SSME FMEA/CIL
REDUNDANCY SCREEN

Component Group:	Combustion Devices	Prepared:	A. Kay
CIL Item:	A055-01	Approved:	T. Nguyen
Part Number:	R0018001	Approval Date:	9/9/99
Component:	Powerhead (Phase II+)	Change #:	1
FMEA Item:	A055	Directive #:	CCBD ME3-01-5238
Failure Mode:	Preburner liner failure.	Page:	1 of 1

Phase	Failure / Effect Description	Criticality Hazard Reference
SMC 4.1	Preburner liner failure results in loss of coolant and faceplate erosion. Erosion generated injector debris punctures nozzle coolant tubes. Tearing of liner restricts turbine discharge flow. Nozzle damage and turbine discharge restrictions result in increased turbine temperatures. Liner failure may result in heat exchanger coil failure or LOX post fracture. Loss of vehicle Redundancy Screens: SINGLE POINT FAILURE: N/A	1 ME-FB1S,A,M,C ME-FC1A,C, ME-FC1S,M, ME-FD1A,C, ME-FD1S,M

SSME FMEA/CIL
DESIGN

Component Group:	Combustion Devices	Prepared:	A. Kay
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Design / Document Reference

FAILURE CAUSE: A: Preburner liner/extension or weld parent material failure.

THE PREBURNER LINER ASSEMBLIES (1) IS A WELDMENT OF HAYNES 188 FORGING (2) AND HAYNES 188 SHEET METAL COMPONENTS (3). HAYNES 188 WAS SELECTED ON THE BASIS OF ITS STRENGTH AT HIGH TEMPERATURES, RESISTANCE TO CREEP AND ITS RESISTANCE TO HYDROGEN ENVIRONMENT EMBRITTLEMENT (4). THE CYLINDRICAL LINER FORMS AN ANNULUS WHEN INSTALLED IN THE PREBURNER BODY (5) THE LINER IS WELDED TO A HAYNES 188 EXTENSION (6). THE EXTENSION DESIGN INCORPORATES A SERIES OF MACHINED RECESSES IN A LIP WHICH INTERFACES WITH A SIMILAR LAND ON THE PREBURNER BODY. THE SERIES OF RECESSES CONTROL HYDROGEN COOLANT FLOW WHICH ORIGINATES FROM THE ORIFICED PREBURNER CHAMBER (5). THE HYDROGEN COOLANT IS DISCHARGED AT THE LOWER END OF THE LINER/PREBURNER BODY INTERFACE TO THE HOT-GAS SUPPLY FOR THE TURBINES. THE INNER DIAMETER OF THE LINER FORMS A DUCT WHICH DIRECTS HOT-GAS TO THE TURBINE ENTRANCES. HYDROGEN BOUNDARY LAYER COOLANT IS PROVIDED TO THE HOT-GAS SIDE OF THE LINER BY A PARALLEL SERIES OF ORIFICES MACHINED IN THE INJECTOR FACEPLATE (7) THE DIVERGENT SECTION OF THE LINER IS FURTHER HEAT PROTECTED BY A THERMAL COATING (8) THE THERMAL COATING, IN CONJUNCTION WITH THE HYDROGEN BOUNDARY LAYER COOLANT, PROVIDE ADEQUATE PROTECTION AGAINST THE HOT-GAS ENVIRONMENT.

(1) R0017428 R0011582; (2) AMS 5772; (3) AMS 5608; (4) RSS-8581-10; (5) R0017426 R0018067; (6) R0017439 R0014554. (7) R0017424, R0017423; (8) RA0109-018, RA0109-019, RA0109-020

FAILURE CAUSE: B: Preburner liner retention system failure due to multiple failure of liner retention straps..

THE PREBURNER LINER ASSEMBLIES ARE RETAINED IN THE PREBURNER BODIES BY A SYSTEM OF EQUALLY SPACED RECTANGULAR HAYNES 188 STRIPS (1). HAYNES 188 WAS SELECTED ON THE BASIS OF ITS STRENGTH, RESISTANCE TO CREEP, AND HIGH CYCLE FATIGUE PROPERTIES (2). THE STRIPS ARE TIG WELDED AT ONE END TO THE INNER DIAMETER OF THE PREBURNER BODY. THE OPPOSITE END IS TIG WELDED TO THE OUTER DIAMETER OF THE LINER. BOTH ENDS OF THE LINER STRIPS INCORPORATE MACHINED RADII TO ATTENUATE HIGH CYCLE FATIGUE EFFECTS

(1) RS009015 R0011582, R0017429 (2) RSS-8581-10

FAILURE CAUSE: ALL CAUSES

THE ANALYSIS FOR HIGH AND LOW CYCLE FATIGUE FOR THE PREBURNER LINER RETENTION SYSTEM MEETS CEI REQUIREMENTS AND MINIMUM REQUIREMENTS FOR FACTORS OF SAFETY. TABLE A055 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 FLIGHT BY RISK ASSESSMENT (1). THE POWERHEAD ASSEMBLY HAS COMPLETED DVR TESTING (2). CONTINUED USE WITH ALLOWABLE DISCREPANCIES RESULTING FROM OPERATION IS EVALUATED AND CONTROLLED PER THE REQUIREMENTS OF THE MAINTENANCE CONTROL DOCUMENT (3).

