ATK ALLIANT TECHSYSTEMS
THIOKOL PROPULSION

CRITICAL ITEMS LIST (CIL)

No. 10-05-02-09R/01

SYSTEM:	Space Shuttle RSRM 10	CRITICALITY CATEGORY:	1R
SUBSYSTEM:	Assembly Hardware/Interfaces 10-05	PART NAME:	Case-to-Nozzle Joint, Primary O-ring, Leak Check Port Plug (2)
ASSEMBLY:	Case-to-Nozzle Interface 10-05-04		
FMEA ITEM NO.:	10-05-02-09R Rev M		
CIL REV NO.:	M (DCN-533)	PART NO:	(See Section 6.0)
DATE:	10 Apr 2002	PHASE(S):	Boost (BT)
SUPERSEDES PAGE:	354-1ff.	QUANTITY:	(See Section 6.0)
DATED:	31 Jul 2000	EFFECTIVITY:	(See Table 101-6)
CIL ANALYST:	R. E. L. Hamilton	HAZARD REF.:	BC-04
APPROVED BY:		DATE:	

RELIABILITY ENGINEERING: K. G. Sanofsky 10 Apr 2002

ENGINEERING: B. H. Prescott 10 Apr 2002

1.0 FAILURE CONDITION: Failure during operation (D)

2.0 FAILURE MODE: 1.0 Leakage of the primary O-ring and leak check port plug

3.0 FAILURE EFFECTS: Failure of the system would result in hot gasses eroding the leak check port creating a larger hole and allowing gas to escape, resulting in a loss of motor chamber pressure and expulsion of the nozzle, causing side thrust, thrust imbalance, or loss of TVC leading to a loss of RSRM, SRB, crew, and vehicle

4.0 FAILURE CAUSES (FC):

FC NO.	DESCRIPTION	FAILURE CAUSE KEY
1.1	Nonconforming O-ring dimensions or improper O-ring splice or repair	A
1.2	O-ring improperly installed, cut, or damaged	B
1.3	Transportation, handling, or assembly damage	C
1.4	Sealing surfaces contamination or corrosion	D
1.5	Age degradation of O-ring	E
1.6	Nonconforming O-ring voids, inclusions, or subsurface indications	F
1.7	Leak port plug improperly installed	G
1.8	O-ring gland does not meet dimensional or surface finish requirements	H
1.9	Moisture and/or fungus degradation of O-ring	I
1.10	Nonconforming physical or mechanical properties	J
1.11	Improper preload	K

5.0 REDUNDANCY SCREENS:

SCREEN A: Fail--The leak check port is not capable of verification.
SCREEN B: Fail--A decrease in motor chamber pressure is not detectable to the crew during boost.
SCREEN C: Pass--The redundant elements can not be lost due to a single credible cause.

1. The primary O-ring and leak check port plug, together, form part of a redundant seal system with the secondary O-ring seals. The leak check port plug will not be pressurized unless the primary O-ring fails. If the primary O-ring fails, the leak check port plug (in addition to the secondary O-ring) will be pressurized and maintain a seal. If the primary O-ring and the leak check port plug fail, a leak path will exist and could result in loss of crew and vehicle.

6.0 ITEM DESCRIPTION:

1. There is one nozzle-to-case joint on each RSRM. It has a leak check port located between the primary and the secondary O-ring. The assembled joint is shown per engineering drawings. Materials are listed in Table 1.

2. The leak check port plug is also known as RSRM Port Plug (leak check port plug).

TABLE 1. MATERIALS

Drawing No.	Name	Material	Specification	Quantity
1U75150	Packing, Preformed Fluorocarbon	Black Fluorocarbon Rubber	STW4-3339	1/motor
1U50228	Packing, Preformed	Black Fluorocarbon Rubber	STW4-3339	1/motor
1U78676	RSRM Port Plug (leak check port plug)	Stainless Steel	QQ-S-763 or AMS 5648	1/motor
1U51916	Cartridge Assembly	Heavy-duty Calcium Grease, Filtered And Placed in an Application Cartridge	STW7-3657	A/R
1U52945	Housing, Nozzle-Fixed			1/motor
1U50129	Case Segment, Aft			1/motor
1U75801	Packing, Lubricated	Black Fluorocarbon Rubber O-ring and Lubricant	STW7-2999	1/motor
	Corrosion-Preventive Compound and O-ring Lubricant	Heavy-Duty Calcium Grease	STW5-2942	A/R
1U77640	Segment Assembly, Rocket Motor, Aft			1/motor

6.1 CHARACTERISTICS:

1. The nozzle-to-case joint allows the nozzle assembly to be mounted to the aft case segment. The unit is sealed with an O-ring and there is a leak check port to verify there is no leakage after assembly (Figures 1 and 2).

