SSME FMEA/CIL
REDUNDANCY SCREEN

Component Group: Joints
CIL Item: L103C-01
Part Number: See Table L103C
Component: Hot Gas System Joints
FMEA Item: L103C
Failure Mode: Leakage.

Prepared: D. Early
Approved: T. Nguyen
Approval Date: 7/25/00
Change #: 1
Directive #: CCBD ME3-01-5638

Phase	Failure / Effect Description	Criticality Hazard Reference
SMC 4.1	Hot gas leakage into aft compartment. Leakage will erode leak path, leading to joint damage, ever increasing leakage, adjacent component damage, aft compartment overpressurization. Possible fire or detonation. Loss of vehicle. Redundancy Screens: SINGLE POINT FAILURE: N/A	1 ME-D3S,A,M,C

SSME FEA/CIL DESIGN

Component Group:	**Joints**	**Prepared:**	**D. Early**
CIL Item:	**L103C-01**	**Approved:**	**T. Nguyen**
Part Number:	**See Table L103C**	**Approval Date:**	**7/25/00**
Component:	**Hot Gas System Joints**	**Change #:**	**1**
FMEA Item:	**L103C**	**Directive #:**	**CCBD ME3-01-5638**
Failure Mode:	**Leakage.**		
		Page:	**1 of 2**

Design / Document Reference

FAILURE CAUSE: A: Seal failure.

