SSME F TA/CIL
REDUNDAN . SCREEN

Component Group:	Fuel Turbopumps	**Prepared:**	F. Cromwell
CIL Item:	B600-10	**Approved:**	T. Nguyen
Part Number:	RS007601	**Approval Date:**	11/1/99
Component:	Low Pressure Fuel Turbopump	**Change #:**	3
FMEA Item:	B600	**Directive #:**	CCBD ME3-01-5248
Failure Mode:	Loss of insulating capability.	**Page:**	1 of 1

Phase	Failure / Effect Description	Critical by Hazard Reference
M 4.'	Insulation leakage may result in the generation of liquid nitrogen (LN2). LN2 impingement on the MFVA RVDT results in RVDT drift. Controller detects error and switches to channel B (servovalve No. 2) when detected by SEII, or by the RVDT comparison test when HPOTP or HPFTP turbine discharge temperatures are outside blueline limits; continuation of failure controller initiates hydraulic lock-up, all actuators. Mission abort may result when hydraulic lockup occurs during Max Q throttling Redundancy Screens: TURBOPUMP 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-G4M

SSME FMEA/CIL
DESIGN

Component Group:	Fuel Turbopumps	Prepared:	F. Cromwell
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Part Number:	RS007601	Approval Date:	11/1/99
Component:	Low Pressure Fuel Turbopump	Change #:	3
FMEA Item:	B600	Directive #:	CCBD ME3-01-5243
Failure Mode:	Loss of insulating capability	Page:	1 of 1

Design / Document Reference

FAILURE CAUSE: A: Insulation damage:
Debonding.
Cracks in Kevlar-resin composite allowing cryopumping.

THE LPFTP HOUSING ASSEMBLY (1) IS INSULATED WITH CO2- BLOWN POLYURETHANE FOAM INSULATION (2), WHICH IS REINFORCED, PROTECTED, AND FULLY ENCAPSULATED BY TWO KEVLAR (3) - POLYURETHANE RESIN (4) COMPOSITE JACKETS (5) AND COVERED WITH FIRE-RETARDANT ALUMINUM TAPE (6). INITIALLY, THE HOUSING IS GRIT BLASTED (7) AND COATED WITH CORROSION-INHIBITING MOLYBDATE PAINT (8). POLYURETHANE RESIN IS THEN USED TO BOND THE KEVLAR INNER JACKET DIRECTLY TO THE HOUSING. THE INNER KEVLAR JACKET IS APPLIED FIRST USING A VACUUM BAG ENCAPSULATION PROCESS TO ASSURE THE JACKET CONFORMS TO ALL THE HOUSING SURFACE CONTOURS DURING THE BONDING PROCESS. THE FOAM IS SELF EXTINGUISHING AND HAS THE REQUIRED MECHANICAL AND THERMAL PROPERTIES. IT IS APPLIED USING A POURABLE FIBERGLASS MOLD OVER THE INNER JACKET. THE OUTER JACKET IS THEN APPLIED AND BONDED TO THE FOAM. LOCALIZED BONDING OF THE INNER AND OUTER JACKET OCCURS AT DESIGNATED TIE-IN AREAS TO ACHIEVE COMPLETE FOAM ENCAPSULATION. THE PROCESS OF JACKET, RESIN, AND FOAM INSTALLATIONS IS GOVERNED BY A STANDARD APPLICATION SPECIFICATION (9). ALUMINUM TAPE IS THEN APPLIED OVER THE OUTER JACKET AS A FIRE RETARDANT. THE MINIMUM FACTORS OF SAFETY FOR INSULATED HOUSING MEET CEI REQUIREMENTS (10). THE LIQUID AIR INSULATION PARENT MATERIALS WERE CLEARED FOR FRACTURE MECHANICS/NDE FLAW GROWTH SINCE THEY CONTAIN NO FRACTURE CRITICAL PARTS. ANY TAPE, KEVLAR, OR INSULATION DAMAGE NOTED IN THE FILED OR AT TURBOPUMP OVERHAUL IS REPAIRED PER STANDARD REPAIR SPECIFICATION (11). THE CONTROLLER SOFTWARE IS CONFIGURED TO DETECT AND RESPOND PROPERLY TO THE FAILURES IDENTIFIED AND COMMAND A SAFE ENGINE STATE (12).

