TOOL ENGINEERING

MANUFACTURE, WORKMANSHIP, AND SHOP PRACTICE

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Preparer Terral W Morgan	DATE 12/11/2008	Management Reed S Hancey	DATE 12/17/2008
Management Jim D Stotts	DATE 01/05/2009	Management Philip W Petersen	DATE 12/17/2008
QE Douglas L Nelson	DATE 12/11/2008	Management James L Ekstrom	DATE 12/11/2008
Management Roger A Sharp	DATE 12/12/2008		

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WORKMANSHIP AND SHOP PRACTICE STANDARD
for
Manufacture of Special Tooling and Equipment

Supersedes TER-01001, Rev F (released August 14, 2008)

ATK Launch Systems Inc.
P. O. Box 707 Brigham City, UT 84302-0707 (435) 863-3511

WORKMANSHIP AND SHOP PRACTICE STANDARD

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REVISION HISTORY

Revision	Description
-	Original Release
A	Unknown, released as 001.
B	Unknown, released as 002.
C	Changed Title, adds section to address coating methods, updates document to ATK Launch Systems, and corrects minor errors.
D	• Added Section 3.14, Fastener Requirements. • Corrected Section 3.1.10, Method 13 Was ….SP-VGF-3.1.1. Now ….GPI000036…Bake out per GPI000036, paragraph 4.6 a. option 1, 2, 3, or 4 as specified on the drawing.
E	• Added TOC • Updated Section 2.0 to add ASME references • Updated Section 3.14 to address machine screws and correct ASME references. • Added Section 3.14.6 (Other Fasteners)
F	• Changed Section 2.0 to removed references not applicable. • Changed Section 3.14: Updated 3.14.1 to clarify 'critical fastener' requirements. Updated 3.14.2 and 3.14.3 to eliminate Fastenal Co. as the sole source supplier. Deleted 3.14.4 and 3.14.5 to allow use in-house fasteners for tooling fabrication.
G	• Added paint methods 2 and 4 to Section 3.1.10. • Changed Section 3.14: Reference to critical fastener definition. Require certifications on critical fasteners and upon request on other fasteners. Allow hex head fasteners to come from foreign or domestic suppliers. • Corrected torque ranges in Section 3.2.2.2, Table II. • Corrected torque references in Section 3.7, Table V. • Added Sections 3.15, Bonding Requirements.

1.0 SCOPE:

1.1 Scope and Application

This document defines and establishes supplemental criteria to be used in conjunction with ATK Launch Systems engineering drawings and specifications, which are not subject to customer control. This document shall be used, when required by drawings or specifications, to establish acceptable standards of quality, good workmanship and accepted shop practice when a specific designation covered herein is not specified or is incompletely defined in the applicable drawing or specification.

1.2 Conflict of Documents

If this document conflicts with a detailed drawing or specification, the detailed drawing or specification shall prevail.

2.0 APPLICABLE DOCUMENTS:

2.1 Government Documents

The latest issues of the following government documents form a part of this standard to the extent specified herein.

STANDARDS

Military

AIA/NAS NASM33540	Safety Wiring, General Practice For
SAE AS 4330	Tubing End, Standard Dimensions for Flared

Copies of government documents can be obtained from the nearest military agency concerned or from a source recommended by that agency.

2.2 Non-Government Documents

The latest issues of the following non-government documents form a part of this standard to the extent specified herein.

Standards

ASME Y14.5	Dimensioning and Tolerancing
ASME B46.1	Surface Texture
ASME B18.2	Hex Head Bolts, Nuts and Screws
ASME B18.3	Socket Head Cap, Shoulder, and Set Screws
ASTM F788	Surface Discontinuities of Bolts, Screws, and Studs
ASTM A574	Alloy Steel Socket-Head Cap Screws
ASTM F837	Stainless Steel Socket-Head Cap Screws

ASME documents can be obtained from the American Society of Mechanical Engineers, United Engineering Center, 345 East 47th Street, New York, NY 10017.

ASTM documents can be obtained from World Engineering Xchange, Ltd, 2671 West 81st Street, Hialeah, FL 33016, USA.

3.1 General Shop Practices

3.1.1 Blending Surface

Connecting curved surfaces or curved and plain surfaces shown as a tangent must blend smoothly. Attention is drawn to the note "Machined inside corners to have radius of .020 inch - .040 inch" appearing on drawings. This requires that, unless otherwise specified, all internal corners of machined parts shall have a radius within the tolerance given.

3.1.2 Mismatch of Machined Surfaces

When two or more machining cuts are required to produce a surface delineated on the drawing as being a theoretical single surface, the maximum misalignment between intersecting or adjacent surfaces shall not exceed 0.005 inch or must be contained within the limits of dimensional size, whichever is the smaller.

3.1.3 Machining Centers

Center holes may be required in shafts, spindles, and other cylindrical or symmetrical parts to receive machine centers on which the work pieces are supported during manufacturing or inspection. Unless otherwise specified, their use is optional.

