CRITICAL ITEMS LIST (CIL)

No. 10-04-02-01/03

SYSTEM:	Space Shuttle RSRM 10	CRITICALITY CATEGORY:	1R
SUBSYSTEM:	Lightning Protection, ESD, And Instrumentation 10-04	PART NAME:	Motor Chamber Operational Pressure Transducer (2)
FMEA ITEM NO.:	10-04-02-01 Rev M	PART NO.:	(See Table A-4)
CIL REV NO.:	M	PHASE(S):	Boost, Separation (BT,SP)
DATE:	31 Jul 2000	QUANTITY:	(See Table A-4)
SUPERSEDES PAGE:	509-1ff.	EFFECTIVITY:	(See Table 101-6)
DATED:	30 Jul 1999	HAZARD REF.:	BI-01
CIL ANALYST:	D. F. Bartelt		
APPROVED BY:		DATE:	

RELIABILITY ENGINEERING: K. G. Sanofsky 31 Jul 2000

ENGINEERING: J. W. Edwards 31 Jul 2000

1.0 FAILURE CONDITIONS: Failure during operation (D)

2.0 FAILURE MODE: 8.0 Structural failure of the diaphragm and secondary containment chamber

3.0 FAILURE EFFECT: Structural failure would result in Forward Dome burn through or loss of capability to separate during the separation phase causing loss of RSRM, SRB, crew, and vehicle

4.0 FAILURE CAUSES (FC):

FC NO.	DESCRIPTION	FAILURE CAUSE KEY
8.1	Structural failure of the diaphragm due to shipping, handling, or propagation of flaws	A
8.2	Loss of glass-to-metal seal in header of secondary chamber	B
8.3	Degradation of material due to corrosion, hydrogen embrittlement, stress corrosion cracking, galvanic corrosion, or fatigue	C
8.4	Nonconforming header welds	D

5.0 REDUNDANCY SCREENS:

SCREEN A: Fail--The secondary containment chamber can not be verified during mission turnaround
SCREEN B: Fail--Secondary chamber failure can not be detected during flight
SCREEN C: Pass--No single credible cause for chamber and diaphragm failure

6.0 ITEM DESCRIPTION:

1. Motor Chamber Operational Pressure Transducer (Figures 1, 2, and 3). Materials are listed in Table 1.

TABLE 1. MATERIALS

Drawing No.	Name	Material	Specification	Quantity
1U50188	Transducer, Motional Pickup, Pressure	17-4PH CRES		3 ea/Motor

6.1 CHARACTERISTICS:

1. The Operational Pressure Transducer provides structural integrity of the RSRM pressure vessel. Pressure Transducer: 0-1000 psia, 1.375 diameter maximum times 3.20 length maximum, 3 required per RSRM, located on Forward Dome at 40, 180, and 270 degrees, attached with Special Bolt.

7.0 FAILURE HISTORY/RELATED EXPERIENCE:

1. Current data on test failures, flight failures, unexplained failures, and other failures during RSRM ground processing activity can be found in the PRACA database.

