

SRB CRITICAL ITEMS LIST

SUBSYSTEM: THRUST VECTOR CONTROL

ITEM NAME: Exhaust Duct Assembly

PART NO.: 10206-0002-102

FM CODE: A01

ITEM CODE: 20-01-44

REVISION: Basic

CRITICALITY CATEGORY: 1

REACTION TIME: Seconds

NO. REQUIRED: 2

DATE: March 1, 1995

CRITICAL PHASES: Final Countdown, Boost

SUPERCEDES: March 1, 1994

FMEA PAGE NO.: A-141

ANALYST: B. Snook/P. Kalia

SHEET 1 OF 4

APPROVED: R. Henrize

FAILURE MODE AND CAUSES: External leakage of hot exhaust gas (System A and/or B) caused by:

- o Bellows fracture/fatigue
- o Flange/duct fracture
  
- o Seal failure
- o Seal surface defect
- o Improper torque
- o Contamination during assembly
- o Improperly lockwired

FAILURE EFFECT SUMMARY: Fire and explosion will lead to loss of mission, vehicle and crew.

REDUNDANCY SCREENS AND MEASUREMENTS: N/A

RATIONALE FOR RETENTION:

A. DESIGN

- o Exhaust duct assembly is made up of three separate assemblies. (Contamination During Assembly)
- o The sections are connected by 8-hole flanges and sealed by two redundant high temperature "E" seals. The flanges are bolted together with NAS1954C13H and NAS1954C24H bolts and NAS1291CA locknuts. (Seal Failure and Seal Surface Defects)
- o The upper duct assembly contains three bellows and is fabricated from 0.043 inch thick Inconel 625. (Bellows Fracture/Fatigue and Flange/Duct Fracture)

- o Bellows are double ply with a lining and are secured to the upper duct by welding. (Bellows Fracture/Fatigue)
- o The middle and lower duct assemblies are fabricated from 0.043 inch thick Inconel 625. (Flange/Duct Fracture)
- o The aft skirt area is purged with GN2 prior to APU start up, reducing the O2 concentration to less than four percent per OMRSD File II, Vol. 1, requirement number SOOFMO 430 (All Failure Causes)
- o All thread fittings and connectors are torqued per engineering specification and are lockwired per MS 33540 as applicable. (Improper Torque, Improperly Lockwired)
- o The upper duct assembly was tested as part of the upper bracket certification vibration test. (All Failure Causes)
- o The completed exhaust duct assembly was subject to a certification vibration test. Documented in Qualification Test Report ET45, ET19 and SST-SC-TR-FR02. (All Failure Causes)

#### B. TESTING

- o Completed upper duct assembly is leak checked at 10 psi using GN2 with the duct submerged in water per Metal Bellows Drawing 82504. (All Failure Causes)
- o Leak test is performed at vendor on upper, 10206-0003 and middle, 10206-0007 duct assemblies. (All Failure Causes)
- o During refurbishment and prior to reuse, exhaust duct assemblies are disassembled, cleaned and inspected per 10SPC-0131. (All Failure Causes)
- o At installation, turbine exhaust duct assemblies are leak tested with GN2 at 14 + 1/-0 psig. Pressure decay greater than 2.5 psig in ten minutes not acceptable per 10REQ-0021, para. 2.3.3.2. This is the last test on the exhaust duct performed prior to launch. (All Failure Causes)
- o Post hotfire inspection and leak check per 10REQ-0021, para. 2.3.16.4.(All Failure Causes)

#### C. INSPECTION

##### VENDOR RELATED INSPECTIONS

- o All material certifications of flange, duct, and bellows are verified by USBI QAR per SIP 1341. (Flange/Duct Fracture and Bellows Fracture/Fatigue)
- o Dimensions are vendor inspected and verified by USBI QAR per SIP 1341. (Bellows Fracture, Flange/Duct Fracture and Seal Failure)
- o Verification of acceptance data pack by USBI QAR per SIP 1341. (All Failure Causes)

- o Verification of qualification of welding schedule including weld evaluation results by USBI QAR per SIP 1341 (Bellows Fracture/Fatigue, Flange/Duct Fracture)
- o Verification of vendor acceptance of finished perpendicularity, flatness and concentricity of flanges is performed by USBI QAR per SIP 1341. (Flange/Duct Fracture)
- o Radiographic inspection of welds performed and verified by USBI QAR per SIP 1341. (Bellows Fracture/Fatigue)
- o Leak testing is performed and witnessed by the vendor on upper, 10206 -0003 and middle 10206-0007 ducts to confirm that leakage is within acceptable limits and is verified by USBI QAR per SIP 1341. (All Failure Causes)
- o Critical Processes/Inspections:
  - Weld per MSFC-SPEC-135
  - Weld Stem (bellows) per MIL-W-6858
  - Radiographic per MIL-STD-453
  - Heat treat per ASTM-B444-82
  - Silver plating of E-seal per AMS 2410G (Para. 3.5.1 and 3.5.1.1 for quality requirements.)

#### KSC RELATED INSPECTIONS

- o Assembly, torque, and lockwire witnessed per 10REQ-0021, para. 2.1.4 using assembly drawing. (Improper Torque, Improperly Lockwired)
- o Sealing surfaces of E-seals are inspected for absence of physical defects prior to exhaust duct installation per 10REQ-0021, para. 2.1.1.2. (Seal Failure and Seal Surface Defect)
- o Turbine exhaust duct leak check is performed per 10REQ-0021, para. 2.3.3.2. (All Failure Causes)
- o O-Rings, K-Seals and E-Seals (as applicable) are inspected prior to installation for absence of physical defects per 10REQ-0021, para. 2.3.0. (Seal Failure)
- o Sealing surfaces are inspected, by USBI, prior to installation verifying no contaminant or obstruction exists per 10REQ-0021, para. 2.3.0. (Seal Surface Defect)

- o Inspections for leaks, rubbing and discoloration are conducted per 10REQ-0021, para. 2.3.11.3 and 2.3.15.3 respectively, following low speed GN2 spin and high speed GN2 spin. (All Failure Causes)
- o Proper function of TVC system is demonstrated during hotfire operations per 10REQ-0021, para. 2.3.16. (All Failure Causes)
- o Post hotfire inspection for leaks and damage is performed per 10REQ-0021, para. 2.3.16.4. (All Failure Causes)

D. FAILURE HISTORY

Criticality Category 1:

- o No SRB failure history for this failure mode.

E. OPERATIONAL USE

- o Not applicable to this failure mode.