



CRITICAL ITEMS LIST (CIL)

No. 10-03-04-16R/01

SYSTEM:	Space Shuttle RSRM 10	CRITICALITY CATEGORY:	1
SUBSYSTEM:	Ignition Subsystem 10-03	PART NAME:	Redesigned Igniter Adapter-To S&A Device Joint, Metal Components (1)
ASSEMBLY:	Igniter Assembly 10-03-04	PART NO.:	(See Table A-3)
FMEA ITEM NO.:	10-03-04-16R Rev N	PHASE(S):	Boost (BT)
CIL REV NO.:	N	QUANTITY:	(See Table A-3)
DATE:	27 Jul 2001	EFFECTIVITY:	(See Table 101-6)
SUPERSEDES PAGE:	442-1ff.	HAZARD REF.:	BI-02
DATED:	31 Jul 2000		
CIL ANALYST:	D. J. McGough	DATE:	
APPROVED BY:			
RELIABILITY ENGINEERING: <u>K. G. Sanofsky</u>		<u>27 Jul 2001</u>	
ENGINEERING: <u>G. A. Ricks</u>		<u>27 Jul 2001</u>	

- 1.0 FAILURE CONDITION: Failure during operation (D)
- 2.0 FAILURE MODE: 1.0 Leakage due to failure of metal components or insufficient compressive load on joint
- 3.0 FAILURE EFFECTS: Loss of sealing function allowing gas path to the atmosphere through the Igniter Adapter, causing a thrust imbalance and loss of RSRM, SRB, crew, and vehicle

4.0 FAILURE CAUSES (FC):

FC NO.	DESCRIPTION	FAILURE CAUSE KEY
1.1	Nonconforming materials or heat treatment	A
1.2	Corrosion	B
1.3	Stress corrosion	C
1.4	Shock and vibration	D
1.5	Cracks or other material defects	E
1.6	Nonconforming dimensions	F
1.7	Insufficient preload on joint	G
1.8	Improper installation of components	H
1.9	Damage to threads	I
1.10	Fatigue	J

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5.0 REDUNDANCY SCREENS:

SCREEN A: N/A
 SCREEN B: N/A
 SCREEN C: N/A

6.0 ITEM DESCRIPTION:

1. Igniter Adapter-to-Safety and Arming (S&A) Device Joint, Metal Components. Materials are listed in Table 1.

TABLE 1. MATERIALS

Drawing No.	Name	Material	Specification	Quantity
1U77426	Assembly and Closeout, RSRM, KSC	Composite of Various Components		1/motor
1U77648	Assembly and Closeout, RSRM, KSC	Composite of Various Components		1/motor
1U77499	Igniter Assembly	Composite of Various Components		1/motor
1U77451	Adapter Assembly, Igniter Insulated	Composite of Various Components		1/motor
1U77450	Adapter, Igniter	D6AC Steel	STW4-2706	1/motor
1U77385	Barrier Booster Assembly, S&A Device	Composite of Various Components		1/motor
1U77383	Housing, Barrier-Booster, Redesigned	Type A286 CRES	AMS-5737	1/motor
1U77464	Gasket-Safe & Arm	Seal-Fluorocarbon Rubber	MIL-R-83248, Type I, Class 1	1/motor
1U77359	Bolt S&A Device	Retainer-4130 Steel Heat Treat MP35N or MP159 Steel	MIL-S-18729 MIL-H-6875, Class A AMS-5844 or AMS-5842	10/motor
1U77472	Preload Indicating (PLI) Washer Assembly	Per Supplier Specification Cadmium Plated	Per Supplier Spec. Plating per QQ-P-416, Type II, Class 3	10/motor
1U51916	Cartridge Assembly Sealant/Adhesive	Lubricating Oil and Gelling Agent	STW5-2942	A/R
MS20995	Wire, Safety or Lock Lubricant, Air Drying Corrosion-Preventive Compound	302 or 304 Stainless Steel Molykote 321R Lubricant Spray Corrosion Preventive Compound	ASTM-A-580 STW4-2955 STW5-2942	A/R A/R A/R
	Primer	Epoxy-Polyamide Primer	STW5-3226	A/R
	Paint (top coat)	Epoxy-Polyamide Paint	STW5-3225	A/R

6.1 CHARACTERISTICS:

1. The RSRM Safe and Arm (S&A) device meets established requirements for performance, design, development, test, manufacture, and acceptance for a two-part electromechanical Safety and Arming (S&A) device.
2. The S&A device is attached to the Igniter Adapter with 10 bolts. A gasket between the Igniter Adapter and Barrier-Booster housing of the S&A device provides a seal between the two units. Figures 1, 2, and 3 depict the Adapter-to-S&A joint.

