ATK ALLIANT TECHSYSTEMS
THIOKOL PROPULSION

CRITICAL ITEMS LIST (CIL)

No. 10-04-02-01/01

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 N	PART NO.:	(See Table A-4)
CIL REV NO.:	N	PHASE(S):	Boost (BT)
DATE:	27 Jul 2001	QUANTITY:	(See Table A-4)
SUPERSEDES PAGE:	507-1ff.	EFFECTIVITY:	(See Table 101-6)
DATED:	31 Jul 2000	HAZARD REF:	SI-01
CIL ANALYST:	D. F. Bartelt		
APPROVED BY:		DATE:	

RELIABILITY ENGINEERING: K. G. Sanofsky 27 Jul 2001

ENGINEERING: J. W. Edwards 27 Jul 2001

1.0 FAILURE CONDITIONS: Failure during operation (D)

2.0 FAILURE MODE: 2.0 Erroneous electrical output (two transducers)

3.0 FAILURE EFFECT: When the separation system is armed, low pressure indications could give early signal of tail off, resulting in premature separation and loss of RSRM, SRB, crew, and vehicle

4.0 FAILURE CAUSES (FC):

FC NO.	DESCRIPTION	FAILURE CAUSE KEY
2.1	Inoperable components due to:	
2.1.1	Faulty electrical circuit	A
2.1.2	Mechanical diaphragm failure	B
2.1.3	Weld failure	C
2.1.4	Plugged inlet port	D
2.2	Improper calibration	E

5.0 REDUNDANCY SCREENS:

SCREEN A: Pass--Output between 764.5 psia " 5 percent of full-scale during the prelaunch chamber pressure simulation test ensures the transducers are properly calibrated. After the test, output between zero and 65 psia ensures the transducers are operational and unbiased. Loss of measurement is detected by the following measurement numbers:

B47P1300A
B47P2300A
B47P1301A
B47P2301A
B47P1302A
B47P2302A

SCREEN B: Pass--Loss of a transducer is detectable by the GPC. Loss of measurement is detected by the following measurement numbers:

B47P1300A
B47P2300A
B47P1301A
B47P2301A
B47P1302A
B47P2302A

595 SCREEN B: Pass--Loss of a transducer signal is detectable by the GPC. Loss of measurement is detected by the following measurement numbers:

B47P1300A
B47P2300A
B47P1301A
B47P2301A
B47P1302A
B47P2302A

SCREEN C: Pass--No more than one transducer can be lost by a single credible cause.

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
1U77610	Segment, Rocket Motor, Forward	Composite of Various Components		1/motor
1U50188	Transducer, Motional Pickup Pressure	17-4PH CRES		3 ea/motor
1U77363	Transducer Bolt Assembly	Composite of Various Components		3 ea/motor

6.1 CHARACTERISTICS:

1. The Motor Chamber Pressure Transducer provides an electrical signal to represent chamber pressure, maintains structural integrity of the RSRM pressure vessel, and indicates 50 psi at pressure tailoff to provide a cue for separation of the SRBs from the external tank. 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.

2. Less than 50 psi indications from two failed OPTs after 100 seconds on each RSRM will cause premature separation of SRBs. Two OPTs on each SRB have to give a less than 50 psi indication, if not, a timer will start separation at 129.8 seconds.

