

CRITICAL ITEMS LIST (CIL)

SYSTEM:	Propulsion/Mechanical	FUNCTIONAL CRIT:	1
SUBSYSTEM:	Ground Umbilical Carrier Assembly	PHASE(S):	a
REV & DATE:	J, 12-19-97	HAZARD REF:	P.05
DCN & DATE:	005, 6-30-00		
ANALYSTS:	J. Attar/H. Claybrook		

FAILURE MODE: Premature Separation

FAILURE EFFECT: a) Loss of mission and vehicle/crew due to leakage of GH2, resulting in fire/explosion.

TIME TO EFFECT: Seconds

FAILURE CAUSE(S):
 A: Structural Failure of Support Hardware
 B: Fracture of Attachment Hardware
 C: Structural Failure of Pyro Separator Bolt
 D: Autoignition of Pyro Separator

REDUNDANCY SCREENS: Not Applicable

FUNCTIONAL DESCRIPTION: Interface hardware to attach ground facilities to ET to provide hazardous gas detection and separation at lift-off.

<u>FMEA ITEM CODE(S)</u>	<u>PART NO.</u>	<u>PART NAME</u>	<u>QTY</u>	<u>EFFECTIVITY</u>
2.14.1.2	82629021000-059 -060	Ground Umbilical Carrier Assy	1 1	LWT-54 thru 114 LWT-115 & Up

REMARKS:

CRITICAL ITEMS LIST (CIL)
CONTINUATION SHEET

SYSTEM: Propulsion/Mechanical
SUBSYSTEM: Ground Umbilical Carrier Assembly
FMEA ITEM CODE(S): 2.14.1.2

REV & DATE: J, 12-19-97
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RATIONALE FOR RETENTION

DESIGN:

The Ground Umbilical Carrier Assembly (GUCA) is a retractable carrier plate containing a 7" hydrogen vent disconnect, six pressurization disconnects, two electrical instrumentation connections, mounting provisions for the pyro separator bolt, cavity purge orifice and attaching support hardware. The assembly incorporates a lip bulb seal to prevent moisture intrusion and ice buildup to the intercavity while exposed to cryogenic temperature. The GUCA is held in a mated position by a pyro separator bolt which attaches to a key lock insert in the External Tank carrier assembly (ETCA). The GUCA pivots away from the Intertank on pivot supports, and retracts away from the ET at T-0.

The GUCA is designed for repeated use and is capable of operating in the primary mode of release, after and during exposure to specified environments for 74 cycles of engagement and disengagement at cryogenic temperatures. In its service usage, the assembly and its component subassemblies are refurbished as required prior to its next use (O & M Manual MMC-ET-CR00023). The service life and primary mode of release were verified by test and analysis.

A, B: The GUCA is fabricated from A356-T61 aluminum alloy 2219-T87 and 2219-T8511 aluminum alloy and is penetrant inspected. The assembly has been designed to meet the required yield (2.0) and ultimate (4.0) safety factors (ET Stress Report 826-2188) and meets other operating and nonoperating requirements specified by CEI T02M264. Materials selected in accordance with MMC-ET-SE16 and controlled per MMMA approved vendor product assurance plan assures conformance of composition, material compatibility and properties.

C, D: The pyro separator assembly is a cartridge actuated device used to attach and release the GUCA. The assembly consists of a separator bolt, an internal piston, an adapter, and two pyrotechnic cartridges. The bolt is designed to fail at the separation notch in the bolt at an axial tensile load of 8000 + 500 lbs. The separator bolt is fabricated from inconel 718 per AMS 5662, has been designed to meet the required minimum ultimate (1.30) safety factor (ET Stress Report 826-2188) and meets other operating and nonoperating requirements specified by PD5000020. Each cartridge incorporates a NASA standard initiator (NSI) that is threaded and welded into the cartridge body. The NSI's principle function is to initiate the cartridge. The material used for the charge was selected to withstand temperatures without detonating. Selection of explosive mix and propellant per MIL-R-398 and Hi-Shear drawing 939321 respectively, assures repetitive conformance of composition and properties.

Weights are controlled per 9391435 (Hi-Shear). Dimensional control of the bulkhead and explosive/propellant chambers, along with weight, mix and packing requirements of the explosive/propellant during the build cycle assures nominal operating characteristics. Each cartridge assembly is capable of withstanding 1.5 times its maximum allowable installation torque without physical damage or change in the bridgewire characteristics of the NSI initiator.

TEST:

The Ground Umbilical Carrier Assembly is qualified. Reference COQ MMC-ET-TM06-038. The Pyro Separator is qualified. Reference COQ MMC-ET-TM06-067.