3.1.4 Breaking Sharp Edges

Unless otherwise stated on the drawing, the standard to which sharp edges must be broken is from 0.010 to 0.020 inch. Any method may be used to break such edges, provided a radius or a flat without sharp corners is produced within the tolerance given. A sharp-cornered flat or a concave radius at the edge is not acceptable. If a sharp corner is required, the drawing will so specify. Dimensions to intersecting surfaces shall be made before breaking or shall be measured to the intersections, which existed before breaking. On sheet metal parts of 1/32-inch thickness or less, the breaking of edges is not mandatory; however, such edges shall be free from burrs. The breaking of edges does not apply to elastomers such as rubber and 'soft' plastics.

3.1.5 Chamfers for Internal Thread Ends

Unless otherwise noted on the drawing, a chamfer with an included angle of 80 to 120 degrees shall be used at internal thread start. The minimum diameter of the chamfer shall be the major diameter of the thread. The maximum diameter of the chamfer shall be the major diameter of the thread plus 0.030 inch.

3.1.6 Chamfers for External Thread Ends

Chamfers shall be provided at the ends of externally threaded parts. The chamfer shall extend to the minor diameter of the thread. The angle of the chamfer shall be 45 plus or minus 5 degrees. The minimum length of the chamfer shall be the height of the external thread.

3.1.7 Thread Length

The thread length dimensions indicated on the drawing are the gaging length or the length of threads having full form. Three perfect or imperfect threads are allowable beyond such limit for lead of tap where hole depth permits.

3.1.8 Repair of Damaged Threaded Holes

Damaged threaded holes may be repaired by installing threaded inserts (Keensert or Helicoil) in accordance with manufacturer's instructions, or by plugging and re-tapping. The decision to repair, and method of repair, shall be the responsibility of ATK Launch Systems Tool Engineering.

3.1.9 Dimensions of Finished Parts

Unless otherwise specified, all dimensions on components show only the end product design. Since the end product design dimensions are for only the final form and sizes without reference to methods of manufacture, all these dimensions are applicable after operations such as heat-treating, stress relieving, aging, sandblasting, buffing, etc. If these operations are required to maintain dimensional stability, they may not be specified on the drawing, but should be added to the fabrication as required.

Dimensions to a cast or forged surface are to apply to the general level of such a surface and local depressions or excrescencies are to be ignored. When a drawing does not specify whether dimensions apply before or after application of a surface coating, the following interpretation shall be used:

a. Unless otherwise specified, dimensional limits and surface roughness designations apply after the application of inorganic finishes, such as platings, ceramic coatings, chromates, oxides, etc.

b. Unless otherwise specified, where organic finishes such as lacquers, varnishes, enamels, plastic coatings, teflon, etc., are used, dimensional and surface roughness designations must be met prior to the application of the organic finish.

3.1.10 Paint and Protective Coatings

Method 1: Yellow paint for metal
Grit blast, solvent clean and apply one coat light gray Aqua-Lac® primer, 32GY025 (35-583309), and one coat yellow water-based polyurethane, 135YW001 (35-583296), Prime Coatings, (Pewaukee, WI.).

Method 2 Gray paint for metal
Grit blast, solvent clean and apply one coat light gray Aqua-Lac® primer, 32GY025 (35-583309), and one coat gray water-based polyurethane, 135GY001 (35-583297), Prime Coatings, (Pewaukee, WI.).

Method 3 White paint for metal
Grit blast, solvent clean and apply one coat light gray Aqua-Lac® primer, 32GY025 (35-583309), and one coat white water-based polyurethane, 135WE003 (35-583307), Prime Coatings, (Pewaukee, WI.).

Method 4 Black paint for metal
Grit blast, solvent clean and apply one coat light gray Aqua-Lac® primer, 32GY025 (35-583309), and one coat black water-based polyurethane, 135BK001, Prime Coatings, (Pewaukee, WI.).

Method 5 Yellow paint for wood
Apply one coat white acrylic emulsion primer, 35933 (35-583295), and one coat yellow water-based polyurethane, 135YW001 (35-583296), Prime Coatings, (Pewaukee, WI.).

Method 6 Gray paint for wood
Apply one coat white acrylic emulsion primer, 35933 (35-583295), and one coat gray water-based polyurethane, 135GY001 (35-583297), Prime Coatings, (Pewaukee, WI.).

Method 7 Selective plating
Using a selective (Brush Plating) electro-deposition per MIL-STD-8865, provide a 0.0005 – 0.0007 inch thick zinc base coating, followed by a 0.0003 – 0.0005 inch thick nickel top coat.

Method 8 Electro-less nickel
Using an electro-less nickel plating method per AMS 2404, provide a 0.0003 – 0.0005 inch thick nickel coat.

Method 9 Black oxide
Black oxide coat per SAE AMS 2485 or MIL-STD-13924.

Method 10 Black anodize
Black anodize per SAE AMS 2472.