2. The seals at the nozzle-to-case joint are designed so that the O-ring maintains constant contact with its cavity at all times. Squeeze and fill are taken into account relating to O-ring groove tolerance, case growth, joint rotation, and O-ring recovery tracking force.

3. The leak check port plug and its O-ring, as well as the primary O-ring, are one-time-use items.

4. The assembled RSRM is a combustion chamber made up of segments and the nozzle, sealed with O-ring, that must contain and direct the pressure generated by the burning propellant.

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

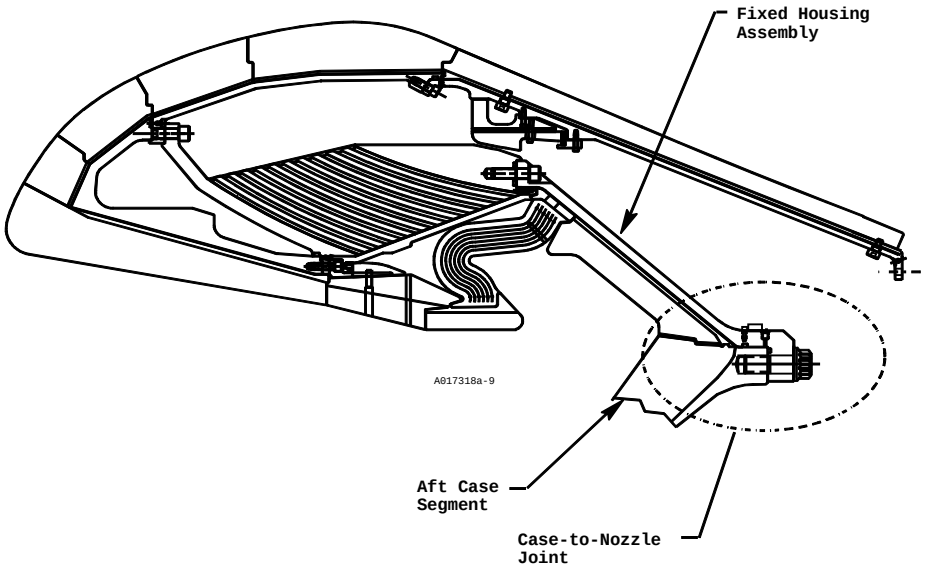

Figure 1. Case-to-Nozzle Joint Location

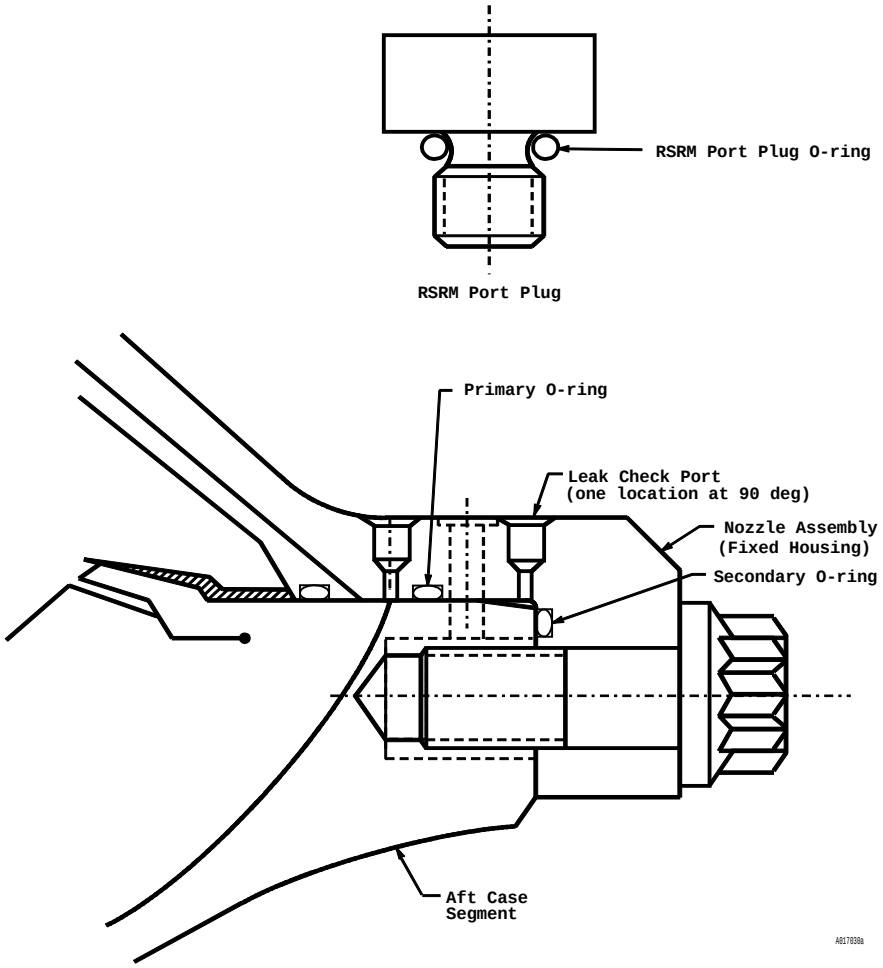

Figure 2. Case-to-Nozzle Joint, Leak Check Port, and RSRM Port Plug

9.0 RATIONALE FOR RETENTION:

9.1 DESIGN:

DCN	FAILURE CAUSES	
A	1.	The leak check port O-ring is a net-molded O-ring with no splices.
A	2.	Large O-rings conform to engineering that covers process controls for fabrication of spliced joints and repairs.
A	3.	Splice joints are cut on a specified angle and bonded together in a mold (using 100 percent of the scarf area) using an adhesive with the same physical and chemical properties as the parent stock.
A	4.	Criteria for primary O-ring dimensions are per TWR-15771.
A	5.	Both O-ring designs provide a constant contact between the O-ring and mating segment sealing surfaces.
A,F	6.	Small and large O-rings conform to engineering that establishes geometric dimensions and fabrication details.
A	7.	O-rings were tested to determine sizes and types of flaws that could cause sealing problems. Results are presented in TWR-17991.
B	8.	Large O-rings are individually packaged. a. Per engineering drawings prior to lubrication. b. Per engineering drawings after lubrication.
B	9.	Small O-rings are individually packaged per engineering.
B	10.	The leak check port O-ring is assembled with the RSRM Port Plug (leak check port plug) using an O-ring installation aid.
