LEONARDO DRS

WORKMANSHIP STANDARD

MC-000201/01

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Section 1		New content for CTQ's	Add bullet point item noting CTQ content in Section 7.		
Section 7		New content for CTQ's	Add note regarding synchronization of Critical to Quality (CTQ) content between MC-000201/01 (this doc) and BPMC-ME-014. Add CTQ content matching BPMC-ME-014.		
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		New content for Sealing Requirements. Key Lock Insert Updates.	Add Section 8 for Sealing Requirements and Standards for DRS Products. Update Section 2.6.2 for clarification on proper Bolt Clearance needed for Blind Hole Key Lock Inserts.		
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		New content for zinc-coating doorstop latches and requiring alignment of door pins for dripproof motor controller doors.	Add Section 2.7.8 for Zinc-Coating Door Stop Latches. Add Section 2.9.3 for Welding Pin Assemblies (13-3258). Update figure numbers.		

DOCUMENT MANAGEMENT NOTE: *To ensure the design team and supply chain are interpreting CTQ's the same way, the contents of the chapter on* ***CTQ Management*** *must be taken verbatim from the Mechanical Best Practice BPMC-ME-014 "Critical to Quality Characteristics". Proposed changes to the content on* ***CTQ Management*** *in this document must be synchronized with the BPMC-ME-014 CTQ Best Practice.*

TABLE OF CONTENTS

ABBREVIATIONS

ASTM	American Society for Testing and Materials
CNC	Computer Numeric Control
CoC	Certificate of Conformance
COTS	Commercial Off The Shelf
CTQ	Critical to Quality
FAI	First Article Inspection
FED	Federal
lbs	pounds (weight)
MS	Military Specification
NAS	National Aerospace Standard
NASM	National Aerospace Standard Model
NEMA	National Electrical Manufacturers Association
PO	Purchase Order
RTV	Room Temperature Vulcanizing
SOW	Statement of Work
STD	Standard
SVR	Supplier Variation Report
UNS	Unified Numbering System

1 PURPOSE

This document defines the following practices that must be followed by DRS Suppliers:

- Section 2: General Fabrication Requirements with examples, such as machining and finishing details that may be difficult to convey in a drawing note but are explained herein with more detail, photographs, tables, etc.
- Section 3: Standard Tolerances to be applied when features on the drawing do not explicitly include a tolerance (example default hole size tolerances).
- Section 4 and following: Commodity specific (example: Bus Bar workmanship requirements).
- Section 7: Requirements and guidance for Critical to Quality Characteristics (CTQ's).

This document is intended to guide the supplier, and DRS internal inspection, to the final product that DRS requires.

1.1 Scope

These requirements apply to parts and assemblies, defined by DRS drawings and specifications when this standard is called-out on the DRS drawing, or when attached to a DRS Purchase Order (PO). See Section 1.2 for order of precedence.

These requirements do not apply to Commercial Off The Shelf (COTS) items.

1.2 Order of Precedence

(1) Revisions to Purchase Order

(2) Purchase Order

(3) Supplier Variation Report

(4) Drawing specified on Purchase Order *

(5) The commodity specific requirements of this document (Section 4 and following)

(6) The general requirements of this document (Section 2 and 3).

* If requirements conflict between this document and the drawing, the drawing shall take precedence. If there are other documents listed on the drawing, those documents shall take precedence over this document. Clarifications should be made through DRS' Supplier Variation Report (SVR) process MQI-SP-302A

2 GENERAL FABRICATION REQUIREMENTS

2.1 Order of Operations

All fabricating operations, such as welding, machining, drilling, and tapping shall be accomplished prior to treating, coating, plating, or painting except that paint may be removed from tapped holes.

2.2 Edges or Corners

All edges and corners shall be broken. For guidance, approximately .005 inch to .020 inch x 45 degree chamfer or radius. Hand operations are permissible.

2.2.1 Burrs

Burrs from machining or punching are undesirable.

The following guidelines in § 2.2.1.1 and 2.2.1.2 shall be observed:

2.2.1.1 Hanging Burrs

A hanging burr is a residual particle left attached to part after machining such that it could later break off. Refer to Figure 1. Hanging burrs are unacceptable.

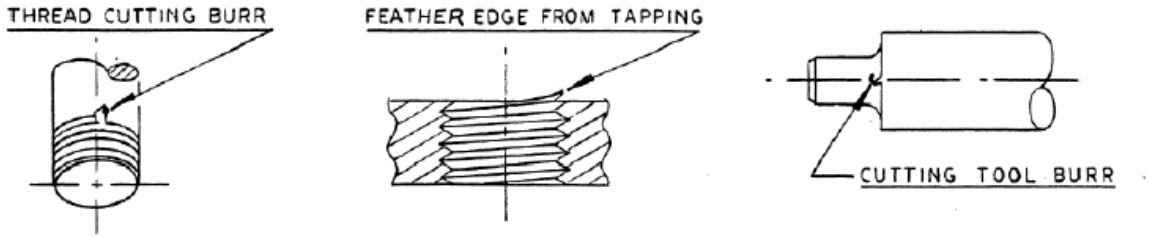


Figure 1 - Hanging Burrs

2.2.1.2 Raised Burrs

A raised burr is a ridge raised above the normal surface of a part or a ragged edge caused by a machining operation. Raised burrs ≥.005 are unacceptable. Refer to Figure 2.