(1) RSS-8756 (2) RSS 8879 1; (3) RSS-8793

SSME HM[illegible] CIL
INSPECTION AND TEST

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Component:	Powerhead (Phase II+)	Change #:	1
FMEA Item:	A055	Directive #:	CCBD ME3-01-5238
Failure Mode:	Preburner liner failure.	Page:	1 of 2

Failure Causes	Significant Characteristics	Inspection(s) / Test(s)	Document Reference
A	FUEL PREBURNER LINER ASSY		R0017428
	LINER EXTENSION		R0017429
	OXIDIZER PREBURNER LINER ASSY		R0011582
	METERING RING		R0014G54
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER DRAWING AND SPECIFICATION REQUIREMENTS.	AMS 5608 AMS 5772
		PREBURNER LINER FORGINGS ARE ULTRASONIC AND PENETRANT INSPECTED PER SPECIFICATION REQUIREMENTS	RA0115-012 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 RA[illegible]07-07 RA0115-116 RA0115-005 RA0115-127 RA1115-007
	SURFACE FINISH	LINER THERMAL COATING IS APPLIED PER SPECIFICATION REQUIREMENTS.	RA0109-018 RA0109-019 RA0109-020
B	LINER STRIP LINER STRIP LINER STRIP		RS009015 R0017428 R0011582
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER DRAWING AND SPECIFICATION REQUIREMENTS.	AMS 5609
	ASSEMBLY INTEGRITY	WELDING GEOMETRY OF STRIPS IS CONTROLLED PER DRAWING REQUIREMENTS.	R0018001
ALL CAUSES		THE PREBURNER LINER TO EXTENSION WELD 50 IS VISUALLY INSPECTED FOR DAMAGE PER TIME/CYCLE REQUIREMENTS.	OMRSD V41BU0.037 OMRSD S00BA0.015
		THE LINER ASSEMBLIES ARE VISUALLY INSPECTED FOR DAMAGE AFTER EVERY FLIGHT AND EACH TIME THE PUMP IS REMOVED.	OMRSD V41BU0.040 OMRSD V41BU0.051C OMRSD V41BU0.051D OMRSD V41BU0.052D

Component Group:	Combustion Devices
CIL Item:	A055-01
Part Number:	R0018001
Component:	Powerhead (Phase II+)
FMEA Item:	A055
Failure Mode:	Preburner liner failure.

Approved:	T. Nguyen
Approval Date:	9/9/99
Change #:	1
Directive #:	CCBD ME3 01-5238
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Failure Causes	Significant Characteristics	Inspection(s) / Test(s)	Document Reference
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:	Not Applicable.		

SSME FEA/CIL
WELD JOINTS

Component Group: Combustion Devices
CIL Item: A056
Component: R0018001
Part Number: Powerhead (Phase II+)
A055

Prepared: A. Kay
Approved: T. Nguyen
Approval Date: 9/9/99
Change #: 3
Directive #: CCBD ME3-01-5238