B	11.	The primary O-ring and the RSRM Port Plug (leak check port plug) are installed per engineering.
B	12.	Installation is performed after coating the O-ring with a light coat of filtered grease.
B	13.	Material selection for the O-ring was based in part on resistance to damage as documented in TWR-17082.
B	14.	Large O-rings are designed to allow for a minimum of stretching without damage. Proper installation without over-stretching is controlled per engineering.
B	15.	Design development testing regarding O-ring twisting and its effect on performance was performed per ETP-0153, with results documented in TWR-17991.
C	16.	Transportation and handling of nozzle assembly items by Thiokol is per IHM 29.
C	17.	The RSRM and its component parts, when protected per TWR-10299 and TWR-11325, are capable of being handled and transported by rail or other suitable means to and from fabrication, test, operational launch, recovery or retrieval, and refurbishment sites.
C	18.	Positive cradling or support devices and tie downs that conform to shape, size,

weight, and contour of components to be transported are provided to support RSRM segments and other components. Shock mounting and other protective devices are used on trucks and dollies to move sensitive loads per TWR-13880.

C 19. Support equipment used to test, handle, transport, and assemble or disassemble the RSRM is certified and verified per TWR-15723.

C 20. Analysis is conducted by Thiokol engineering to assess vibration and shock load response of the RSRM nozzle during transportation and handling to assembly and launch sites per TWR-16975.

C 21. The nozzle assembly is shipped in the aft segment. Railcar transportation shock and vibration levels are monitored per engineering and applicable loads are derived by analysis. Monitoring records are evaluated by Thiokol to verify shock and vibration levels per MSFC specification SE-019-049-2H were not exceeded. TWR-16975 documents compliance of the nozzle with environments per MSFC specifications.