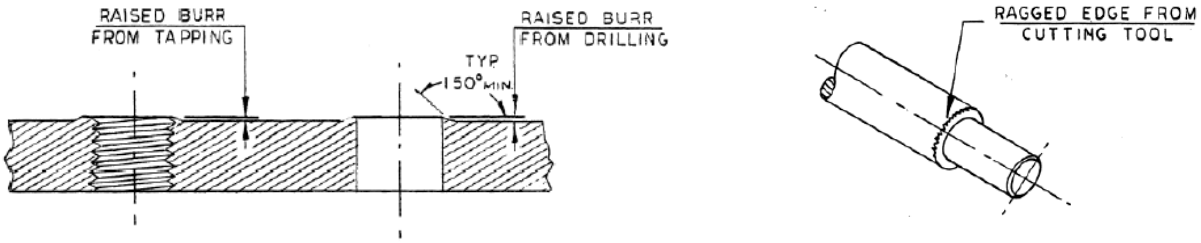


Figure 2 - Raised Burrs

2.3 Surface Roughness

The maximum surface roughness on machined parts shall be 125 micro-inch *Ra* (Roughness Average).

2.4 Drilled Holes

Drilled hole depth is measured from the surface to the bottom of the full diameter. The drill point is not included in the drill depth measurement. Refer to Figure 3.

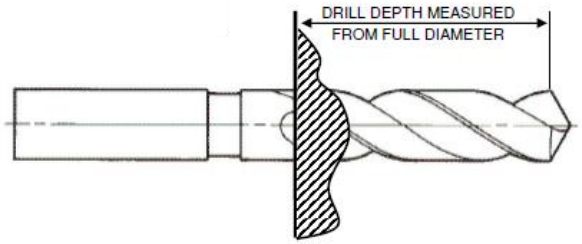


Figure 3 – Drill Depth

2.4.1 Drill Point

The drill point is assumed to be 118 degrees based upon DRS' modeling standards. Other drill points may be used but shall not break through the part.

2.5 Threads

Threads shall be in accordance with Federal Standard, FED-STD-H28/2.

Tapped holes, except for threaded inserts, shall be countersunk 120 degrees to remove burrs and provide proper screw lead in.

- The threaded holes of less than .250 inch nominal diameter shall have a counter sink outer diameter no greater than 10% larger than the nominal diameter (example a .190 inch hole, shall be .209 inch or less).
- The threaded holes equal or greater to .250 inch nominal diameter shall have a counter sink outer diameter no greater than 5% larger than the nominal diameter (example a .500 inch hole, shall be .525 inch or less).

Threads shall show no evidence of cross-threading or mutilation.

Threads shall be free of primer, paint, and anodizing. Supplier may remove primer, paint, and anodizing from threaded holes as long as the removal process does not affect the threads.

2.6 Threaded Inserts

Threaded inserts should be installed after completing all primer, paint, and anodizing processes.

2.6.1 Military Specification Helical Coil Threaded Inserts

Where specified, Military Specification, MS122076 thru MS124850 and MS21209 inserts shall be installed per National Aerospace Standard Model, NASM33537. National Aerospace Standard, NAS1130 inserts shall be installed per NAS1130.

Tangs shall be removed from all tanged inserts.

2.6.2 Military Specification Key-Locked Threaded Inserts

Where specified, MS51830, MS51831, and MS51832 inserts shall be installed per MS51835.

Keys shall be fully seated with no evidence of mutilation and keys shall be below the surface of the base material.

A minimum of three threads past the MS51835 stated full thread length shall be required unless otherwise specified on the drawing or design documentation.

2.6.3 Threaded Inserts without Installation Requirements

Where threaded insert installation guidelines are not present, manufacturer's recommendations or guidelines shall be used.

2.7 Painting

Unless otherwise specified on the drawing, dimensions apply prior to painting.

2.7.1 Surface Preparation of Adhesion

The supplier shall prepare the surface and control the application process to ensure proper primer and paint adhesion. Surfaces shall be free of dirt, spatter, grease, oil, mill scale, corrosion, moisture, and other surface contaminants immediately prior to painting. Aluminum surfaces shall not be prepared with carbon steel mediums.

2.7.2 Paint and Primer Thickness

Unless otherwise specified on the drawing, paint and primer thickness shall be per applicable specification. If neither the drawing or applicable specification specify paint and primer thickness the manufacturers' recommended thickness shall be used. Paint thickness shall be taken as an average over the painted surface.

2.7.3 Painted Metal Surfaces

Painted surfaces shall be maintained in a manner to deliver the equipment in "as new" painted condition. Damage (chips, scratches, dings, etc.) or deterioration (blistering, peeling, pin holes, discoloration, etc.) of the paint shall be repaired to "as new" condition in accordance with the painting requirements for the surface. This "as new" condition shall apply for all outside surfaces to ensure the aesthetics are clean and the product looks new.

a. Repairs to painted surfaces shall consist of removing the coating to bare metal, apply any necessary cleaning to remove contamination or corrosion, and reapplication of the entire paint process specified for the surface.

b. If as new condition (in both appearance and corrosion protection) can be accomplished by touch-up of the specific deteriorated area, touch-up is allowed.

2.7.3.1 Touch-up painting

Where only localized areas or spots require repainting, removal of old paint shall be carried back around the edges of the spot or area until an area of completely intact and adhering paint film is present and no rust or blisters are evident. The edges of the remaining tightly adherent paint around the area to be repainted shall be smoothed (feathered) down to the bare surface.

2.7.3.2 Old Paint

Where a surface is to be repainted and all the old paint is not to be removed, the surface shall be clean and dry before new paint is applied.