ALL THE HOT GAS JOINTS NOTED IN THE FMEA USE PRESSURE-ASSISTED SEALS. THE PRESSURE-ASSISTED SEALS, EXCEPT FOR THE BELLOWS SEAL, ARE A VARIATION OF A "U" SHAPE CROSS-SECTION SEAL RING (1). THE SEALS ARE COMPRESSED DURING THE JOINT ASSEMBLY, WHICH PROVIDES A LOAD AT THE SEAL TIPS TO PROVIDE SEALING CAPABILITY AT LOW PRESSURES. AS THE PRESSURE INCREASES, IT ACTS ON THE "U" SHAPE AND INCREASES THE LOAD TO THE SEAL TIPS AND PROVIDES SEALING CAPABILITY AT THE HIGH SYSTEM PRESSURES. THE COMBINATION OF THE INSTALLATION DEFLECTION AND THE PRESSURE INSIDE OF THE "U" SHAPE PERMITS THE SEALING TIP TO COMPENSATE FOR THE JOINT SEPARATION UNDER SYSTEM PRESSURE. THESE INTERACTIONS PROVIDE FOR LEAK FREE JOINTS. THE SEAL MATERIAL IS INCONEL 718. THIS ALLOY IS USED FOR ITS STRENGTH, HEAT TREATABILITY, AND ABILITY TO RETAIN ITS STRENGTH AT BOTH CRYOGENIC AND ELEVATED TEMPERATURES (2). THE SEALS ARE PLATED OR TEFLON COATED TO PROVIDE A DUCTILE LOW YIELD STRENGTH MATERIAL ON THE SEAL TIP SO THE SEAL WILL CONFORM TO THE SURFACE TOPOGRAPHY ON THE MATING FLANGES. THE RD261-3017 (VARIOUS SIZES) SEALS ARE MADE OF INCONEL 718 AND ARE USED IN JOINTS WITH SERVICE TEMPERATURE REQUIREMENTS FROM -423 DEGREES F TO 1000 DEGREES F, AND PRESSURES UP TO 8,000 PSIG. THEY ARE SILVER PLATED WITH AN INITIAL GOLD UNDERCOAT. THE GOLD UNDERCOAT PREVENTS OXIDATION OF THE SUBSTRATE AT TEMPERATURES ABOVE 600 DEGREES F, AND THUS PREVENTS BLISTERING OF THE SILVER PLATING. SILVER IS USED DUE TO ITS LOW YIELD STRENGTH AND DUCTILITY REQUIRED FOR EFFECTING A SEAL, AND ITS CORROSION RESISTANCE (2). SEAL PART NUMBER RD261-3016 IS SIMILAR TO THE RD261-3017 EXCEPT IT HAS A RHODIUM OVERPLATE ON THE SILVER PLATING TO PREVENT THE BONDING OF THE SILVER TO THE MATING FLANGE SURFACE AT TEMPERATURES ABOVE 1000 DEGREES F (2). SILVER PLATING PROVIDES PROTECTION FROM HYDROGEN ENVIRONMENT EFFECTS (2). A PRESSURE-ASSISTED BELLOWS SEAL, PART NUMBER RS008861, WITH HIGH DEFLECTION CAPABILITY IS USED AT THE MAIN COMBUSTION CHAMBER-TO-NOZZLE JOINT (G15). THIS SEAL CONFIGURATION IS USED TO COMPENSATE FOR JOINT SEPARATION WHICH OCCURS DURING ENGINE GIMBALING. THE BELLOWS SEAL HAS FOUR CONVOLUTIONS, IS A MULTIPLE BELLOWS CONFIGURATION WITH THE SEAL TIPS ON EACH END OF THE BELLOWS. THIS SEAL IS MADE OF INCONEL 718 WITH TEFLON COATING ON EACH SEAL TIP. A SPRING RATE TEST IS REQUIRED TO ASSURE ADEQUATE MECHANICAL LOADING OF THE SEAL (3). TO PREVENT BELLOWS SEAL LIFE DEGRADATION FROM NOZZLE BOUNDARY LAYER HOT-GAS IMPINGEMENT AND SUBSEQUENT RECIRCULATION OF HOT-GAS AGAINST THE INNER DIAMETER OF THE SEAL, A FLOW RECIRCULATION INHIBITOR (FRI) (15) IS INSTALLED IN THE G15 JOINT. THE FRI IS MANUFACTURED USING ALUMINA-BORIA-SILICA (NEXTEL) BRAIDED CERAMIC TUBULAR SLEEVING (16) FILLED WITH ALUMINA FIBER (SAFFIL) INSULATION BATTING MATERIAL (17). THE CERAMIC MATERIALS WERE SELECTED FOR THEIR HIGH TEMPERATURE RESISTANCE, INSULATING PROPERTIES PERMEABILITY AND RESILIENCE (18). THE FRI MATERIALS ARE CURRENTLY USED ON THE ORBITER AS AN INTEGRAL FILLER BETWEEN THE INSULATION TILES AND ARE PROCURED BY AN INTERDIVISIONAL SUPPORT REQUEST TO SPACE TRANSPORTATION SYSTEM DIVISION. THE FRI IS INSTALLED AROUND THE FULL DIAMETER OF THE NOZZLE TO MCC AREA (19). THE FRI IS INSTALLED IN FOUR SEGMENTS WHICH ARE HELD IN PLACE BY MULTIPLE STITCHING, ELASTOMER APPLICATIONS, AND JOINT GEOMETRY (20). THE RETAINING THREAD IS MANUFACTURED UTILIZING AN ALUMINA-BORIA-SILICA CERAMIC FIBER THREAD (21). THE THREAD MATERIAL WAS SELECTED FOR ITS HIGH TEMPERATURE RESISTANCE AND TENSILE STRENGTH. THE ELASTOMER (22) HAS BEEN USED IN A SIMILAR ENVIORNMENT ON THE CURRENT JOINT G15 INSTALLATION (23). THE NOZZLE TUBE EFFECTIVE PROTRUSION AND MCC/NOZZLE EFFECTIVE GAP ARE ESTABLISHED PER SPECIFICATION REQUIREMENTS (24) TO VERIFY ENGINE JOINT G15 GEOMETRY IS WITHIN DEMONSTRATION UNIT GEOMETRIC MARGINS. UNDER THESE MARGINS THE BELLOWS SEAL IS CAPABLE OF WITHSTANDING ONE FLIGHT WITHOUT THE FRI INSTALLED (25). FRI LIFE LIMITS ARE CONTROLLED BY MAJOR WAIVER (26). THE FLOW RECIRCULATION INHIBITOR HAS COMPLETED CERTIFICATION BASED ON ANALYSIS, LAB TEST, AND HOT-FIRE TESTING (27). ENGINE 0211 DEMONSTRATED SEAL BLUING WITH MAXIMAL GEOMETRIES WITHOUT A STRESS RUPTURE FOR 1,840 SECONDS (18). THE ENSUING BELLOWS SEAL DVS AND ENGINE TEST INFORMATION WAS ACCUMULATED WITHOUT THE FRI INSTALLED. THE BELLOWS SEAL WAS DVS TESTED TO VERIFY SPRING RATE (4) AND SEALING CAPABILITY UNDER OPERATING CONDITIONS. BELLOWS SEALING IS ENHANCED BY THE APPLICATION OF AN ELASTOMER SEALANT TO BOTH THE NOZZLE AND MCC SEALING SURFACES. THE BELLOWS SEALS FROM ENGINES 2010 AND 2014 WERE EXAMINED AFTER HOT FIRE TESTING. ALTHOUGH THE TEFLON COATING WAS FOUND TO BE CUT DUE TO SEAL LOAD, THE DAMAGE WAS CONSIDERED NORMAL AND OF NO CONCERN SINCE THE ELASTOMER PROVIDES SEALING BETWEEN THE BELLOWS SEAL AND THE FLANGES BY FILLING THE SMALL LEAK PATHS. THE ELASTOMER SEALANT SHOWED AREAS OF HEAT DISCOLORATION DUE TO SMALL JOINT LEAKAGES ON BOTH ENGINES. THE DISCOLORATION OF THE ELASTOMER WAS NOTED AS COMMON ON THIS JOINT AFTER ENGINE HOT FIRE TESTS. THE COLOR OF THE SEALANT INDICATED EXPOSURE TO TEMPERATURES OF APPROXIMATELY 500-600 DEGREES F. THE BELLOWS JOINTS ON BOTH ENGINES PASSED 25 PSIG LEAK TESTS PRIOR TO DISASSEMBLY.

