CRITICAL ITEMS LIST (CIL)

SYSTEM:	Propulsion/Mechanical	FUNCTIONAL CRIT:	1
SUBSYSTEM:	GO2 Pressurization	PHASE(S):	a, b, c
REV & DATE:	J, 12-19-97	HAZARD REF:	P.03, P.06, P.07, P.09, P.10, S.03, S.07, S.11
DCN & DATE:			
ANALYSTS:	J. Attar/H. Claybrook		

FAILURE MODE: Leakage

FAILURE EFFECT:
a) Loss of mission and vehicle/crew due to fire/explosion.
b) Loss of mission and vehicle/crew due to fire/explosion or LO2 tank structural failure.
c) Loss of life due to ET impact outside designated footprint.

TIME TO EFFECT: Seconds

FAILURE CAUSE(S):
A: Structural Failure of Hardline Component
B: Flange Mating Surface Defects
C: Structural Failure of Flex Joint Component
D: Seizure of Flex Joint
E: Fracture of One Attachment Bolt

REDUNDANCY SCREENS: Not Applicable

FUNCTIONAL DESCRIPTION: Transports GHe/GO2 during prelaunch and GO2 during ascent to maintain ullage pressure requirements.

FMEA ITEM CODE(S)	PART NO.	PART NAME	QTY	EFFECTIVITY
2.2.1.1	PD4800180-069	Upper Line Assy (Flex)	1	LWT-54 & Up

REMARKS:

SYSTEM:	Propulsion/Mechanical	REV & DATE:	J, 12-19-97
SUBSYSTEM:	GO2 Pressurization	DCN & DATE:	
FMEA ITEM CODE(S):	2.2.1.1		

RATIONALE FOR RETENTION

DESIGN:

The Upper Line Assembly consists of fixed flanges, straight tubing and tube bend sections and three bellows type flexible joints. Each flexible joint contains a pressure carrier bellows and a ball strut assembly. A fixed support for the line assembly is located at station 370.88 on the forward end of the LO2 Ogive. Attachment points are included on the line assembly and LO2 tank forward ogive.

A, C, D: The line assembly is an all welded configuration fabricated from Inconel 718 and ARMCO 21-6-9 CRES. The line assembly has been designed to meet the required ultimate safety factors (1.4 for loads and 1.5 for pressure) and the required yield safety factors (1.1 for loads and 1.25 for pressure) (ET Stress Report 826-2188 and ET10-SR-0001-1, Arrowhead). Emphasis has been placed on joint geometry to enhance weld integrity. The line assembly also meets the other operational and nonoperational requirements defined per P04800180. Fusion and seam welding specifications, processes, and quality controls are in accordance with MPS-MPQ-103 (Arrowhead). Material selected in accordance with MMC-ET-SE16 and controlled per MMMA approved vendor product assurance plan assures conformance of composition, material compatibility and properties.

B: Mating surface flatness, waviness and finish are specified on engineering drawings to assure performance within the capability of the seal.

C, D: The flexible joint assemblies provide for installation misalignments and recurring motions during loading and boost. The pressure carrier bellows is fabricated from 3 plies of .008 inch thickness material and the joint design provides isolation from flow induced vibration. The ball located within the ball strut assembly is fabricated from Inconel 718. Vitrolube is applied to prevent seizure of the ball and strut. Compatibility testing for oxygen service is specified per NHB 8060.1.

E: Attachment fasteners were selected from the Approved Standard Parts List (ASPL 826-3500), installed per STP2014 and torqued using values specified on engineering drawings.

TEST:

The Upper Line Assembly is qualified. Reference COQ MMC-ET-TM06-023.

BSTRA Development Test: Five ball-strut tie rod assembly flexible joints were subjected to development tests to determine the torsional loading capability. In each test, loading was applied incrementally until failure occurred. Should binding occur, test results have shown that the BSTRA can resist up to 6,800 in-lb which is more than twice the maximum flight load (ET-DTR-10950-73, Arrowhead).

Qualification: Testing of one line assembly included load deflection, proof load/operating pressure, deflection and leakage for acceptance, 500 motion/operating pressure cycles, leakage, 10 thermal cycles, electrical bonding (for impedance), sine and random vibration, leakage, mounting bracket load test at 3,871 lbs axial and 468 lbs shear and ultimate load test of 1970 psig. There was no evidence of rupture or collapse as a result of the ultimate load tests. Leakage criteria was no bubbles (GN2) at 300 psig, (MMC-ET-RA09-34).

MPTA Firings/Tankings: A similar upper line assembly (except that instrumentation bosses and hard mount attachments were incorporated) has accumulated 62.5 minutes of firing time, 27 cryogenic cycles, and 42 pressurization cycles. There was no evidence of structural damage.

Acceptance:

Vendor - (Subassembly):

C, D: Perform load versus deflection test on each BSTRA joint. (ATP 180-309-7 or ATP 14180-309-7, Arrowhead as applicable).

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RATIONALE FOR RETENTION

TEST: (cont)

Vendor - (Line Assembly):

A, C, D: Perform proof loads/operating pressure test (ATP 180-309-7 or ATP 14180-309-7, Arrowhead as applicable).

C, D: Perform four deflection tests (two with line unpressurized and two with line pressurized) (ATP 180-309-7 or ATP 14180-309-7, Arrowhead as applicable).

A, C, D: Perform leakage rate test after proof loads/operating pressure test and deflection tests (ATP 180-309-7 or ATP 14180-309-7, Arrowhead as applicable).

E: Attachment hardware is procured and tested to Standard drawing 26L4.

MAF - (Line Assembly):

B: Perform dual seal leakage rate test on flange joints after installation. (MMC-ET-TM04K).

INSPECTION:

Vendor Inspection - Lockheed Martin Surveillance:

A, C, D: Verify materials selection and verification controls (MMC-ET-SE16, Standard drawing 26L2, and drawings 14180-21, 14180-3, 14180-23-3, 14180-5-9, 14180-79, 14180-91, 14180-89, 10950-53-13 and 10950-53-15 Arrowhead).

A, C: Inspect welding (MPS-MPQ-103, Arrowhead).

A, C: Witness penetrant inspection (MIL-I-6866, Type I, Method A, Sensitivity Group VI).

A, C: Verify x-ray results (QCI-16-057, Arrowhead).

B: Inspect mating surface flatness, finish and dimensions (drawings 14180-21 and 14180-3, Arrowhead).

D: Inspect dimensions (drawing 10950-73-25, Arrowhead).

D: Verify lubrication application (MPS-MPQ-121, Arrowhead).

D: Witness cleaning (MPS-MPQ-105, Arrowhead).

Lockheed Martin Procurement Quality Representative:

A, C: Verify post proof x-ray results (drawing 14180-309).

A-D: Witness loads vs deflection, proof load/operating pressure, deflection and leakage tests (ATP 180-309-7 or ATP 14180-309-7, Arrowhead as applicable).

MAF Quality Inspection:

B: Inspect sealing surfaces for freedom of nicks, radial scratches or other imperfections (acceptance drawing 82620000001).

B, E: Verify installation and witness torque (drawing 80921021009).

B: Witness seal flange leakage test (MMC-ET-TM04k).

FAILURE HISTORY:

Current data on test failures, unexplained anomalies and other failures experienced during ground processing activity can be found in the PRACA data base.