2.7.4 Paint in Holes

Unless otherwise specified on the drawing, through holes for fasteners shall be free of paint for aluminum and zinc plated steel.

2.7.5 Adhesion Testing

Paint adhesion testing per American Society for Testing and Materials (ASTM) D3359 shall be done for all new suppliers, or changes in the paint process application method, and the respective adhesion test records shall be sent with the first article reports.

2.7.6 Acceptance Criteria – Inside Surfaces

After painting parts, the surface shall have a smooth uniform appearance.

For all surfaces that will be inside the completed assembly, the following can be considered ACCEPTABLE:

Figure 4 – Random (4 or 5) debris less than 1/8" will be accepted. If debris patterns become greater than 5 or extends to more than 2 surfaces, the process will be deemed out of control and will be unacceptable.

Figure 5 – Surfaces that may exhibit some over paint from masking removal are acceptable if they do not exceed 1/4".

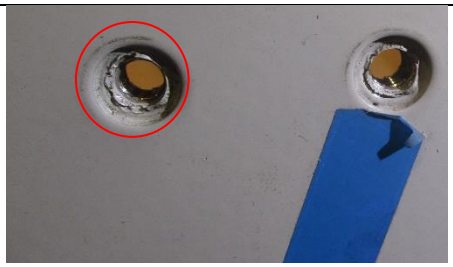


Figure 6 – Paint excess from plug removal is acceptable as long as no paint is apparent on threads and a thread gage has been used to verify functionality.

Figure 7 – Paint build up/hanger marks on enclosure/case or panel mounting hole.

Figure 8 – Thin/missing paint in enclosure/case or panel mounting hole that exposes less than ½" of bare metal.

Figure 9 – Small, shallow abrasions

2.7.6.1 Unacceptable Paint Defects – All Surfaces – Refer to Figure 10 through Figure 19.

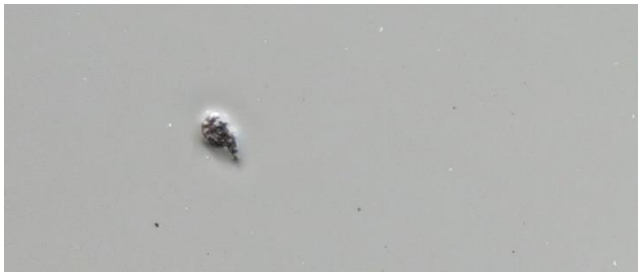


Figure 10 – Any Debris in Paint Exterior

Figure 11 – Chipped Paint

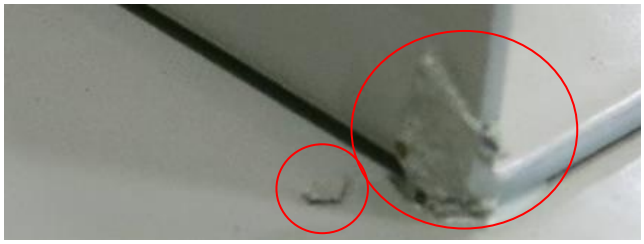


Figure 12 – Large (greater than 1/8”) Debris in Paint

Figure 13 – Scuffed Paint where bare metal is exposed.

Figure 14 – Painted Thread

Figure 15 – Paint Drip Surface

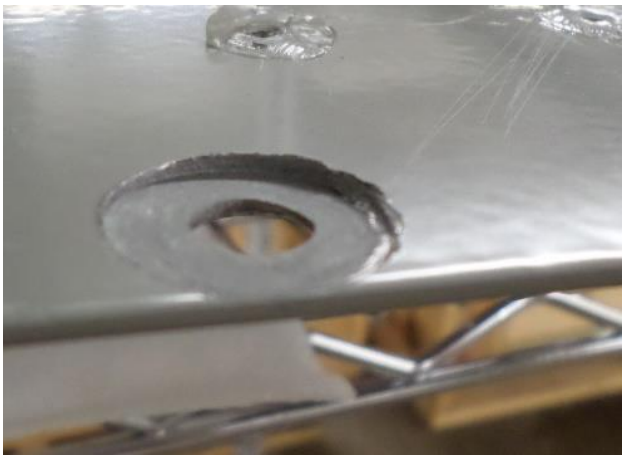


Figure 16 – Structural Damage to Metal

Figure 17 – Damage to Threads That Prevents Hardware Mating

Figure 18 – Area Missing Zinc Paint Greater Than 1/8 in.Wide

Figure 19 – Area of Rust Greater Than 1/8 in. Wide

2.7.7 "Orange Peel" Surface

In cases where the painted surface finish has an "orange peel" like appearance (See Figure 20) at approximately 18 - 24 inches away perform a non-destructive adhesion test (Reference 50-212-3C of DRS Spec #50-212) to ensure the painted surface will perform the corrosion barrier as defined by specifications. A successful pass will result in material acceptance. Supplier to provide documentation of the tape test when performed.

Figure 20 – "Orange Peel" Surface

2.7.8 Zinc-Coating Door Stop Latches

For all doorstop latches (79-7177, Figure 21), a 0.62 ± .10-inch square area where the latches rest when fully engaged shall be masked and free of paint from the painting process (DRS Spec #50-726). See Figure 22 below for reference. After painting of the door, apply corrosion-protecting, conductive zinc-coating, per ASTM A780, to the exposed metal area.