C,D,I 22. Protection of leak check port threads from damage and contamination during handling is provided by installed protective plugs. Protective plugs are removed when leak tests are performed and a flight plug (RSRM Port Plug, leak check port plug) is installed. Inspections are performed to verify no transportation or handling damage.

D 23. Corrosion-preventative compound is applied to all sealing surfaces per engineering.

D 24. Filtered grease is applied to all sealing surfaces per engineering.

D 25. Filtered grease filtering is per engineering to control contamination.

D 26. Removal of surface contamination or corrosion is standard shop practice used whenever contamination or corrosion is noted per shop planning.

D 27. Contamination control requirements and procedures are per TWR-16564.

E 28. Fluorocarbon rubber O-rings are suitable for periods of storage up to 20 years (O-ring Handbook, Ord 5700, Copyright 1982, by Parker Seal Group, Lexington, KY). Environment and age is significant to useful seal life, both in storage and actual service.

a. O-rings are packaged and stored to preclude deterioration caused by ozone, grease, ultraviolet light, and excessive temperature.

E 29. Small and large O-ring time duration of supplier storage and total shelf life prior to installation is limited per engineering

E 30. 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.

E 31. O-rings (leak check port and primary) are one-time-use items.

E 32. Grease is stored at warehouse-ambient condition that is any condition 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.

E	33.	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	34.	Large O-rings, small O-rings, and filtered grease are included in the aft segment life verification.
G,H	35.	RSRM Port Plug (leak check port plug) design requirements are established per engineering.
G	36.	To assure proper installation without thread damage, the RSRM Port Plug (leak check port plug) is installed per engineering.
G	37.	Required torque for the RSRM Port Plug (leak check port plug) is called out per engineering drawings and specifications. This value is based on results from sealability tests documented in TWR-16964.
H	38.	Primary O-ring gland design is established by engineering drawings and conforms to dimensions determined by Thiokol Design Engineering calculations for squeeze, fill, and tracking per TWR-15771.
H	39.	Fixed housing leak check port design conforms to the design criteria of MS specifications.
H	40.	The RSRM Port Plug (leak check port plug) is a one-time-use item.
H	41.	Design verification analysis of data from the live firing test series joint environmental simulator per TWR-16534 and TWR-17563 shows that O-ring sealing surfaces are acceptable for flight use as reported in TWR-18764-02.
H	42.	Sealing surface requirements during refurbishment are established per engineering for the fixed housing and aft case segment.
I	43.	Small and large O-rings are black fluorocarbon rubber.
I	44.	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	45.	Fluorocarbon rubber is a non-nutrient to fungus growth (O-ring Handbook, ORD 5700, Copyright 1982, by Parker Seal Group, Lexington, KY).
I	46.	Small and large O-rings are kept clean and dry prior to packaging.
I	47.	Small O-rings are individually packaged in an opaque, waterproof, grease-proof, and heat-sealed bag per engineering.
J	48.	The RSRM Port Plug (leak check port plug) is made from stainless steel per aerospace material specifications or Federal Specifications. The RSRM Port Plug (leak check port plug) is a one-time-use item.
J	49.	Small and large O-rings are high-temperature, low compression set, fluid-resistant, black fluorocarbon rubber.
J	50.	Filtered grease material requirements are per engineering.