7.0 FAILURE HISTORY/RELATED EXPERIENCE:



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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

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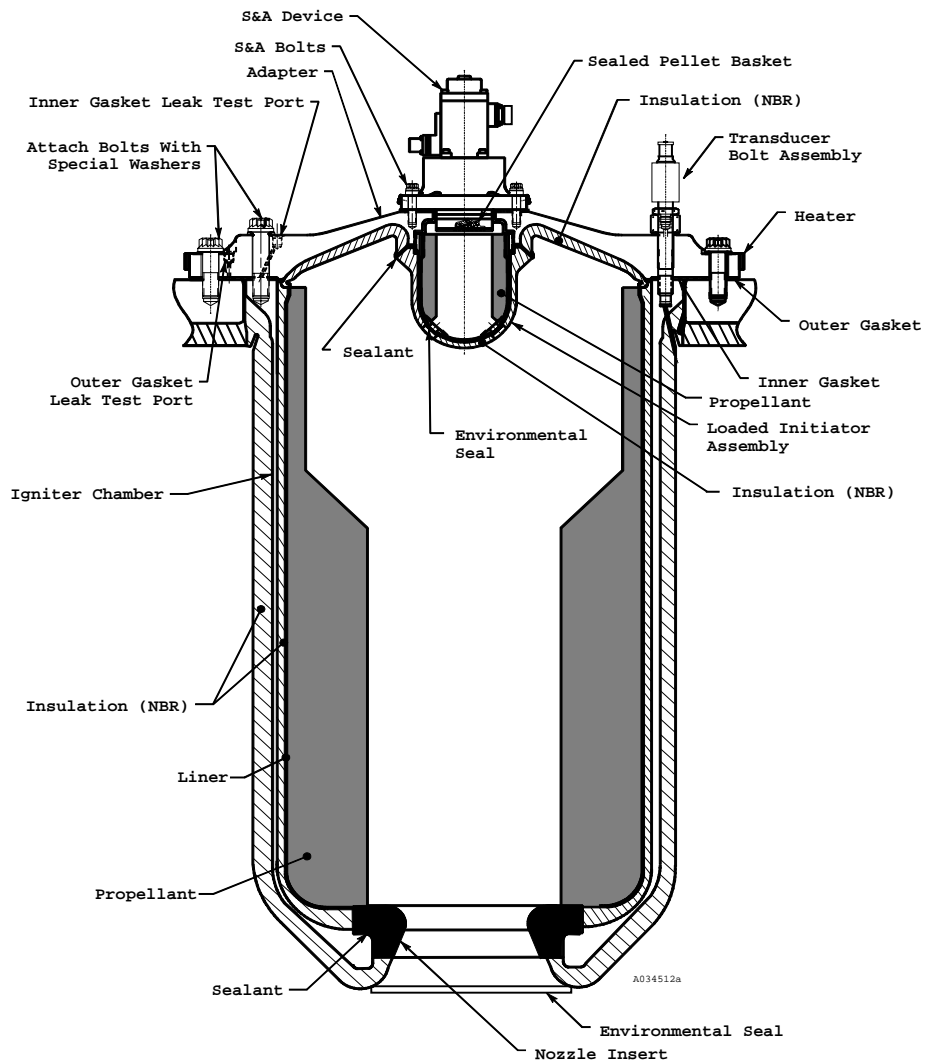