8.0 OPERATIONAL USE: N/A

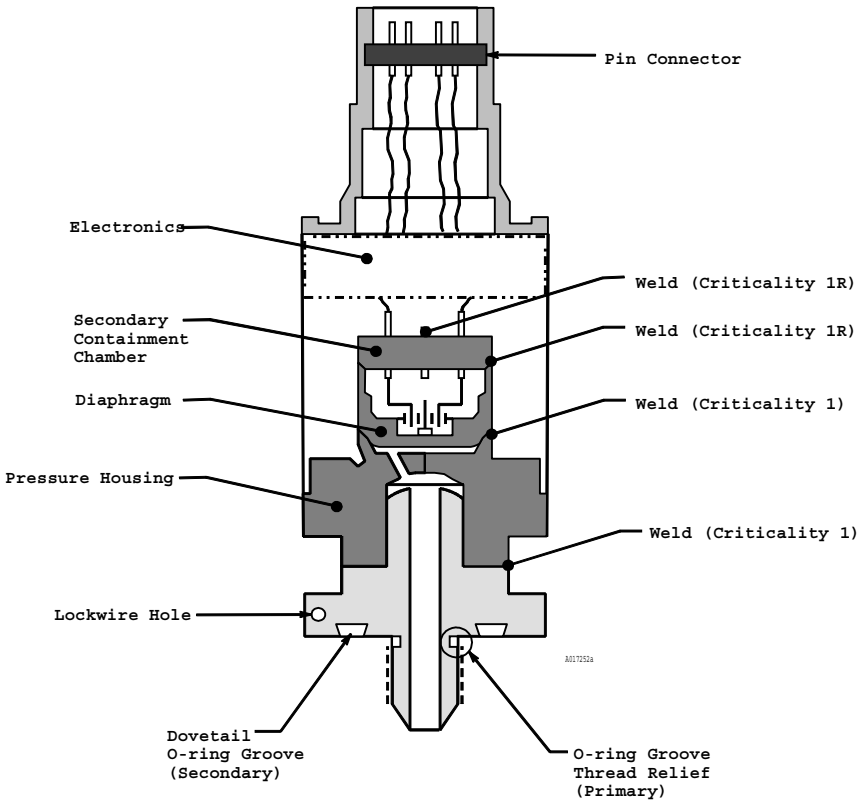

Figure 1. Pressure Transducer Section

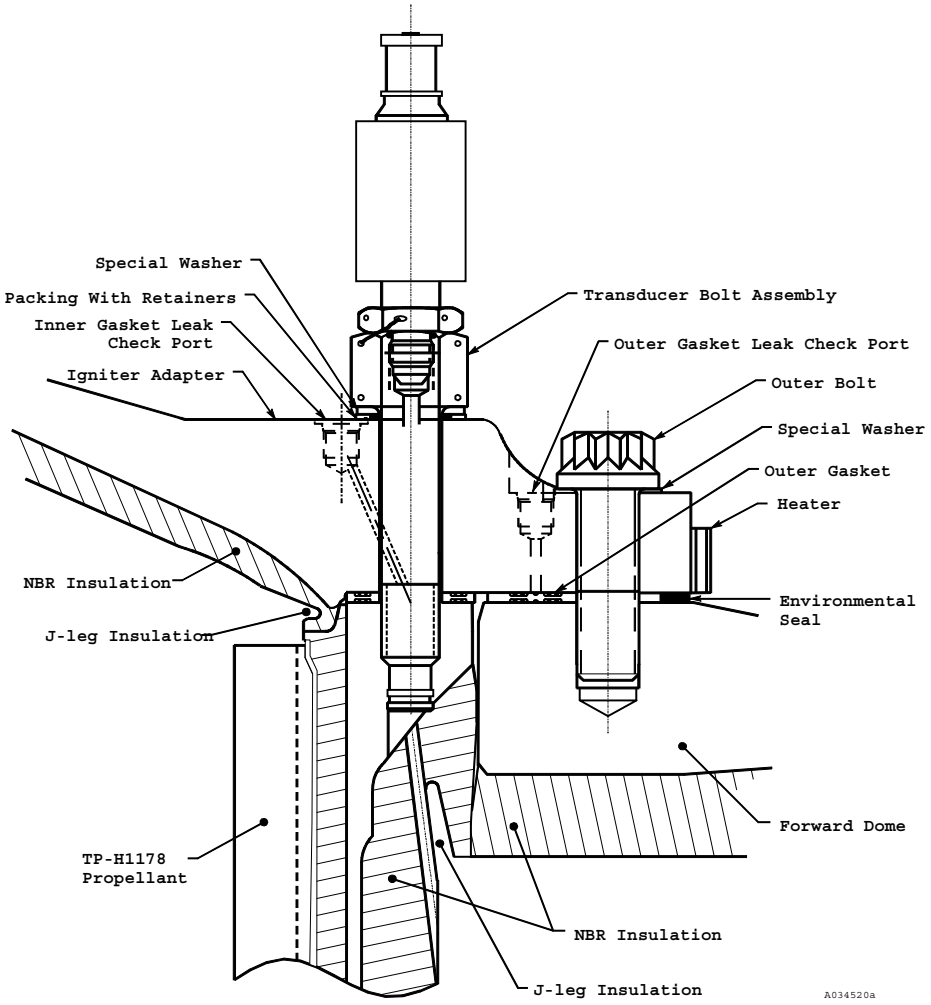

Figure 2. Installed Pressure Transducer and Special Bolt

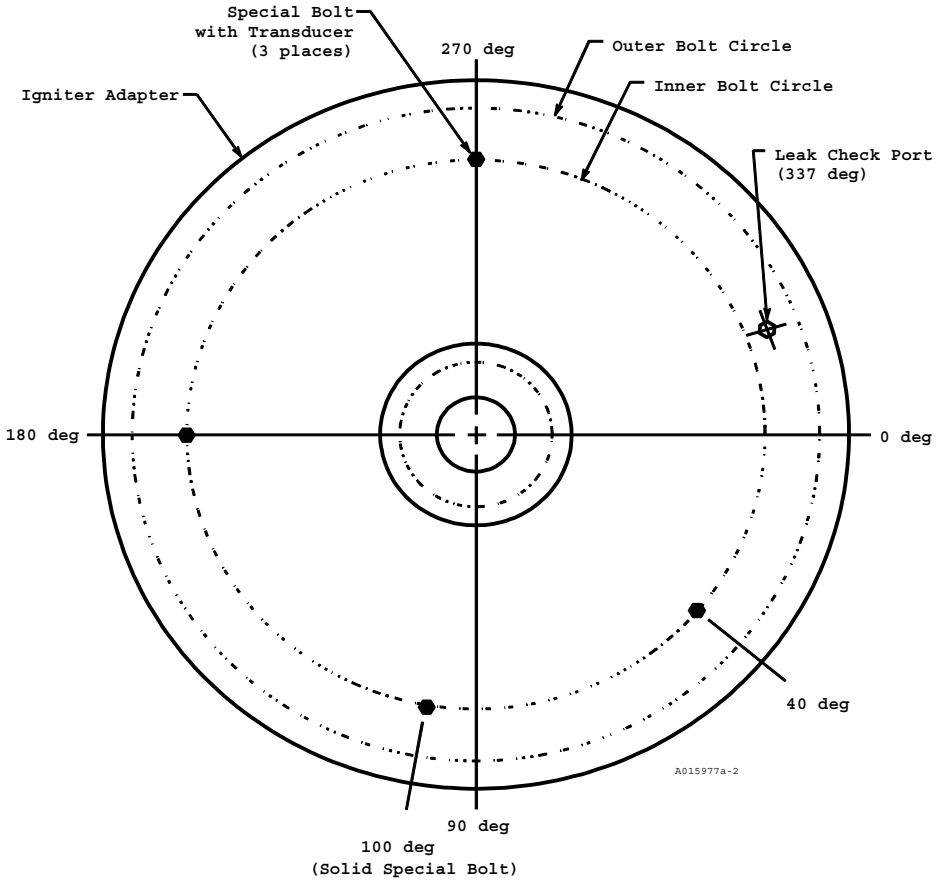

Figure 3. Special Bolt and Leak Check Port Location

9.0 RATIONALE FOR RETENTION:

9.1 DESIGN:

DCN FAILURE CAUSES

A,D

1. Design requirements for the diaphragm are per engineering drawings and specifications as follows:

   a. The diaphragm was designed to withstand 200 percent of the rated pressure without permanent deformation or physical damage.
   b. Material: The diaphragm is constructed of 17-4PH stainless steel, heat treated and solution annealed after welding. The material is tested for the following:

      1) Yield strength
      2) Tensile strength
      3) Fracture toughness
      4) Rupture strength
      5) Corrosion resistance to oxidizing chemicals and salt water

   c. After welding, the joints are heat treated per engineering.

A,B,D

2. Qualification testing was performed per engineering. The following tests show the secondary chamber will contain operating pressure if the diaphragm fails:

   a. Transducer housings, identical to production units (except without diaphragms), were demonstrated to withstand 200 percent of the rated pressure for a minimum of 10 seconds without permanent deformation or physical damage.
   b. These tests demonstrated a safety reliability of 99.8 percent with at least 95 percent confidence (1550 tests on each of five OPTs).