	J	51. Temperature prior to launch is monitored for the nozzle flexible bearing and case-to-nozzle joint and is maintained to requirements as established per TWR-15832. Joint thermal analysis (O-ring resiliency testing) is documented in TWR-16818.
	K	52. Snug torque values, installation sequence, and angle of rotation for the axial and radial bolts of the Nozzle-to-Case Joint are per engineering. The bolt loading method was qualified per TWR-66211 and TWR-66738.
	K	53. Nozzle-to-case joint radial and axial bolts are refurbished per engineering.
	K	54. Structural analyses per TWR-16975 show that all metal components of the joint have a positive margin of safety based on factors of safety of 1.4 on ultimate and 1.1 on yield.
	K	55. Nozzle-to-case joint axial bolts are heat treated Inconel 718. Requirements are for tensile and yield strengths.
	K	56. Radial bolt Material is heat treated MP35N alloy steel per AMS specifications.
	K	57. Aft Dome internal threads at the Case-to-Nozzle Joint must satisfy thread requirements for new and refurbished Aft Domes per engineering. Threads will have no damage or defects greater than called out in engineering. Threads are inspected after proof testing.
	K	58. New and refurbished Aft Domes are proof tested per engineering. Aft Dome threads are loaded in this test.
	K	59. Thread damage repair requires Discrepancy Report and Materials Review Board action per engineering. Helical inserts may be used per engineering.
	K	60. Nozzle-to-Case bolt preload controls joint gap opening when dimensions and allowable surface defects are within limits per engineering. Thermal analysis per TWR-17016, TWR-73594, and testing demonstrates that controlled gap opening (less then 0.004 inch) reduces the temperature of motor gas to the primary O-ring and greatly reduces the gas temperature at the secondary O-ring.
	A,C,H	61. Analysis of carbon-cloth phenolic ply angle changes for the nozzle was performed. Results show that redesigned nozzle phenolic components have a reduced in-plane fiber strain and wedge-out potential per TWR-16975. New loads that were driven by the Performance Enhancement (PE) Program were addressed in TWR-73984. No significant effects on the performance of the RSRM nozzle were identified due to PE.
533	A,C,H	62. Thermal analysis per TWR-17219 shows the nozzle phenolic meets the new performance factor equation based on the remaining virgin material after boost phase is complete. This performance factor will be equal to or greater than a safety factor of 1.4 for the fixed housing assembly per TWR-74238 and TWR-75135. (Carbon phenolic-to-glass interface, bondline temperature and metal housing temperatures were all taken into consideration). The new performance factor will insure that the CEI requirements will be met which requires that the bond between carbon and glass will not exceed 600 degree F, bondline of glass-to-metal remains at ambient temperature during boost phase, and the metal will not be heat affected at splashdown.
	A,C,H	63. TWR-61410 was updated to include boundary conditions created by the Performance Enhancement (PE) Program. This report analyzed temperature conditions created from flight loads. PE temperatures are equal to current generic temperatures for all locations for the critical time of liftoff. For a few locations at the

factory joints and case acreage during flight, temperatures rise, but only slightly, and maximum case temperatures are lower than current generic certification. For flight load events, PE temperatures are not significantly different from current generic temperatures. There is no impact on previous analyses or margins of safety for case membranes, factory joints, and field joints per TWR-61410.

G 64. Port plug vibration testing, documented in TWR-73485, demonstrated that a very small amount of torque from any combination of O-ring load or thread friction is sufficient to prevent loss of port plugs during flight.

G 65. RSRM Port Plug (leak check port plug) vibration testing, documented in TWR-73485, demonstrated that a very small amount of torque from any combination of O-ring load or thread friction is sufficient to prevent loss of port plugs during flight.

9.2 TEST AND INSPECTION:

DCN	FAILURE CAUSES and TESTS (T)			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
B,F,I		e.	Surface quality	AAQ234,AAQ233
E,I		f.	Individually packaged and sealed in opaque bags; material is per engineering	AAQ211
E		g.	No shipping or handling damage	AAQ212
I,J		h.	Material is fluorocarbon rubber	AAQ157,AAQ117
I		i.	Dry and clean prior to packaging	AAQ092,AAQ023
J	(T)	j.	Shore A hardness	LAA001,LAA006,LAA011,LAA016
J	(T)	k.	Tensile strength	LAA002,LAA007,LAA012,LAA017
J	(T)	l.	Ultimate elongation	LAA003,LAA008,LAA013,LAA018
J	(T)	m.	Compression-set	LAA004,LAA009,LAA014,LAA019
J	(T)	n.	Tear strength	LAA005,LAA010,LAA015
		2.	For New Large O-ring verify:	
A		a.	Diameter	AEB014,AEB015,AEB018 AEB023,AEB026,AEB027
A		b.	Correct identification	AEB087,AEB100
A		c.	Splice is bonded over 100 percent of the scarf area	AEB133,AEB134
A		d.	No more than five splices	AEB167,AEB169
A		e.	Repairs	AEB265,AEB266
A		f.	Adhesive is made from fluorocarbon rubber	AEB308,AEB311
A		g.	Splice bond integrity	AEB317,AEB319
A,F	(T)	h.	Subsurface indications	AEB354
A,B,F,I		i.	Surface quality	AEB388,AEB389
A,J	(T)	j.	Tensile strength	AEB401,AEB402
A,J	(T)	k.	Ultimate elongation	AEB442,AEB443
B,E,I		l.	Packaging is free of staples or other objects	LAA054
E,I		m.	Packaging for damage or violation	AEB179
E,I,J		n.	Material is fluorocarbon rubber	AEB151,AEB141
I		o.	Clean and dry when packaged	AEB031,AEB034
J	(T)	p.	Shore A hardness	AGM304,AGM312
J	(T)	q.	Compression set	AKW006,AKW011
		3.	For New O-ring, Lubricated verify:	
B,E,I	a.		O-ring packaging was not damaged or violated	LAA103
B		b.	O-ring is cleaned and lubricated per drawing requirements	LAA104
B		c.	O-ring is packaged per drawing requirements	LAA105
		4.	For New RSRM Port Plug (leak check port plug) verify:	
D,J		a.	Plug material	AAB053
D,H		b.	No shipping or handling damage to packaging	AAB090
G		c.	Thread surface blemishes	LAA268
G		d.	Correct thread form	AAB082
G		e.	Plug length	AAB018
H		f.	O-ring groove width dimension	AAB047