Figure 1. RSRM Ignition System

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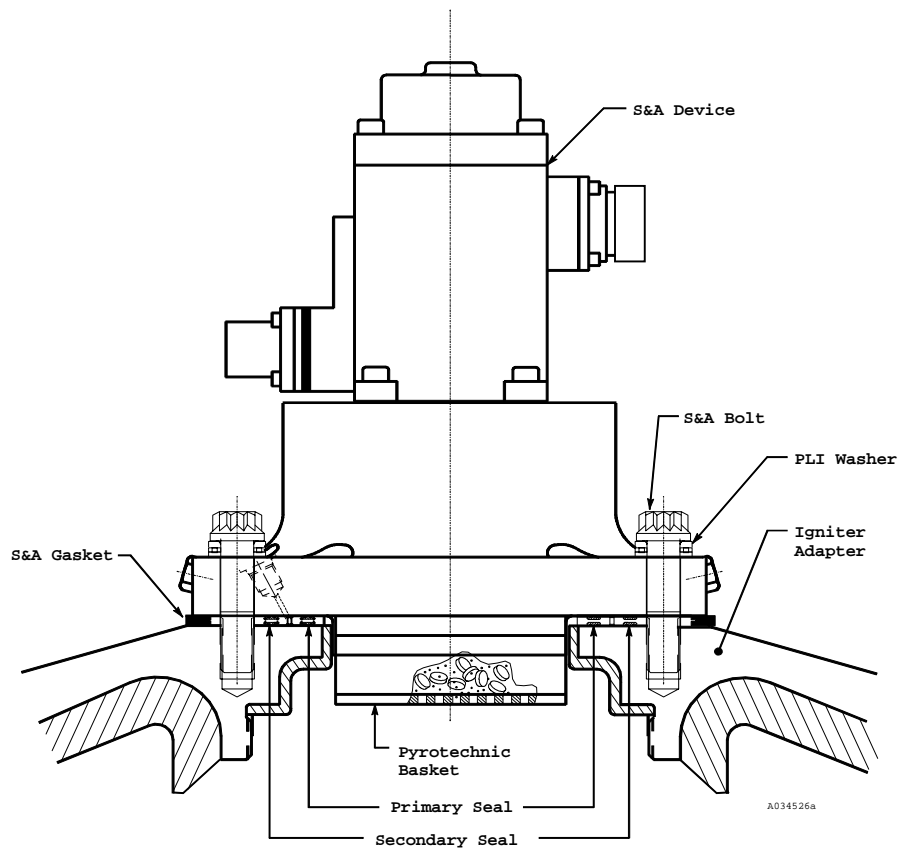


Figure 2. Safety and Arming Device-to-Igniter Adapter Joint

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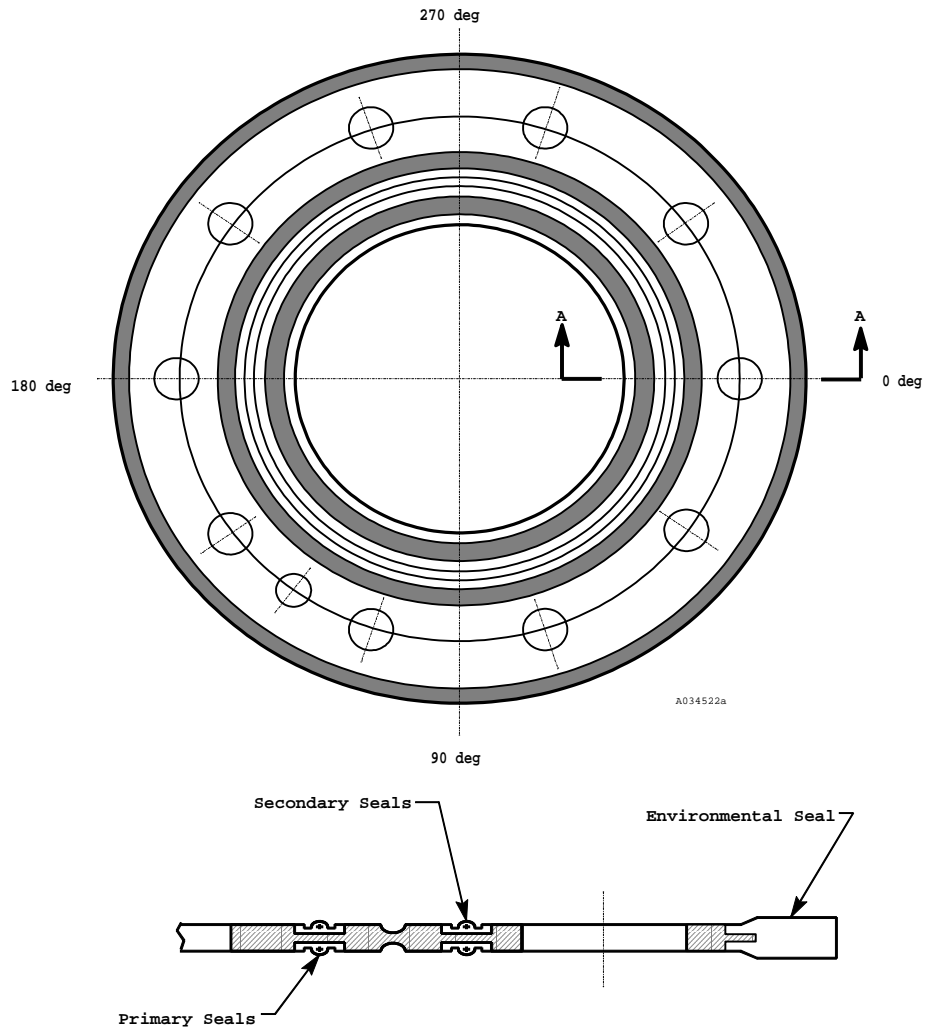


