CRITICAL ITEMS LIST (CIL)

SYSTEM:	Electrical	FUNCTIONAL CRIT:	1R
SUBSYSTEM:	LH2 Depletion System	PHASE(S):	b
REV & DATE:	J, 12-19-97	HAZARD REF:	E.01, P.06
DCN & DATE:			
ANALYSTS:	J. Bowski/A. Oser		

FAILURE MODE: Fails with False Dry Signal

FAILURE EFFECT: b) Loss of mission and vehicle/crew due to premature MECO.

TIME TO EFFECT: Seconds

FAILURE CAUSE(S): Sensor Resistance in False Dry Range

REDUNDANCY SCREENS:
Screen A: PASS
Screen B: FAIL - Not detectable in flight.
Screen C: PASS

FUNCTIONAL DESCRIPTION: The four depletion sensors located near the bottom of the LH2 tank are a backup to the Orbiter guidance, navigation and control (GN & C) signal and to the LO2 ECO sensors for SSME cutoff during normal mission. Sensors also provide signals for transition to fastfill. (Measurement Number: T41X1730X, T41X1731X, T41X1732X, T41X1733X)

FMEA ITEM CODE(S)	PART NO.	PART NAME	QTY	EFFECTIVITY
3.6.1.2	74L4-2 (302A14, 302A15, 302A16, 302A17)	LH2 Depletion Sensors	4	LWT-54 & Up

REMARKS:

SYSTEM:	Electrical	REV & DATE:	J, 12-19-97
SUBSYSTEM:	LH2 Depletion System	DCN & DATE:	
FMEA ITEM CODE(S):	3.6.1.2		

RATIONALE FOR RETENTION

DESIGN:

The level sensor is a warm wire sensor utilizing the principal of cryogenic liquids wetting the wire thus causing a change of resistance. This change in resistance is reflected by a change in voltage while a constant current is maintained. The finite resistance change reflects a wet or dry condition.

The sensing element is a .0005 inch diameter gold flashed platinum wire. It is approximately 6 inches long and is wound zig-zag fashion over 10 gold-plated iron-nickel-cobalt alloy posts cemented in a flat ceramic substrate. The substrate is hollow to allow cryogenic fluid to pass through freely and surround the sensor element. To prevent erroneous readings the ceramic substrate is inserted into a cover/baffle assembly which diverts bubbles caused by boiling of the cryogenic liquid.

The cover and housing are aluminum alloy and the base has two mounting holes and an alignment pin. The alignment pin prevents rotation and improper installation.

The sensor is fuel cleaned to level 1000 per Simmonds Precision Process I-1109. It is maintained at this level through packaging and shipping to Lockheed Martin. It is maintained clean per STP5011 during staging and installation in the hydrogen tank.

Welding is controlled by a Simmonds process using actual hardware and platinum wire to perform a sample weld prior to performing production welds and another sample weld at the end of each day or production lot of 25 assemblies, whichever occurs first.

The design of the sensor requires a controlled amount of slack in the wire to minimize strain.

The ten pins which hold the platinum winding are bonded into holes in the ceramic substrate using cement. The completed assembly is air dried and then oven cured.

Ten pins provide separation of the adjacent loops in the sensing element and are bonded into holes in the ceramic substrate using cement.

Redundancy Description

Four sensors, all at the same level are used in the LH2 tank for the LH2 depletion function. Any two of these sensors must indicate dry to signal the Orbiter that depletion of LH2 is occurring. For the false dry failure mode:

Effect of First Failure

If any one sensor fails dry there is no effect since two sensors dry are required for the depletion function.

Effect of First Redundancy Loss

If a second sensor has failed dry the effect described above will occur.

SYSTEM: Electrical
SUBSYSTEM: LH2 Depletion System
FMEA ITEM CODE(S): 3.6.1.2

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

RATIONALE FOR RETENTION

TEST:

The LH2 Depletion Sensors are qualified. Reference COQ MMC-ET-TM06-118.

The level sensors were originally qualified for NASA by Simmonds on a subcontract to Rockwell. The qualification report number is CAR OID-10-432-0205-0001F/07-23-82.

Vendor:

Perform Certification Test on sensor element wire (Simmonds Precision Drawing 044540).

Perform DC Resistance Test (Lockheed Martin Standard 74L4).

Perform Thermal Shock Test (Lockheed Martin Standard 74L4).

Perform Push Test on pins (Simmonds Precision PP518).

MAF:

Perform DC Resistance Test (TM04k).

Launch Site:

Perform DC Resistance Test (OMRSD File IV).

Perform Sensor Operational Test (OMRSD File II).

INSPECTION:

Vendor Inspection - Lockheed Martin Surveillance:

Verify parts have been cleaned (Simmonds Precision I-1109 or Titeflex SP 101-144).

Verify material selection and verification controls (Lockheed Martin Standard 74L4).

Verify acceptance and certification of sensor element wire (Simmonds Precision Drawing 044540).

Verify certification of swaging operator (Simmonds Precision PP515).

Inspect for acceptable swage (Simmonds Precision PP515).

Inspect for cleanliness of parts and material prior to welding (Simmonds Precision I-1109 or Titeflex SP 101-144).

SYSTEM: Electrical
SUBSYSTEM: LH2 Depletion System
FMEA ITEM CODE(S): 3.6.1.2

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

RATIONALE FOR RETENTION

INSPECTION: (cont)

Verify certification of weld operator (Simmonds Precision PP471).

Inspect for acceptable weld (Simmonds Precision PP471).

Witness tension applied on sensor winding (Simmonds Precision Drawing 1500035-002).

Verify certification of bonding operator (Simmonds Precision PP518).

Inspect bonding of pins (Simmonds Precision PP518).

Witness Push Test of bonded pins (Simmonds Precision PP518).

Lockheed Martin Procurement Quality Representative:

Witness DC Resistance Test (Lockheed Martin Standard 74L4).

Witness Thermal Shock Test (Lockheed Martin Standard 74L4).

MAF Quality Inspection:

Witness DC Resistance Test from the ET interface (TM04k).

Launch Site:

Witness DC Resistance Test in dry condition (OMRSD File IV).

Witness sensors change from dry to solid wet indications at completion of slow fill (OMRSD File II).

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.