Method 11 Clear anodize
Clear anodize per SAE AMS 2471

Method 12 Plastic flame-coat
Grit blast, solvent clean and apply plastic flame-coat, PF111/XXX (22-5781XX) per manufactures specifications. Plastic Flame-coat Systems (Big Spring, TX.).

Method 13 Teflon Coat
Teflon coat per ATK Launch Systems Inc., specification GPI000036. All dimensions apply prior to coating. Bake out per GPI000036, paragraph 4.6 a. option 1, 2, 3, or 4 as specified on the tool drawing.

Method 14: Yellow paint for metal in outside or other harsh environments
Grit blast and solvent clean per manufacturers instructions. Apply two coats of grey primer (HS9381407) and two coats of yellow polyurethane topcoat (9844419) per manufacturers specifications. Rust-Oleum Corp. (Vernon hills, IL)

Method 15: Grey paint for metal in outside or other harsh environments
Grit blast and solvent clean per manufacturers instructions. Apply two coats of grey primer (HS9381407) and two coats of grey polyurethane topcoat (9886419) per manufacturers specifications. Rust-Oleum Corp. (Vernon hills, IL)

3.2 Surface Roughness, Waviness and Lay

Surface roughness, waviness and lay requirements shall be interpreted in accordance with ASME B46.1, latest edition.

3.2.1 Surface Roughness Not Specified

When the surface roughness is not specified, the surface can be left as shaped roughness height (micro-inch), as listed in Table IA below:

Table IA

Process	Roughness Height (Micro-inch)
Forged	500
Hot Rolled	1000
Extruded	125
Cold Rolled	125
Investment Cast	125
Flame Cut	1000
Die Cast	63
Sawed	1000

3.2.2 Roughness Height Rating Values

Surface roughness height for surfaces listed in Table IB below shall not be greater than indicated.

Table IB

Surfaces	Roughness Height (Micro-inch)
Reamed holes or thread surfaces	63
Drilled holes	250
Splines, serrations, and broached surfaces	63
Spotfaced surfaces	125
Counterbore	125
Countersink	125

3.2.2.1 Finishes of Small Radii or Changes in Contour

Unless surface finishes are designated on small radii or changes in contour, the finish is to be equivalent to the least quality of surface finish required on adjoining surfaces.

3.2.2.2 Relationship of Surface Texture to Tolerances

The variations introduced by surface roughness shall not exceed the tolerances placed on the dimension. On parts where very small dimensional tolerances are given, the surface roughness height requirements shall not be greater than the values listed in Table II:

Table II

Tolerance (inch)	Roughness Height (Micro-inch)
0.0051 and over	125
0.0011 to 0.005	63
0.00051 to 0.001	32
0.00021 to 0.0005	16
0.0000 to 0.0002	12

3.2.3 Key Slots

Key slots shall be centered with the shaft axis within 0.002 TIR and shall be parallel with the shaft within 0.0005 inch for each inch of length.

3.2.4 Keyways

Keyways shall be centered with the bore within 0.006 TIR and shall be parallel with the bore within 0.005 inch for each inch of length.

3.3 Materials

The final product shall incorporate the materials specified on the drawing and modified by any specific process, such as heat treatment, anodizing, plating, etc., as applicable.

Note: A36 steel is interchangeable with the steel series designated AISI 1018 to AISI 1025.

3.4 Surface Cleanliness

The surface of material of parts that are subjected to heat treatment, welding, or both, shall be clean and free of markings from lead pencils, wax crayons, grease pencils, carbon, and other foreign substances.

3.5 General Cleanliness

Parts for which no cleaning specification is specified on the drawing shall be sufficiently cleaned to be used for the application intended. Such parts shall be free of cutting oil, dirt, chips, and scale. Particular attention shall be given to parts having threads, recesses, or cavities, to ensure that these areas are clean. All steel surfaces not otherwise coated (coat surface before assembly) will be oiled with Conoco HD2.

3.6 Installation of Rigid Tubing

3.6.1 Recommended Rigid Tubing Minimum Bend Radius

The minimum allowable rigid tubing bend radius (measured to the centerline of the tubing) specified in Table III requires no approval and shall be used wherever possible. Flattening, wrinkles, and scratch requirements on all bends shall be as specified in 3.6.1.1 and 3.6.1.2.

Table III
Minimum Allowable Bend Radius

Tube OD, (inch)	Minimum Bend Radius	Tube OD, (inch)	Minimum Bend Radius
1/8	3/8	1-1/8	3-1/2
3/16	7/16	1-1/4	3-3/4
¼	9/16	1-3/8	5
5/16	11/16	1-1/2	5
3/8	15/16	1-5/8	6
7/16	1-1/4	1-3/4	7
½	1-1/4	2	8
5/8	1-1/2	2-1/4	9
¾	1-3/4	2-1/2	10
7/8	2	2-3/4	11
1	3	3	12

3.6.1.1 Flattening Limitations

Tubes for fluid systems with working pressures of 1000 psi or greater shall not be flattened more than 5 percent, and for fluid systems with working pressures less than 1000 psi shall not be flattened more than 10 percent. Flattened in the cross section is defined by the following formula:

$$\text{Flattened} = \frac{\text{max. OD - min. OD}}{\text{nominal OD}} \times 100 \text{ percent}$$

3.6.1.2 Wrinkles and Scratches

a. For fluid systems with working pressures 500 psi or greater, there shall be no wrinkles or kinks deeper than 1 percent of tubing OD and no scratches deeper than 5 percent of the nominal tubing wall thickness.

b. For fluid systems with working pressures of less than 500 psi, there shall be no wrinkles or kinks deeper than 2 percent of tubing OD and no scratches deeper than 10 percent of the nominal tubing wall thickness.