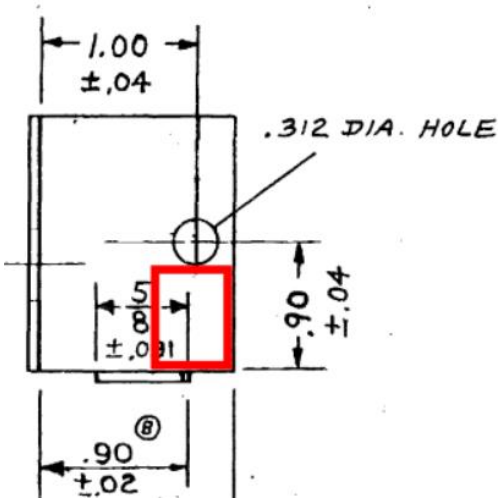


Figure 21 - Doorstop latch drawing (79-7177). Area in red is to be free of paint and zinc-coated on the interior of the latch.

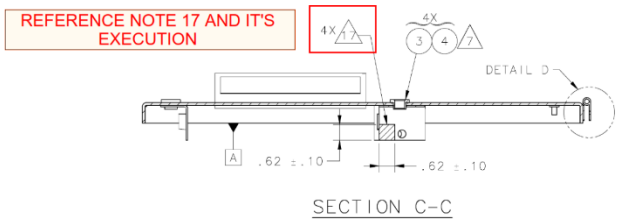


Figure 22 – Drawing reference. Area indicated to be free of paint. Corrosion-protect with zinc coating per ASTM A780, near side. Taken from 47-25133 Rev D, Page 2.

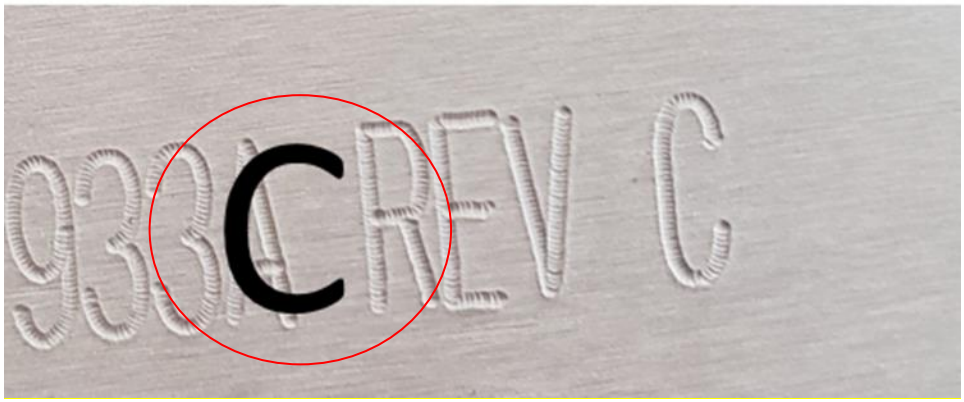
2.8 Part Marking

Unless otherwise specified on the drawing, mark each part with epoxy ink per A-A-56032 Type I in the location shown on the drawing with the part number and revision listed on the purchase order. Character height shall be .19 inch minimum. Where the drawing shows the exact part number and revision, mark the shown nomenclature. Where the drawing shows a boxed area or points to a general area, mark the part in the approximate location shown. Where marking location is not shown on a drawing, the part shall not be marked; but shall be boxed, bagged or tagged with the part number and revision listed on the purchase order.

2.8.1 Part Marking Errors

For Part marking mistakes the supplier is allowed to correct the mistake if the correction is legible enough to ensure the correct part number marking is still readable and understood. One such example (etched marking) is listed below:

We are proposing overstamping the "A" above with the approved Epoxy Ink so that it would read "C".



2.9 Welding

DRS written approval is required prior to the beginning of any welding. Weld procedures shall be submitted via the DRS SVR process for approval.

Weld repair not in accordance with a repair procedure approved by DRS, or per the applicable specification shall be approved via the DRS SVR process.

2.9.1 Weld Acceptance Criteria

In the absence of weld acceptance criteria, MIL-STD-2035 Class 1 shall be met, in addition to the following requirements.

Where intermittent welds are used the requirements of MIL-STD-2035 applies to the entire weld.

If not specified on the drawing, or per welding specification, the weld size shall not be greater than shown in Table 1.

Table 1 – Weld Maximum Size

Specified Weld Size inches	Percent Larger Than Specified Weld
Up to 1/8	50 percent
1/8 but less than 1/4	35 percent
1/4 but less than 1/2	20 percent
1/2 or greater	10 percent

2.9.2 Welding 6000 Series Aluminum

When welding 6000 series aluminum sharp transitions from weld to base metal shall be avoided. Overlap, with no magnification, is not permitted. Refer to Figure 23. Complete fusion shall be accomplished at the ends of the weld. Craters with sharp contours are not acceptable.

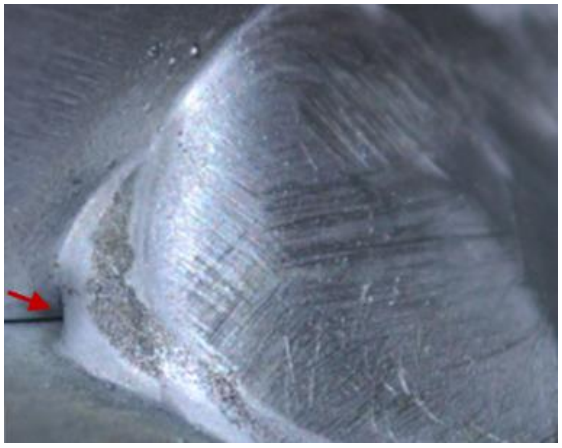


Figure 23 – Overlap

2.9.3 Welding Pin Assemblies (13-3258)

When welding pins (13-1609) to angle brackets (79-4738) to produce pin assemblies (13-3258), tooling shall control the relative alignment of the pin to the angle bracket during the welding process. Figure 24 and Figure 25 show an acceptable example of adjustable tooling to control alignment of the pin assembly components during welding.

