ATK ALLIANT TECHSYSTEMS
THIOKOL PROPULSION

CRITICAL ITEMS LIST (CIL)

No. 10-04-02-01/02

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.:	M (DCN-562R1)	PHASE(S):	Boost, Separation (BT, SP)
DATE:	05 Oct 2001	QUANTITY:	(See Table A-4)
SUPERSEDES PAGE:	508-1ff.	EFFECTIVITY:	(See Table 101-6)
DATED:	31 Jul 2000	HAZARD REF.:	BI-02
CIL ANALYST:	D. F. Bartelt		
APPROVED BY:		DATE:	

RELIABILITY ENGINEERING: K. G. Sanofsky 05 Oct 2001

ENGINEERING: K. J. Speas 05 Oct 2001

1.0 FAILURE CONDITIONS: Failure during operation (D)

2.0 FAILURE MODE: 5.0 Leakage of the primary and secondary O-rings

3.0 FAILURE EFFECT: Boost: Leakage of the redundant O-rings would result in Forward Dome burn-through causing a loss of RSRM, SRB, crew, and vehicle.

Separation: Leakage of the redundant O-rings would result in loss of the separation system causing a loss of RSRM, SRB, crew, and vehicle.

4.0 FAILURE CAUSES (FC):

FC NO.	DESCRIPTION	FAILURE CAUSE KEY
5.1	O-ring geometric deviations, cross-section and circumferential diameters too small	A
5.2	O-ring groove does not meet dimensional and surface finish requirements	B
5.3	O-ring cut, damaged, improperly installed, or has voids or inclusions	C
5.4	Improper lubrication of seals or nonconforming lubricant	D
5.5	Metal surface contamination	E
5.6	Damage to sealing surfaces during transportation and handling	F
5.7	O-ring contamination	G
5.8	Nonconforming O-ring material	H
5.9	Degradation of elastomer due to exceeded shelf life or installation life in the presence of moisture or fungus	I
5.10	Transducer fails to maintain a compressive load on the seals	
5.10.1	Improper torque applied	J
5.10.2	Thread damage or contamination	K

5.0 REDUNDANCY SCREENS:

SCREEN A: Fail--The redundant O-ring for the OPT is not verified
SCREEN B: Fail--The redundant O-ring for the OPT is not verified during boost and separation
SCREEN C: Pass--The use of a dovetail and chamfer for O-rings make a single cause not credible

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
1U77363	Transducer Bolt, Assembly	Composite of Various Components		3/Motor
1U50188	Transducer, Motional Pickup Pressure	17-4PH CRES		3/Motor
1U77356	Bolt, Special	MP159 High-strength Alloy	AMS-5842	3/Motor
1U50228	Packing, Preformed	Fluorocarbon Rubber	STW4-3339	3/Motor
	Lock/safety wire	CRES	MS20995C32	A/R/Motor
	Lubricant, Thread	Molykote 321R Lubricant	STW4-2955	A/R/Motor
	Corrosion-Preventive Compound and O-ring Lubricant	Heavy-Duty Calcium Grease	STW5-2942	A/R/Motor
1U51916	Cartridge Assembly	Heavy-Duty Calcium Grease, Filtered and Placed in an Application Cartridge	STW7-3657	AR

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 activities can be found in the PRACA database.

