

SEALTH PROCESS SPECIFICATION

SPS-510 WORKMANSHIP (MANUFACTURING)

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Revision J

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1. Purpose

Workmanship: “The quality imparted to an item in the process of being made”; or, “The art or skill of a workman”.

The purpose of this specification is to attempt, as best as possible, to define and explain the “Standards” or “Minimum Requirements” necessary to produce items by and for Sealth Aero Marine.

2. Scope

This specification is applicable to all items produced by and for Sealth Aero Marine and is to be considered a part of each Engineering Drawing, Purchase Order and Work Order.

Where a specific requirement, is listed on a Drawing or Purchase Order, that characteristic shall take precedence over the criteria in this specification.

The criteria listed in this specification apply to all “end user” visible areas of a part and areas where other “mating” parts interact or function with the part being reviewed.

3. Responsibilities

Employees and Inspectors performing work by and for Sealth Aero Marine are responsible for verifying that their work meets the requirements established by this specification.

Sealth Aero Marine supervisory and Inspection personnel are required to be familiar with the requirements of this specification and are required to assure that all work leaving their areas of responsibility comply with the requirements within.

4. Reference Documents

SPD-110	Material Specifications
ASME 18.29.1	Helical Coil Screw Thread Inserts ...

5. Notes

This release contains workmanship or manufacturing standards for Sealth Aero Marine hardware. This document may be expanded to include all applicable requirements as they are required.

6. Definitions & Acronyms

For this Specification, the definitions in the referenced documents shall apply

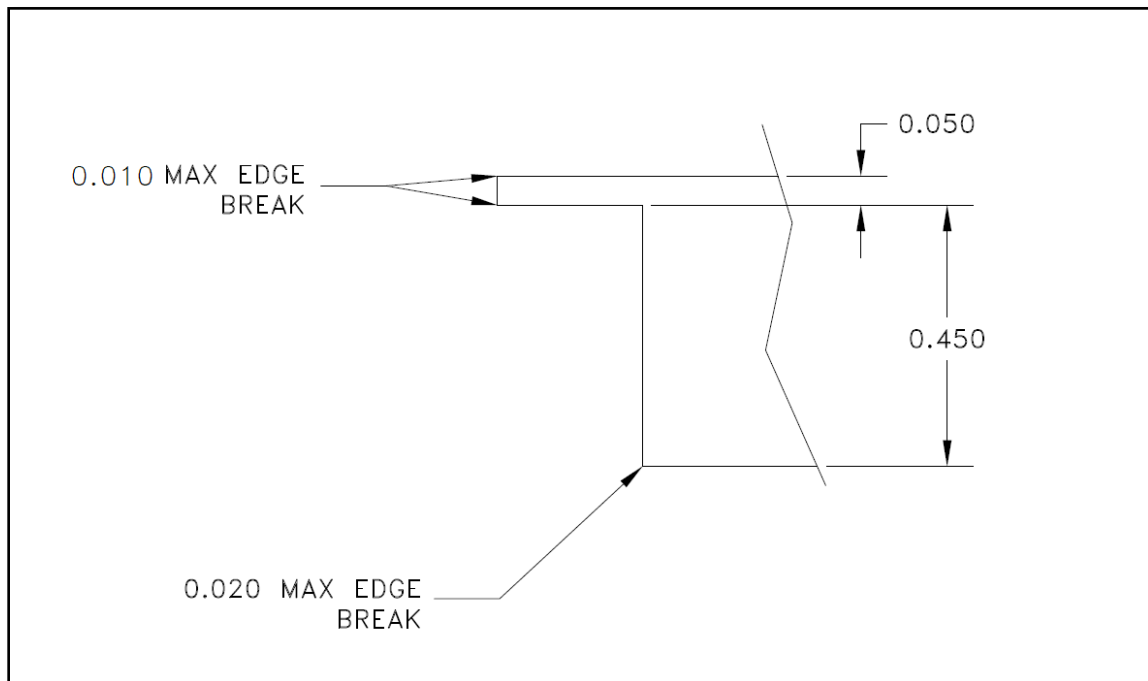
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7. General Manufacturing

7.1 Edges

7.1.1 Break Edges

Unless otherwise stated on the drawing, the standard to which sharp edges must be broken is from 0.005 to 0.020 inch or no greater than 1/5 the intersecting surfaces widths. 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 (0.03125) 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.

A "broken edge" will be smoothed to the extent that fingernails will slide over the edges without getting stuck or caught, and hands or fingers will not be cut. Electrical wires, mating parts or clothes will not score or fray in any way if in contact with the edge.

7.1.2 Deburr Edges

Burrs shall not be present on edges of manufactured parts. In situations where breaking the edge is not possible, the edge must be free from burrs.

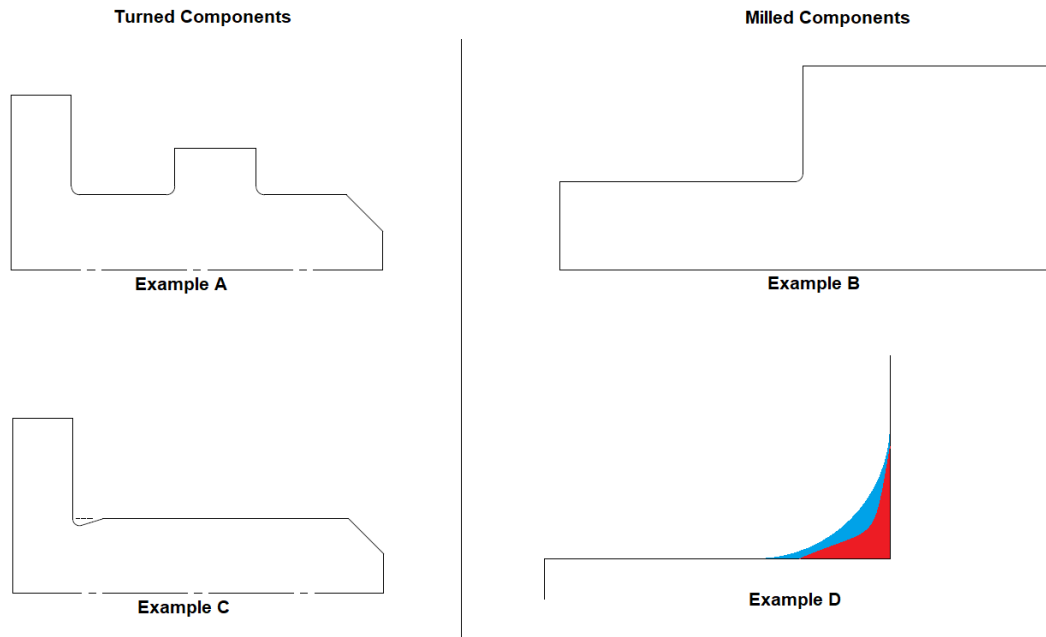
A “deburred edge” will be smoothed to the extent that fingernails will slide over the edges without getting stuck or caught.