Figure 25 – Adjustable Hinge Pin Alignment Fixture (Perspective View)

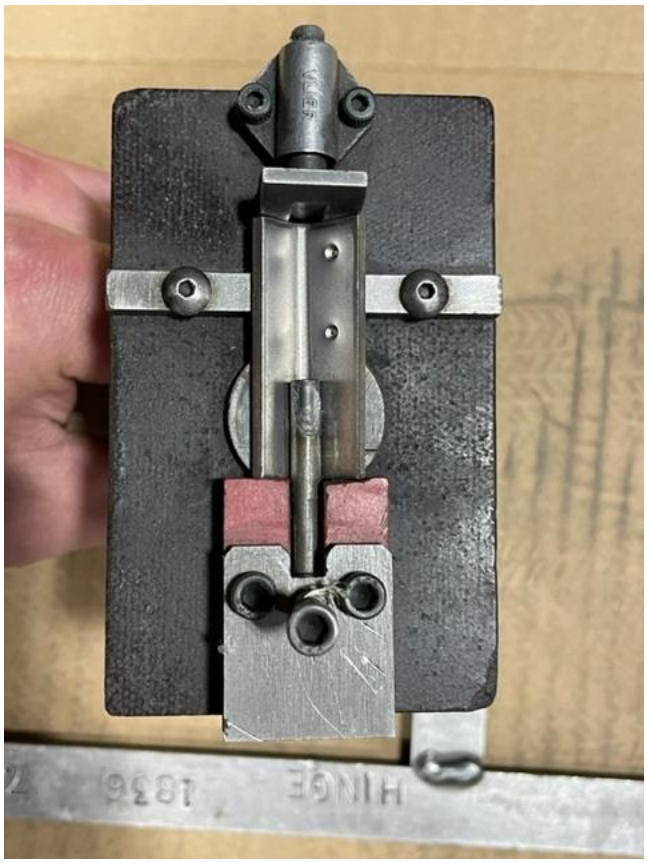


Figure 24 – Adjustable Hinge Pin Alignment Fixture (Top View)

When welding pin assemblies (13-3258) to dripproof motor controller doors, ensure the pin assemblies are collectively and individually aligned and straight. Figure 26 provides an acceptable example of fixturing that controls pin assembly location.

Figure 26 – Pin Assembly Location Fixture

Figure 27 is an example of unacceptable poor quality in pin assembly alignment.

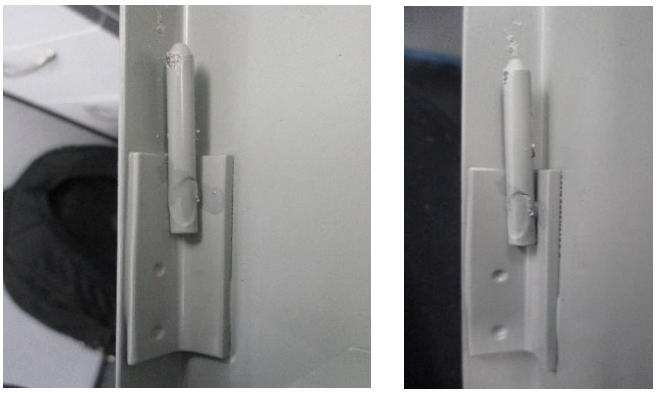


Figure 27 – Poor Quality Pin Alignment

3 STANDARD TOLERANCES

Where feature tolerance has not been specified on the drawing, the defaults in this section shall be observed.

3.1 Hole Tolerances

Default holes size tolerances shall be per Table 2 when not explicitly defined on the drawing.

Table 2 - Hole Diameter Tolerances

Implied Tolerances, Metallic Parts		
Hole Size Diameter Inches	Tolerance	
	+	-
.094 and Under	0.004	0.002
Over.094 to .156	0.005	0.003
Over.156 to .281	0.006	0.003
Over.281 to .438	0.007	0.003
Over.438 to .625	0.008	0.003
Over.625 to .875	0.009	0.003
Over.875 to 1.00	0.010	0.004
Over 1.00	0.030	0.010

Implied Tolerances, Non-Metallic Parts		
Hole Size Diameter Inches	Tolerance	
	+	-
.062 and Under	0.004	0.004
Over.062 to .250	0.004	0.006
Over.250 to .375	0.005	0.007
Over.375 to .500	0.006	0.007
Over.500 to .625	0.007	0.007
Over.625 to .750	0.008	0.007
Over.750 to .875	0.009	0.007
Over .875	0.030	0.010

3.2 Stock Shape Tolerance

- For parts made from stock material the tolerances of the governing specification shall apply.
- Larger material may be machined to meet stock sizes, but shall meet stock part tolerances.

4 BUS BAR

4.1 Bus Bar Type

Bus bar conforming to ASTM B187 shall have rounded corners or rounded edges along the length. For holes, cut ends, or custom shapes, these edges do not require rounding unless specified on the drawing. Copper bus material shall conform to the Unified Numbering System, UNS C11000. The temper shall be as follows; for ASTM B187-06, or earlier, the temper shall be H04 and for ASTM B187-11, or later, the temper shall be H02.