SEALS REMOVED FROM BROKEN JOINTS ARE EITHER REPLACED OR ARE REINSPECTED AND REUSED. GENERAL GUIDELINES ARE TO REPLACE SEALS AT ALL STRETCH JOINTS AND OTHER HARD-TO-GET-AT JOINT SEALS. NON-STRETCH JOINT SEALS WITH EASY ACCESS ARE REINSPECTED AND REUSED IF FOUND ACCEPTABLE. SPECIAL SEALS MAY BE RETURNED FOR OVERHAUL REFURBISHING IF DISASSEMBLY INSPECTIONS FIND SCRATCHES OR OTHER DEFECTS (5).

THE RD261-3016 SEAL WAS DVS TESTED IN A SIMULATED ENGINE JOINT AT A HIGH TEMPERATURE. THE SEALS MET LEAKAGE REQUIREMENTS WHILE THE PRESSURE WAS CYCLED FROM AMBIENT TO 5,000 PSIG FOR 240 CYCLES (6). IN ADDITION TO THE ABOVE TESTS, SEALS HAVE BEEN SUBJECTED TO STRUCTURAL VERIFICATION AT PRESSURES UP TO TWICE OPERATING PRESSURE. AFTER COMPLETION OF 240 PRESSURE CYCLES, THE SEALS STILL MET THE LEAKAGE REQUIREMENT (7). HIGH CYCLE AND LOW CYCLE

Design / Document Reference

FATIGUE LIFE OF THE HOT GAS SEALS MEET CEI REQUIREMENTS (10). THE MINIMUM FACTORS OF SAFETY FOR THE SEALS MEET CEI REQUIREMENTS (11). THE SEALS WERE CLEARED FOR FRACTURE MECHANICS/NDE FLAW GROWTH SINCE THEY ARE NOT FRACTURE CRITICAL PARTS (12). SPECIAL PACKAGING REQUIREMENTS ARE SPECIFIED TO PROTECT THE SEALS DURING SHIPMENT OR STORAGE (13).