7.1.3 Inside Edges

Inside edges shown sharp at 90° must not have a radius larger than 0.010 between the perpendicular surfaces.

Note: Broken tools that produce an inside edge that is not sharp must not extend beyond a true 0.010 Radius as seen in *Example D*.

Annotations specifically noting sharp corners or edges, must allow for a mating component with a sharp corner to fit tangent to both mating surfaces. Turned components may have a small undercut to make sure a mating component with a sharp corner can fully engage as shown in *Example C* below. The allowed undercut must not exceed 0.010.



Shown In blue: True 0.010 Radius
Shown in red: Material left from broken tool

7.2 Dimensions

7.2.1 Standard Tolerances (MFG)

Unless otherwise specified on the drawing field or title block the standard tolerances shall be as followed for manufactured product.

LINEAR	
X.	0.125
X.X	0.030
X.XX	0.010
X.XXX	0.005
X.XXXX	0.002

ANGULAR	
X.	2°
X.X	1°
X.XX	½°
SURFACE ROUGHNESS	
See 7.3.3	

7.2.2 Approximate Dimensions

Approximate dimensions are dimensions that little to no effect on final fit or function. Dimensions marked with approx. should be within ± 0.062 of the displayed dimension. Angular tolerance should be within $\pm 10^\circ$

7.2.3 Reference / Stock Dimensions

Dimensions marked with either Reference or Stock are dimensions that are typically carried through from a previous requirement. Either another detailed drawing or standard manufacturing tolerances or extruded material.

7.2.4 Dimensions and Finishes

Unless otherwise specified, all dimensions on detail components shall be measured prior to all finishing operations. Processes such as heat-treating, stress relieving, aging and passivation are not considered “finishes” for this purpose.

Since the product may be either finished or unfinished, processed such as plating, painting, dry-lube, sand blasting, graining, and buffing shall be performed following the final dimensional inspection. If these operations are required to maintain dimensional stability, this shall be specified on the drawing.

Note: Any product that receives an abrasive cosmetic finish such as graining or buffing, machine all cosmetic surfaces (typically flange thickness, countersink diameters, overall diameters) to the higher end of the tolerance to allow for material removal

7.2.5 Dimensions Across Centerlines

Unless otherwise specified, dimensions, or features on a centerline are to be centered within the lowest listed tolerance in the Title Block.

7.2.6 Dimensions of Sheet Metal (Formed) Parts.

Unless otherwise specified by the engineering drawing, the allowable flatness tolerances, mold line straightness, deviation from contour, web bow and twist shall be +/- 0.030 inch. Fabricated parts may be deflected to meet the specified tolerance provided the following conditions are met:

- a) Where dimensional requirements for parts can be met during application of localized pressure in a manner simulating actual attachment in the assembly. The maximum localized pressure and its application requirements should be as follows:
 1. 0.5 pounds for metal thickness less than 0.045 inch.
 2. 1.25 pounds for metal thickness 0.045 inch and greater.
 3. The force shall be applied at 4-inch intervals or at an equivalent smaller force to smaller interval (e.g., $\frac{1}{2}$ the specified weight on a 2-inch interval, or $\frac{1}{4}$ the specified weight on a 1-inch interval).
 4. Any number of force units may be applied providing the appropriate intervals are maintained.
- b) Where such deflection of parts does not produce permanent set in the material.
- c) Where such deflection does not cause detrimental deformation of mating parts and specified dimensions and tolerances are met after installation and assembly.

Unless otherwise specified on Engineering drawings, the maximum reduction in any dimension in localized areas from forming shall be as follows:

- a) 10 percent for sheet metal parts of 2024, 6013 and 7000 series aluminum alloys, and for corrosion resistant steels, $\frac{1}{4}$ H and harder.
- b) 30 percent in sheet metal parts of 5052, 6061 aluminum and annealed corrosion resistant steels.

There is no specified limit for thickening due to forming operations except that such thickening shall not interfere with assy. operations.

7.3 Surface Finish

7.3.1 Surface Transitions

Connecting curved surfaces or curved and plain surfaces shown as a tangent must blend smoothly (See 7.3.2). Attention is drawn to any drawing radius dimension and tolerance call-out which are required to be maintained.

7.3.2 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 24 times the largest surface texture value specified for the features. Surfaces shall also fall within the tolerance of size or form for the features. See Table

Specified Ra (micro-inches)	Maximum Mismatch (inches)
8	0.0002
16	0.0004
32	0.0008
63	0.0016
125	0.003
250	0.006
500	0.013

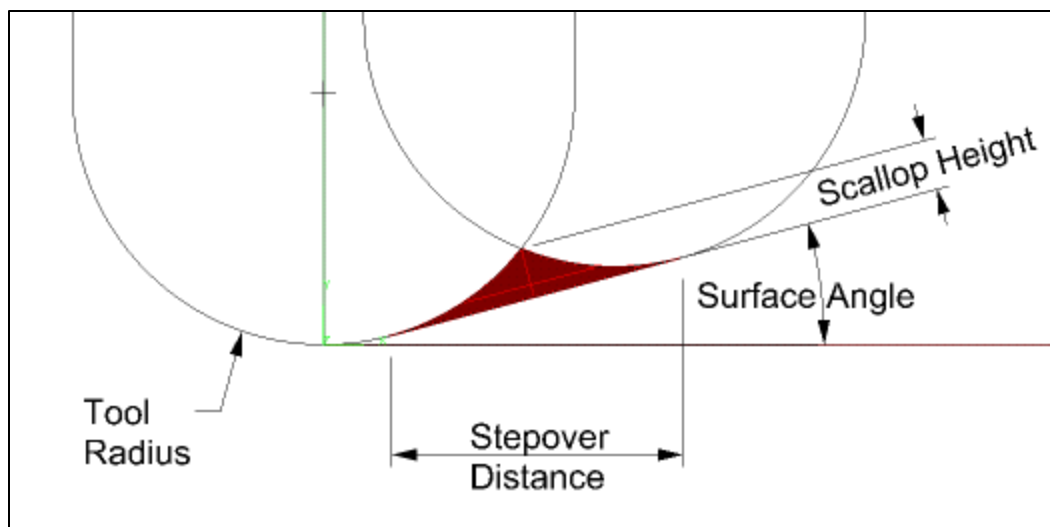
7.3.3 Surfaces Roughness

Sealth Aero Marine produces decorative, interior parts. The surface roughness and finish are of the utmost importance. Unless otherwise specified, the following table shall be used for surface roughness and finish minimum requirements.