8.0 OPERATIONAL USE: N/A

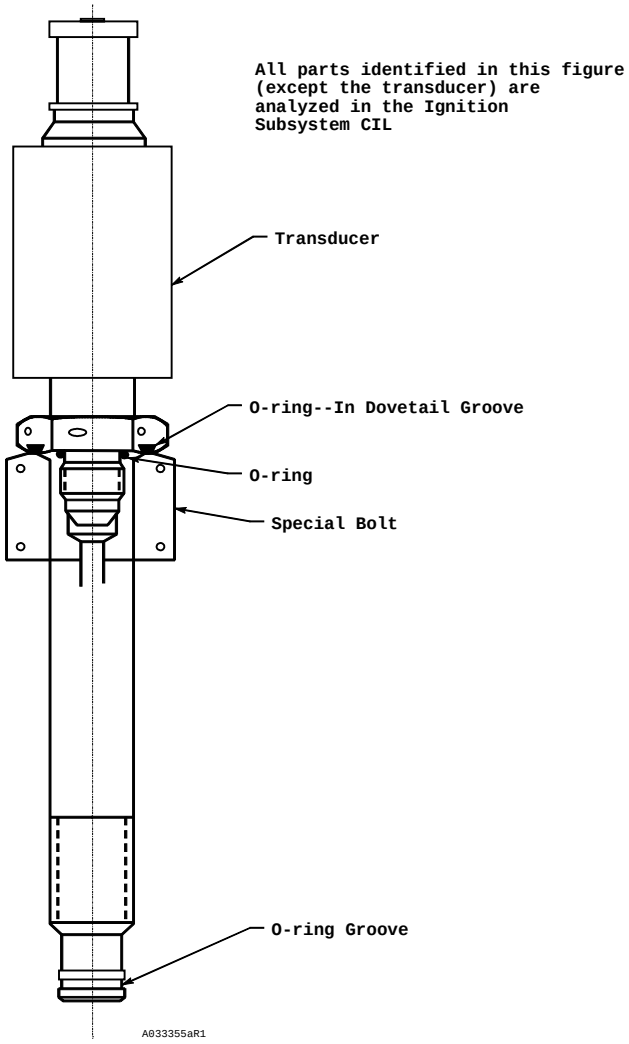

Figure 1. Transducer Bolt Assembly

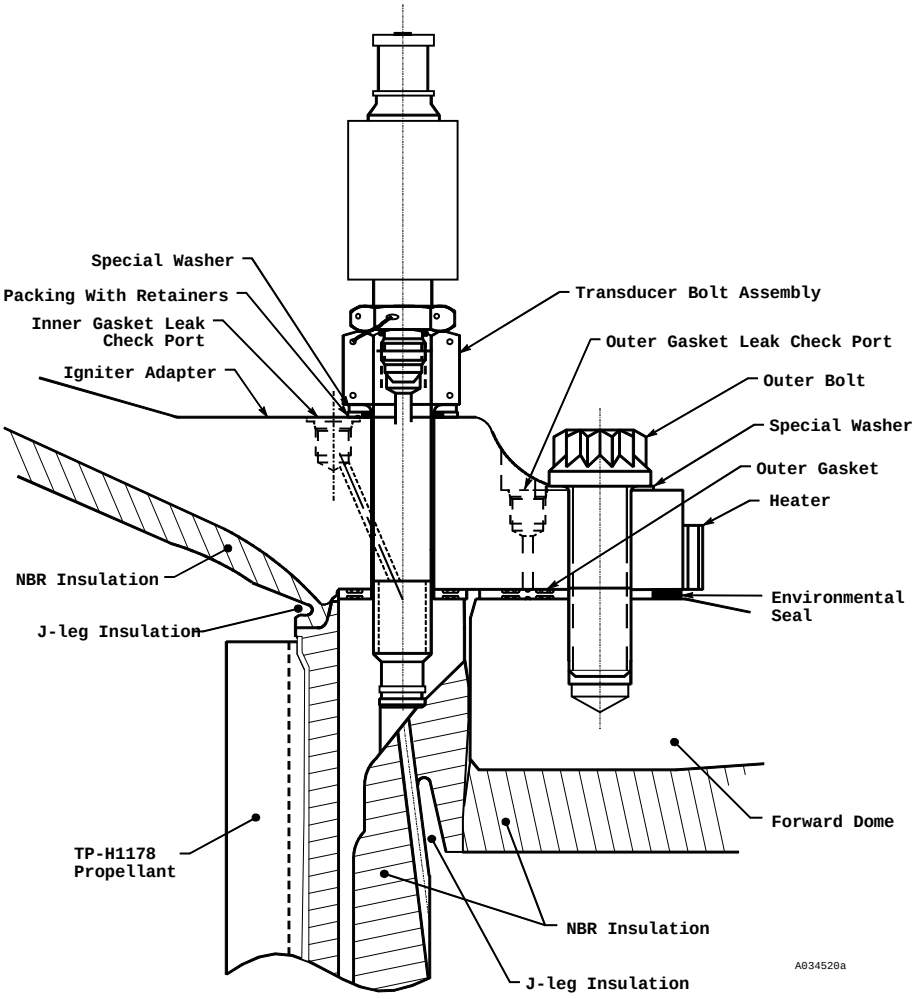

Figure 2. Installed Pressure Transducer and Special Bolt

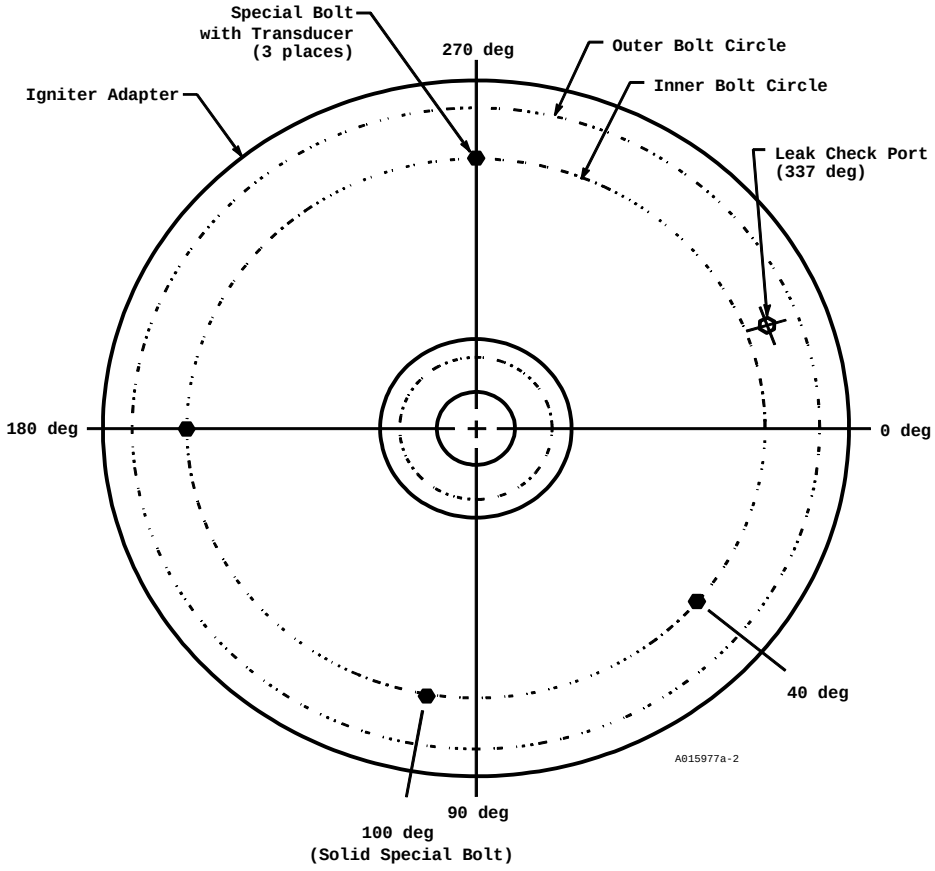

Figure 3. Special Bolt and Leak Check Port Location

9.0 RATIONALE FOR RETENTION:

9.1 DESIGN:

DCN	FAILURE CAUSES	
A,G	1.	Small O-rings are per engineering that establishes geometric dimensions and fabrication details.
B	2.	O-ring grooves are per engineering drawings for the transducer to provide the recommended squeeze.
B	3.	Transducer design uses O-ring gland designs per engineering.
C	4.	Small O-ring surface quality is per engineering that establishes design requirements and fabrication details.
C	5.	O-ring grooves are per engineering drawings to provide the recommended squeeze.
C	6.	Small O-rings are replaced with new small O-rings upon disassembly of the Transducer Bolt Assembly.
G	7.	Small O-rings are individually packaged per engineering.
C	8.	O-rings are lubricated with filtered grease.
D	9.	Design requirements for grease are per engineering. Grease was selected to inhibit metal corrosion and to aid in installation and sealing performance of the seals.
D	10.	Samples of the candidate material were subjected to qualification testing per engineering. These tests included the following: a. Drop point test per the ASTM test: Drop point was no less than 500°F and did not differ by more than 25°F. b. Apparent viscosity test per the ASTM test: Apparent viscosity did not exceed specifications at the required temperature.
D	11.	Compatibility was determined by exposing a lubricated O-ring to 350°F for 10 hours, then verifying the O-ring continued to meet dimensional and hardness requirements per engineering.
D	12.	Grease is stored at warehouse-ambient conditions that are any conditions of temperature and relative humidity experienced by the material when stored in an enclosed warehouse, in unopened containers, or containers that were resealed after each use. Storage life under these conditions is per engineering.
D	13.	Aging studies to demonstrate characteristics of grease after 5 years installation life were performed on TEM-9. Results showed that grease provided adequate corrosion protection for D6AC steel, and that all chemical properties of grease remained intact per TWR-61408 and TWR-64397.
E	14.	Average finish roughness for the bottom and sides of the groove of the special bolt and transducer facilitate cleaning and inspection.
E	15.	A corrosion-preventive compound is required for transducer bolt assembly.