H		g.	O-ring groove surface finish	AAB043
H		h.	O-ring groove diameter dimension	AAB036
H		i.	O-ring groove sealing surface blemishes	LAA264
J	(T)	j.	Tensile strength	AAB081
J	(T)	k.	Yield strength	AAB091

5. For New Grease verify:

D,E,I		a.	Material received in closed containers	ANO015
E,I		b.	Type	ANO050
E		c.	No shipping or handling damage	ANO058
J	(T)	d.	Penetration	LAA037
J	(T)	e.	Dropping point	ANO042
J	(T)	f.	Zinc concentration	LAA038

6. For New Filtered Grease verify:

D,E,I,J,K		a.	Grease is received from storage unopened or resealed	ACP015
D,E,I,J		b.	Shelf life of the grease, prior to filtering	AMB018L
D,E,I,J		c.	Contamination	ANO064
D,E,I,J		d.	Grease conforms to specification	LAA044
D,E,I,J		e.	Cartridge conforms to drawing	LAA046
D,E,I,J,K		f.	Filtered grease is capped and sealed after filling	LAA047
D,E,I,J,K		g.	Filtered grease is sent to storage capped and sealed (recapped and resealed)	LAA063

7. For New Case Segment, Aft, verify:

H		a.	Surface finish of aft boss O-ring sealing surfaces.	AAJ072
K		b.	Flatness of Datum -G-	AAJ062,AAJ063
K	(T)	c.	Axial and radial threaded bolt holes are eddy-current inspected after hydroproof, and all non-conforming conditions are dispositioned	AAJ051
K		d.	Depth of threads in aft boss threaded holes	AAJ038,AAJ039
K		e.	Tap drill depth of aft boss threaded holes	AAJ036,AAJ167
K		f.	Axial and radial threaded holes with Go-No-Go gauge after hydroproof	AAJ010

8. For Refurbished Case Segment, Aft, verify:

H		a.	Surface finish of aft boss O-ring sealing surfaces	AAJ157
K		b.	Axial and radial threaded holes with Go-No-Go gauge after hydroproof	AAJ011
K	(T)	c.	Axial and radial threaded bolt holes are eddy-current inspected after hydroproof, and all non-conforming conditions are dispositioned	RAA208

9. For New Housing, Nozzle-Fixed verify:

H		a.	Conformance of port to specification	ADV024
H		b.	Diameter	ADV049
H		c.	O-ring groove depth	ADV140
H		d.	Surface finish	ADV164,ADV167
H		e.	O-ring groove width	ADV146
K	(T)	f.	Ultimate tensile strength	ADV213
K	(T)	g.	Yield strength	ADV229
K		h.	Flatness	ADV039,ADV040,ADV042,ADV043