Surface Type	Roughness, Maximum Ra (in micro inches)
When specified to meet Plating Standards, on the cosmetic surfaces	32
Surface/Stitch Milled, shaped splines, rolled serrations, reamed holes	63
Spot face or counter bore flats, broached splines or holes, countersinks	125
Finished turned surfaces, milled surfaces, drilled holes of 1/4inch diameter or less	125
Machined surfaces not listed above or otherwise limited by drawing notes (this is not applicable to pierced or sheared surfaces)	125

The following chart is for programming references when determining the theoretical scallop height for appropriate Ra.

Scallop Height	Roughness, Ra
0.001	250
0.00045	125
0.00025	63
0.00013	32



7.3.4 Plating Standard Surfaces

Surfaces or parts annotated to be of “Plating Standards” require special attention during the manufacturing process. These surfaces require a 32Ra surface finish or better, and no mismatch between surfaces greater than 0.0008. (See sections 7.3.2 and 7.3.3).

The use of barrel tumbling or vibratory tumbling for the means of deburr which leaves a “dulled” finish is *prohibited*. Any tumbling operations performed on Plating Standard parts must leave or maintain a polished / bright appearance.

Lead in/out moves, or cutter transition lines should be spaced as such to create a shallow angle seam.

Note: Any changes to the G-Code that affect the Plating Standard surfaces should be submitted for review prior to manufacturing, along with the required new FAI report.

7.4 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.

For material manufacturing specifications see SPD-110 for acceptable manufacturing standards for any given material type.

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

7.5 Radii

7.5.1 Complete Radii

Unless otherwise specified on the drawing, radii are to be full and tangent to intersecting geometry. Unless surface finishes are designated on small radii or changes in contour, the finish is to be equivalent to the lowest Ra or surface finish required on adjoining surfaces

7.5.2 Radii on Turned Parts

Unless otherwise specified on the drawing, the maximum inside radius allowed between two intersecting surfaces shall be R0.010

7.6 Cleanliness

7.6.1 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 and free from burrs.

7.6.2 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.

7.7 Holes

Where most practical, through and blind holes should be manufactured with drills using standard drill points mentioned in section 7.7.2. Where a hole or diameter is annotated, the closest available drill size, in fraction, letter or number size should be used. When a diameter is annotated in between sizes, the next largest incremental size should be used.

The tolerance of drilled holes should follow the tolerance table in section 7.7.1.

7.7.1 Drilled Holes

Where the engineering drawing specifies a drill size and does not specify a diameter tolerance other than the general tolerance in the title block, the tolerance specified in the table below shall apply.

Drill Size - inch -	Drill Size - mm -	Allowable Tolerances - inch - (mm)
#80 (0.014) to #30 (0.129)	0.36 to 3.28	+0.004 / -0.001 (+0.10 / -0.03)
#29 (0.136) to E or 1/4 (0.250)	3.45 to 6.35	+0.005 / -0.001 (+0.13 / -0.03)
F (0.257) to 1/2 (0.500)	6.53 to 12.70	+0.006 / -0.001 (+0.15 / -0.03)
33/64 (0.516) to 3/4 (0.750)	13.11 to 19.05	+0.008 / -0.001 (+0.20 / -0.03)
49/64 (0.766) to 1 (1.000)	19.46 to 25.40	+0.010 / -0.001 (+0.25 / -0.03)
1-1/64 (1.016) to 2-1/2 (2.500)	25.81 to 63.50	+0.012 / -0.001 (+0.31 / -0.03)

7.7.2 Blind Holes

Unless otherwise specified on the drawing, the depth of blind holes is the depth of the full diameter, including spotfaces. Standard drill points for blind holes are 135°, and where permitted 118° drill points can be used. Blind holes that require flat bottoms will be annotated on the drawing.

7.7.3 Countersunk Holes

Unless otherwise specified on the drawing, countersink diameters will take precedence over hole diameters on thin features where both conditions cannot be met. Holes made oversized by the countersink shall be deburred or drilled oversized to leave an apparent flat, (approximately 0.002 to 0.005).

When a countersunk hole is called out by fastener size, the following table shall be used to determine the dimensional requirements of the countersunk hole.

Fastener Size	Fastener OD	TPI	Hole Thru		Deg	Countersink Dia	
			MIN	MAX		MIN	MAX
#0	0.0600	80	0.0630	0.0730	100°	0.119	0.155
#1	0.0730	64 / 72	0.0810	0.0890		0.146	0.182
#2	0.0860	56 / 64	0.0890	0.1065		0.172	0.208
#3	0.0990	48 / 56	0.1040	0.1200		0.199	0.235
#4	0.1220	40 / 48	0.1360	0.1470		0.225	0.253
#6	0.1380	32 / 40	0.1610	0.1720		0.280	0.308
#8	0.1640	32 / 36	0.1910	0.2030		0.335	0.365
#10	0.1900	24 / 32	0.2180	0.2290		0.390	0.420
1/4	0.2500	20 / 28	0.2790	0.2910		0.515	0.545
5/16	0.3125	18 / 24	0.3420	0.3540		0.645	0.677
3/8	0.3750	16 / 24	0.3860	0.4062		0.762	0.798
7/16	0.4375	14 / 20	0.4531	0.4844		0.890	0.926
1/2	0.5000	13 / 20	0.5156	0.5469		1.017	1.053

7.7.4 Counterbored Holes

Unless otherwise specified on the drawing, counter bore depths will be determined from the same plane that the holes originate from. Counter bores should be concentric to their corresponding holes within 0.003 inch.

When a counterbored hole is called out by fastener size, the following table shall be used to determine the dimensional requirements of the counterbored hole.

Fastener Size	Fastener OD	TPI	Hole Thru		C'Bore Depth	Counterbore Dia	
			MIN	MAX		MIN	MAX
#0	0.0600	80	0.0630	0.0730	0.060	0.125	0.135
#1	0.0730	64 / 72	0.0810	0.0890	0.073	0.156	0.168
#2	0.0860	56 / 64	0.0890	0.1065	0.086	0.188	0.204
#3	0.0990	48 / 56	0.1040	0.1200	0.099	0.203	0.219
#4	0.1220	40 / 48	0.1360	0.1470	0.112	0.219	0.238
#6	0.1380	32 / 40	0.1610	0.1720	0.138	0.282	0.306
#8	0.1640	32 / 36	0.1910	0.2030	0.164	0.313	0.336
#10	0.1900	24 / 32	0.2180	0.2290	0.190	0.375	0.402
1/4	0.2500	20 / 28	0.2790	0.2910	0.250	0.478	0.461
5/16	0.3125	18 / 24	0.3420	0.3540	0.313	0.532	0.551
3/8	0.3750	16 / 24	0.3860	0.4062	0.375	0.625	0.645
7/16	0.4375	14 / 20	0.4531	0.4844	0.438	0.719	0.749
1/2	0.5000	13 / 20	0.5156	0.5469	0.500	0.813	0.844