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

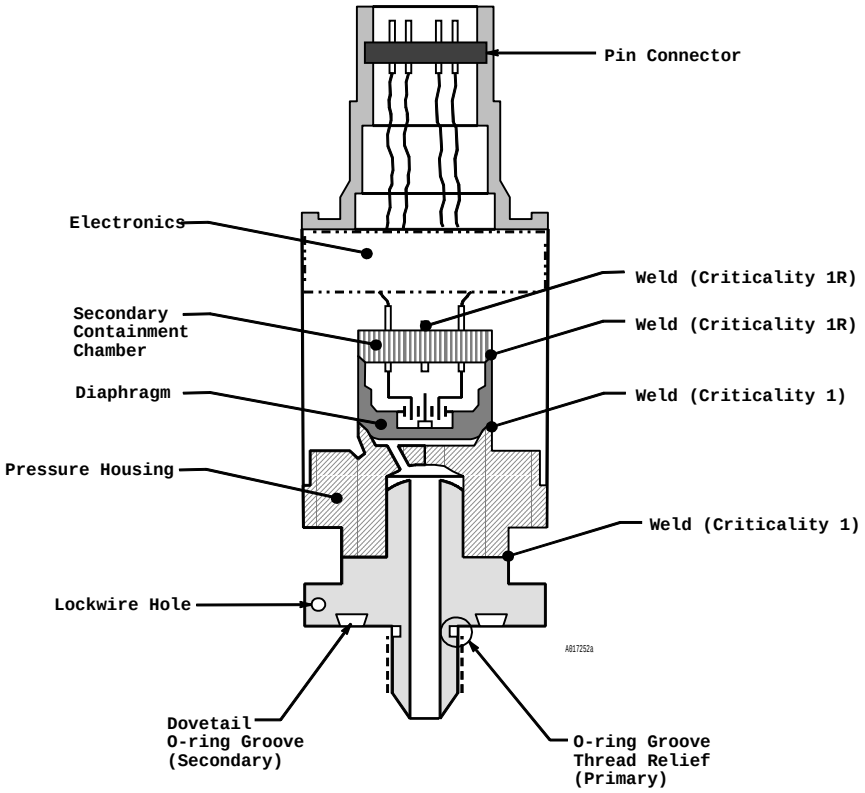

Figure 1. Pressure Transducer Section

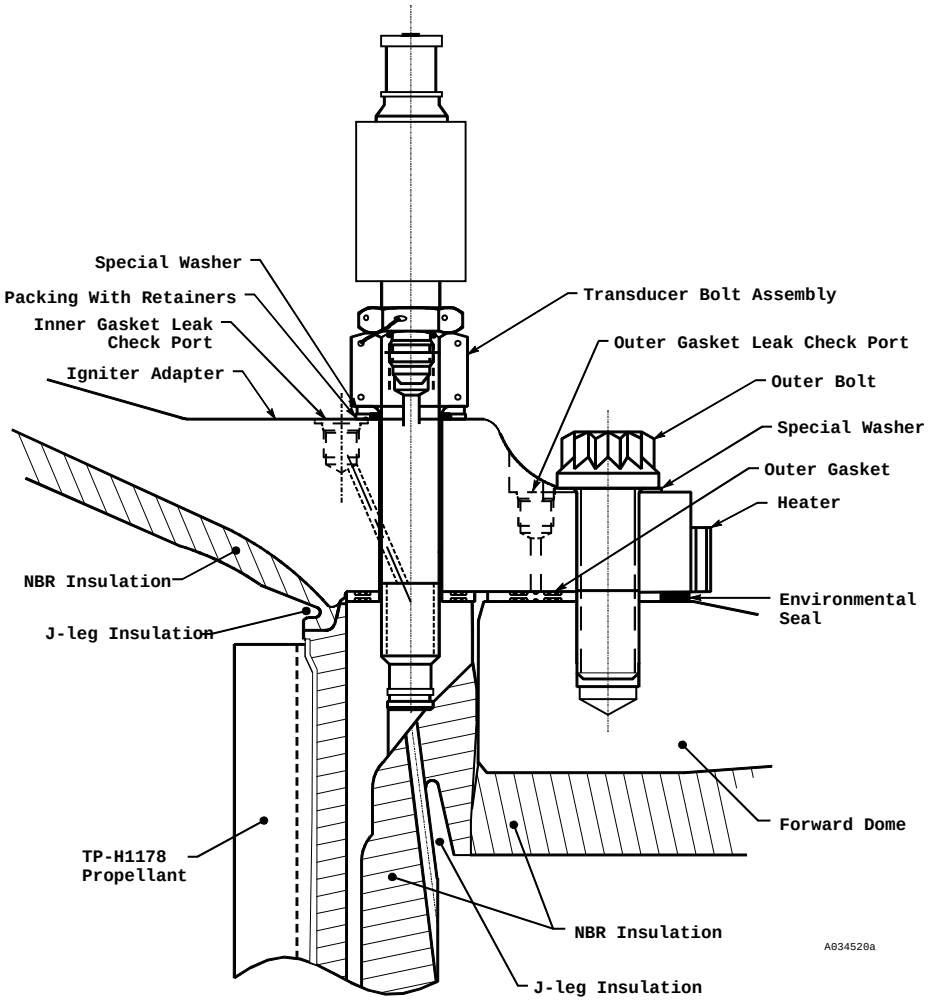

Figure 2. Installed Pressure Transducer and Special Bolt

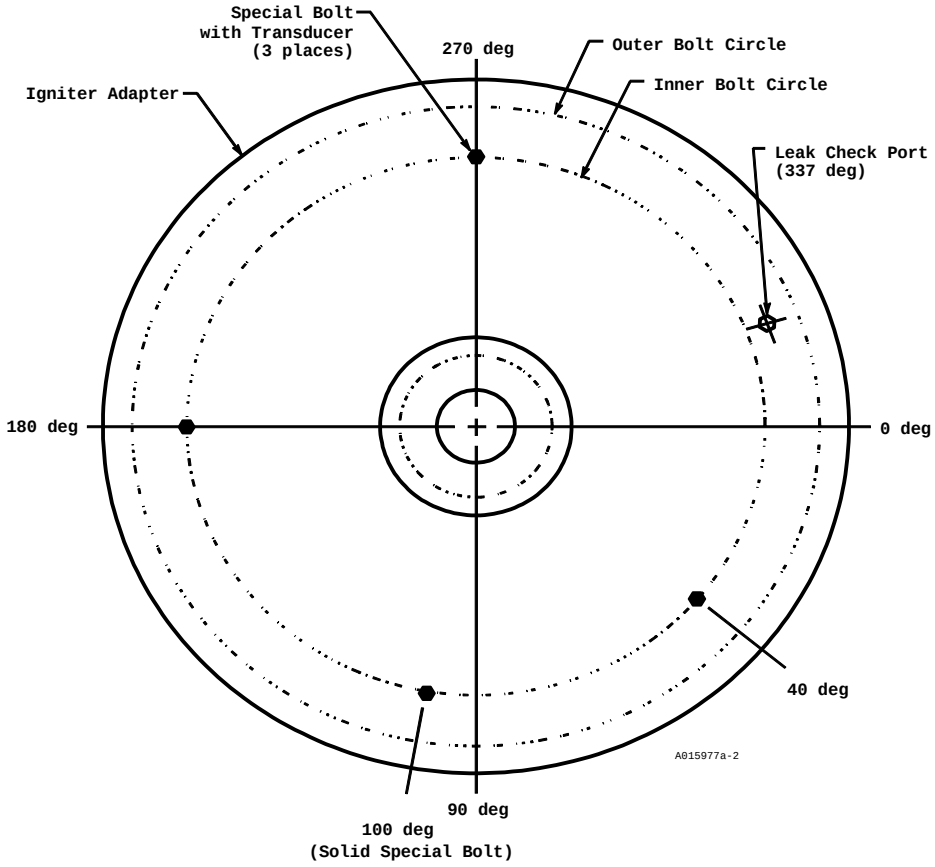

Figure 3. Special Bolt and Leak Check Port Location

9.0 RATIONALE FOR RETENTION:

9.1 DESIGN:

DCN FAILURE CAUSES

A,D,E 1. Transducer redundancy assures separation cue availability in case of electrical failure of a single transducer. Engineering requires three transducers at specified degree locations. Physical separation enhances redundancy.

A,B,C,E 2. Qualification testing was performed as follows:

a. Transducers were demonstrated to meet electrical performance requirements after exposure to ground and flight environment cycles including 150 percent of maximum expected operating pressure.
b. These tests demonstrated a performance reliability of 95 percent with at least 95 percent confidence (58 tests on each of 5 OPTs).

A,B,C,E 3. Transducer certification is per TWR-10405. This report shows similarity to the original Qualification Test Report by Bell & Howell (QTR-10210-21C).

B 4. Design requirements for the transducer diaphragm are per engineering as follows:

a. The diaphragm and housing are designed to withstand a pressure of 200 percent of rated pressure without permanent deformation or physical damage.
b. Material: Diaphragm material must be heat treated 17-4PH stainless steel. The material is tested for the following:

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

c. After welding, the joints are heat treated.