(1) RS007632; RS019864; RS007603 (2) RB0130-128; (3) AMS 3904; (4) RB0120-061 (5) RE2333 (6) L-T-80 (7) RA0110-014 (8) RB0125-009, RA1608-010 (9) RA1106-015, (10) RSS-8546 CP320R0003B. (11) RF00D1-079. (12) CP406R0002PT 1 3.2.3:6.1 3.3.2 3:6.1.4

SSME FMEA/CIL
INSPECTION AND TEST

Component Group:	Fuel Turbopumps	Prepared:	F. Cromwell
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Failure Mode:	**Loss of insulating capability.**	Page:	1 of 1

Failure Causes	Significant Characteristics	Inspection(s) / Test(s)	Document Reference
A	HOUSING ASSEMBLY MANIFOLD VOLUTE KEVLAR JACKETS		RS007632 RS007603 R0019864 RE2333
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RB0125-009 AMS 3904 RBC120-061 RBC130-128 L-T-80
	ASSEMBLY INTEGRITY	GRIT BLASTING, PAINTING, AND INSULATION SYSTEM ARE MADE PER SPECIFICATION REQUIREMENTS.	RA0110-014 RA*608-010 RA*135-015
	LPFTP		RS007601
	ASSEMBLY INTEGRITY	THE PUMP SUBASSEMBLIES ARE INSPECTED DURING OVERHAUL PER SPECIFICATION REQUIREMENTS. INSPECTIONS INCLUDE VISUAL DIMENSIONAL, PENETRANT, AND REPLACEMENT OF USAGE ITEMS AS APPLICABLE, PER OVERHAUL CLASSIFICATION.	RL00531 RA0115-116
		OPERATION/PERFORMANCE IS VERIFIED BY ENGINE HOT-FIRE TESTING AND 2ND E & M TESTS ON INSPECTIONS.	RL00050-04 RL00056-06 RL00056-07 RL00451
		AFT CLOSEOUT INSPECTION IS PERFORMED PRIOR TO EACH FLIGHT.	OMRSD V41BU0.070
		AN EXTERNAL VISUAL INSPECTION IS PERFORMED EACH FLIGHT	OMRSD V41BU0.030
		DATA FROM PREVIOUS FLIGHT OR HOT-FIRE IS REVIEWED FOR PROPER TURBOPUMP OPERATION/PERFORMANCE. (LAST TEST)	MSFC PLN 1228

Failure History: Comprehensive failure history data is maintained in the Problem Reporting database (PRAMS/PRACA)
Reference: NASA letter SA21/88/308 and Rocketdyne letter 88RC0976!

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 F A/CIL
LD JOINTS

Component Group: Fuel Turbopumps
CIL Item: B600
Part Number: RS007601
Component: Low Pressure Fuel Turbopump
FMEA Item: B600

Prepared: P. Cromwell
Approved: T. Nguyen
Approval Date: 11/1/99
Change #: 2
Directive #: CCBD ME3-01-5248
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Component	Basic Part Number	Weld Number	Weld Type	Class	Root Side Not Access	Critical Initial Flaw Size Not Detectable HCF	LCF	Comments
MANIFOLD	RS007603	1	EBW	Ia	X			
MANIFOLD	RS007603	2	GTAW	I				
MANIFOLD	RS007603	5,8,10	GTAW	II	X	X		
MANIFOLD	RS007603	9,10	GTAW	II	X			
MANIFOLD	RS007603	13	GTAW	I				
MANIFOLD	RS007603	17	EBW	II	X	X	X	
MANIFOLD	RS007603	18	GTAW	I	X	X	X	

SSME FMEA/CIL

FIELD CONFIGURATION VARIANCES FROM CIL RATIONALE

Component Group: Fuel Turbopumps
Item Name: Low Pressure Fuel Turbopump
Item Number: B600
Part Number: RS007601

Prepared: F. Cromwell
Approved: T. Nguyen
Approval Date: 11/1/99
Change #: 3
Directive #: CCBD ME3-01-5248