3.6.2 Flaring Tubing

The flared ends of tubing shall meet all requirements of Standard SAE AS4330.

3.6.3 Torquing of AN Fittings

The acceptable torque values for AN type fittings used on the flared ends of rigid tubing shall be in accordance with Table IV:

Table IV

Allowable Torques for AN Type Fittings Used with Rigid Tubing (Torque Limit in. -lb)

Tube OD	Aluminum Alloy Tubing		Steel Tubing	
(inch)	Minimum	Maximum	Minimum	Maximum
1/8	--	--	--	--
3/16	--	--	90	100
1/4	40	65	135	150
5/16	60	80	180	200
3/8	75	125	270	300
1/2	150	250	450	500
5/8	200	350	650	700
3/4	300	500	900	1000
1	500	700	1200	1400
1 1/4	600	900	--	--
1 1/2	600	900	--	--
1 3/4	--	--	--	--
2	--	--	--	--

3.7 Torquing of Threaded Fasteners

Unless otherwise specified, the acceptable torque values for threaded fasteners shall be in accordance with Table V. Special lubricants (Conoco HD2 is not a special lubricant and should not be present) shall not be used for the assembly of threaded fasteners unless specifically called out on the drawing. Use the "Dry" value for fasteners coated with Conoco HD2. Use the lubricated value if the fasteners are coated with high stress ability lubricants (never SeeZ compound, graphite and oil, molybdenum disulphite, colloidal copper, and white lead are examples).

Table V
Torque Values for Bolted Installation [a] [b]

	Low Carbon Steel Bolts and Nuts (Grade 2)				Higher Strength Steel Bolts and Nuts (Grade 5 or higher)			
	Tightening Torque [c] [f]				Tightening Torque [d]			
	Dry		Lubricated		Dry		Lubricated	
Size	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
	lb-inch		lb-inch		lb-inch		lb-inch	
2-56		2.2				2.5		
2-64		2.7				3.0		
3-48		3.5				3.9		
3-56		4.0				4.4		
4-40	4.5	5	3.6	4	7	8	5	6
4-48	5	6	4.5	5	8	9	6	7
6-32	9	10	7	8	14	16	11	12
6-40	11	12	8	9	16	18	12	13
8-32	17	19	13	14	27	30	20	22
8-36	18	20	14	15	28	31	21	23
10-24	24	27	19	21	39	43	29	32
10-36	28	31	21	23	44	49	32	36
1/4-20	59	66	44	49	86	96	68	75
1/4-28	68	76	50	56	108	120	77	86
	lb-ft		lb-ft		lb-ft		lb-ft	
5/16-18	10	11	7	8	15	17	12	13
5/16-24	11	12	8	9	17	19	13	14
3/8-16	18	20	14	15	27	30	21	23
3/8-24	21	23	15	17	32	35	23	25
7/16-14	27	30	22	24	45	50	32	35
7/16-20	32	35	23	25	50	55	36	40
1/2-13	45	50	32	35	67	75	50	55
1/2-20	50	55	36	40	81	90	59	65
9/16-12	59	65	45	50	99	110	72	80
9/16-18	68	75	50	55	100	120	81	90
5/8-11	81	90	63	70	135	150	99	110
5/8-18	90	100	72	80	162	180	117	130
3/4-10	144	160	108	120	234	260	180	200
3/4-16	162	180	126	140	270	300	198	220
7/8-9	126	140	99	110	360	400	270	300
7/8-14	140	155	108	120	396	440	288	320
1-8	198	220	144	160	522	580	396	440
1-12	216	240	153	170	576	640	432	480
1 1/8-7	270	300	198	220	720	800	540	600
1 1/8-12	306	340	234	260	792	880	594	660

1 1/4-7	378	420	288	320	1008	1120	756	840
1 1/4-12	414	460	324	360	1116	1240	828	920
1 3/8-6	504	560	378	420	1314	1460	990	1100
1 3/8-12	576	640	414	460	1512	1080	1134	1260
1 1/2-6	666	740	504	560	1746	1940	1314	1460
1 1/2-12	756	840	558	620	1980	2200	1476	1640

