SSME FMEA/CIL
REDUNDANCY SCREEN

Component Group:	**Ducts and Lines**	**Prepared:**	**D. Early**
CIL Item:	**K204-02**	**Approved:**	**T. Nguyen**
Part Number:	**RS007016**	**Approval Date:**	**7/25/00**
Component:	**Oxidizer Tank Pressurant Duct**	**Change #:**	**1**
FMEA Item:	**K204**	**Directive #:**	**CCBD ME3-01-5638**
Failure Mode:	**Internal structural failure.**		
		Page:	**1 of 1**

Phase	Failure / Effect Description	Criticality Hazard Reference
SMC 4.1	Fire from LOX impact or rubbing. Loss of vehicle. Redundancy Screens: SINGLE POINT FAILURE: N/A	1 ME-C3S, ME-C3M, ME-C3A,C

SSME FMEA/CIL
DESIGN

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Design / Document Reference

FAILURE CAUSE: A: Structural failure of: Stabilizer, Inlet sleeve, Outlet sleeve, Filters.

THE STABILIZER AND SLEEVES (1) ARE MANUFACTURED UTILIZING INCONEL 718. INCONEL 718 WAS SELECTED FOR ITS HIGH TEMPERATURE STRENGTH, RESISTANCE TO STRESS CORROSION, CORROSION RESISTANCE, HIGH/LOW CYCLE FATIGUE CHARACTERISTICS, AND WELDABILITY (2). THE FILTER ASSEMBLY (3) IS MANUFACTURED UTILIZING 316L CRES AND WAS SELECTED BECAUSE OF ITS STRENGTH (2). MATERIALS ARE HEAT TREATED TO DEVELOP FULL MATERIAL STRENGTH AND HARDNESS (2). ALL MATERIALS USED IN THE DUCT FABRICATION ARE LOX COMPATIBLE (2). INSTALLATION IS CONTROLLED FOR ANGULARITY AND OFFSET (4). MATING ROTATIONAL SURFACES HAVE TIGHT TOLERANCE CONTROLS TO INCREASE SURFACE CONTACT AREA WHICH REDUCES GALLING, STRESS RISERS, AND OFFSET LOADING. TOLERANCE CONTROLS ALSO DECREASE LUBRICANT WEAR, INCREASING LIFE. DRY-FILM LUBRICANT IS USED TO REDUCE FRICTION, GALLING, AND PARTICLE GENERATION. INTERNAL STABILIZERS REDUCE TURBULENCE OVER THE BELLOWS ASSEMBLY AND PROVIDES LAMINAR FLOW WHICH INHIBITS FLOW INDUCED VIBRATION. VENT HOLES ARE MANUFACTURED IN THE STABILIZERS TO EQUALIZE PRESSURE ACROSS THE SURFACE. SCREENS KEEP CONTAMINATION FROM COLLECTING IN THE CONVOLUTION AREA IN ADDITION TO EQUALIZING PRESSURE. MINIMUM FACTORS OF SAFETY FOR THE DUCT MEET CEI REQUIREMENTS (5). HIGH AND LOW CYCLE FATIGUE LIFE FOR THE DUCT MEET CEI REQUIREMENTS (6). THE FLEX JOINT HAS COMPLETED BENDING MOMENT, FLEXURAL ENDURANCE, ULTIMATE PRESSURE, PROOF PRESSURE, VIBRATION, AND SECTIONING DVS TESTING (7). THE DUCT ASSEMBLY PARENT MATERIAL WAS CLEARED FOR FRACTURE MECHANICS/NDE FLAW GROWTH, SINCE THEY ARE NOT FRACTURE CRITICAL PARTS (8). TABLE K204 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 (9). THE VISUAL BELLOWS INSPECTION, HE MASS LEAK, AND ACCESSIBLE BELLOWS WELDS DYE PENETRANT INSPECTION TESTS HAVE BEEN COMPLETED ON ENGINE 2010 (10) AND 2014 (11) FLEX JOINTS. NO ANOMALIES WERE FOUND. THE 2010 DUCT HAD ACCUMULATED 65 STARTS AND 19,903 SECONDS. THE 2014 HAD ACCUMULATED 53 STARTS AND 15,346 SECONDS.