THE FLANGES ARE DESIGNED TO INTERFACE WITH THE SEAL AND HAVE THE NECESSARY FEATURES TO PROVIDE A LEAK FREE JOINT. THE FLANGE DESIGN SPECIFIES THE REQUIREMENTS FOR SURFACE FLATNESS, SURFACE FINISH, AND THE SEALING SURFACE AREA ON THE FLANGE. THIS ENSURES THAT THE SEAL MATING AREA IS CLOSELY INSPECTED TO VERIFY IT IS FREE OF DEFECTS WHICH WOULD CAUSE LEAKAGE. TYPICALLY, ONE FLANGE HAS A SEAL GROOVE FOR POSITIONING THE SEAL WHILE THE OTHER FLANGE IS FLAT. BOLT HOLE CLEARANCES ARE CONTROLLED BY THE FLANGE DESIGN TO PREVENT EXCESSIVE LATERAL MOTION WITHIN THE JOINT. THE FLANGE DESIGN ALSO CONTROLS THE DEFLECTION IN BOTH THE RADIAL AND CIRCUMFERENTIAL DIRECTIONS. RADIAL DEFLECTIONS ARE LARGELY CONTROLLED BY THE THICKNESS OF THE FLANGE WHILE CIRCUMFERENTIAL DEFLECTIONS ARE CONTROLLED BY FLANGE THICKNESS AND BOLTING REQUIREMENTS. THE JOINT DESIGNS HAVE CLOSE BOLT SPACING TO PREVENT UNACCEPTABLE FLANGE BOWING (DEFLECTION) BETWEEN BOLTS. TYPICAL FLANGES WERE USED DURING DVS STATIC SEAL TESTING WHICH CONFIRMED DESIGN REQUIREMENTS ON THE ENGINE FLANGES (6) (7) (14). LEAK CHECKS DURING ENGINE BUILD AND AT INTERVALS DURING ENGINE SERVICE HAVE SHOWN THAT THE FLANGES PERFORM SATISFACTORILY AND MAINTAIN JOINT INTEGRITY. THIS HAS BEEN FURTHER DEMONSTRATED BY THE FLANGES ON TWO HIGH TIME ENGINES: ENGINE 2010 WITH 65 STARTS AND 19,903 SECONDS OF HOT FIRE TIME (8), AND ENGINE 2014 WITH 70 STARTS AND 19,102 SECONDS OF HOT FIRE TIME (9).

(1) RD261-3016, RD261-3017, RS008861; (2) RSS-8582; (3) RS008861; (4) RSS-514-9; (5) RD261-3016, RS008861; (6) RSS-514-12; (7) RSS-514-6; (8) 529-143-IL-85-0126; (9) SSME-86-00096; (10) RL00532, CP320R0003B; (11) RSS-8546; (12) NASA TASK 117; (13) RA0116-082; (14) RSS-514-16; (15) R039124; (16) RB0135-041; (17) RB0135-042; (18) ECP 1060; (19) RL01030; (20) RS007002, RF0001-084, RL01030; (21) RB0135-035; (22) RB0120-052, TYPE II; (23) RS007002; (24) RF0001-084; (25) IL CD-89-N0Z-0004A1; (26) DAR 2325; (27) VRS 326

FAILURE CAUSE: B: Loss of bolt preload.