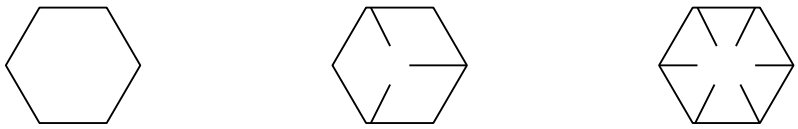
Table V NOTES

a. These torque values are only applicable in steel (or in steel inserts) when the length of thread engagement is at least the same as the nominal diameter of the thread.

b. When shear-type nuts and thin nuts are used where the height of the nuts is approximately half the size of the major diameter of the threads, the torque values shall be reduce by 50 percent.

c. The low carbon tightening torque values are for general use on standard bolts, studs, and nuts which have no grade or identification marking.

d. These tightening torque values are to be used only with standard Grade 5 or better bolts, studs, and nuts. Grade 5 bolts and studs are identified by three radial dashes 120 degrees apart on the heads of bolts and on the nut end of studs. Grade 5 nuts are identified by three radial dashes spaced 120 degrees apart on the top face of the nut, see Hd cap screws. Grade 8 bolts, studs, and nuts which are identified by six radial dashes 60 degrees apart, could have higher torque values than specified herein to utilize their full capability.



Unmarked Grade 5 Grade 8

e. These torque values are only applicable when the length of thread engagement in cast iron is at least 1-1/2 times the nominal diameter of the threads.

f. These torque values are only applicable when the length of thread engagement in aluminum is at least 3 times the nominal diameter of the threads.

3.8 Seals, Gaskets, Burst Discs, and Diaphragms

A part designated as a seal, gasket, burst disc, or diaphragm shall be free from scratches, wrinkles, or indentations and shall be suitably protected in handling.

3.9 Hydraulic System Testing

A hydraulic system will be defined as such things as (but not necessarily limited to only) lines, vessels, valves, and fittings that enclose pressure higher than the environment. Each hydraulic system will be tested to 150% of the working pressure on at least the first article. For a propellant system test, water can be used. For an oil system, it is recommended that the oil used in the system also be used during the test.

3.10 Marking of Parts

When no marking requirements are specified on the applicable drawing for a part or separable detail, the part or detail shall be marked with the drawing number and the applicable three digit detail number, if at all possible. When marking is not possible, it shall be tagged or packaged and the appropriate marking placed on the tag or package. When additional markings are needed, they shall be made by the same marking or identification method or by any permanent marking method that will not render a machined surface useless. To ensure proper reassembly, all subassemblies and detail parts may be coded and indexed in relation to their adjacent parts with permanent type letters and/or numbers and/or arrows.

3.11 Machining Graphite or Phenolics

Liquid coolants shall not be used in the machining of graphite or phenolics unless specifically authorized by a note on the engineering drawing.

3.12 Safety Wiring

When safety wiring is required and the method is not specified on the drawing, safety wiring shall be in accordance with Military Standard MS33540 except for internal wrenching bolts and thin head bolts, which shall be safety wired as follows:

a. For all applications, the safety wiring of internal wrenching bolts, using the method of safety wiring given in Paragraph 3.12.1, shall be acceptable.

b. When used on airborne equipment, the alternate method of safety wiring of internal wrenching bolts given in Paragraph 3.12.2, shall be acceptable.

c. When used on airborne equipment, thin head bolts and plugs shall be safety wired as specified in 3.12.2.

3.12.1 Safety Wiring of Internal (Hexagonal) Wrenching Bolts

Safety wiring shall be installed on internal wrenching bolts using the modified double-twist method for multiple fastener application shown in Figure 1. The following general instructions shall apply:

a. The safety wire shall be in accordance with applicable drawings and the requirements of Table VI. The number of twists per inch as specified in Table VI represents general practice, and is to be used as guidance information only. Safety wire shall be new upon each application.

b. The units to be safety wired shall be correctly torqued before the safety wire is installed. Parts shall be safety wired in such a manner that the safety wire shall be put in tension when the part tends to loosen.

c. When the multiple fasteners are from 4 to 6 inches apart, three fasteners shall be the maximum number in a series that can be safety wired together.

d. When the multiple fasteners are spaced more than 6 inches apart, the multiple fastener application specified in Figure I and Figure 2 shall not be used unless the points are provided on adjacent parts to shorten the span of the wire to less than 6 inches.

e. When the multiple fasteners are closely spaced, the maximum number of fasteners that can be safety wired together shall be the number of fasteners that can be wired with a 24-inch length of wire.

f. One end of the safety wire shall be inserted through one set of lockwire holes in the head of each unit. The other end of the safety wire shall be looped around the head to the next set of lockwire holes in the same unit and inserted through this set of lockwire holes.