Base Line Rationale	Variance	Change Rationale	Variant Dash Number
1. B600-05: RS007605, RS007606; CAUSE A. THE INNER AND OUTER BEARING RINGS ARE EDDY CURRENT INSPECTED PER RA1615-034.	BEARING RINGS RECEIVED FROM SUPPLIER SPLIT BALL BEARING INCORPORATED RECEIVED NO GENERAL EDDY CURRENT INSPECTION.	GENERAL EDDY CURRENT INSPECTION OF RINGS REPLACES TYPE IVC IN PENETRANT INSPECTION IN DETECTING SURFACE FLAWS. USE AS IS RATIONALE: 1 RINGS ARE SUPPLIED BY SPLIT BALL BEARING INCORPORATED RECEIVED 10X VISUAL AND TYPE IVC PENETRANT INSPECTION INSTEAD OF GENERAL EDDY CURRENT INSPECTION. FLAW DETECTABILITY RELIABILITY LEVELS BETWEEN PENETRANT AND GENERAL EDDY CURRENT INSPECTIONS ARE 0.060 AND 0.057 RESPECTIVELY	SEE DAR 2745 FOR VARIANT PART SERIAL NUMBERS
2. B600-10. THE HOUSING INSULATION IS PROTECTED BY A KEVLAR COMPOSITE SURFACE WITH L-T-80 FIRE RETARDANT ALUMINUM TAPE APPLIED TO THE KEVLAR SURFACE	CERTAIN FLIGHT HOUSINGS HAVE NICKEL PLATED INSULATION WITH COPPER PLATED TIE-IN AREAS.	THE BLOCK I AND PHASE II HAVE NICKEL PLATING TO PROTECT THE INSULATION FROM MECHANICAL DAMAGE AND PROVIDE A MOISTURE BARRIER. THE HOUSING IS COPPER PLATED AT THE INSULATION CLOSE-OUT AREAS TO IMPROVE THE NICKEL BOND. THE MINIMUM FACTORS OF SAFETY FOR THE INSULATED HOUSING MEET C.E.I. REQUIREMENTS. DAR 2068 ADDRESSES THE TIME CONSTRAINTS FOR NICKEL PLATED INSULATION WITH COPPER PLATED TIE-IN CONFIGURATIONS.	RS007632-121, -131, -231, -21*
3. B600-05. THE BALLS ARE POSITIONED BY AN FEP COATED ARMALON CAGE. FEP COATING ON CAGES USED TO REDUCE POCKET AND BALL WEAR THUS INCREASING BEARING LIFE.	BLOCK I AND PHASE II PUMPS DO NOT HAVE FEP COATED CAGES.	BLOCK I AND PHASE II CAGES HAVE TEFLON CONTAINED IN THE FIBERGLASS CAGE THAT PROVIDES BEARING LUBRICATION.	RS007605-027 RS007606-007, -025
4. B600-01. BLOCK II NOZZLE ASSEMBLY ALLOWS A MINIMUM OF 12 OF THE 43 NOZZLE PASSAGES TO BE BLOCKED.	BLOCK I PHASE II NOZZLE ASSEMBLY ALLOWS A MINIMUM OF 16 OF THE 43 NOZZLE PASSAGES TO BE BLOCKED	THE BLOCK I PHASE II NOZZLE ASSEMBLY DOES NOT VIOLATE THE REQUIREMENTS OF THE BLOCK II NOZZLE ASSEMBLY. BLOCK I PHASE II NOZZLE MEETS CEI NOZZLE VANE REQUIREMENTS.	R0019780-091
5. B600-02. CAUSE B,C THE SECOND STAGE ROTOR BRAZE JOINT INTEGRITY IS ULTRASONIC INSPECTED PER DRAWING REQUIREMENTS.	CERTAIN SECOND STAGE ROTORS RECEIVED NO ULTRASONIC INSPECTION OF THE BRAZE JOINT.	THE BRAZE JOINTS OF ALL SECOND STAGE ROTORS HAVE RECEIVED A VISUAL AND PENETRANT INSPECTION. ALL PARTS SUSPECTED TO HAVE BRAZE JOINT ANOMALIES HAVE BEEN ADDRESSED.	RS007625-031
6. B600-02. CAUSE D NOZZLE COPPER PLATING ADHESION IS VERIFIED PER DRAWING REQUIREMENTS.	CERTAIN NOZZLES DID NOT RECEIVE A BAKE TEST.	ADHESION BAKE TEST IS NOT REQUIRED FOR NOZZLES WHICH HAVE BEEN PREVIOUSLY HOT FIRE TESTED. THE HOT FIRE ENVIRONMENT ADEQUATELY VERIFIES THE COPPER PLATING ADHESION INTEGRITY.	RS007622-025 R0019783-023
7. B600-02. CAUSE E. THE STATOR COPPER PLATING ADHESION IS VERIFIED PER DRAWING REQUIREMENTS	CERTAIN STATORS DID NOT RECEIVE A BAKE TEST.	ADHESION BAKE TEST IS NOT REQUIRED FOR STATORS WHICH HAVE BEEN PREVIOUSLY HOT FIRE TESTED. THE HOT FIRE ENVIRONMENT ADEQUATELY VERIFIES THE COPPER PLATING ADHESION INTEGRITY	RS007623-031