Figure 3. S&A Gasket

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9.0 RATIONALE FOR RETENTION:

9.1 DESIGN:

DCN FAILURE CAUSES

- | | | |
|-------|-----|---|
| A,B | 1. | S&A bolt material is MP35N or MP159, having tensile ultimate strength and tensile yield strength per engineering drawings and specifications. |
| A | 2. | The metal retainer portion of the S&A gasket is made of heat treated 4130 alloy steel. Gaskets meet acceptance criteria per engineering. |
| A | 3. | The preload indicating (PLI) washer assembly was qualified for use in TEM-9 per TWR-17669 and on FSM-3 per TWR-63347. |
| A,B | 4. | Lock/safety wire is 302 or 304 stainless steel. |
| A | 5. | The Igniter Adapter is fabricated of D6AC steel and heat treated per engineering drawings. |
| A,B,E | 6. | The Barrier-Booster housing is CRES, Type A286. |
| A | 7. | Properties of grease are per engineering. |
| A | 8. | Air drying lubricant, Molykote 321R, is a molybdenum disulfide spray lubricant. The cured lubricant film is controlled per engineering. |
| A | 9. | A three-dimensional structural analysis of the modified ignition system was performed. The results are documented in TWR-17265 and TWR-61222. Analysis shows that under worst-case pressure loading the Adapter area and the S&A boss have a positive margin of safety. |
| A | 10. | Results of the evaluation of the first production forging of the Igniter Adapter were reported in TWR-10735. The report concludes that forgings produced per engineering requirements are suitable for production. |
| A,D,J | 11. | As documented in TWR-11559, three Igniter Chamber and Adapter Assemblies as originally configured were fatigue cycled to a total of 160 pressurizations per test and then hydroburst. In two cases, the chamber failed in the membrane area approximately 6 inches from the Chamber-Adapter interface at 4847 and 4730 psi. In the third case, the test was terminated by failure of a Special Bolt at 4570 psi. Based on igniter Maximum Expected Operating Pressure (MEOP) and a factor of safety of 1.4 over ultimate, these results demonstrated actual positive margins of safety. |
| A | 12. | Development Motors DM-8 and DM-9 were static test fired to evaluate the performance of accepted baseline RSRM hardware. The Igniter Adapter is certified based upon Qualification Motor QM-6 static test as reported in TWR-18764-03. |
| A,E | 13. | The Igniter Redesign Baseline Barrier-Booster is similar to the RSRM Barrier-Booster per TWR-63653. |
| B,C | 14. | The Igniter Adapter is made of high-strength D6AC steel. Because it is made of this material, it is defined as susceptible to corrosion per MSFC Specifications and included in the Material Use Agreement. Surfaces are provided with corrosion protection as required during storage or delays in manufacturing per engineering. |
| B | 15. | New and refurbished igniter chambers and igniter adapters are cleaned by spray- |

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in-air per engineering and corrosion is removed by glass beading or hand wipe prior to further processing. Sufficient margin of safety per TWR-17265 and TWR-61222 exists to permit subsequent refurbish cycles without excessive loss of material. A minimum acceptable wall thickness is verified in key areas after each refurbishment per engineering. The outer surface of the igniter insulated adapter is finished with primer paint and top coat paint for corrosion protection per engineering. The assembled igniter is stored in an airtight container or exposed metal surfaces remaining are coated with filtered grease.