7.8 Threads

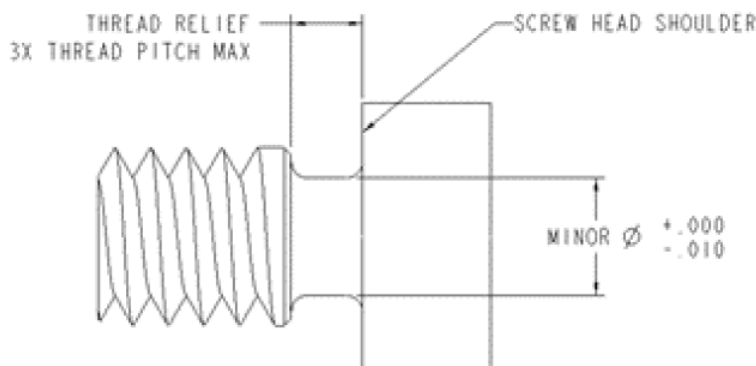
7.8.1 Thread Lengths

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

Note: The above rule also applies to external threads where a thread relief is not used.

7.8.2 Thread Relief

A drawing delineating full threads to the screw head shoulder, with no relief depicted or defined in accordance with a separate specification, shall be manufactured so that the gage will thread tightly to the shoulder without interference. A thread relief shall be permitted so that the gauge will thread tightly to the shoulder without interference. Thread reliefs shall not exceed 3x the pitch and be within 0.010 of the minor diameter of the threads (*see image below*).



7.8.3 Chamfers for Internal Threads

Unless otherwise specified 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 0.020 inch.

7.8.4 Chamfers for External Threads

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 $45 \pm 3^\circ$. The minimum length of the chamfer shall be the height of the external thread.

7.8.5 Thread Classes

Unless otherwise specified, threads shall be manufactured to class 2A or 2B as applicable. Sealth Aero Marine uses Go / No-Go gages to determine thread acceptability.

7.8.6 Thread Depth for Threaded Inserts

When a threaded insert depth is annotated using the insert size x length, ASME B18.29.1 Table 1 should be used to determine the tap and drill depth of Helical Coil Screw Threaded Inserts.

The following equation is an acceptable alternative to be used to determine the minimum thread depth accepted.

$$\text{Insert Size} \times \text{Insert Length} + 1 / \text{Pitch}.$$

7.9 3D Datasets / Engineering

Unless specified on the drawing, 3D CAD files supplied by SAM are to be used as reference only aid in manufacturing. When part geometry is defined by the 3D file, all geometry shall be basic and held to the three decimal tolerances found on the drawing. Dimensions featured on the drawing take precedence over the 3D files. The revision of the drawing and the 3D file shall be the same.

7.10 Non-Conventional Manufacturing and Inspection Methods

Parts shall be manufactured using conventional machining methods unless otherwise specified. Non-conventional methods that could impact structural characteristics, or compromise the cosmetic appearance such as thermal cutting, laser cutting, electrical discharge machining (EDM), abrasive water jet cutting, and chemical milling shall be approved by Sealth Aero Marine engineering or unless otherwise specified.

Parts to receive visual inspection. Parts that have other inspection techniques such as liquid penetrant inspection, magnetic particle inspection, etc.... must be specified

8. General Assembly

8.1 Dimensions

8.1.1 Standard Tolerances (ASY)

Unless otherwise specified on the drawing field or title block the standard tolerances shall be as followed for assembled product.

LINEAR	
X.	0.125
X.X	0.050
X.XX	0.030
X.XXX	0.010
X.XXXX	0.005

ANGULAR	
X.	2°
X.X	1°
X.XX	½°
SURFACE ROUGHNESS	
N/A	

8.1.2 Install Reference vs Required

Dimensions shown on final assemblies that are referenced on lower detail drawings are for installation or procurement reference. These dimensions, once validated on the detailed drawings, do not require a second validation at final assembly.

All dimensions that measure mating components and how they interface together must be validated at final assembly inspection for drawing conformity.

8.1.3 Build Instructions

Unless otherwise specified on the drawing or customer purchase order / contract, parts shall be built and packaged in accordance with the build instructions as established within Enterprise Resource Planning (ERP) system.

8.2 Screws and Bolts

8.2.1 Screw / Bolt Installation

If the drawing does not specify a specific torque value, hand tighten using standard hand or power tools may be done using the following procedures.

Bolt and Nuts: Tighten the nut or bolt snug to remove gaps and to a point where firm resistance is felt. Once snug, make an additional rotation of the hex nut or bolt by one flat (60°) max.

Machine Screws: Tighten the screw snug to remove any gaps and to a point where firm resistance is felt. Once snug, make an additional rotation of the head by approximately 45°

Clutch settings on all power tools need to be set in accordance with the hand tightening procedure to prevent over torquing.

Machine screws installed into aluminum threads without a lock-type insert may have locking sealant applied to the threads at installation.

8.2.2 Screw Lengths and Engagement

At assembly, threaded engagements shall be equal to or greater than one diameter of the screw diameter. In situations where tolerances may prevent a fastener from reaching its minimum engagement or seating properly, the next fastener length, up or down, may be used in place of the required fastener.

8.2.3 Countersunk Screws

Countersunk screw shall be installed near flush with the top surface. Screw heads shall not protrude more than .010in or sit recessed more than .030in. Screws shall seat with 360° contact with the mating material. Uneven contact may be a result of mis-aligned components or improper countersinks.

8.2.4 Fastener Torque Specifications

When no torque specification is specified on the drawing, the following chart shows the suggested maximum torque values for threaded parts. Fasteners installed using the methods in 8.2.1 should not exceed these values.

Size	18-8 CRES	316 CRES	Brass	AL 2024 / 7075	AL 6061-T6
2-56	2.5	2.6	2.0	1.4	1.1
4-40	5.2	5.5	4.3	2.9	2.3
4-48	6.6	6.9	5.4	3.6	2.9
6-32	9.6	10.1	7.9	5.3	4.2
6-40	12.1	12.7	9.9	6.6	5.3
8-32	19.8	20.7	16.2	10.8	8.6
8-36	22.0	23.0	18.0	12.0	9.6
10-24	22.8	23.8	18.6	13.8	11.0
10-32	31.7	33.1	25.9	19.2	15.4
1/4-20	75	78.8	61.5	45.6	36.5
1/4-28	94	99	77	57	45.6
5/16-18	132	138	107	80	64.0
5/16-24	142	147	116	86	68.8
3/8-16	236	247	192	143	114
3/8-24	259	271	212	157	125
7/16-14	376	393	317	228	182
7/16-20	400	418	357	242	193
1/2-13	517	542	422	313	250
1/2-20	541	565	443	328	262
9/16-12	682	713	558	413	330
9/16-18	752	787	615	456	364
5/8-11	1110	1160	907	715	572
5/8-18	1244	1301	1016	798	638

8.2.5 Lubricated Installation of Fasteners

It is permissible to use an anti-seize compound when installing a threaded fastener, of 300 series stainless steel, into a locking threaded insert to prevent galling during installation.