	E	16. Prior to assembly and installation, transducer parts and the O-ring are cleaned per engineering.
	E,G	17. Contamination control requirements and procedures are per TWR-16564.
	F	18. Transducer motional pickup pressure is required to be preserved and packaged per procurement data list requirements (packing, handling, and transportation per engineering).
	F	19. To assure sealing surfaces were not damaged during shipping and handling, a leak test is performed on the Transducer Bolt Assembly.
	H,I	20. Small O-rings are high-temperature, low-compression set, fluid-resistant, black fluorocarbon rubber.
	H	21. Normal working temperature range for O-ring material is considered to be minus 15°F to 400°F and up to 600°F for short periods (Parker Handbook, ORD-5700). Thermal requirements for the transducer are 20°F to 400°F per engineering.
	H	22. Comparative material properties are listed in Parker Handbook ORD-5700 as follows: a. Chemical resistance — Good b. Heat resistance — Excellent c. Set resistance — Good to excellent
	I	23. Small O-rings are packaged and stored to preclude deterioration from ozone, grease, ultraviolet light, and excessive temperature. Small O-rings are individually packaged in an opaque, waterproof, grease proof, and heat-sealed bag per engineering.
	I	24. Small O-ring time duration of supplier storage and total shelf life prior to installation is per engineering.
	I	25. O-ring swell is negligible unless the O-ring undergoes a long period of water immersion (O-ring Handbook, ORD 5700, Copyright 1982, by Parker Seal Group, Lexington, KY).
	I	26. Fluorocarbon rubber is a non-nutrient to fungus growth (O-ring Handbook, ORD 5700, Copyright 1982, by Parker Seal Group, Lexington, KY).
	I	27. Small O-rings are kept dry and clean prior to packaging.
	I	28. Aging studies of O-rings after 5 years installation life were performed. Test results are applicable to all RSRM fluorocarbon seals. Fluorocarbon maintained its tracking ability and resiliency. Fluorocarbon was certified to maintain its sealing capability over 5 years per TWR-65546.
	I	29. Small O-rings and filtered grease are included in forward segment life verification.
562	J	30. The Transducer Bolt Assembly is torqued and lock/safety wired, double-twist method, using lock/safety wire per the industry standard.
	K	31. Interface between the transducer and Special Bolt has threads with a Class 3 fit, which help prevent engagement if damaged or contaminated.
	K	32. Each New Transducer, Motional Pickup Pressure, is subjected to Radiographic and Dye Penetrant inspection per engineering.

K 33. Each Transducer, Motional Pickup Pressure, proposed for reuse is subjected to a Dye penetrant inspection per engineering.

B,F,K 34. Igniter special bolts are acceptable for reuse if engineering requirements are met. The special bolts are considered a fracture control item per TWR-16874. The bolts are made from a high-strength multiphase alloy with high fracture toughness and resistance to stress corrosion per TWR-66014. After refurbishment, Special Bolts must meet the eddy current inspection criteria.