(1) RS008701, RS008721; (2) RSS-8582, RSS-8575; (3) RS008752; (4) I.L. 0126-8066; (5) RSS-8546, CP320R0003B; (6) RL00532, CP320R0003B; (7) RSS-511-43; (8) NASA TASK 117; (9) RSS-8756; (10) CD#2-0152; (11) CD#2-87-0031

SSME FMEA/CIL
INSPECTION AND TEST

Component Group:	Ducts and Lines	Prepared:	D. Early
CIL Item:	K204-02	Approved:	T. Nguyen
Part Number:	RS007016	Approval Date:	7/25/00
Component:	Oxidizer Tank Pressurant Duct	Change #:	1
FMEA Item:	K204	Directive #:	CCBD ME3-01-5638
Failure Mode:	Internal structural failure.	Page:	1 of 2

Failure Causes	Significant Characteristics	Inspection(s) / Test(s)	Document Reference
A	STABILIZER		RS008701 RS008721
	STABILIZER		
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER DRAWING REQUIREMENTS.	RS008701 RS008721
	HEAT TREAT	HEAT TREAT IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RA0611-020
	SURFACE FINISH	THE STABILIZER DRY FILM LUBRICATION IS VERIFIED PER DRAWING REQUIREMENTS.	RS008701 RS008721
	ASSEMBLY INTEGRITY	INNER RADII ARE INSPECTED PER DRAWING REQUIREMENTS.	RS008701 RS008721
	INLET/OUTLET SLEEVE		RS008701 RS008721
	INLET/OUTLET SLEEVE		
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER DRAWING REQUIREMENTS.	RS008701 RS008721
	HEAT TREAT	HEAT TREAT IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RA0611-020
	SURFACE FINISH	THE SLEEVE DRY FILM LUBRICATION IS VERIFIED PER DRAWING REQUIREMENTS.	RS008701 RS008721
	ASSEMBLY INTEGRITY	INNER RADII ARE INSPECTED PER DRAWING REQUIREMENTS.	RS008701 RS008721
	FILTER		RS008752
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER DRAWING REQUIREMENTS.	RS008752
	FLEX JOINT		RS008701 RS008721
	FLEX JOINT		
	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 FLEX JOINT IS GIMBAL TESTED PER DRAWING REQUIREMENTS.	RS008701 RS008721
		THE FLEX JOINT IS ACCEPTANCE TESTED PER SPECIFICATION REQUIREMENTS. (LAST TEST)	RL00212 RL00213
	DUCT		RS007016
	COMPONENT CLEANLINESS	CLEANLINESS IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RA1610-002 RA1610-004

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Component:	**Oxidizer Tank Pressurant Duct**	**Change #:**	**1**
FMEA Item:	**K204**	**Directive #:**	**CCBD ME3-01-5638**
Failure Mode:	Internal structural failure.	Page:	2 of 2

Failure Causes	Significant Characteristics	Inspection(s) / Test(s)	Document Reference
A	FLIGHT FLOW TESTING	THE EXTERNAL SURFACE IS VISUALLY INSPECTED PRIOR TO EACH LAUNCH.	OMRSD V41BU0.030

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
WELD JOINTS

Component Group: Ducts and Lines
CIL Item: K204
Part Number: RS007016
Component: Oxidizer Tank Pressurant Duct
FMEA Item: K204

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

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
DUCT	RS007016	7,14,17	GTAW	I	X	X		
DUCT	RS007016	8-13,16	GTAW	I	X			
DUCT	RS007016	15	GTAW	I				
DUCT	RS007016	18	GTAW	I	X			
DUCT	RS007016	19,21	GTAW	I	X	X		
DUCT	RS007016	20	GTAW	I	X	X	X	
DUCT	RS007016	22,23	GTAW	I	X			
FLEX JOINT	RS008701	1-4	EBW	I	X			
FLEX JOINT	RS008701	5,6	EBW	I	X			
FLEX JOINT	RS008701	7-10	EBW	I	X			
FLEX JOINT	RS008701	4 PLCS	GTAW	III				
FLEX JOINT	RS008721	1,2	EBW	I	X			
FLEX JOINT	RS008721	3-6	EBW	I	X			
BELLOWS	RS008898	1-4	GTAW	I			X	
BELLOWS	RS008898	5,6	EBW	I				
BELLOWS	RS008899	1	GTAW	I				
BELLOWS	RS008899	2	GTAW	I				
BELLOWS	RS008899	3	GTAW	I				
BELLOWS	RS008899	4,5	EBW	I				