8.3 Part Mark

When no location is specified on the drawing, part mark shall be placed in a non-cosmetic location. Parts with a configuration that does not accommodate a part mark shall have the part mark on the packaging.

Parts are **not** to be engraved without written authorization from SAM representative, when authorization is given only the part number shall be engraved.

8.3.1 Part Marking Minimum Requirements

- Complete Part Number
- Revision Level
- SAM Work Order or Purchase Order Number

Note: Reference SAM Task (140-030-001) for additional Part Marking requirements.

8.4 Threaded Inserts

8.4.1 Insert Installation

Threaded inserts shall be installed either with a pneumatic drive tool or by manual hand cranked tool. Final installation requirements shall be met, regardless of which tool is used for installation.

Threaded inserts shall be installed in the orientation or view shown on the drawing, unless otherwise specified. Insert shall be installed to a depth .5-2 threads below flush.

8.4.2 Installation Trouble

If there is difficulty installing threaded inserts, first check to be sure that the correct Go / No-Go gage threads freely to the bottom of the threads. If there is a gritty feel to the threads, debris may be causing problems and should be cleaned out with alcohol or chasing with a tap.

If the thread is undersize or deformed, an NCR shall be written, and disposition provided before any rework to threads may be done.

8.4.3 Insert Tab

After installation, the install tab of the threaded insert shall be removed on all inserts installed into a through hole. Install tabs are not required to be removed on inserts that are installed into, blind holes unless otherwise specified.

8.4.4 Wet Installation

When wet installation is reference on drawing, purchase order, or build instructions, threaded inserts shall be installed wet using FR primer in accordance with SMS200 Type II or Type III.

Apply primer to threaded hole using applicator tip. Sufficient primer should be applied so that there is a barrier between the substrate material and threaded insert, but sparingly, as to not gum up on assembly (install fastener).

8.5 Rivets

8.5.1 Rivet Holes

8.5.1.1 Drilling

When predrilled holes are not provided for riveting, the rivet holes shall be drilled in accordance with the following requirements.

- a. All holes shall be drilled at 90° (normal) to the working surface.
- b. Oversize, oblong and irregular-shaped holes shall be cause for rejection.
- c. When drilling through multiple components for riveting, hold all components securely together so there is no misalignment of holes due to shifting.
- d. Hole size for rivets shall conform to table I unless otherwise specified.

8.5.1.2 Countersinking

When pre-countersunk holes are not provided for riveting, the rivet countersinks shall be countersunk in accordance with the following requirements.

- a. Countersinking shall be used in the installation of all flush type rivets.
- b. Countersinks should be produced with a tool that incorporates an automatic stop feature.
- c. The countersink shall be at 90° (normal) to the working surface.
- d. Countersinks are to be free from chatter marks and concentric with the rivet holes.
- e. The countersink diameter shall be in accordance with Table V

8.5.2 Manufactured Heads vs Driven Heads

The provided head of the rivet is the “Manufactured Head”. The head created upon installing the rivet, or bucking, is the “Driven Head”.

8.5.3 Manufactured Heads

A deformation of the manufactured head caused by the mating die is acceptable provided there are not sharp discontinuities in the deformed surfaces.

Damage to the structural surface, resulting from the use of a rivet die too large is a rejectable condition.

Flattened head height of the manufactured head shall not be less than those values listed in table II.

8.5.4 Manufactured Head Direction

Unless otherwise specified on the engineering drawing, the manufactured head of the rivet should be located on the exterior (cosmetic) surface of the part.

8.5.5 Driven Head Diameter

Unless otherwise specified, all rivets shall be driven to minimum head diameter specified in table III. Driven head thickness larger than the maximum specified in table III must be approved by engineering.

8.5.6 Manufactured Head Height

The height of the manufactured heads after riveting shall not be less than as specified in table II.

Unless otherwise specified, flushness of countersunk rivets shall be .010in above to .005in below the original surface.

Rivets failing to meet requirements may be shaved to meet the requirements noted above. The material surface shall not be damaged by the shaving tool. The cutter must be larger than the head of the rivet being shaved. Shaved rivets may not protrude prior to shaving more than the dimensions shown in table IV. The minimum head diameter after shaving shall be as specified in table IV. Refinishing of shaved rivet heads shall be required in areas where the parent material is painted, chemically treated, or primed. Refinishing shall be to the same requirements as the parent material.

8.5.7 Installation Grip

The rivet grip length should be verified prior to installation. Rivet length may be changed as material thickness dictates are required to achieve minimum head dimensions as shown in table III.

Cutting or shaving the length of a rivet prior to installation is also an acceptable method if all requirements are met.

Minimum rivet length for a specified grip length shall be as shown below.

$$\text{Grip Length} + (\text{Rivet Dia} \times 1.5)$$

8.5.8 Corrosion Prevention (Wet Install)

When the rivet material is dissimilar to the material being riveted, or specified on the engineering drawing, the rivet hole, countersink, and rivet shall be coated with primer in accordance with SMS200 Type II or Type III prior to installation.

Apply primer to hole using applicator tip. Sufficient primer should be applied so that there is a barrier between the substrate material and rivet. Once the rivet has been installed, all excess primer shall be cleaned from the surrounding area.

8.5.9 Defect Standard

Rivet installations showing evidence of the following defects shall be determined defective. See figures in section 8.5.11 for examples.

- a. A beveled driven head where the minimum or maximum head height is outside of table III (Figure A)
- b. At an offset, clinched, bent over, or clubbed driven head: (1) where a portion of the hole or the deburred surface is visible; (2) rivets on which the entire periphery of the bucked head does not show evidence of upset; or (3) clubbed or bent over portion exceeds the heights listed in table III over any part of the surface area. (Figure B)
- c. In a stepped driven head where the minimum or maximum head height is outside table III. The high part may be removed to be within acceptable limits. (Figure C)
- d. Rivet does not complete fill hole. (Figure D)
- e. Punch rings in driven head where lowest or highest surface is outside table III. (Figure E)
- f. Loose Rivets. (Figure F)
- g. Separation between components after riveting which allows a .003 feeler gage to be inserted between components from any direction far enough to touch the rivet shank. (Figure G and H)
- h. Cracked, cut of ringed heads on flush type rivets. (Figure J)
- i. Misshaped driven heads: (1) whose head heights exceed that shown in table III; (2) where the shortest dimension is less than the minimum diameter of table III; or (3) where the longest dimension of the head exceeds 1.5 times the shortest dimension. (Figure K)
- j. Crack in driven heads: (1) which fall within a circle which is concentric with and 1.1 times the nominal shank diameter; (2) intersecting cracks; or (3) five or more cracks. (Figure L)