JOINT BOLTING IS AN INTEGRAL PART OF STATIC SEAL JOINTS. THE BOLTING IS DESIGNED TO TAKE INTO CONSIDERATION BOTH THE PRESSURE SEPARATING LOAD AND ALL EXTERNAL LOADS THAT ACT ON THE JOINT. BOLTS ARE SPACED CLOSE TOGETHER TO MINIMIZE FLANGE DEFLECTION. HIGH STRENGTH BOLTS ARE USED TO PROVIDE THE NECESSARY CLAMPING LOAD WHILE KEEPING THE TOTAL JOINT WEIGHT TO A MINIMUM. THE BOLT MATERIALS ON FLUID SYSTEMS ARE A-286 AND INCONEL 718, WHICH ARE USED FOR THEIR STRENGTH, ELASTIC MODULUS, AND COMPATABILITY WITH ENGINE ENVIRONMENT (1) TEMPERATURES. THE BOLTS OR NUTS ARE NORMALLY COATED WITH DRY-FILM LUBRICANTS OR PLATED TO REDUCE THE TORQUE REQUIRED FOR TIGHTENING AND TO REDUCE THE LOAD RANGE VARIATIONS DUE TO FRICTION. THE FASTENERS (BOLTS AND STUDS) MAY BE INSTALLED INTO THREADED HOLES OR IN NUTS. THE BOLTS ARE LOCKWIRED TO PREVENT BOLT BACKOFF ON THREADED HOLE INSTALLATIONS AND THE NUTS HAVE SELF-LOCKING, DEFORMED THREADS, TO PREVENT NUT BACKOFF ON BOLT-NUT INSTALLATIONS. FASTENER INSTALLATION IS CONTROLLED AT ENGINE ASSEMBLY TO ENSURE THAT THE INSTALLATION HAS THE PROPER BOLT LOADING AND NO DAMAGE OCCURS TO EITHER THE FASTENERS OR FLANGES. ON TORQUED INSTALLATIONS THE TORQUE IS APPLIED IN THREE EQUAL STEPS WITH TORQUE AT EACH STEP APPLIED IN A CROSS TORQUEING PROCEDURE (2). ON HIGH PRESSURE JOINT INSTALLATIONS, THE FASTENERS (BOLTS AND STUDS) ARE STRETCHED TO A DRAWING SPECIFIED ELONGATION. THIS OPERATION IS CONTROLLED BY A SPECIFICATION (3) WHICH REQUIRES AN INITIAL TORQUE TO BE APPLIED IN A CROSS TORQUEING PROCEDURE. THE FASTENERS ARE THEN STRETCHED TO A FINAL ELONGATION USING A SPECIAL MACHINE (EXTENSOMETER) AND USING A CROSS TORQUEING PROCEDURE. THE STRETCHING PROCEDURES ARE PERFORMED BY TRAINED AND CERTIFIED PERSONNEL AND WITNESSED BY A CERTIFIED INSPECTOR. BOLTS ARE REQUIRED TO BE LOCKWIRED AFTER INSTALLATION (2)(3). REUSE OF A FASTENER REQUIRES RELUBRICATION AND INSPECTION FOR GALLING, THREAD DAMAGE, OR WRENCHING ELEMENT DISTORTION. ALL SELF LOCKING NUTS REQUIRE VERIFICATION OF THE LOCKING FEATURE DURING NUT INSTALLATION (2)(3). THE MATERIALS USED FOR THE WASHERS IN THE JOINT BOLTING ARE SELECTED FOR THEIR COMPRESSIVE YIELD STRENGTH TO PREVENT YIELDING UNDER JOINT OPERATING PRESSURES (1). THE STRETCH FASTENERS WERE USED THROUGHOUT THE STATIC SEAL DVS TESTING ON SIMULATED JOINTS WHICH DEMONSTRATED THE BOLTING DESIGN APPROACH AND THE ABILITY OF THE JOINTS TO MEET THE LEAKAGE REQUIREMENTS (4). LEAK CHECKS DURING ENGINE BUILD AND AT INTERVALS DURING ENGINE SERVICE HAVE SHOWN THAT JOINT INTEGRITY IS SATISFACTORILY MAINTAINED BY THE BOLTING DESIGNS.

(1) RSS-8582; (2) RA0101-002; (3) RL00114; (4) RSS-514-16, RSS-514-12, RSS-514-6

SSME FI /CIL
INSPECTION AND TEST

Component Group: Joints
CIL Item: L103C-01
Part Number: See Table L103C
Component: Hot Gas System Joints
FMEA Item: L103C
Failure Mode: Leakage.

Prepared: D. Early
Approved: T. Nguyen
Approval Date: 7/25/00
Change #: 1
Directive #: CCBD ME3-01-5638