9.2 TEST AND INSPECTION:

DCN	TESTS	(T)	FAILURE CAUSES and	CIL CODES
			1. For New Small O-ring verify:	
A			a. Correct identification	AAQ047
A			b. Inside diameter "A"	AAQ002,AAQ003
A			c. Cross-sectional dimension "W"	AAQ004,AAQ062
A			d. Flash dimensions	AAQ111,AAQ112
C,G			e. Dry and clean prior to packaging	AAQ092,AAQ023
C,G,I			f. Surface quality	AAQ234,AAQ233
C,G,I			g. Package has no damage or violation of the seal	AAQ120
C,G,I			h. No shipping or handling damage	AAQ212
G,I			i. Individually packaged and sealed in opaque bags; material is per engineering	AAQ211
H,I			j. Material is fluorocarbon rubber	AAQ157,AAQ117
H		(T)	k. Shore A hardness	LAA001,LAA006,LAA011,LAA016
H		(T)	l. Tensile strength	LAA002,LAA007,LAA012,LAA017
H		(T)	m. Ultimate elongation	LAA003,LAA008,LAA013,LAA018
H		(T)	n. Compression-set	LAA004,LAA009,LAA014,LAA019
H		(T)	o. Tear strength	LAA005,LAA010,LAA015,LAA020
I			p. Time from cure date to shipment	AAQ251
			2. For New Transducer Bolt Assembly, verify:	
A,B,C, D,E,F,G		(T)	a. Leak test results	AHC018
C,E,I,k			b. Cleanliness of Special Bolt prior to assembly	AHC008
C,E,I,k			c. Cleanliness of transducer prior to assembly	AHC008A
C,E,G,I,k			d. Cleanliness of O-rings prior to assembly	AHC009
C			e. O-rings are properly installed on transducer prior to assembly to Special Bolt	AHC030
D			f. Proper lubricant has been applied to O-rings	AHC001
I			g. O-ring shelf life compliance per acceptance tag, prior to installation	AHC031
J,k			h. Molykote lubricant spray has been applied to threads of the transducer and air dried before installation	AHC001A
J			i. Torque value acceptable	AHC040
J			j. Bolt-to-pressure transducer gap	MKL006
J			k. Proper safety wiring	AHC032
			3. For New Transducer, Motional Pickup, Pressure verify:	
B			a. Depth of dove tail o-ring groove	AAP000
B			b. Outside diameter of dove tail o-ring groove	AAP001
B			c. Width of dove tail o-ring groove	AAP003
B,E,F,K			d. No shipping or handling damage to the container or transducer	AAP039
B,F			e. Sealing surfaces are per specification	AAP306
B,E,K			f. Workmanship (cleanliness)	AAP349
B			g. Surface finishes	AAQ094
K			h. Certificate of Conformance is complete and acceptable	AAP024
K			i. Pressure fitting threads conform to specification	AAP078
K			j. OPT pressure housing, diaphragm and fitting end (port) are 17-4PH stainless steel or equivalent material	AAP187
K			k. Protective caps in place	AAP227
K		(T)	l. Dye penetrant inspection is acceptable	MKL010
K		(T)	m. Radiographic inspection is acceptable	MKL011

		4.	For Refurbished Transducer, Motional Pickup, Pressure verify:	
K		a.	All exterior surfaces of each transducer cleaned	AAP013
K		b.	Defect repairs are acceptable	MKL014
K	(T)	c.	Dye penetrant inspection is acceptable	MKL015
K		d.	No visible defects.	AAP037
K		e.	Pressure fitting threads are acceptable	AAP076
B,F		f.	Sealing surfaces are per specification	AAP137
		5.	For New Grease verify:	
D	(T)	a.	Penetration	LAA037
D	(T)	b.	Zinc concentration	LAA038
D	(T)	c.	Drop point	ANO042
D		d.	Type	ANO050
D		e.	No shipping or handling damage	ANO058
		6.	For New Filtered Grease verify:	
D	(T)	a.	Contamination	ANO064
		7.	For New Bolt, Special, verify:	
J		a.	Head width	ACC003
K		b.	Port depth	ACC007
E,K	(T)	c.	Eddy current inspection is acceptable	CCC055
E,F,K		d.	No shipping or handling damage	ACC076
K		e.	Port is per engineering	ACC094
E		f.	Surface finish of sealing surfaces in port area	ACC110
		8.	For Refurbished Special Bolt verify:	
B,F,K		a.	Surface finish of O-ring groove	LHA901
B,F,K		b.	Surface finish of shank and bolt head bottom surface	LHA902
B,F,K		c.	External threads	LHA903
B,F,K		d.	Port threads	LHA904
B,F,K		e.	Surface finish of sealing surfaces in port area	LHA905
B,F,K		f.	Eddy current inspection is acceptable	LHA906
		9.	KSC verifies:	
I		a.	Life requirements for the expected launch schedule are met per OMRSD File II, Vol. III, C00CA0.030	OMD019
562 J		b.	Lock/safety wire on the igniter adapter inner and outer bolt circles, the OPTs, and the RSRM Port Plugs (leak check port plug for lock/safety wire) to be unbroken prior to forward skirt closeout per OMRSD File V, Vol. I, B47IG0.040	OMD045