- k. Cracks in non-flush type manufactured rivet heads which fall within a circle which is concentric with and 1.4 times the nominal shank diameter. (Figure M)
- l. The occurrence of any gap around a continuous 60 percent of the circumference of the driven head. In the other 40 percent, gaps which allow a feeler gauge larger than .002 inches to be inserted. Any gap under the manufactured head. (Figure N)
- m. Rivets not meeting sections 8.5.2 thru 8.5.5

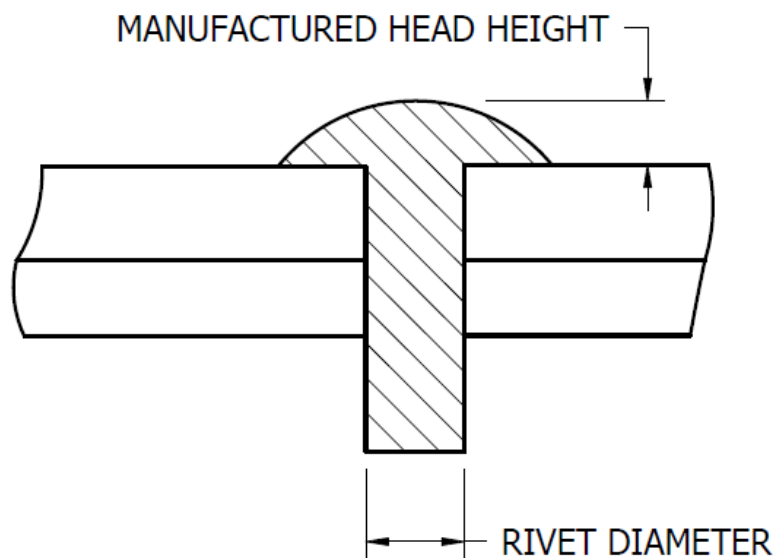
8.5.10 Rivet Tables

Table I – Hole Size, Standard Rivets

Rivet Diameter (Inches)	Recommended Drill Size	Hole Diameter Limits	
		Min	Max
1/16	#51 (.067)	.062	.072
3/32	#40 (.098)	.093	.103
1/8	#30 (.128)	.125	.135
5/32	#21 (.159) #20 (.161)	.156	.171
3/16	#11 (.191) #10 (.194)	.187	.202
7/32	#1 (.228)	.218	.233
1/4	F (.257)	.250	.265
9/32	L (.290)	.281	.296
5/16	O (.316)	.312	.327
11/32	S (.348)	.343	.358
3/8	V (.377)	.375	.390

**Table II – Minimum Flattened Dimensions
Of Manufactured Rivet Heads**

Rivet Shank, Nominal Diameter	Minimum Manufactured Head Height (Inches)
1/16	.022
3/32	.032
1/8	.042
5/32	.052
3/16	.062
7/32	.072
1/4	.083
9/32	.093
5/16	.104
11/32	.114
3/8	.125



**Table III – Standard Flat Driven
Head Dimensions**

Rivet Shank, Nominal Diameter	Minimum Driven Head Diameter (Inches)	Driven Head Thickness (Inches)	
		Min	Max
1/16	.081	.025	.040
3/32	.122	.038	.050
1/8	.163	.050	.070
5/32	.203	.062	.092
3/16	.244	.075	.105
7/32	.285	.087	.110
1/4	.325	.100	.130
9/32	.365	.113	.140
5/16	.406	.125	.158
11/32	.450	.137	.170
3/8	.488	.150	.190

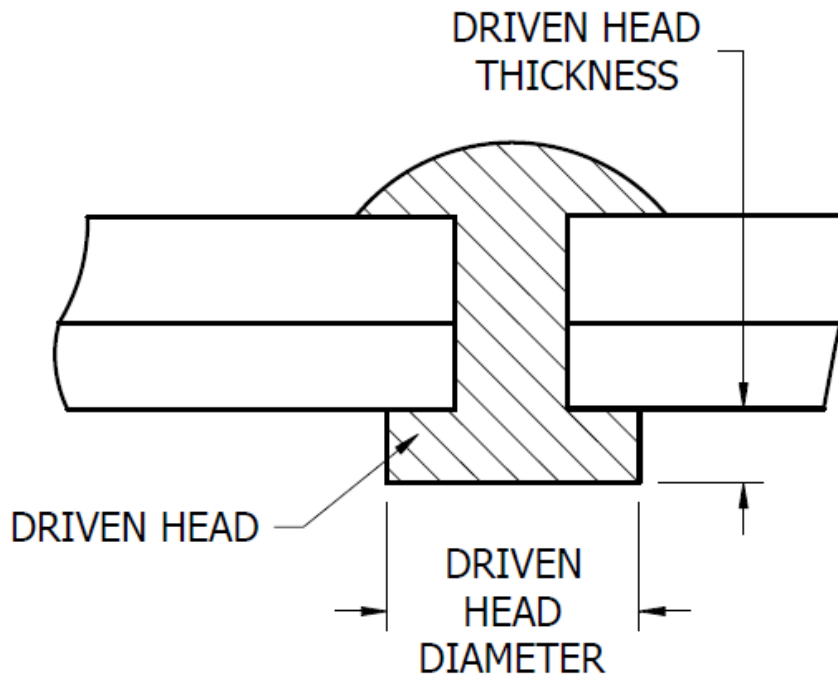


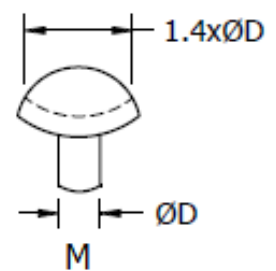
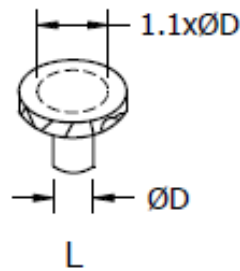
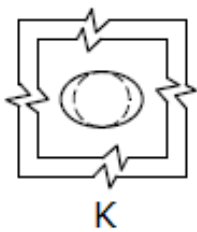
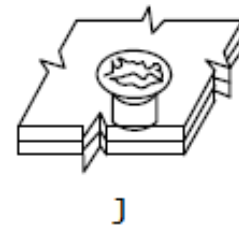
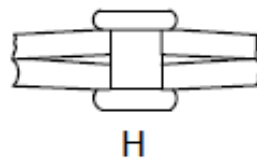
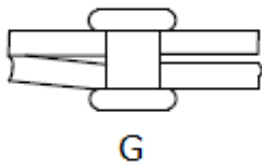
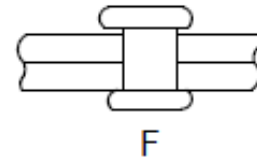
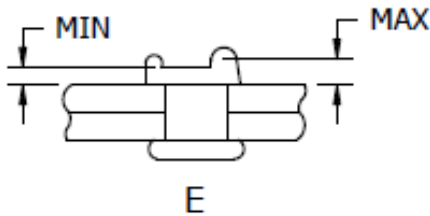
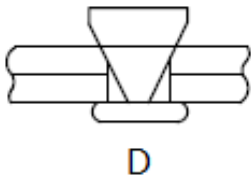
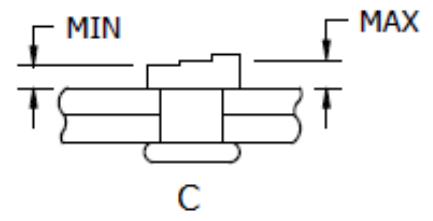
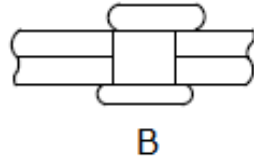
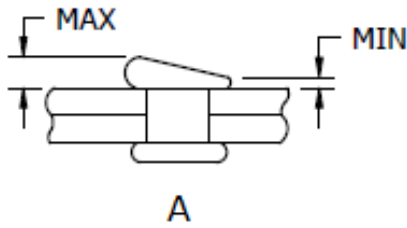
Table IV – Required Dimensions for Rivet Shaving