Failure Causes	Significant Characteristics	Inspection(s) / Test(s)	Document Reference
A	SEAL-P/A SEAL-P/A		RD261-3016 RD261-3017
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER DRAWING REQUIREMENTS.	RD261-3016 RD261-3017
		HEAT TREAT OF SEALS IS VERIFIED PER DRAWING REQUIREMENTS.	RD261-3016 RD261-3017
		SEALS ARE PENETRANT INSPECTED PER DRAWING REQUIREMENTS.	RD261-3016 RD261-3017
	PLATING INTEGRITY	SEAL PLATING IS VERIFIED PER DRAWING AND SPECIFICATION REQUIREMENTS.	RD261-3016 RD261-3017 RA1609-020 RA1609-001
	SURFACE FINISH	SEAL SURFACE FINISHES ARE VERIFIED PER DRAWING REQUIREMENTS.	RD261-3016 RD261-3017
	CLEANLINESS	SEALS ARE VERIFIED TO BE CLEAN TO PROPELLANT SERVICE LEVEL PER DRAWING REQUIREMENTS.	RD261-3016 RD261-3017
	SEAL, BELLOWS		RS008861
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER DRAWING REQUIREMENTS.	RS008861
		HEAT TREAT OF SEAL IS VERIFIED PER DRAWING REQUIREMENTS.	RS008861
		SEAL IS PENETRANT INSPECTED PER DRAWING REQUIREMENTS.	RS008861
		BELLOWS SPRING RATE IS INSPECTED.	RS008861
	TEFLON COATING INTEGRITY	THE TEFLON COATING IS VERIFIED PER DRAWING AND SPECIFICATION REQUIREMENTS.	RS008861
	SEALING SURFACE INTEGRITY	THE SEALING SURFACE FINISH IS VERIFIED PER DRAWING REQUIREMENTS.	RS008861
		SEALANT APPLICATION AT BELLOWS JOINT IS INSPECTED.	RS007002
	FLANGE SEALING SURFACE INTEGRITY	ALL FLANGE SEALING SURFACES ARE INSPECTED FOR SURFACE FINISH, WIDTH, AND LOCATION PER DRAWING REQUIREMENTS.	SEE TABLE L103C-CIL.
		SEAL GROOVE DIMENSIONS ARE VERIFIED ON APPLICABLE JOINT FLANGES PER DRAWING REQUIREMENTS.	SEE TABLE L103C-CIL.
	FLOW RECIRCULATION INHIBITOR		R039124

Component Group:	**Joints**	**Prepared:**	**D. Early**
CIL Item:	**L103C-01**	**Approved:**	**T. Nguyen**
Part Number:	**See Table L103C**	**Approval Date:**	**7/25/00**
Component:	**Hot Gas System Joints**	**Change #:**	**1**
FMEA Item:	**L103C**	**Directive #:**	**CCBD ME3-01-5638**
Failure Mode:	**Leakage.**	**Page:**	**2 of 3**