A,B,D

3. An operational pressure transducer was demonstrated to be capable of sustaining a pressure of 5,000 psi without leakage (both with and without diaphragm intact) per TWR-17795.

A

4. In view of the above tests, the 150 percent over pressure production tests are adequate to prove structural integrity of the OPT. Such tests subject the OPT to a greater pressure than case segments and other structural components during hydroproof testing.

A,B,C,D

5. Transducer certification is per TWR-10405. This report shows similarity to the original Qualification Test Report by Bell & Howell per QTR-10210-21C.

A

6. Investigation of transducer diaphragm degradation from multiple use and flight experience indicated that the transducers are good for multiple flights.

B

7. Reliability of the pressure transducer without the diaphragm is per engineering.

B

8. Following the Secondary Chamber Assembly, a helium leak test is performed to verify proper assembly of the glass seals and welding. The primary chamber is verified for workmanship and leakage by a helium leak test following assembly of the two chambers.

B

9. Pressure testing of the secondary containment chamber is impossible after assembly of the OPT since the only place for pressure to be applied is to the

primary pressure chamber (diaphragm). Hence, there are no tests to verify the integrity of the secondary chamber after assembly. Although the secondary chamber cannot be exposed to a pressure test due to the presence of the diaphragm, prelaunch tests are performed which verify the presence of vacuum within the secondary chamber.

C 10. Material for the diaphragm and secondary containment chamber is 17-4PH stainless steel per engineering drawings.

C 11. Per engineering, use of dissimilar metals complies with MIL Specifications.

C 12. Qualification testing was performed per engineering. Testing associated with degradation of material properties included the following:

a. Storage life
b. Humidity

C 13. Assurance that this part is resistant to hydrogen embrittlement is established by heat treatment per engineering.

C 14. Stress corrosion of the diaphragm is controlled by solution annealing. Other parts of the transducer are also heat treated per engineering.

C 15. Flaw growth analysis per TWR-61739 shows that the design and materials selected have high resistance to stress corrosion cracking and flaw growth.

D 16. Electron beam welds and resistance welds comply with engineering.

9.2 TEST AND INSPECTION:

DCN	FAILURE CAUSES and TESTS	(T)			CIL CODES
			1.	For New Transducer, Motional Pickup, Pressure, verify:	
B,D		(T)	a.	Helium leak test	AIK000
B			b.	Final header assembly for completeness	AOY000
B			c.	Glass insulation in header assembly is resistance tested following header assembly fabrication	AOY001
A,B,D			d.	Certificate of Conformance is complete and acceptable	AAP024
B			e.	Heat treat prior to welding	AAP029
A,D			f.	No shipping or handling damage to the container or transducer	AAP039
D			g.	Records for welds per approved vendor specification	AAP111
A			h.	OPT pressure housing, diaphragm and fitting end (port) are 17-4PH stainless steel or equivalent material	AAP187
A		(T)	i.	Each transducer is subject to 150 percent of rated pressure	AAP209
B			j.	Workmanship (cleanliness)	AAP349
			2.	For Refurbished Transducer, Motional Pickup, Pressure, verify:	
A,C			a.	Each transducer is subject to 150 percent of rated pressure	AAP005
C			b.	All transducer exterior surfaces are cleaned	AAP013
A,C,D			c.	No shipping or handling damage	AAP042
A,D			d.	The transducer is in its protective container	AAP266
			3.	KSC verifies:	
B		(T)	a.	Operation of chamber pressure transducer circuits, after power is applied, to time of launch commit per OMRSD, File II, Vol I, S00000.450	OMD004
B		(T)	b.	Chamber pressure transducer bias and calibration values during prelaunch operations per OMRSD File II, Vol I, S00FF0.161	OMD016
B		(T)	c.	Chamber pressure transducer bias and calibration values are at 75% full scale during prelaunch operations per OMRSD, File II, Vol I, S00FF0.180	OMD017
A,C			d.	Installed transducers are free from damage and contamination per OMRSD File V, Vol I, B47TD0.030	OMD115