FIGURE 1

SAFETY WIRING; MULTIPLE INTERNAL WRENCHING BOLT APPLICATION
(Modified double-twist method having a safety wire through each of two sets of lockwire holes)

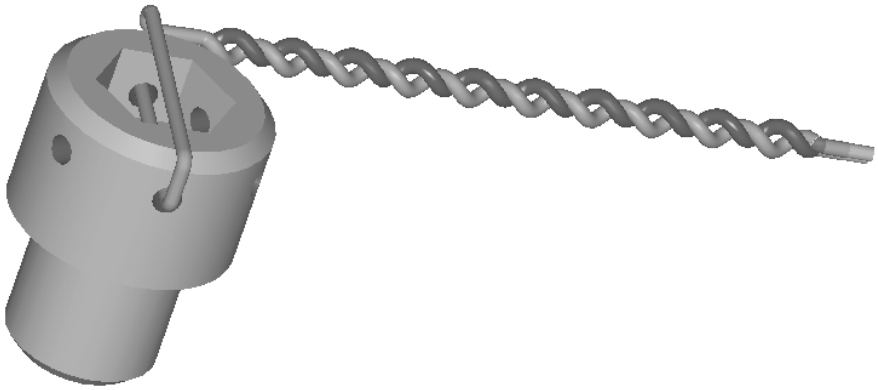


FIGURE 2

SAFETY WIRING MULTIPLE INTERNAL WRENCHING BOLT OR THIN HEAD BOLT APPLICATION
(Modified double-twist method having a safety wire through the bolt lockwire holes and a loop of safety wire over the top of the bolt head)

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Table VI

Safety Wire Parameters

Wire Diameter (inch)	Tolerance (± inch) Ref. Only	700°F AMS5685 Ref. Only	1800°F AMS 5687 Ref. Only	Twists per Inch	Recommended Hole Diameter Ref. Only	Recommended Countersink Dia. (90 ± 5° Incl.) Ref. Only
0.016	0.001	----	MS9226-01	11-14	0.037 - 0.057[2/]	0.070 - 0.090
0.020[1/]	0.001	----	MS9226-02	9-12	0.037 - 0.57[2/]	0.070 - 0.090
0.025[1/]	0.001	AS100027	MS9226-03	9-12	0.060 - 0.080[2/]	0.090 - 0.110
0.032[1/]	0.002	AS100028	MS9226-04	7-10	0.060 - 0.080[2/]	0.090 - 0.110
0.040[1/]	0.002	AS100029	MS9226-05	7-10	0.060 - 0.080[2/]	0.090 - 0.110
0.051	0.002	AS100030	MS9226-06	5-8	0.060 - 0.080[2/]	0.090 - 0.110
0.063	0.002	AS100031	MS9226-07	5-9	0.070 - 0.090	0.100 - 0.120
0.091	0.002	----	MS9226-08	4-7	0.100 - 0.120	0.140 - 0.160

[1/] Preferred size

[2/] Where parts cannot accommodate the recommended hole size, it is permissible to use a smaller hole provided a minimum diametral clearance of 0.003 inch is maintained between the wire and the hole.

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3.12.2 Acceptable Alternate Method of Safety Wiring Applicable Only to Airborne Equipment

When internal wrenching bolts are used on air borne equipment, the following method of safety wiring shall be an acceptable alternate method for the method given in 3.12.1. The following method shall also be used for safety wiring thin head bolts and plugs used on air-borne equipment. Safety wire shall be installed using the modified double-twist method for multiple fastener application shown in Figure 2. The following general instructions shall apply:

a. The safety wire shall be in accordance with applicable drawings and the requirements of Table VI. The number of twists per inch as specified in Table VI represents general practice, and is to be used as guidance information only. Safety wire shall be new upon each application.

b. The units to be safety wired shall be correctly torqued before the safety wire is installed. Parts shall be safety wired in such a manner that the safety wire shall be put in tension when the part tends to loosen.

c. When the multiple fasteners are from 4 to 6 inches apart, three fasteners shall be the maximum number in a series that can be safety wired together.

d. When the multiple fasteners are spaced more than 6 inches apart, the multiple fastener application specified in Figure I shall not be used unless the points are provided on adjacent parts to shorten the span of the wire to less than 6 inches.

e. When the multiple fasteners are closely spaced, the maximum number of fasteners that can be safety wired together shall be the number of fasteners that can be wired with a 24-inch length of wire.

f. The safety wire shall be inserted through one lockwire hole in thin head bolts and plugs or through one set on diametrically opposite lock-wire holes in internal wrenching bolts and then the loop of the double wire shall pass over the top of the head as shown in Figure 2.

g. The strands, while taut, shall be twisted until the twisted part is just short of a hole in the next unit. The twisted portion shall be within 1/8 inch of the hole in either unit. Caution shall be exercised during the twisting operation to keep the wire tight without overstressing it or allowing it to become nicked, kinked, or otherwise mutilated, except that abrasions normally caused by commercially available wire-twisting pliers shall be acceptable.

h. After wiring the last unit, the wires shall be twisted to form a pigtail of three to five twists. The excess wire shall be cut off. The pigtail shall be bent in toward the part in such a manner as to prevent it from becoming a snag.