Failure Causes	Significant Characteristics	Inspection(s) / Test(s)	Document Reference
A	MATERIAL INTEGRITY	FRI MATERIAL INTEGRITY IS VERIFIED PER DRAWING AND SPECIFICATION REQUIREMENTS.	R039124 MB0135-066, RB0135-041. RB0135-036, -042, MB0135-067. RB0135-035 TYPE II, RB0135-031 TYPE C, MB0135-099, -029. RB0120-052, TYPE II.
		FRI INSULATION MATERIAL FILL DENSITY IS VERIFIED PER DRAWING REQUIREMENTS.	R039124
	ASSEMBLY INTEGRITY	FRI INSTALLATION IS VERIFIED PER DRAWING AND SPECIFICATION REQUIREMENTS.	RS007002 RL01030
		EFFECTIVE NOZZLE TUBE PROTRUSION AND COMBUSTION CHAMBER EFFECTIVE NOZZLE GAP IS CONTROLLED PER SPECIFICATION REQUIREMENTS.	RF0001-084
		HOT FIRE TESTING AND ACCEPTANCE TESTING VERIFIES FRI INTEGRITY.	RL00050-04 RL00056-06
	FLIGHT FLOW TESTING	POST-FLIGHT A VISUAL INSPECTION IS PERFORMED TO CHECK FOR EVIDENCE OF DEGRADATION OR FRI PROTRUSION.	OMRSD V41BU0.040
		AFTER MCC TO NOZZLE REPLACEMENT OR JOINT G15 MAINTENANCE THE NOZZLE, EFFECTIVE TUBE PROTRUSION AND EFFECTIVE TUBE GAP ARE VERIFIED PER DRAWING AND SPECIFICATION REQUIREMENTS.	RF0001-084
B	BOLT BOLT BOLT		RD111-4022 RD111-4101 RD111-4105
	BOLT PRELOAD	BOLT AND NUT FINAL TORQUES ARE VERIFIED PER DRAWING REQUIREMENTS.	SEE TABLE L103C-CIL.
		STRETCH BOLT LENGTHS ARE INSPECTED PRIOR TO INSTALLATION PER DRAWING REQUIREMENTS.	SEE TABLE L103C-CIL.
		FINAL STRETCH BOLT LENGTHS ARE VERIFIED PER DRAWING REQUIREMENTS.	SEE TABLE L103C-CIL.
		PROPER LOCK WIRING OF BOLTS IS VERIFIED.	SEE TABLE L103C-CIL.
		NEW SELF-LOCKING NUTS ARE LOT SAMPLE ACCEPTANCE TESTED TO ASSURE BREAK AWAY TORQUES AND LOCKING FEATURES ARE MAINTAINED AFTER MULTIPLE INSTALLATION AND REMOVAL CYCLES.	RB0170-156 RD114-8010
	BOLT LUBRICATION	BOLT DRY-FILM LUBRICATION IS VERIFIED PER DRAWING REQUIREMENTS.	RD111-4022 RD111-4101 RD111-4105
ALL CAUSES	LEAK TESTS	THE ENGINE ASSEMBLY ABOVE THE HEAT SHIELD IS BAGGED AND HELIUM LEAK TESTED WHICH VERIFIES ADEQUATE JOINT SEALING.	RL00712
		ALL JOINTS ARE LEAK TESTED PRIOR TO HOT FIRE.	RL00050-04

Componer up:	Joints	Prepared:	D. Early
CIL Item:	L103C-01	Approved:	T. Nguye.
Part Number:	See Table L103C	Approval Date:	7/25/00
Component:	Hot Gas System Joints	Change #:	1
FMEA Item:	L103C	Directive #:	CCBD ME3-01-5638
Failure Mode:	Leakage.	Page:	3 of 3

Failure Causes	Significant Characteristics	Inspection(s) / Test(s)	Document Reference
ALL CAUSES	LEAK TESTS	ALL INTERCONNECT JOINTS ARE LEAK TESTED AFTER HOT FIRE.	RL00056-06 RL00056-07
		JOINTS ARE LEAK TESTED WHENEVER DISTURBED.	OMRSD V41GEN.565
		ALL ENGINE JOINTS WITHIN THE AFT COMPARTMENT (EXCEPT INSTRUMENTATION AND MCC TO NOZZLE JOINTS) ARE SIGNATURE LEAK TESTED PRIOR TO EACH FLIGHT. CONTINGENCY REQUIREMENTS FOR VIOLATED PROPELLANT JOINTS, AFTER SIGNATURE LEAK TEST, WITH 4 FASTENERS OR LESS ARE BUBBLE SOAP AND MASS SPECTROMETER LEAK TESTED PRIOR TO EACH FLIGHT.	OMRSD S00000.950 OMRSD V41GEN.565 MF0001-003
		MCC TO NOZZLE JOINT IS LEAK TESTED PRIOR TO EACH FLIGHT. (LAST TEST)	OMRSD V41BQ0.200

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 FMEA/CIL
CIL SYSTEM JOINTS

Component Group: Joints
Item Name: Hot Gas System Joints
Item Number: L103C

Prepared: D. Early
Approved: T. Nguyen
Approval Date: 7/25/00
Change #: 1
Directive #: CCBD ME3-01-5638