Component	Basic Part Number	Weld Number	Weld Type	Class	Root Side Not Access	Critical Initial Flaw Size Not Detectable HCF	LCF	Comments
OXIDIZER PREBURNER LINER	R0011582	1(OPT)	EBW	I		X		
OXIDIZER PREBURNER LINER	R0011582	1(OPT)	GTAW	I		X		
OXIDIZER PREBURNER LINER	R0011582	2(OPT)	EBW	I		X		
OXIDIZER PREBURNER LINER	R0011582	2(OPT)	GTAW	I		X		
FUEL PREBURNER LINER	R0017428	1	GTAW OR EBW	I				
FUEL PREBURNER LINER	R0017428	2	GTAW OR EBW	I				
POWERHEAD	R0018001	1	GTAW	I	X	X	X	
POWERHEAD	R0018001	3	GTAW	I	X	X	X	
POWERHEAD	R0018001	5	GTAW	I		X		
POWERHEAD	R0018001	6	GTAW	I				
POWERHEAD	R0018001	7	GTAW	I	X			
POWERHEAD	R0018001	8	GTAW	I	X	X	X	
POWERHEAD	R0018001	9	GTAW	I	X	X	X	
POWERHEAD	R0018001	10	GTAW	I	X	X	X	
POWERHEAD	R0018001	11	GTAW	I	X	X	X	
POWERHEAD	R0018001	12	GTAW	I	X	X	X	
POWERHEAD	R0018001	13	GTAW	I	X	X		
POWERHEAD	R0018001	16	GTAW	II	X			
POWERHEAD	R0018001	17-24	GTAW	II	X	X		
POWERHEAD	R0018001	25	GTAW	II	X			
POWERHEAD	R0018001	26-29	GTAW	II	X			
POWERHEAD	R0018001	50	GTAW	II	X		X	
POWERHEAD	R0018001	51-52	EBW/GTAW	NONE/II	X	X	X	
POWERHEAD	R0018001	53	GTAW	I				
POWERHEAD	R0018001	54	GTAW	I				
FPB FUEL SUPPLY DUCT	R0018002	1	GTAW	I				
FPB FUEL SUPPLY DUCT	R0018002	2	GTAW	I	X			
FPB FUEL SUPPLY DUCT	R0018002	3	GTAW	I		X		
FPB FUEL SUPPLY DUCT	R0018002	4	GTAW	I	X	X	X	
FPB FUEL SUPPLY DUCT	R0018002	5	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
FPB FUEL SUPPLY DUCT	R0018002	6	GTAW	I		X	X	
PREBURNER FUEL SUPPLY DUCT	R0018004	1	GTAW	I				
PREBURNER FUEL SUPPLY DUCT	R0018004	2	GTAW	I				
HGM COOLANT SUPPLY DUCT	R0018011	1	GTAW	I				
HGM COOLANT SUPPLY DUCT	R0018011	2	GTAW	I				
HOT GAS MANIFOLD	R0018020	1	EBW	NONE	X	X		
HOT GAS MANIFOLD	R0018020	2	EBW	NONE	X	X	X	
HOT GAS MANIFOLD	R0018020	3	EBW	II	X	X	X	
HOT GAS MANIFOLD	R0018020	4	EBW	II	X	X	X	
HOT GAS MANIFOLD	R0018020	5	EBW	NONE	X	X		
HOT GAS MANIFOLD	R0018020	6	EBW	NONE	X	X	X	
HOT GAS MANIFOLD	R0018020	7	EBW	II	X	X	X	
HOT GAS MANIFOLD	R0018020	8	EBW	II	X	X	X	
HOT GAS MANIFOLD	R0018020	9-10	EBW	I		X	X	
HOT GAS MANIFOLD	R0018020 R0018022 R039051	13&59,2,3	GTAW	I II	X	X		
HOT GAS MANIFOLD	R0018020	16	GTAW/EBW	II	X	X	X	
HOT GAS MANIFOLD	R0018020	17	EBW	Ib			X	
HOT GAS MANIFOLD	R0018020	18&57	GTAW	I	X	X	X	
HOT GAS MANIFOLD	R0018020	53	GTAW	I	X	X		
HOT GAS MANIFOLD	R0018020	56	GTAW	I	X	X	X	
HOT GAS MANIFOLD	R0018020	58	GTAW	I	X	X	X	
HOT GAS MANIFOLD	R0018020	61	GTAW	I	X	X	X	
FUEL HALF SHELL HGM	R0018021	1&7	EBW/GTAW	I	X	X		
FUEL HALF SHELL HGM	R0018021	3	GTAW	I				
FUEL HALF SHELL HGM	R0018021	4	EBW	I				
FUEL HALF SHELL HGM	R0018021	5	EBW	I	X			
OXIDIZER HALF SHELL HGM	R0018022	6	EBW	I		X	X	
HOT GAS MANIFOLD	R0018020	62	GTAW	1	X	X	X	

SSME FMEA/CIL
FIELD CONFIGURATION VARIANCES FROM CIL RATIONALE

Component Group: Combustion Devices
Item Name: Powerhead (Phase II+)
Item Number: A056
Part Number: R0018001

Prepared: A. Kay
Approved: T. Nguyen
Approval Date: 9/9/99
Change #: 7
Directive #: CCBD ME3-01-5236

Base Line Rationale	Variance	Change Rationale	Variant Dash Number
1. R0018011-11 INCORPORATES COMBINED DETAILS ELIMINATING 10 WELD JOINTS.	POWERHEAD CONFIGURATIONS EXIST WITH FABRICATED COOLANT DUCT SUB ASSEMBLIES REQUIRING ADDITIONAL WELD JOINTS	IMPROVED HARDWARE RELIABILITY DUE TO THE ELIMINATION OF 10 WELD JOINTS. CEI REQUIREMENTS ARE MAINTAINED.	R0018011-1 R0018012-1 R0018013-1 R0018001-681, -701, -731, -991, -1051.
2. A056-03: NO RATIONALE EFFECTED.	POWERHEADS EXIST UTILIZING THE COMBINED FOUR ZONE PROOF PRESSURE TEST FROM THE HOT GAS MANIFOLD. CEI REQUIREMENTS ARE MAINTAINED.	HOT GAS MANIFOLD PROOF PRESSURE TEST ACCOMPLISHED SEPARATELY PRIOR TO COOLANT DUCT AND MAIN INJECTOR INSTALLATION.	R0018001-681, -701, -731, -991, -1051.