ASTM B187-11 changed the bar temper designation from H04 to H02. This change did not affect the material properties of the bar. On DRS drawings where H04 or H02 is listed the hardness shall be as follows:

- For ASTM B187-06, or earlier, the temper shall be H04.
- For ASTM B187-11, or later, the temper shall be H02.

4.2 Order of Operations

The order of operations shall be done in the following order:

1. Fabrication operations (example: welding, machining, drilling, punching, and tapping)
2. Surface preparation prior to plating (example: deburring, chamfering holes, sanding)
3. Silver Plating and Powder/Epoxy Coating

Silver plating before powder/epoxy coating is the preferred method but the supplier may at their discretion apply powder/epoxy coating before silver plating. The supplier shall ensure plating adhesion is sufficient if powder/epoxy coating is applied before silver plating.

4.3 Bus Bar Forming

When forming bus bars, where the bend radius is not specified, the following minimum values shall be met per Table 3 and Table 4.

Table 3 - Flat Bends

Bus Bar Thickness [T] Inches	Minimum Inside Bend Radius Inches
≤ 1/8	150%T
> 1/8	T

Table 4 - Edgewise Bends

Bus Bar Width Inches	Minimum Inside Bend Radius Inches
≤ 2	1
> 2	2

4.4 Holes in Bus Bars

Holes in bus bars for bolting may be either punched or drilled, but the contact area shall be smoothed and burr free before silver surfacing. Holes in bus bars greater than 3/8 inch in thickness should be drilled. Where punching is used, the operation shall not alter the surface flatness by more than 0.003 inch in the vicinity of the hole(s).

Supplier should chamfer or radius all thru holes of a part to be silver plated, to prevent the formation of burrs. For guidance, the chamfer size should be based on the weight of the bus bars per Table 5.

Raised burrs due to the hanging process during silver plating are unacceptable.

Table 5 – Chamfer and Radii Sizes on Bus Bars

Bus Bar Weight lbs	Chamfer Size inches	Radius Size inches
0 but less than 4	Broken edge up to .01	Up to .01
4 but less than 8	.010 min, but less than .025	.005 min, but less than .015
8 but less than 15	.020 min, but less than .025	.020 min, but less than .025
15 or greater	Shall not Chamfer	.020 min, but less than .025

4.5 Bus Joint Definition

The critical areas of bus bars are where electric current carrying connections are made; these are referred to as “joints”, (For reference, ASTM B700 uses the term “significant surfaces” and emphasizes the functionally critical nature of these “joint” surfaces.) Adjacent edges and holes are not considered to be a part of the joint. Examples of bus bar joints and their associated critical contact surfaces are shown in Figure 28 and Figure 29. Standard bus joint patterns are shown in Figure 28. Joints extend two inches past the outer diameter of each hole pattern forming a rectangular pattern as shown in Figure 29. If the joint area is not inherently clear the entire bus shall be considered the joint area. The joint area is limited to the area where electrical conductors (bus bars) touch.

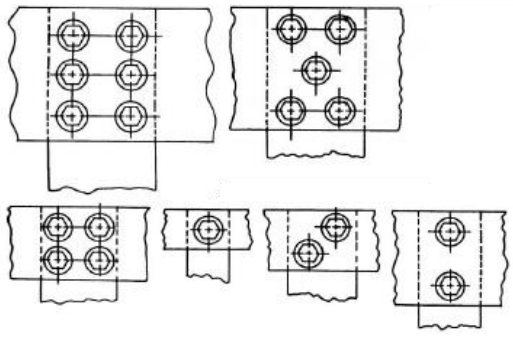


Figure 28 – Typical Patterns

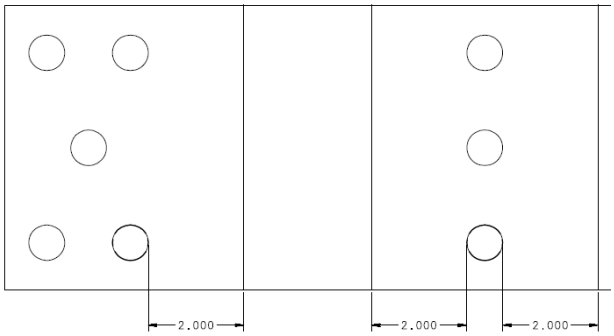


Figure 29 – Bus Joint

4.6 Silver Plating Preparation

The supplier shall prepare the bus bars prior to silver plating to remove surface defects from the flat surface of the bus bars. The surface shall be sanded or blasted to remove any features that stand proud of the surface and would prevent full electrical contact between the joints. The cleaning medium may not leave any corrosive substance. The surface shall be properly cleaned in preparation for plating. Bus bar edges, rounds, and hole inside diameters are not considered joints and do not require the same rigor of preparation; they simply must ensure the integrity of the main surface plating, (Reference ASTM B700 §3.2.2 for definition and §6.7.1 for guidance.)

4.7 Silver Plating of Bus Bars

When not specified on the drawing, bus bars shall be electrodeposited Type 1, Grade A, B, or C, Class N silver coatings as specified in ASTM B700. Silver plating shall conform to the requirements of ASTM B700, with the exception that the silver plate shall not be less than 0.0002 inch minimum thick in the entire joint area. Contact surfaces of bus bars shall be silver plated up to 1 inch past the joint area, and as a rule of thumb, 2 inches beyond any hole pattern. The entire bus may be silver plated at the discretion of the supplier. If the joint area is not specified, the entire bus shall be silver plated.

