

**SSME FM CIL  
INSPECTION AND TEST**

Component Group: Ducts and Lines  
 CIL Item: K420-01  
 Part Number: RS007121  
 Component: MFVA Hydraulic Return Manifold  
 FMEA Item: K420, K421, K422  
 Failure Mode: Fails to contain hydraulic fluid.

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

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Failure Causes	Significant Characteristics	Inspection(s) / Test(s)	Document Reference
A	MANIFOLD		RS007121
	FITTING		RS010438
	FLANGE		RS007140
	FLANGE		RS007235
	TEE		RS007149
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER DRAWING REQUIREMENTS.	RS007121 RS010438 RS007140 RS007235 RS007149
		DETAILS ARE PENETRANT INSPECTED PER SPECIFICATION REQUIREMENTS.	RA0115-116
	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 RA0607-094 RA0115-116 RA0115-006 RA1115-001 RA0115-127
	ASSEMBLY INTEGRITY	THE ASSEMBLY IS PROOF PRESSURE TESTED PER DRAWING REQUIREMENTS.	RS007121
	FLIGHT FLOW TESTING	FOLLOWING REPAIR OR REPLACEMENT, AN EXTERNAL LEAK CHECK IS PERFORMED TO REVALIDATE THE SUBSYSTEM.  DURING EXTERNAL INSPECTIONS, THE HYDRAULIC SYSTEM IS VISUALLY INSPECTED FOR LEAKAGE.  DURING AFT CLOSEOUT INSPECTION, ANY EVIDENCE OF PREVIOUS HYDRAULIC LEAKAGE REQUIRES FURTHER DISPOSITION. (LAST TEST)	OMRSD V41GEN.575  OMRSD V41BU0.030  OMRSD V41BU0.070

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: 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 FMEA/CIL**  
**DESIGN**

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Design / Document Reference

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**FAILURE CAUSE: A: Parent material failure or weld failure.**

THE MANIFOLD ASSEMBLY (1) IS MANUFACTURED UTILIZING 321 CRES TUBE AND INCONEL 625 BAR. 321 CRES TUBING WAS SELECTED BECAUSE OF ITS STRENGTH, FABRICABILITY, GENERAL CORROSION RESISTANCE, AND STRESS CORROSION RESISTANCE (2). INCONEL 625 WAS SELECTED FOR ITS WELDABILITY, FORMABILITY, RESISTANCE TO STRESS CORROSION CRACKING, AND CORROSION RESISTANCE (2). INCONEL 625 POSSESSES THE REQUIRED STRENGTH WITHOUT REQUIRING HEAT TREAT. FLANGE, TEE, AND FITTING SECTIONS INCORPORATE RADIUS JOINTS TO REDUCE STRESS CONCENTRATIONS. OFFSET LIMIT REQUIREMENTS ARE ESTABLISHED TO REDUCE STRESS CONCENTRATIONS AND IMPROVE WELD GEOMETRY. TUBING STOCK IS DRAWN TO MAINTAIN SURFACE REGULARITY. INSTALLATION IS CONTROLLED FOR ANGULARITY AND OFFSET PER SPECIFICATION REQUIREMENTS (3). MINIMUM FACTORS OF SAFETY FOR THE MANIFOLD MEET CEI REQUIREMENTS (4). HIGH AND LOW CYCLE FATIGUE LIFE MEET CEI REQUIREMENTS (5). THE MANIFOLD ASSEMBLY HAS COMPLETED PRESSURE CYCLING AND ULTIMATE PRESSURE DVS TESTING (6). THE MANIFOLD ASSEMBLY PARENT MATERIALS WERE CLEARED FOR FRACTURE MECHANICS/NDE FLAW GROWTH, SINCE THEY ARE NOT FRACTURE CRITICAL PARTS (7). TABLE K420 LISTS ALL THE 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. THESE WELDS HAVE BEEN ASSESSED AS ACCEPTABLE FOR FLIGHT BY RISK ASSESSMENT (8).

(1) RS007121; (2) RSS-8582; (3) RA1102-006; (4) RSS-8546, CP320R0003B; (5) RL00532, CP320R0003B; (6) RSS-511-43; (7) NASA TASK 117; (8) RSS-8756

**SSME EA/CIL  
REDUNDANCY SCREEN**

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Phase	Failure / Effect Description	Criticality Hazard Reference
M 4.1	Hydraulic fluid in aft compartment. Loss of return flow to reservoir. External leakage will eventually result in low reservoir level, loss of hydraulic pressure, and engine hydraulic lockup. Loss of mission may result when hydraulic lockup occurs during Max Q throttling.	1R ME-E1P,S,A,M,C,D
Redundancy Screens: LINE 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.		

**SSME FMEA/CIL**  
**WELD JOINTS**

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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	
MANIFOLD	RS007121	1-6,1a,2a	GTAW	I	X	X		