B,C 5. 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.

C 6. Design requirements for welds are per engineering as follows:

a. Pressure housing welds are designed to withstand 200 percent of the rated pressure without permanent deformation or physical damage
b. Material: The pressure housing is constructed of welded and heat treated 17-4PH stainless steel. The material is tested follows:

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.

C 7. Electron beam and Resistance welds are performed per engineering.

D 8. Transducer redundancy assures separation cue availability in case of plugging of a transducer inlet port.

D

9. The inlet port is located in the insulation j-leg on the exterior of the Igniter Chamber per engineering drawings. TWR-63655 shows tolerance study findings for the Special Bolt and Chamber insulation, provides gas flow analysis, and includes insulation structural analysis relative to this port.

9.2 TEST AND INSPECTION:

DCN	FAILURE CAUSES and TESTS (T)			CIL CODES
		1.	For New Transducer, Motional Pickup, Pressure verify:	
C	(T)	a.	Helium leak test	AIK000
B,C	(T)	b.	Each transducer is subject to 150 percent of rated pressure	AAP007,AAP209
A	(T)	c.	Isolation impedance	AAP008,AAP011
A,B		d.	Certificate of Conformance is complete and acceptable	AAP024
A,B,C		e.	No shipping or handling damage to the container or transducer	AAP039
A		f.	Electrical receptacle conforms to military specification	AAO062
A	(T)	g.	Excitation power supply	AAP067,AAP070
A	(T)	h.	Hysteresis	AAP101,AAP104
C		i.	Records for welds per approved supplier specification	AAP111
A	(T)	j.	Insulation resistance	AAP112,AAP118
A,E		k.	Launch pad calibration temperature range	AAP124,AAP130
A	(T)	l.	Noise	AAP143,AAP144
A	(T)	m.	Non-linearity	AAP154,AAP157
A	(T)	n.	Non-repeatability	AAP163,AAP166
B		o.	OPT pressure housing, diaphragm and fitting end(port) are 17-4PH stainless steel or equivalent material	AAP187
A	(T)	p.	Output limit	AAP197
A	(T)	q.	Output voltage	AAP199,AAP202
A,E	(T)	r.	Simulated pressure calibration	AAP275,AAP279
A	(T)	s.	Thermal sensitivity shift	AAP313,AAP318
A	(T)	t.	Thermal zero shift	AAP320,AAP325
A	(T)	u.	Vibration response	AAP336
A	(T)	v.	Zero-pressure output voltage	AAP350,AAP353
		2.	For Refurbished Transducer, Motional Pickup, Pressure verify:	
A,B,C	(T)	a.	Each transducer is subject to 150 percent of rated pressure	AAP005
A	(T)	b.	Isolation impedance	AAP012
D		c.	All exterior surfaces of each transducer cleaned	AAP013
A,C		d.	No shipping or handling damage	AAP042
B,D		e.	Each transducer pressure port is flushed	AAP056
A	(T)	f.	Power supply	AAP071
A	(T)	g.	Transducer error (linearity, hysteresis, non-repeatability, thermal zero shift, and thermal sensitivity shift)	AAP107
A	(T)	h.	Insulation impedance	AAP119
A	(T)	i.	Noise	AAP145
A	(T)	j.	Output impedance	AAP194
A	(T)	k.	Output voltage	AAP205
A,E	(T)	l.	Simulated pressure calibration	AAP222
A,B,C		m.	Transducer in protective container	AAP266
A	(T)	n.	Zero-pressure output voltage	AAP354
		3.	For New Transducer Bolt Assembly, verify:	
A		a.	No loose, bent, or broken pins	AAP153
		4.	For New Segment, Rocket Motor, Forward, verify:	
D		a.	Insertion of a wire or rod into the transducer pressure holes to ensure there is no foreign material blocking the holes	AEG436

5. KSC verifies:

A,E	(T)	a.	Chamber pressure transducer bias and calibration values during prelaunch operations per OMRSD File II, Vol I, S00FF0.161	OMD016
A,B		b.	Installed transducers are free from damage per OMRSD File V, Vol I, B47TD0.030	OMD115