3.13 Fluid System (Hydraulic, Pneumatic, Inert, Gas, Propellant etc.) Cleanliness Requirements

3.13.1 Piping Components and Assemblies

Piping components and assemblies shall have rust, scale, and weld spatter removed from inside and from sealing surfaces, either mechanically or with a pickling process. Items shall then be further cleaned using filtered compressed air[1] and/or solvent[2] and then be capped or placed in clean plastic bags until installation.

3.13.2 Tubing Assemblies, Hose Assemblies and Fittings

Tubing assemblies, hose assemblies and fittings shall have all loose material removed from inside and from sealing surfaces using filtered compressed air[1] and/or solvent[2] and then be capped or placed in clean plastic bags until installation.

[1] 5-micron absolute or better filtration required.
[2] No solvent residue to remain on cleaned surfaces.

3.13.3 Non Plumbing Purchased Components

Non plumbing purchased components (pumps, reservoirs, cylinders, valves, etc.) are to remain sealed, as received, until installation. Additional cleaning of these components will normally not be required.

3.13.4 Extreme care must be taken during system assembly to insure no foreign materials enter the system. All components are to remain capped until installation.

3.13.5 Pipe Threads

Pipe threads are to be sealed with standard pipe dope or teflon tape. If teflon tape is used, care must be taken to insure that no residue enters the system.

3.13.6 Additional Flushing of System

Additional flushing of the system may be required to meet ISO (International Organization for Standardization) cleanliness code or ATK Launch Systems requirements. Such requirements, if any, will be noted on the tool drawing, or in the tool specification. The method of flushing is to be coordinated with cognizant tool engineer.

3.13.7 Securement

In many applications it may be necessary to restrain, protect, or guide hydraulic and pneumatic hose or tubing assemblies to protect them from damage by unnecessary flexing, pressure surges and contact with other mechanical components. These reference documents may be used as suggested guidelines (REF. SAE 21.104 and JIC/NFPA.)

3.14 Fastener Requirements

3.14.1 Critical Fasteners:
These fasteners are used in a critical application, as determined by Tool Engineering, and shall have specific testing and/or inspection requirements specified in a flag note on the tool drawing (e.g. Mechanical Testing per ASTM F788). These fasteners require certifications from Suppliers.

Critical fasteners are defined in the ATK Tool Design Manual, TR017940.

3.14.2 Socket Head Cap Screws, Shoulder Screws and Set Screws:

These fasteners shall comply with ASME B18.3, and the following:

a. Fasteners made from Alloy Steel material shall include black oxide coating and comply with ASTM A574.

b. Fasteners made from Stainless and Corrosion Resistant Steel material shall comply with ASTM F837.

c. Fasteners may be from foreign or domestic manufacturers, unless specified otherwise.

   When domestic fasteners are specified, the fasteners must be machined in North America and materials must be produced in the United States or meet regulations of the Berry Amendment (USC Section 10, Title 2533a).

d. Fastener Certifications shall be provided upon request from the Supplier (e.g. Critical Fasteners). When requested, certifications shall include, as a minimum: Manufacturer's name and all associated data (Material type, sample size, heat number, lot number, manufacture date, dimensional inspection results).

3.14.3 Hex Head Bolts, Nuts and Screws:

These fasteners shall comply with ASME B18.2, and the following:

a. Fastener material shall be dependent upon grade specified in parts list. If no grade is specified, grade 5 is implied.

b. Fasteners may be from foreign or domestic manufacturers, unless specified otherwise.

   When domestic fasteners are specified, the fasteners must be machined in North America and materials must be produced in the United States or meet regulations of the Berry Amendment (USC Section 10, Title 2533a).

c. Fastener Certifications shall be provided upon request from the Supplier (e.g. Critical Fasteners). When requested, certifications shall include, as a minimum: Manufacturer's name and all associated data (Material type, sample size, heat number, lot number, manufacture date, dimensional inspection results).

3.14.4 Other Fasteners:
All other fasteners not addressed in previous sections shall be manufactured to domestic or foreign industry standards.

3.15 Bonding Requirements

3.15.1 Adhesive Selection

Adhesive 1 **Epibond 1210 A/B**
Huntsman Advanced Materials, (Salt Lake City, UT.). (ATK Stock No. 22-008026).

Bond surfaces using Epibond 1210 A/B at a ratio of 100 parts A to 100 parts B (hardener) (* see 3.16). Apply and work adhesive onto both prepared surfaces prior to joining. Cure per manufacturer's requirements.

Adhesive 2 **Epibond 1210 with 9615 Hardener**
Huntsman Advanced Materials, (Salt Lake City, UT.). (ATK Stock No. 57-020178)

Bond surfaces using Epibond 1210 with 9615 hardener at a ratio of 100 parts A to 80 parts (hardener) (* see 3.16). Apply and work adhesive onto both prepared surfaces prior to joining. Cure per manufacturer's requirements.

Adhesive 3 **Stabond T-161 Contact Adhesive**
Stabond Corp, (Gardena, Ca). (ATK Stock No. 01-063005)

Bond surfaces using Stabond T-161. Apply to both prepared surfaces and allow adhesive solvents to flash until fully dry, then mate surfaces and clamp into place. Allow to cure 8 hours or as required per manufacturer's or engineer's requirements.