Nominal Rivet Diameter	H Max Head Protrusion Prior to Shaving	ØD Min Head Diameter After Shaving
1/16	.005	.095
3/32	.006	.161
1/8	.007	.204
5/32	.009	.262
3/16	.010	.326
7/32	.011	.383
1/4	.012	.443
9/32	.013	.490
5/16	.014	.526
11/32	.015	.588
3/8	.016	.650

Table V – Countersink Diameters

Rivet Diameter	Countersink Diameter
1/16	.110
3/32	.176
1/8	.222
5/32	.284
3/16	.351
7/32	.411
1/4	.474
9/32	.522
5/16	.560
11/32	.625
3/8	.690

8.5.11 Rivet Figures



Rivet Figures Continued...

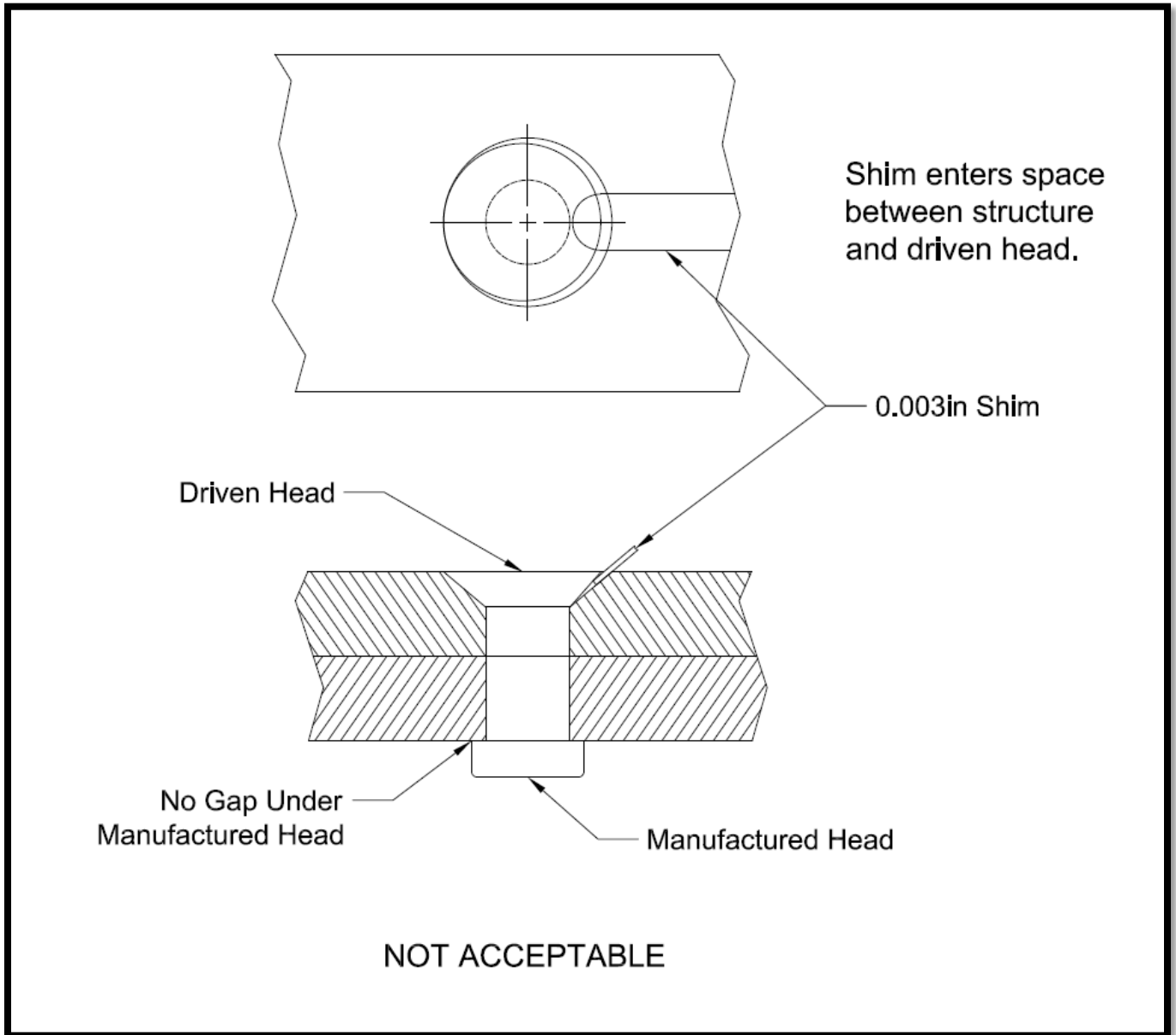


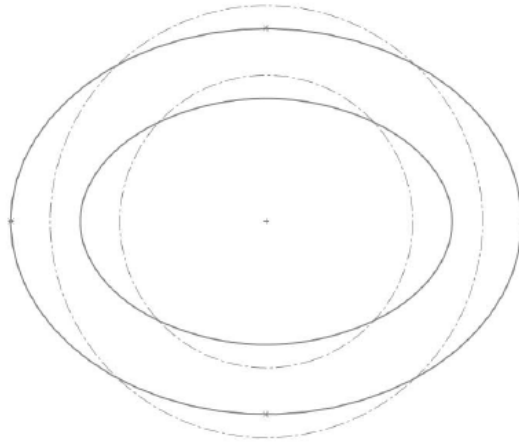
Figure N

8.6 Pins

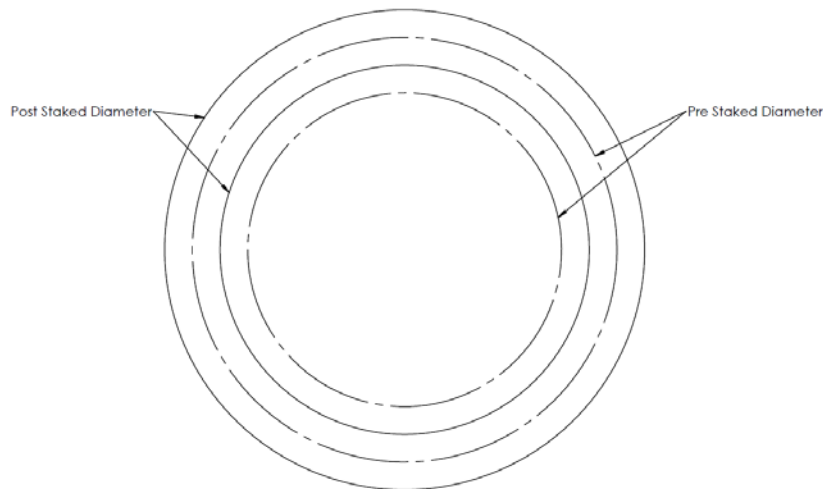
8.6.1 Pivot Pins

Pivot pins shall be “staked” or deformed on both end after installation. Pins shall be deformed in a manner that, at minimum, the diameter in one direction is greater than the pivot hole. Assemblies sold in a raw or unfinished state shall be lightly staked or deformed on both ends in a manner that, at minimum, the diameter in one direction is equal to the through hole diameter.

Example: Staked One Direction



Example: Staked Concentric



8.6.2 Hinge Pins

8.6.2.1 Pin Lengths

Hinge pins will be issued in 36-inch lengths and will be trimmed to length unless otherwise specified. On hinges longer than 36 inches, two or more pins will be used with the pins meeting at the approx. midpoint of a lug. The hinge pin shall engage into the end lugs with a minimum of 0.050in engagement and must not be able to shift significantly, as to impede on the minimum engagement.

Hinge pins shall be sufficiently short (0.05 – 0.25) to allow for the hinge end to be swage or crimped for pin retention.

Note: Minimum pin engagement is still required to be maintained once trimmed.

Hinges with cosmetic caps installed must have the pin trimmed to allow for the installation of the caps.

Hinges installed with a dampener will need to be cut so that one end of the pin is flush or against the dampener pin, while the other end meets the above-mentioned requirements.

Where possible a tolerance of ± 0.030 will be used to govern the length when trimming hinge pins to length. If a ± 0.030 tolerance will infringe on one of above-mentioned requirements, a range tolerance will be applied.

8.6.2.2 Pin Retention

The hinge lug shall be swaged from the non-cosmetic (visible side) of the hinge deforming the hole and preventing the pin working out. The hole shall be $0.80D \pm 0.10D$ after swaging.

Example: 0.093 Diameter Pin Hole
0.074 \pm 0.009 after swaging

Hinges with cosmetic caps shall have the end cap and hinge swage together from the non-cosmetic (visible side) of the hinge. The swage shall be made with 0.050 ± 0.015 dia swage tool and at a depth of $0.30D \pm 0.030$ into the lug diameter. If a swage is performed too deep, the integrity of the cap can be compromised, and the stem of the cap may become severed and fall from the lug.

Example: 0.188 Diameter Lug
0.056 Depth of swage.

8.6.3 Split / Spring Pins

Pins shall be installed to MS / AMS recommended standard holes. Pins shall not protrude more than .005 from the installed hole.

