| | | NOZZLE WELDS ARE PENETRANT INSPECTED AFTER PROOF TEST PER SPECIFICATION REQUIREMENTS. | RA0115-116 |
| | | THE HOT FIRE TESTING AND 2ND E & M INSPECTIONS VERIFY NOZZLE INTEGRITY. | RL00056-04<br>RL00056-05<br>RL00056-07 |
| | | THE HELIUM SIGNATURE LEAK TEST VERIFIES NO LEAKAGE INTO AFT COMPARTMENT PRIOR TO EACH FLIGHT | OMRSD S00000.950 |
| | | THE JACKET ASSEMBLY IS INSPECTED AT CRITICAL AREAS BETWEEN HATBANDS 8 AND 9 AND MIDWAY BETWEEN STEERHORNS FOR BUCKLING AFTER EACH FLIGHT. | OMRSD V41BJ0.029 |
| | | NOZZLE IS LEAK TESTED PRIOR TO EACH FLIGHT. (LAST TEST) | OMRSD V41BQ0.160 |

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|---|---|---|---|
| **Component Group:** | Combustion Devices | **Approved:** | T. Nguyen |
| **CIL Item:** | A340-02 | **Approval Date:** | 9/9/99 |
| **Part Number:** | RS001168 | **Change #:** | 3 |
| **Component:** | Nozzle Assembly | **Directive #:** | CCBD ME3-01-5238 |
| **FMEA Item:** | A340 | | |
| **Failure Mode:** | External rupture. | **Page:** | 4 of 4 |

| Failure Causes | Significant Characteristics | Inspection(s) / Test(s) | Document Reference |
|---|---|---|---|

Failure History: Comprehensive failure history data is maintained in the Problem Reporting database (FRAMS/PRACA)
Reference: NASA letter SA21/83/309 and Rocketdyne letter 83RC09761.

Operational Use: Not Applicable.

# SSME FMEA/CIL
# WELD JOINTS

Component Group: Combustion Devices
CIL Item: A340
Component: RS009168
Part Number: Nozzle Assembly A340

Prepared: A. El-Ahmad
Approved: T. Nguyen
Approval Date: 9/9/99
Change #: 1
Directive #: CCRD MF3-01-5238


| 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 |
|---|---|---|---|---|---|---|---|---|
| NOZZLE STEERHORN | R0012279 | 1(OPT), 2(OPT) | GTAW | I | | X | X | |
| NOZZLE STEERHORN | R0012279 | 3 | GTAW | I | X | X | X | |
| NOZZLE STEERHORN | R0012279 | 4 | GTAW | I | | X | | |
| NOZZLE STEERHORN | R0012279 | 5,6 | GTAW | I | X | X | | |
| NOZZLE STEERHORN | R0012279 | 9 | GTAW | I | | X | X | |
| NOZZLE STEERHORN | R0012279 | 10 | GTAW | I | X | X | X | |
| CCV DUCT | RS008161 | 1 | EBW | I | X | X | | |
| CCV DUCT | RS008161 | 2 | EBW | I | | X | | |
| CCV DUCT | RS008161 | 3 | GTAW | I | | X | X | |
| CCV DUCT | RS008161 | 5 | EBW | I | | | | |
| NOZZLE JACKET | RS009150 | 1,4,5,16 | GTAW | I | | X | | |
| NOZZLE JACKET | RS009150 | 2,3,6,7,10 11 ,14,15,18,19 22,23,26,27, 30,31,34,35 | GTAW | II | X | | | |
| NOZZLE JACKET | RS009150 | 8,9,12,13,17, 20 | GTAW | I | | | | |
| NOZZLE JACKET | RS009150 | 21 | GTAW | I | | | | |
| NOZZLE JACKET | RS009150 | 24,25,28,29, 32,33,36 | GTAW | II | | | | |
| INLET DIFFUSER | RS009156 | 1 PLG(OPT) | EBW | I | X | | | |
| MIXER | RS009158 | 4 | GTAW | I | | X | | |
| MIXER | RS009158 | 5 | GTAW | I | | X | X | |
| MIXER | RS009158 | 7 | GTAW | I | | | | |
| MIXER | RS009158 | 8 | GTAW | I | | X | | |
| MIXER | RS009158 | 10 | GTAW | I | | X | X | |
| FWD MANIFOLD | RS009165 | 44,45 | GTAW | I | | | | |
| FWD MANIFOLD | RS009165 | 46 | GTAW | I | X | | | |
| FWD MANIFOLD | RS009165 | 47 | GTAW | I | X | | | |
| NOZZLE | RS009168 | 1,2 | GTAW | I | X | X | X | |
| NOZZLE | RS009168 | 3 | GTAW | I | X | X | X | |
| NOZZLE | RS009168 | 13,14 | GTAW | I | X | X | | |