- B 16. The preload indicating (PLI) washer assembly is cadmium plated. The finish is a chromate finish on electro-deposited cadmium plating that provides additional corrosion protection over that provided by cadmium plating alone.
- B 17. Grease is applied to the underside of the bolt head when the bolts and preload indicating (PLI) washer assemblies are pre-assembled. After the bolts are torqued, grease is applied at the interface of the bolts and preload indicating (PLI) washer assemblies with the Adapter flange.
- B,E 18. All sealing surfaces of Igniter Assembly components conform to engineering drawings and specifications.
- C 19. Sustained tensile stresses in the Igniter Adapter in a corrosive environment are below the stress corrosion cracking threshold per Material Use Agreement and TWR-16104.
- C,D,E,J 20. The Igniter Adapter is refurbished and is included in TWR-16874. Fracture control analysis of the modified igniter presented in TWR-16874 shows that the Igniter Adapter complies with the requirement of ensuring a minimum of four missions after proof test.
- C,D,E,J 21. TWR-16874 establishes pressure level requirements for proof testing of Igniter Adapters. Hydroproof tests are performed per engineering for new and refurbished hardware.
- C 22. Other materials used in this assembly are alloys with high resistance to stress-corrosion cracking:
 - a. S&A bolts Stainless steel, MP35N or MP159 (alternate material)
 - b. Preload indicating (PLI) washer assemblies Material per Supplier specification, cadmium plated
 - c. S&A gasket retainer 4130 alloy steel, heat treated to ultimate per drawing
 - d. Lock/safety wire Stainless steel
 - e. Barrier-Booster housing Stainless steel
- C 23. Inherent resistance to corrosion and stress-corrosion cracking of the metal parts is augmented by the use of grease. Filtered grease is applied to the underside of S&A bolt heads before preload indicating (PLI) washer assemblies are installed at KSC per engineering drawings.
- D,G,H,J 24. Installation of the S&A device is performed at KSC per engineering drawings.
- D,E,J 25. Analyses and testing to qualify the Igniter Adapter are reported in TWR-10735, TWR-11559, TWR-61222, and TWR-16104. Qualification testing of the Redesign Baseline Igniter, including the Adapter, was performed on TEM-9 per TWR-17669 and FSM-3 per TWR-63347. In a hydroproof test of the igniter, it successfully withstood a pressure of 1.4 times MEOP, thereby demonstrating an actual factor of

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safety of 1.4 per TWR-61012.

- D,J 26. S&A bolts are not reused, reducing the possibility of failure due to fatigue or the propagation of flaws in the bolts.
- D,E,J 27. S&A gasket retainer may be reused provided it meets engineering requirements.
- D,J 28. Fatigue failure of the Barrier-Booster housing, is not considered to be a possibility.
 - a. The material is A286 CRES.
 - b. Each Barrier-Booster is designed to be reusable 19 times. Thus a Barrier-Booster will see 40 pressure cycles in its lifetime (20 flights plus 20 acceptable tests). Stress analysis of the barrier booster at a MEOP of 2600 psi that includes analysis of all threaded holes is documented in TWR-61222. The design factor of safety is 2.0.
- D,J 29. S&A bolts are lock/safety wired at KSC per engineering drawings.
- E 30. The S&A bolt material is MP35N or MP159 per engineering drawings. Limits on grain size are specified, and forgings must have substantially uniform macrostructure and grain flow.
- E 31. Each S&A bolt is dye penetrant inspected after forming the head and prior to threading.
- F 32. Tolerances for the redesigned igniter baseline design are established in TWR-63258.
- F,I 33. S&A bolt threads, thread length, and other dimensions are per engineering drawings.
- F,G,I 34. Igniter Adapter dimensions are established per engineering drawings.
- F 35. S&A gasket dimensions are per engineering.
- F 36. Barrier-Booster housing dimensions are per engineering drawings.
- F 37. Adapter thickness and sealing surface flatness is per engineering.
- F 38. Sealing surfaces of the Barrier-Booster flange are per engineering.
- F,G 39. Dimensions of the preload indicating washer are per engineering drawings.
- G 40. Materials were selected for suitability in the intended application. Developed yield strengths provide sufficient margin from working loads to preclude plastic deformation of components per TWR-61222.
- G,I 41. S&A bolt torque values were selected on the basis of manufacturer recommendations and structural analysis per TWR-61222.
- G 42. Bolt thread length is per engineering drawings.
- H 43. Lubricant is procured in aerosol spray cans.
- H 44. Grease is a smooth, homogeneous mixture of a lubricating oil and a gelling agent with or without additive agents. Grease is free from any abrasive or otherwise undesirable fillers or impurities per engineering.



