SSME F A/CIL
REDUNDANC / SCREEN

Component Group:	Combustion Devices	Prepared:	A. Kay
CIL Item:	A155-02	Approved:	T. Nguyen
Part Number:	RD39080	Approval Date:	9/9/99
Component:	Single Tube Heat Exchanger (Phase II+)	Change #:	1
FMEA Item:	A155	Directive #:	CCBD ME3-91-5238
Failure Mode:	Inlet, bypass line, or outlet rupture.	Page:	1 of 1

Phase	Failure / Effect Description	Critical Ity Hazard Reference
SMC 4.1	The oxidizer would leak out of the fracture external to the STINEX coil. Potential coil collapse and failure resulting in hot gas entering the pressurant system. Overpressurization of aft compartment. Loss of vehicle. Redundancy Screens: SINGLE POINT FAILURE: N/A	1 ME-FB2S, ME-FB3A,C,M ME-FG5S,A,M,C

SSME FMEA/CIL
DESIGN

Component Group:	Combustion Devices	Prepared:	A. Kay
CIL Item:	A155-02	Approved:	T. Nguyen
Part Number:	R039060	Approval Date:	9/9/99
Component:	Single Tube Heat Exchanger (Phase II+)	Change #:	1
FMEA Item:	A155	Directive #:	CCBD ME3-01-6239
Failure Mode:	Inlet, bypass line, or outlet rupture.	Page:	1 of 1

Design / Document Reference

FAILURE CAUSE: A: Weld or parent material fracture.

THE INLET MANIFOLD (1) OUTLET MIXER (2) AND BYPASS LINE ASSEMBLY (3) ARE MADE FROM HAYNES 188. HAYNES WAS CHOSEN FOR ITS WELDABILITY AND STRENGTH AT CRYOGENIC AND ELEVATED TEMPERATURES. THE ALLOY HAS BEEN TESTED IN OXYGEN AND FOUND TO BE SATISFACTORY (4). THE HEAT EXCHANGER OUTLET DUCT (5) IS FABRICATED FROM INCONEL 625 NICKEL BASED ALLOY. INCONEL 625 WAS SELECTED FOR STRENGTH, DUCTILITY, OXYGEN COMPATIBILITY, AND WELDABILITY (6). PRIMARY STRESS FACTORS OF SAFETY MET CEI REQUIREMENTS (7). HIGH CYCLE AND LOW CYCLE FATIGUE ANALYSIS SHOWS THAT CEI LIFE REQUIREMENTS ARE MET (8). THE PARENT MATERIAL OF THE INLET MANIFOLD, OUTLET MIXER, BYPASS LINE ASSEMBLY, AND OUTLET DUCT WAS CLEARED FOR FRACTURE MECHANICS/NDE FLAW GROWTH SINCE THEY CONTAIN NO FRACTURE CRITICAL PARTS (9). THE FMEA/CIL WELDS ARE CLEARED FOR FRACTURE MECHANICS/NDE FLAW GROWTH BY THE WELD ASSESSMENT (10). TABLE A155 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 ACCESSIBLE FOR INSPECTION. THOSE WELDS IN WHICH THE CRITICAL INITIAL FLAW SIZE IS NOT DETECTABLE ARE ACCEPTABLE FOR FLIGHT BY RISK ASSESSMENT (10).

(1) R039062; (2) R039053 (3) R039054; (4) RSS-8581-10; (5) R0018008; (6) RSS-8581-10 (7) RSS-8548, CP320R00038; (8) RL00532, CP320R00030; (9) NASA TASK 117; (10) RSS-8756

SSME FMI CIL
INSPECTION AND TEST

Component Group:	Combustion Devices	**Prepared:**	A. Kay
CIL Item:	A155-02	**Approved:**	T. Nguyen
Part Number	R039060	**Approval Date:**	9/9/99
Component:	Single Tube Heat Exchanger (Phase II+)	**Change #:**	1
FMEA Item:	A155	**Directive #:**	CCBD ME3-01-5238
Failure Mode:	Inlet, bypass line, or outlet rupture.	**Page:**	1 of 2