Note: Care should be taken when mating surfaces as adhesive does not allow for movement after mating. If surface are not mated correctly, separate parts immediately, remove old adhesive with solvent and rebond.

Adhesive 4 **3M-1357 High Performance Contact Adhesive or 3M Super Weather Stripping No. 1300**
3M Corp. (St.Paul, MN). (ATK Stock No. 57-020210 & 35-013013)

Bond surfaces using 3M-1357 or 3M-1300. Apply to both prepared surfaces and allow adhesive solvents to flash until fully dry, then mate surfaces and clamp into place. Allow to cure 8 hours or as required per manufacturer's or engineer's requirements.

Note: Care should be taken when mating surfaces as adhesive does not allow for movement after mating. If surface are not mated correctly, separate parts immediately, remove old adhesive with solvent and rebond.

Adhesive 5 **Hysol U-05FL Polyurethane Adhesive**
Loctite Corp., (Rocky Hills, CT.).

Bond surfaces using Hysol U-05FL adhesive. Apply and work adhesive onto both prepared surfaces prior to joining. Mix and apply per manufacturer's instructions.

Adhesive 6 **Ren-CO-Thane RP6401-01 or RP6402-01 Polyurethane**
Huntsman Advanced Materials (Salt Lake City, UT).

Bond surfaces using RP6401-01 or RP6402-01.
Mix and deaerate per manufactures' instructions. Material may be thickened using cotton fibers or silicon dioxide, or by allowing rencothane to thicken by exotherming. Minimum bondline thickness: 0.010 inch.

Adhesive 7 **Q3-6093 RTV Adhesive**
Dow Corning Corp., (Midland, MI.).

Bond surface using Q3-6093 RTV adhesive, Use a base to curative ratio of 10 to 1 (*see 3.16). Apply and work onto both prepared surfaces prior to mating. Cure per manufactures' requirement.

Other **Special Adhesives not addressed in this Section**
Adhesives not specifically covered in this section may be used, but it is the Tool Engineer's responsibility to make sure that the adhesive is compatible and is called out correctly on the drawing.

3.15.2 Surface Preparation

Method 1 **Steel (all types including Stainless Steel)**
Prior to abrading, clean all bonding surfaces, as required, of all loose materials, oils and coating. Aggressively abrade the bonding surfaces using 30 to 80 grit sandpaper, Scotchbrite® or grit blast. Then solvent clean abraded surfaces with MEK, or alcohol and let surfaces fully dry before applying adhesive.

Method 2 **Aluminum (all types)**
Same as Method 1 except aluminum will quickly develop an oxidation layer when exposed, so bonding must be performed within 24 hours of surface preparation.

Method 3 **Teflon (including filled)**

Method 3A **Plastics vendor etching**
Etch Teflon bonding surface using sodium ammonia etching process, (Porter process), (Hatfield, PA). A division of Plastomer Technologies, (Houston, TX). Etching acceptance per AMS 2491-D, "Surface Treatment of PTFE Preparation for bonding".

Method 3B **In-house or spot etching**
Etch Teflon bonding surface using Fluoroetch, Action Technologies, (Pittston, PA) as follows: Solvent clean bonding surface, Warm Teflon and Fluoroetch liquid to 100F to 150F, brush Fluoroetch on Teflon surface to be bonded. Let Fluoroetch remain on surface per manufacturer's instruction then wash and dry using rags and dry air.

Note: When spot etching, protect/mask surfaces that etchant is not desired on.

Method 4 **Nylon (including filled, and conductive)**
Same as Method 1 except grit blasting is not allowed on nylon. Nylon will quickly develop an oxidation layer when exposed, so bonding must be performed within 24 hours of surface preparation.

Method 5 **Neoprene / Rubber**
Same as Method 1 except grit-blasting is not allowed on neoprene / rubber. Neoprene will quickly develop an oxidation layer when exposed, so bonding must be performed within 24 hours of surface preparation.

Method 6 **Silastic J**
Aggressively abrade the bonding surfaces using 30 to 100 grit sandpaper or Scotchbrite® to remove mold release. Then solvent clean abraded surfaces with MEK or alcohol and let surfaces fully dry before applying adhesive. Be sure to remove all loose particles.

3.16 General Workmanship Instructions for All Bonding

- * Ratios other than noted shall be defined by ATK tool engineering drawing note.
- Apply and work adhesive onto both prepared bonding surfaces.
- Always assure complete adhesive coverage.
- Control squeeze out by masking any surfaces where adhesive is not wanted, especially Teflon-coated surfaces.
- When bonding a previously Teflon-coated tool, all overspray on a bonding surface (including Teflon primer) must be completely removed.
- Unless directed otherwise by ATK Tool Engineering, adhesive must be cured per manufacturer's specifications.
- Both mating parts must be at room temperature when bonding.
- Do not touch prepared bonding surfaces with bare hands or contaminated gloves.