4.7.1 Exposed Copper on Silver Plated Bus

Exposed copper inside holes and on exterior edges (i.e., the perpendicular surface from the joint contacting surfaces) due to the silver-plating process is acceptable as long as the adjacent surface is fully plated and ensures good plating integrity in the joint area. Blooming (difference in color) is acceptable around the holes where bus bars are hung during the silver-plating process.

Bus bar holes may have areas free of silver plating where they are used to hang the bus for the silver-plating process. A non-uniform ‘halo’ at hanger locations, bends or corners is acceptable.

4.7.2 Hanging of Bus Bars during Silver Plating

Hanging hooks shall be properly sized with sufficiently large radius to reduce the stresses on the holes where the bus bars are hung. Multiple hooks should be used on heavy bus bars (approximately 10lbs or greater). The end of the hook shall not touch the bus bars during the plating process as shown in Figure 30. See Figure 30 for improper and Figure 31 for proper hanging technique. Damage from the end of the plating hook (Figure 32) is not allowed.

Figure 30 – Improper Hanging

Figure 31 – Proper Hanging

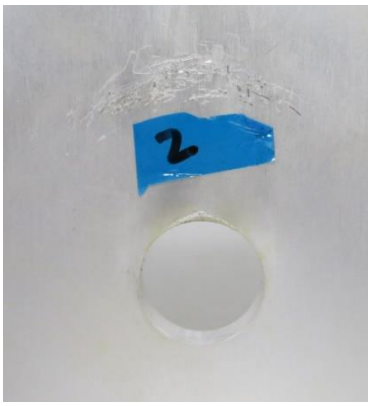


Figure 32 – Damage from Improper Hanging

4.8 Epoxy Coatings

Epoxy coating shall be free of pin holes.

Epoxy coatings shall not be subjected to any modifications after the coating process, unless explicitly stated on the drawing.

Epoxy coating shall bond to the base substrate.

Epoxy coatings shall be free of cracks or chips. Refer to Figure 33 and Figure 34.

Epoxy coatings on the bus bars shall not be permitted in the through holes where the holes are located in the masked area.

Figure 33 – Chipped Coating

Figure 34 – Cracked Coating

4.9 Threaded Inserts

Install inserts after silver plating. Supplier may use a tap to clean out any excess silver plating in the holes that build up during the plating process. Exposed copper in threaded holes is acceptable.

4.10 Bus Bar Defects

Typical defects and acceptability criteria are detailed below.

4.10.1 Cracks

Bars shall be free from cracks.

4.10.2 Scratches and Gouges

Minor scratches in bus bars are acceptable in small quantities. Refer to Figure 35 and Figure 36. The scratches shall not be through the copper in the bus joint area. Scratches through the copper in non-bus joint areas are acceptable. Small quantities are defined as no more than 10 scratches in any 4-inch x 4 inch area.

Figure 35 – Gouge in Base Material (No Copper Exposed)

Figure 36 – Scratched Plating (No Copper Exposed)

4.10.3 General Handling Damage

General handling damage in joint areas is not acceptable. General handling damage is acceptable in localized non-bus joint areas. The damage shall not result in burrs as defined in this document. There shall be less than two defects in approximately any two square inches. There shall be no more than five defects on each part.

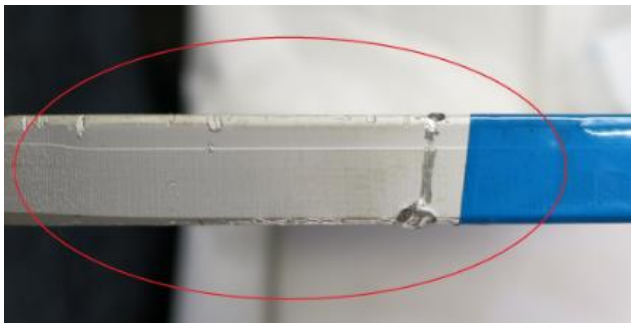


Figure 37 – Nicked Edges

Figure 38 – Damage in Joint Area

4.10.4 Discoloration or Oxides

Slight black discolorations, similar to those shown in Figure 39**Error! Reference source not found.** and Figure 41**Error! Reference source not found.**, ("tarnish" oxide from silver) of silver plated bus bars is acceptable in localized areas (less than 1 in^2). The black colored discoloration is due to the lack of corrosion protection and is expected in small amounts on silver plated bus bars.

Slight yellow discolorations, similar to those shown in Figure 40**Error! Reference source not found.**, of silver-plated bus bars are acceptable. These are either due to corrosion preventative paste or fingerprints. Either are acceptable.

Slight green discolorations, similar to those shown in Figure 42**Error! Reference source not found.**, (oxide from copper) of silver-plated bus bars are not acceptable in bus joint areas. This is a chemical reaction with the copper and the plating chemicals. The green discoloration should be removed by grade #00 steel wool or a non-marring scouring pad.

