

CRITICAL ITEMS LIST (CIL)

SYSTEM:	Propulsion/Mechanical	FUNCTIONAL CRIT:	1
SUBSYSTEM:	GH2 Pressurization	PHASE(S):	a, b, c
REV & DATE:	J, 12-19-97	HAZARD REF:	P.03, P.06,
DCN & DATE:			P.07, S.04,
ANALYSTS:	J. Attar/H. Claybrook		S.06

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 LH2 tank structural failure.
 c) Loss of mission due to premature engine shutdown caused by loss of NPSP.
 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
 D: Seizure of Flex Joint

REDUNDANCY SCREENS: Not Applicable

FUNCTIONAL DESCRIPTION: Transports GHe/GH2 during prelaunch and GH2 during ascent to maintain LH2 tank ullage pressure requirements.

<u>FMEA ITEM CODE(S)</u>	<u>PART NO.</u>	<u>PART NAME</u>	<u>QTY</u>	<u>EFFECTIVITY</u>
2.7.6.1	PD4800205-029	Elbow Flex Line	1	LWT-54 & Up

REMARKS:

CRITICAL ITEMS LIST (CIL)
CONTINUATION SHEET

SYSTEM: Propulsion/Mechanical
SUBSYSTEM: GH2 Pressurization
FMEA ITEM CODE(S): 2.7.6.1

REV & DATE: J, 12-19-97
DCN & DATE:

RATIONALE FOR RETENTION

DESIGN:

- A, C, D: The Elbow Flex Line Assembly consists of fixed flanges, straight tubing and tube bend sections, and 3 bellows type flexible joints. Each flexible joint contains a pressure carrier bellows and a ball strut assembly. The line assembly is fabricated from ARMC0 21-6-9 CRES and is an all welded configuration. Emphasis has been placed on joint geometry to enhance weld integrity. 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-0002, Arrowhead). The line assembly also meets the other operational and nonoperational requirements defined per PD4800205. Materials selected in accordance with MMC-ET-SE16 and controlled per MMMA Approved Vendor Product Assurance Plan assures repetitive conformance of composition, material compatibility and properties. Fusion and seam welding specifications, processes, and quality controls are in accordance with MPS-MPO-103 (Arrowhead).
- B: Flange mating seal 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 thick 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.

TEST:

The Elbow Flex Line Assembly is qualified. Reference COQ MMC-ET-TM06-086.

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

Qualification. Testing of one line assembly included load deflection, proof load/operating pressure cycle deflection and leakage for acceptance, electrical bonding (for impedance), 500 motion/operating pressure cycles, leakage, sine and random vibration, and ultimate load tests at 2,780 psig on the line assembly, and tensile loads to 30,630 lbs for welds. There was no evidence of rupture or collapse as a result of the ultimate loads test. Acceptance criteria was no bubbles (helium) at 300 psig (MMC-ET-RA09-98)

Delta Qualification (SLWT Project). One PD4800205-029 line assembly underwent additional testing to qualify the present design for SLWT environments (QTR-14205-329). These tests were performed on a fully accepted line assembly after successfully passing ATP-14205-329. Following ATP, three additional qualification tests were performed; (1) sine and random vibration while pressurized to 600 PSIG with GN2 for three minutes, (2) post vibration proof test pressurized to 1510 PSIG with deionized water for 60 seconds maximum and (3) post proof leak test at 300 PSIG with Ghe for five minutes. All tests passed, structural integrity was maintained and no damage or leaks were experienced.

Acceptance:

Vendor - (Line Subassembly):

- A: Perform flight proof load test during the build cycle (ATP 14205, Arrowhead).
- C, D: Perform load vs deflection test on each BSTRA joint (ATP 205-329 or ATP 14205-329, Arrowhead as applicable).

Vendor - (Line Assembly):

- A-D: Perform proof loads/operating pressure test and leakage rate test (ATP 205-329 or ATP 14205-329 Arrowhead as applicable).

CRITICAL ITEMS LIST (CIL)
CONTINUATION SHEET

SYSTEM: Propulsion/Mechanical
SUBSYSTEM: GH2 Pressurization
FMEA ITEM CODE(S): 2.7.6.1

REV & DATE: J, 12-19-97
DCN & DATE:

RATIONALE FOR RETENTION

TEST: (cont)

Acceptance: (cont)

MAF - (Line Assembly):

- B: Perform dual seal leakage rate test for flange joints after production line assembly installation (MMC-ET-TM04k).

INSPECTION:

Vendor Inspection - Lockheed Martin Surveillance:

- A, C: Verify materials selection and verification controls (MMC-ET-SE16 and drawings 14205-61, 14205-71, 14205-39, 14205-37, 14205-35, 14205-31, 14205-27, 10950-53-13-3, 10950-73-39-11, 10950-73-39-13, and 10950-53-15-7, Arrowhead).
- A, C: Inspect welding (MPS-MPQ-103, Arrowhead).
- A, C: Penetrant inspect welding (MIL-I-6866, Type I, Method A, Group VI).
- A, C: Verify X-ray results (OCI-16-057, Arrowhead).
- B: Inspect mating surface flatness, finish, and dimensions (drawing 14205-61 and 14205-71, Arrowhead).
- D: Inspect dimensions (drawing 10950-73-25, Arrowhead).
- D: Verify vitrolube 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 14205-329, Arrowhead).
- A: Witness flight proof load test during build cycle (ATP 14205, Arrowhead).
- A-D: Witness load vs deflection, proof load/operating pressure, deflection and leakage tests (ATP 205-329 or ATP 14205-329, Arrowhead as applicable).

MAF Quality Inspection:

- B: Inspect sealing surfaces for freedom of nicks, radial scratches or other imperfections (acceptance drawing 82620000001).
- B: Verify installation (drawing 80921021009).
- B: Witness seal flange leakage tests (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.