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- H 45. The Igniter Adapter is proof tested per engineering. The Igniter Adapter threads are loaded in this test.
- H 46. Refurbished Igniter Adapters are acceptable for use if they meet refurbishment engineering. Threads are visually inspected for surface contamination, damage, and surface defects. Threads will have no damage or defects greater than that called out per engineering. Threads are inspected after proof testing.
- I 47. Leak test requirements and procedures are determined per TWR-17922.

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9.2 TEST AND INSPECTION:

<u>DCN</u>	<u>FAILURE CAUSES and TESTS (T)</u>	<u>CIL CODES</u>
	1. For New Igniter Adapter, verify:	
A,C,D,E,J (T)	a. Chemical analysis	AAS029,AAS323
A,C,D,E,J (T)	b. Mechanical properties	AAS404,RAA044
A,C,D,E,J (T)	c. Metallurgical characteristics	AAS404C,RAA045
A,C,D, E,I,J (T)	d. Heat treatment	AAS175,AAS177
A,B,C,D, E,I,J (T)	e. Proof test	AAS198A
A,B,C,D, E,I,J (T)	f. Magnetic-particle inspection after proof test is complete and acceptable	AAS313A
A,B,C,D,E,I,J	g. Material is D6AC steel	AAS029A
A,B,C,D,E,F,G,I,J	h. Supplier records are complete and acceptable	AAS550
B,C,D, E,I,J (T)	i. Ultrasonic testing complete and acceptable	AAS541,RAA001
F,I	j. True position of S&A bolt holes	AAS235,AAS237
F,G,I	k. Threaded holes for S&A bolts	AAS490,RAA103
F	l. Flatness of top surface (Datum -B-)	RAA106,RAA110
	2. For Refurbished Igniter Adapter, verify:	
A,B,C,D, E,I,J (T)	a. Hydroproof successful	AAN008
A,B,C,D, E,I,J (T)	b. Magnetic-particle after hydroproof test	AAS301
E,I	c. Sealing and mating surfaces for surface defects and surface finish	AAS107
E,F,G,I	d. Threaded holes for surface contamination, damage, surface irregularities, raised metal and scratches after hydroproof testing	AAS123
F	e. Flatness and parallelism of sealing and mating surfaces	AAS136
	3. For New Adapter Assembly, Igniter Insulated verify:	
B,C	a. Surface preparation is complete and acceptable on surfaces to be primed and painted	AEF100
	4. For New Bolt, S&A Device, verify:	
A,B,C, D,E,J (T)	a. Material - tensile ultimate strength, tensile yield strength, and alloy	RAA058
A,B,C,D,E,F,G,I,J	b. Certificate of Conformance is complete and acceptable	RAA060
B,D,E, G,I,J (T)	c. No surface discontinuities detected by dye penetrant inspection	RAA059
E,F,G,I	d. Threads per engineering	RAA067
E,I	e. No shipping or handling damage	RAA093
F,G,I	f. Bolt length	RAA063
F,G,I	g. Grip length	RAA064
F,G,I	h. Grip diameter	RAA065
F,G,I	i. Fillet radius	RAA066
F,G,I	j. Perpendicularity of bolt axis-to-bolt shoulder	RAA068
F,G	k. Head diameter	RAA069
F	l. Dimension "F"	RAA070

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5. For New S&A Gasket, verify:

A,C	(T)	a.	Chemical composition of metal retainer	ACR028,ACR027
A		b.	Grain size of metal retainer	ACR078,ACR077
A	(T)	c.	Decarburization of metal retainer	ACR049,ACR048
A	(T)	d.	Hardness of metal retainer	ACR082,ACR081
A	(T)	e.	Tensile strength of metal retainer	ACR109,ACR108
A	(T)	f.	Yield strength of metal retainer	ACR128,ACR127
A	(T)	g.	Minimum elongation, percent of, metal retainer	ACR096,ACR095
A	(T)	h.	Bending of metal retainer	ACR001,ACR000
A,C	(T)	i.	Heat treat of metal retainer	ACR083A,ACR083
A,B,C, D,E,J	(T)	j.	Magnetic particle testing	ACR088,RAA005
A,D,F,G,J		k.	Supplier records are complete and acceptable	ACR022
B,E		l.	Voids, circumferential scratches and radial scratches in metal retainer do not exceed acceptable conditions	RAA031,RAA035
B,E		m.	Absence of corrosion on the metal retainer	RAA034,RAA038
B,E		n.	No shipping/handling damage	ACR105
F		o.	Primary and secondary seals for crown height	ACR030
F		p.	Diameter of index pin thru hole	ACR059A
F		q.	Diameter of bolt thru holes	ACR059
F		r.	True position of bolt through holes	ACR059B
F,G		s.	Metal retainer thickness	RAA027