| Component | Basic Part Number | Weld Number | Weld Type | Class | Root Side Not Access | Critical Initial Flaw Size Not Detectable HCF | LCF | Comments |
|---|---|---|---|---|---|---|---|---|
| NOZZLE | RSC09168 | 15,16 | GTAW | I | X | X | | |
| NOZZLE | RSC09168 | 17 | GTAW | I | X | X | | |
| NOZZLE | RSC09168 | 18 | GTAW | I | X | X | | |
| NOZZLE | RSC09168 | 19 | GTAW | I | | X | | |
| NOZZLE | RSC09168 | 20 | GTAW | I | | X | | |
| NOZZLE | RSC09168 | 21 | GTAW | I | X | X | | |
| NOZZLE | RSC09168 | 23 | GTAW | I | X | X | | |
| NOZZLE | RSC09168 | 24 | GTAW | I | X | X | X | |
| NOZZLE | RSC09168 | 26 | GTAW | I | | X | | |
| NOZZLE | RSC09168 | 27 | GTAW | I,II | | X | | |
| NOZZLE | RSC09168 | 152 | GTAW | I | X | | | |
| NOZZLE | RSC09168 | 172 | GTAW | I | | X | | |
| NOZZLE | RSC09168 | 306A | GTAW | I | X | X | X | |
| NOZZLE | RSC09168 | 1503-1508 | GTAW | I | X | X | X | |
| NOZZLE | RSC09168 | 1723,1724 | GTAW | I | X | X | X | |
| NOZZLE | RSC09168 | 1725,1726 | GTAW | I | X | X | X | |
| NOZZLE TUBE STACK | RSC09169 | 1 | GTAW | I | X | | | |
| NOZZLE TUBE STACK | RSC09169 | 2 3 | GTAW | I | X | X | X | |
| NOZZLE TUBE STACK | RSC09169 | 49 50 | GTAW | I | X | X | | |
| NOZZLE TUBE STACK | RSC09169 | 51-56 | GTAW | I | X | X | | |
| NOZZLE TUBE STACK | RSC09169 | 168-170 | GTAW | II,I | | | | |
| AFT MANIFOLD | RSC09286 | 1 2 | GTAW | I | | | | |
| AFT MANIFOLD | RSC09286 | 30-35 | GTAW | I | | X | X | |
| NOZZLE FUEL FEEDLINE | R056820 | 1 | GTAW | I | | X | | |

# SSME F A/CIL
## FIELD CONFIGURATION VARIANCES FROM CIL RATIONALE

**Component Group:** Combustion Devices
**Item Name:** Nozzle Assembly
**Item Number:** A340
**Part Number:** RS009168

**Prepared:** A. El-Ahmad
**Approved:** T. Nguyen
**Approval Date:** 9/9/99
**Change #:** 2
**Directive #:** CCBD ME3-01-5239



| Base Line Rationale | Variance | Change Rationale | Variant Dash Number |
|---|---|---|---|
| A340 02. Elimination of 9 welds from nozzle fuel coolant and distribution circuit. This change will utilize a one piece seam welded tube with a welded transition ring which is within the experience of flight history. Design eliminates 9 welds during the fabrication of each nozzle (3 welds each feedline, 3 feedlines per nozzle) | Use of nine weld design RO01227d - Weld No. 1(x3) Weld No. 2 (x3) RS009168 - Weld No. 1456, 1457 1512, 1509-1511 | The nozzle high pressure fuel feed system parent materials were cleared for fracture mechanics/NDE flaw growth since they contain no fracture critical parts (NASA TASK 117). The FMEA/CIL welds are cleared for fracture mechanic/NDE flaw growth by the weld assessment (RSS-8755). | 162,132,1031,1041,10 21,1031 1041,1051,10 61,1081 1091,1101,11 11,1131,1141,1151,11 61,1171,1181,1191,12 01,1211,1221 231,124 1,1251,1261,271,1281, 1291,1301 |