A-D: Qualification: Testing of one GUCA and ETCA included life cycle separation (15 cycles at cryogenic temperature) using pyro separator bolt. In addition the carrier assemblies successfully functioned when subjected to the loads of a simulated full scale retract line load. The carrier assemblies were separated two times at cryogenic temperatures using lanyard separation. There was no evidence of structural damage (MMC-ET-RA09-48).

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TEST: (cont)

Qualification (Component): The pyro separator is qualified by engineering test, and by similarity to the -039 assembly.

Twenty separator assemblies (PD5000020-039) were test fired at ambient and -200°F and included units that were subjected to vibration, drop test, over torque and 85% pyro charge. The specimens successfully performed the separation function (MMC-ET-RA09-64).

Ultimate strength tests were performed on three bolts (from the lot of test bolts) to verify that the bolts met the 8000 ± 500 lb (tension) requirement. All three bolts had acceptable ultimate strengths. There was no evidence of premature separation (Hi-Shear ETR 9363116-2576).

One unit was subjected to an autoignition test. The unit was maintained at 250°F for four hours. The temperature was then increased at a rate of approximately 5°F/minute. The cartridge did not ignite after reaching a final temperature of 500°F (MMC-ET-RA09-64).

System Qualification: The ET umbilical and intertank access arm system qualification testing was conducted at the Launch Equipment Test Facility (LETF) at KSC. The objectives were to verify the KSC ground system hardware design and to perform integrated testing with the ETCA. Testing was conducted in a series of 13 tracking tests and 17 disconnect tests simulating various vehicle configurations with motions for anticipated environmental, test, and launch conditions from predicted worst-case vehicle stacking and on-pad positioning offsets including 2.75 seconds of simulated engine firing.

Test results and data analysis verified that the KSC design/hardware is satisfactory, and when integrated with the MSFC flight umbilical, the system meets all of the specified requirements and is qualified for Space Shuttle operations at launch sites (KSC-DD-119-TR).

Vendor:

Lot Acceptance:

(Subassembly): (Hi-Shear 9363067-2347)

- C, D: Perform two proof pressure tests on all separator components (33,300 psi).
- C: Perform ultimate pull test on three bolts (minimum) and define the groove diameter for a given lot.
- C: Perform tension proof load and ultimate strength tests on three bolts.

(Pressure Cartridge): (Hi-Shear 9391479-2340)

- D: Perform bridgewire resistance, helium leakage test, x-ray inspection, and n-ray inspection on all production units.
- D: Perform a closed bomb firing and pressure time test on ten percent of lot size or ten units (minimum) selected from the production lot.

(Total Assembly): (Hi-Shear 9363116-1669)

- C, D: Perform lot acceptance test on ten percent of lot size or ten units (minimum) selected from the production lot.

NOTE: Lot size equals sample size plus usable units.

- D: Perform bond resistance test (MMC-ET-TM04k).

Launch Site:

- D: Perform bond resistance test (drawing 82629021109).

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INSPECTION:

Vendor Inspection - Lockheed Martin Surveillance:

- A-C: Verify materials selection and verification controls (MMC-ET-SE16 and drawings 82629021002, 82629021008, 82629021003, Standards drawings 26L15, 26L2 and drawing 9363068, 939321 Hi-Shear).
- A: Penetrant inspect welding after machining (drawing 82629021008).
- A: Inspect welding (drawing 82629021008).
- C: Penetrant Inspect (MIL-I-6866, Type I, Method B).
- C: Witness assembly and torque (drawing 9363067 and 9363116, Hi-Shear).
- D: Witness helium leakage test (Hi-Shear 9391479-2340).

Lockheed Martin Procurement Quality Representative:

- A: Verify x-ray results (drawing 82629021002).
- C: Witness tension proof load and ultimate strength tests (document 9363067-2347, Hi-Shear).
- D: Verify n-ray and x-ray results (Hi-Shear, 9391479-2340).
- D: Witness bridgewire resistance and closed bomb firing (Hi-Shear, 9391479-2340).
- C, D: Witness proof pressure test (Hi-Shear, 9363067-2347).
- C: Witness lot acceptance test (ATP 9363116-1669, Hi-Shear).
- C: Verify bore and groove dimensions (drawing 9363068, Hi-Shear).

MAF:

- D: Witness bond resistance test on ET GUCP (MMC-ET-TM04k).

Launch Site:

- A, B: Inspect for freedom of damage during refurbish (OMI-T6148).
- B-D: Witness assembly installation and torque (drawings 82629021000 and 82629021109, and OMI T1147).
- D: Witness bond resistance test (drawing 82629021109).

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.