6. For Refurbished S&A Gasket, verify:

A,D,F,G,J		a.	Supplier records are complete and acceptable	ACR022A
B,E		b.	Voids, circumferential scratches and radial scratches in metal retainer do not exceed acceptable conditions	RAA031A,RAA035A
B,E		c.	Absence of corrosion on the metal retainer	RAA034A,RAA038A
B,E		d.	No shipping/handling damage	ACR105A
F		e.	Primary and secondary seals for crown height	ACR030A

7. For New Preload Indicating Washer Assembly verify:

A,B,C,E,F,G		a.	Certificate of Conformance is complete and acceptable	AJX001
B		b.	Cadmium plate	RAA121
E		c.	No shipping or handling damage	AJX013
F,G,H	(T)	d.	Lot acceptance test is complete and acceptable	RAA122
F,G		e.	Countersink angle	RAA123
F,G		f.	Thickness of outer center ring	RAA124
F,G		g.	Thickness of crush ring	RAA125
F,G,H		h.	Thickness of unloaded, washer assembly	AJX015

8. For New Lock/Safety wire, verify:

A,D		a.	Certificate of Conformance complete and acceptable	AJV000
D,F,H		b.	Diameter	AJV005

9. For New Barrier-Booster Housing, verify:

A,B		a.	Barrier-Booster housing is A286 CRES.	ACY027
F		b.	Leak check ports (4 places)	ACY068
F		c.	Leak Check Port spot face diameter (4 places)	ACY130
F,G		d.	Thickness of flange	ACY140
F		e.	Initiator hole spot face depth	ACY061
F		f.	Initiator hole spot face diameter	ACY062
F		g.	Initiator hole thread configuration	ACY063

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F		h.	Through diameter of SII port (2 places)	ACY151	
		10.	For Refurbished Barrier-Booster Assembly, verify:		
F,G		a.	Thickness of flange	ACY139	
F		b.	Thread depth of SII port (2 places)	ACY146	
F		c.	Rotor bore diameter	ACZ161A	
F		d.	Certificate of Conformance	ACZ054A	
		11.	For New Lubricant Molykote 321R verify:		
A	(T)	a.	Nonvolatile content	AMB007	
		12.	For New Grease verify:		
A	(T)	a.	Penetration	LAA037	
A	(T)	b.	Dropping point	ANO042	
A	(T)	c.	Zinc concentration	LAA038	
		13.	For New Filtered Grease verify:		
A	(T)	a.	Contamination	ANO064	
		14.	KSC verifies:		
595	A,B,C, E,H,I	(T)	a.	Integrity of the S&A device and S&A gasket installation by high- and low-pressure leak test per OMRSD File V, Vol I, B47SA0.110	OMD072
	B,E,F,G,H,I		b.	S&A device, Igniter interfacing surfaces and Barrier-Booster housing, for the following per OMRSD File V, Vol I, B47SA0.051:	OMD063
			1.	Contamination	
			2.	Deformation	
			3.	Raised metal	
			4.	Surface defects	
			5.	Corrosion	
			6.	S&A device leak check through hole is unobstructed	
	B,E,G,H		c.	The following per OMRSD File V, Vol I, B47SA0.060:	OMD064
			1.	S&A gasket shipping container (box) has no evidence of being opened or crushed	
			2.	S&A gasket shipping bag has no broken seal and no penetrations	
			3.	S&A gasket is free of visible contamination and corrosion after excess grease is removed	
	D,G,H,I		d.	Bolts fastening the igniter S&A device to the Igniter Adapter are torqued in an established pattern to the specified torque per OMRSD File V, Vol I, B47GEN.130	OMD039
	D		e.	Lock/safety wire is installed correctly per applicable drawing and OMRSD per OMRSD File V, Vol I, B47GEN.140	OMD041