10. For Refurbished Housing, Nozzle Fixed verify:

H		a.	Surface finish	ADV192
		11.	For New Segment, Rocket Motor, Aft verify:	
B		a.	Correct identification of O-rings at time of installation	AGJ098,AGJ099
A,B,C, D,F,H	(T)	b.	Joint seal leak test results	AGJ157
B,G		c.	Proper initial installation of RSRM Port Plug (leak check port plug) prior to final torque	AGJ136
B,G		d.	Final torque properly performed during installation of RSRM Port Plug (leak check port plug)	AGJ126
B		e.	Proper installation of leak check port O-ring	AGJ240
B		f.	Installation and fit of primary O-ring	AGJ123
B,C		g.	Aft end sealing surfaces on Case Segment, Aft are free from damage	LAA083
B,C		h.	O-rings are free from damage prior to mating with RSRM Port Plug (leak check port plug)	AGJ130,AGJ131,AGJ189
B,G		i.	Application of lubricant to O-rings	AGJ050,AGJ056
B,D		j.	Application of lubricant to Fixed Housing aft end leak check port	AGJ048
B,D,G		k.	Application of lubricant to RSRM Port Plug (leak check port plug)	LAA141
B		l.	O-ring grooves on Fixed Housing aft end are finalized	LAA067
B		m.	No visible damage of primary O-ring after installation into O-ring groove	AGJ188
B		n.	All O-ring installation clips are removed just prior to seating nozzle assembly with Aft Case Segment	AGJ213
C		o.	O-ring grooves in Fixed Housing aft end are free from damage	AGJ175
C		p.	Fixed Housing aft end leak check port is free from damage prior to installation of the RSRM Port Plug (leak check port plug)	AGJ015
C,D,I		q.	Leak check ports have protective plugs installed	AGJ148
D		r.	Aft Boss sealing surfaces on Case Segment, are free from contamination and corrosion prior to assembly	AGJ006
D		s.	O-ring grooves in Fixed Housing aft end are free from contamination and corrosion	AGJ174
B,D		t.	Application of lubricant to o-ring groove prior to assembly	AGJ060
D		u.	Fixed Housing aft end leak check port is free from corrosion and contamination prior to installation of the RSRM Port Plug (leak check port plug)	LAA143
E		v.	Shelf life of the lubricant	LAA088
E		w.	Leak check port O-ring shelf life	AGJ134
E		x.	Primary O-ring storage life	AGJ222
E		y.	Primary O-ring packaging has not been damaged	AGJ195
I		z.	Leak check port O-ring is free from fungus and moisture prior to mating with the RSRM Port Plug (leak check port plug)	AGJ132,AGJ133
I		aa.	O-ring grooves in the Fixed Housing aft end are free from fungus and moisture	AGJ192, AGJ194
I		ab.	Fixed Housing aft end leak check port is free from fungus and moisture prior to installation of the RSRM Port Plug (leak check port plug)	AGJ241, AGJ242
I		ac.	Primary O-ring is free from fungus, moisture and contamination	LAA106,LAA107,AGJ161
C,D,I		ad.	RSRM Port Plug (leak check port plug) is free from damage, corrosion and contamination	AGJ186,AGJ186A
K		ae.	Aft Segment Boss and Fixed Housing aft end holes are clean and free from debris and foreign matter prior to assembly	AGJ007
K		af.	Aft Segment Boss and Fixed Housing Aft end holes are free from damage including scratches, pits, galls, and burrs prior to assembly	AGJ104
K		ag.	Proper location of all bolts	AGJ205
K	(T)	ah.	Axial and Radial bolts are tightened with a snug torque and angle-of-twist	AGJ238

K		ai.	Axial bolts are coated with lubricant on grips and under heads	AGJ075
K		aj.	Radial bolts are coated with lubricant on grips and under heads	AGJ209
K		ak.	Molykote spray lubricant is applied to the threads of the axial bolts and air dried before installation per the process specification	LHA047
K		al.	Molykote spray lubricant is applied to the threads of the radial bolts and air dried before installation per the process specification	LHA048
		12.	For New Bolt, Case/Nozzle verify:	
K		a.	Chemical composition	AGE003
K		b.	Mechanical properties after heat treat	AGE010
K		c.	Material is Inconel 718	AGE020
		13.	For Refurbished Bolt, Case/Nozzle verify:	
K		a.	Threads	AGE017
K		b.	Surface defects	AGE006
K		c.	Part is acceptable	AGE034
		14.	For New Bolt, Machine verify:	
K	(T)	a.	Ultimate tensile strength	AEI040
K	(T)	b.	Material and chemical composition	AEI018
K		c.	Threads	AEI016,AEI017
		15.	For Refurbished Bolt, Machine verify:	
K		a.	Threads	AEI015
K		b.	Surface defects	AEI004A
K		c.	Part is acceptable	AEI501
		16.	KSC verifies:	
E		a.	Life requirements for the expected launch schedule are met per OMRSD File II, Vol III, C00CA0.030	OMD019