Joint	Location	Seal Part Number	Seal Part Number Description	Torque or Stretch	Locking Feature	Assembly Drawing
G8.2	OFFSET MOUNT MCC Pc TRANSDUCER LINE RS010760 TO MCC RS009111 BOSS	RD261-3017	PRESSURE ACTUATED - SILVER PLATE OVER GOLD OVER INCO 718	TORQUE	LOCKWIRE	RS007007
OR						
G8.7	REMOTE MOUNT MCC Pc TRANSDUCER LINE RS007371 TO MCC RS009111 BOSS	RD261-3017	PRESSURE ACTUATED - SILVER PLATE OVER GOLD OVER INCO 718	TORQUE	LOCKWIRE	RS007007
G8.2.4	MCC PRESSURE TRANSDUCER RES7001/RE2233 TO OFFSET MOUNT MCC Pc TRANSDUCER LINERS010760	RD261-3017	PRESSURE ACTUATED - SILVER PLATE OVER GOLD OVER INCO 718	TORQUE	LOCKWIRE	RS007007
OR						
G8.7.1	MCC PRESSURE TRANSDUCER RES7001/RE2233 TO REMOTE MOUNT MCC Pc TRANSDUCER LINE RS007371	RD261-3017	PRESSURE ACTUATED - SILVER PLATE OVER GOLD OVER INCO 718	TORQUE	LOCKWIRE	RS007007
G8.3	OFFSET MOUNT MCC Pc TRANSDUCER LINE RS010760 TO MCC RS009111 BOSS CG2CP	RD261-3017	PRESSURE ACTUATED - SILVER PLATE OVER GOLD OVER INCO 718	TORQUE	LOCKWIRE	RS007007
OR						
G8.8	OFFSET MOUNT MCC Pc TRANSDUCER LINE RS010760 TO MCC RS009111 BOSS CG2EP	RD261-3017	PRESSURE ACTUATED - SILVER PLATE OVER GOLD OVER INCO 718	TORQUE	LOCKWIRE	RS007007
G8.3.4	MCC PRESSURE TRANSDUCER RES7001/RE2233 TO OFFSET MOUNT MCC Pc TRANSDUCER LINE RS010760	RD261-3016	PRESSURE ACTUATED - RHODIUM PLATE OVER SILVER OVER GOLD OVER INCO 718.	TORQUE	LOCKWIRE	RS007007
OR						
G8.8.1	MCC PRESSURE TRANSDUCER RES7001/RE2233 TO OFFSET MOUNT MCC Pc TRANSDUCER LINE RS010760	RD261-3017	PRESSURE ACTUATED - SILVER PLATE OVER GOLD OVER INCO 718	TORQUE	LOCKWIRE	RS007007
G9	OPB RS009005 TO SPARK IGNITER RS003685	RD261-3016	PRESSURE ACTUATED - RHODIUM PLATE OVER SILVER OVER GOLD OVER INCO 718.	TORQUE	LOCKWIRE	RS007007
G10	OPB RS009005 TO SPARK IGNITER RS003685	RD261-3016	PRESSURE ACTUATED - RHODIUM PLATE OVER SILVER OVER GOLD OVER INCO 718.	TORQUE	LOCKWIRE	RS007007
G11	FPB RS009021 TO SPARK IGNITER RS003685	RD261-3016	PRESSURE ACTUATED - RHODIUM PLATE OVER SILVER OVER GOLD OVER INCO 718.	TORQUE	LOCKWIRE	RS007007
G12	FPB RS009021 TO SPARK IGNITER RS003685	RD261-3016	PRESSURE ACTUATED - RHODIUM PLATE OVER SILVER OVER GOLD OVER INCO 718.	TORQUE	LOCKWIRE	RS007007

* Unnumbered Component Joint

Joint	Location	Seal Part Number	Seal Part Number Description	Torque or Stretch	Locking Feature	Assembly Drawing
G13	MAIN INJECTOR RS009062 TO SPARK IGNITER RS003685	RD261-3016	PRESSURE ACTUATED - RHODIUM PLATE OVER SILVER OVER GOLD OVER INCO 718.	TORQUE	LKG SLEEVE	RS007007
G14	MAIN INJECTOR RS009062 TO SPARK IGNITER RS003685	RD261-3016	PRESSURE ACTUATED - RHODIUM PLATE OVER SILVER OVER GOLD OVER INCO 718.	TORQUE	LKG SLEEVE	RS007007
G15	MCC RS009101 TO NOZZLE RS009175	RS008861		STRETCH	LOCKWIRE	RS007002

* Unnumbered Component Joint