Failure Causes	Significant Characteristics	Inspection(s) / Test(s)	Document Reference
A	INLET MANIFOLD OUTLET MIXER BYPASS LINE ASSEMBLY DUCT, PRESSURANT FLANGE POWERHEAD ASSEMBLY		R039052 R039053 R039054 R039055 R039056 R0019001
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER DRAWING AND SPECIFICATION REQUIREMENTS.	RB0170-214 AMS 5772 RB0170-153 RB0170-213
		BYPASS LINE DETAILS ARE PENETRANT INSPECTED PER SPECIFICATION REQUIREMENTS PRIOR TO USE.	RA0115-116
		OUTLET DUCT DETAILS ARE PENETRANT INSPECTED PER SPECIFICATION REQUIREMENTS	
		TUBING IS ULTRASONICALLY INSPECTED PER MATERIAL SPECIFICATION REQUIREMENTS	RB0170-214 RA0115-124
	HEAT TREAT	BYPASS SYSTEM DETAILS ARE HEAT TREATED PER DRAWING AND SPECIFICATION REQUIREMENTS.	RA0611-018
		PRESSURANT OUTLET DUCT IS ANNEALED AND HEAT TREATED PER DRAWING AND SPECIFICATION REQUIREMENTS.	
		PRESSURANT DUCT FLANGE IS ANNEALED AND HEAT TREATED PER DRAWING AND SPECIFICATION REQUIREMENTS.	RA0611-020
	WELD INTEGRITY	ALL WELDS ARE INSPECTED TO DRAWING AND SPECIFICATION REQUIREMENTS PER WELD CLASS. INSPECTIONS INCLUDE: VISUAL, DIMENSIONAL, PENETRANT, RADIOGRAPHIC, AND FILLER MATERIAL, AS APPLICABLE.	RL10011 RA0115-116 RA0115-328
		BYPASS LINE ASSEMBLY TUBE WELDS ARE BORESCOPE INSPECTED AFTER FABRICATION PER DRAWING AND SPECIFICATION REQUIREMENTS.	R039054 RL10011
		THE FABRICATED BYPASS SYSTEM (INLET MANIFOLD, BYPASS LINE ASSEMBLY, OUTLET MIXER, AND PRESSURANT DUCT) IS PROOF TESTED PER DRAWING AND SPECIFICATION REQUIREMENTS (PROOF TEST).	R039060 RL10055
		A HELIUM LEAK TEST IS PERFORMED ON THE INLET MANIFOLD, OUTLET MIXER, PRESSURANT DUCT, COIL ASSEMBLY, AND BYPASS LINE ASSEMBLY AFTER FABRICATION.	RA0115-105
		THE INLET MANIFOLD AND OUTLET MIXER ARE CLEANED TO SPECIFICATION REQUIREMENTS	R039052 R039053 RL10001
	ASSEMBLY INTEGRITY	THE HOT FIRE TESTING AND 2ND E & M INSPECTIONS VERIFY ASSEMBLY INTEGRITY.	RL00052-04 RL00056-05 RL00056-07

Component Group:	Combustion Devices	Prepared:	[illegible]
CIL Item:	A155-02	Approved:	T. Nguyen
Part Number:	R039060	Approval Date:	8/9/99
Component:	Single Tube Heat Exchanger (Phase II+)	Change #:	1
FMEA Item:	A155	Directive #:	CCBD ME3-01-5238
Failure Mode:	Inlet, bypass line, or outlet rupture.	Page:	2 of 2

Failure Causes	Significant Characteristics	Inspection(s) / Test(s)	Document Reference
A	ASSEMBLY INTEGRITY	AN EXTERNAL LEAK CHECK OF GOX HEAT EXCHANGER JOINTS IS PERFORMED PRIOR TO EACH FLIGHT.	OMRSD V41BP0.020
		BYPASS LINE TUBING IS INSPECTED FOR DAMAGE PER TIME/CYCLE REQUIREMENTS.	RLC1065 OMRSD V41BU0.125
		HEAT EXCHANGER ASSEMBLY IS LEAK TESTED PRIOR TO EACH FLIGHT (LAST TEST).	OMRSD V41BP0.020

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

WELD JOINTS

Component Group: Combustion Devices
CIL Item: A155
Component: R039060
Part Number: Single Tube Heat Exchanger (Phase II+)
A155

Prepared: A. Kay
Approved: T. Nguyen
Approval Date: 9/9/99
Change #: 1
Directive #: CCBD ME3-01-S238
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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
STHEX COIL ASSEMBLY	R039040	1	EBW	I				
STHEX COIL ASSEMBLY	R039040	2	EBW	I				
STHEX BRACKETS	R039045	1-2	GTAW	II	X			
STHEX BRACKETS	R039045	3-4	GTAW	II	X			
STHEX BRACKETS	R039045	9-10	GTAW	II	X			
STHEX LOWER LINER	R039047	*	EBW	II	X	X	X	
STHEX LOWER LINER	R039050	*-11	GTAW	II	X	X	X	
STHEX LOWER LINER	R039050	156	GTAW	I				
STHEX LOWER LINER	R039050	157	GTAW	I				
STHEX LOWER LINER	R039050	12-139, 158-173	GTAW	II	X			
STHEX LOWER LINER	R039050	140-147, 148-155	GTAW	I	X			
STHEX STRUCTURAL SHELL	R039051	5	EBW	I				
STHEX BYPASS LINE	R039054	1 2	GTAW	I				
STHEX OXID TANK PRESSURANT	R039060,R039051	1,*						
STHEX OXID TANK PRESSURANT	R039060	2	GTAW	II	X	X		
STHEX OXID TANK PRESSURANT	R039060,R039051	3,	GTAW	II	X	X	X	
STHEX OXID TANK PRESSURANT	R039060,R039051	4,	GTAW	II	X	X	X	

SSME CA/CIL
FIELD CONFIGURATION VARIANCES FROM CIL RATIONALE

Component Group: Combustion Devices
Item Name: Single Tube Heat Exchanger (Phase II+)
Item Number: A155
Part Number: R039050

Prepared: A. Kay
Approved: T. Nguyen
Approval Date: 9/9/99
Change #: 1
Directive #: CCBD ME3-C1-5238

	Base Line Rationale	Variance	Change Rationale	Variant Dash Number
1	NO RATIONALE EFFECTED	CUTBACK TURNING VANE MODIFICATION EXISTS ON ONE POWERHEAD ASSEMBLY.	CUTBACK DESIGN WAS IMPLEMENTED TO STOP CRACKING OBSERVED WHEN ATD HPOTP WAS USED. USE AS IS RATIONALE:	R008584-025
2	NO RATIONALE EFFECTED	R039051 WELDS 3 & 4 EXIST ON 5 POWERHEAD ASSEMBLIES.	STRUCTURAL ANALYSIS SHOWS NO HFF PROTECTION REQUIRED	R039051-11