Pins with a diameter of 0.078 or smaller should not be re-installed once removed from an assembly.

8.7 Retaining Rings

Retaining rings for shafts 0.125 inch or smaller should not be re-installed once removed.

8.8 Surface Touch-up

8.8.1 Anodized Surfaces

Aluminum surfaces that are bare shall be touched up with Alodine RTU solution prior to final assembly inspection. Alodine shall only be used on 10% or less of the surface area. If greater coverage is required, the parts must be re-anodized.

8.8.2 Painted Surfaces

Painted surfaces shall be touched up by SAM employees when only when exposed surfaces are less than 0.032 in diameter or scratches that are less than 0.250 in length. Touch up of paint shall be done in accordance with any specifications for application on the drawing.

8.8.3 Primered Surfaces

Primered surfaces shall be touched up by SAM employees when only when exposed surfaces are less than 0.125 in diameter or scratches that are less than 0.750 in length. Touch up of primer shall be done in accordance with any specifications for application on the drawing.

8.8.4 Dry Film Surfaces

Components with dry film lubricant shall be touched up using aerosol spray slip plate or equivalent. Slip plate shall only be used on 20% or less of the surface area. Aerosol Slip Plate shall be applied per manufacturer's directions. If greater coverage is required, the parts must be stripped and re-finished.

8.9 Precious Metal Plating

8.9.1 Surface Protection

Prior to assembly, cosmetic surfaces of precious metal plated parts shall be protected with clear film. Once assembly is complete, film shall be removed, and part inspected for possible damage caused during assembly.

8.9.2 Cleaning

Parts shall be wiped down with a non-scratch towel and cleaning solution to remove any fingerprints or residue from assembly.

8.9.3 Packaging

All plated parts shall be wrapped in non-scratch towels and sealed in thick plastic bags to prevent any damage during transportation or storage.

RECORD OF REVISIONS

Rev. No.	Issue Date	By	Description
IR	APR 27/15	R Hughes	
A	SEP 16/15	R Hughes	
B	OCT 21/16	C Carlson	
C	DEC 19/17	DSM	Workmanship standard was rewritten. Sections 7.7, 8, 9, 10 and are new to the workmanship standard.
D	MAR 06/19	DSM	Added General assembly section and thread class. Added table of contents.
E	Aug 28/19	DSM	Updated part mark section, and revised pin cut length section.
F	MAY 24/21	DSM	Added Max torque spec table. Added 8.3.1 Part Mark Requirements. Added RA to general tolerances, added drill size tolerances to drilled holes section. Add Countersink and Counterbore Charts.
G	Jan 28/22	DSM	Added 7.1.3, 7.5.2, 7.8.6 and second chart in 7.3.3. Made thread relief is own section 7.8.2 and re numbered existing section after it. Revised 8.6.2.1 to provide clarity.
H	June 21/22	DSM	Added section 7.2.5, 7.2.6, 7.3.4, Moved Drilled Holes to subsection 7.7.1 and increments subsequent subsections. Added Paragraph 2 to 7.7.1 "Drilled Holes" Added Paragraph 2 to 8.6.3, added 8.2.5, added 8.1.3
J	Nov 16/22	DSM	Added 8.4.4, Revised section 8.5, Revised 8.6.1 by adding at minimum two places and second example.