Figure 39 – Discolored Plating (Black)

Figure 40 – Discolored Plating (Yellow)

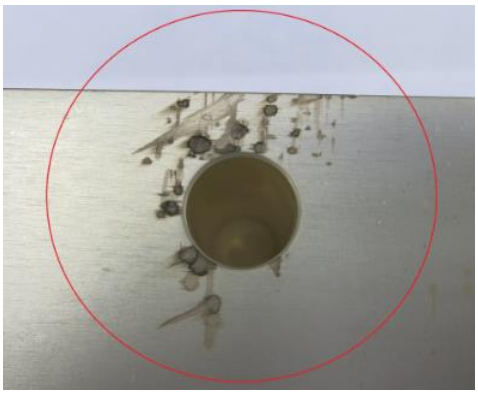


Figure 41 – Discolored Plating (Black)

Figure 42 – Discolored Plating (Green)

4.11 Packaging

Package per ASTM B700 (Note §9 & §10 references to ASTM D3951) to protect against corrosive elements that would tarnish the silver. Silver plated bus bars shall be individually wrapped in paper free of sulfur. Packaging tape shall not contain potentially tarnishing out-gassing substances and shall not contact the bus bars. Packaging must prevent parts from impacting adjacent parts and causing damage.

5 THERMOSETTING PRODUCT REQUIREMENTS

This section refers to products in accordance with MIL-I-24768 or National Electrical Manufacturers Association NEMA LI 1 (e.g. FR4, GPO, etc.).

5.1 Fabrication Order of Operations

All fabricating operations, such as machining, drilling, and tapping shall have been completed prior to coating, or painting.

5.2 Coating

Machined edges shall be sealed per MIL-I-46058 or Dolph-Spray AC-46 to prevent moisture infusion. It is preferred that the supplier only coat the cut edges of the parts. The supplier may coat the entire parts at their discretion, but must ensure the coating adheres to the un-cut edges. Supplier shall control coating thickness in holes to ensure proper installation of inserts.

5.3 Delamination

Slight delamination of parts manufactured in layers (e.g. FR4 Laminate Material) may occur. The delamination shall be limited to ensure that a gauge ≥ .020 inch shall not fit between the delamination. The surface size of the delamination shall not exceed 3/8 inch x 3/8 inch in area. All delaminated edges shall be coated.

5.4 Painting

Where painting is required, the surface shall be lightly sanded to ensure adherence.

Machined edges that are to be painted shall not be coated as specified in Section 5.2.

6 ALUMINUM

6.1 Coating

Where MIL-C-5541 or MIL-DTL-5541 is specified but type or class is not defined the supplier shall use Type II or Class 3.

7 Critical to Quality (CTQ) Characteristics

DOCUMENT MANAGEMENT NOTE: *To ensure the design team and supply chain are interpreting CTQ's the same way, the contents of the chapter on* ***CTQ Management*** *must be taken verbatim from the Mechanical Best Practice BPMC-ME-014 "Critical to Quality Characteristics". Proposed changes to the content on* ***CTQ Management*** *in this document must be synchronized with the BPMC-ME-014 CTQ Best Practice.*

7.1 Specifications

CTQ labeling will be found in a number of ways on a drawing. A CTQ table, seen in the Figure 43 example, shall be at the beginning of the drawing, as much as possible, to allow for easy reference. A specific bubble callout on the drawing shall identify the characteristic that needs to be measured, as seen in the Figure 44 example. The location of the CTQ balloon shall include the sheet and zone to quickly locate the requirement. The "Remarks" column in the CTQ table can be used for providing more instruction regarding the data to be collected. For example, the size of a particular hole may be important and thus must be measured, but the location of the hole does not require measurement. So in this case the remark would specify that only the diameter needs be inspected/reported.

CTQ's can be defined on any type of specification. CTQ labeling can appear on notes or other items other than dimensions. A good example of this is when a material certification will be required, seen in Figure 45. Sometimes test results are also necessary and should be identified as a CTQ. Welder certification may be contractually required and may potentially need to be listed as a CTQ as well.

As another example of a CTQ further defined with "Remarks", compare Figure 43 CTQ 3 with Figure 46 drawing detail. In this case the tapped hole depth is critical (for assembly at the next higher level). If tapped depth is not achieved, the risk is that the fastener would bottom out and indicate full torque was achieved without truly providing clamping. In this example the part is supplier controlled and it is known that a CNC (Computer Numerical Controlled machining center) will be used. Therefore, to reduce risk without the need for laborious inspections, only the first and last holes are inspected as the CTQ to ensure the drill or tap have not slipped.

CTQ	LOCATION		REMARKS
	SHEET	ZONE	
1	2	C5	SIZE AND LOCATION
2	1	D6	MILL CERTIFICATION REQUIRED
3	2	C3	THREAD DEPTH, FIRST & LAST HOLE

Figure 43 – Example CTQ Table

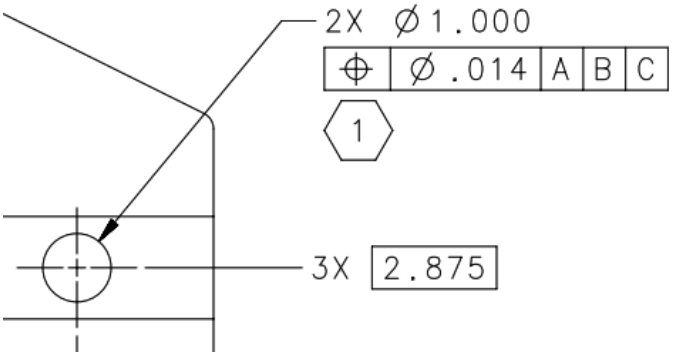


Figure 44 – Example of CTQ Feature Measurement

NOTES:

1. INTERPRET DRAWING PER ASME Y14.100.

2. MATERIAL: .500 INCH THICK STOCK, ALUMINUM 5086-H-32. (2)

Figure 45 – Example of CTQ Note

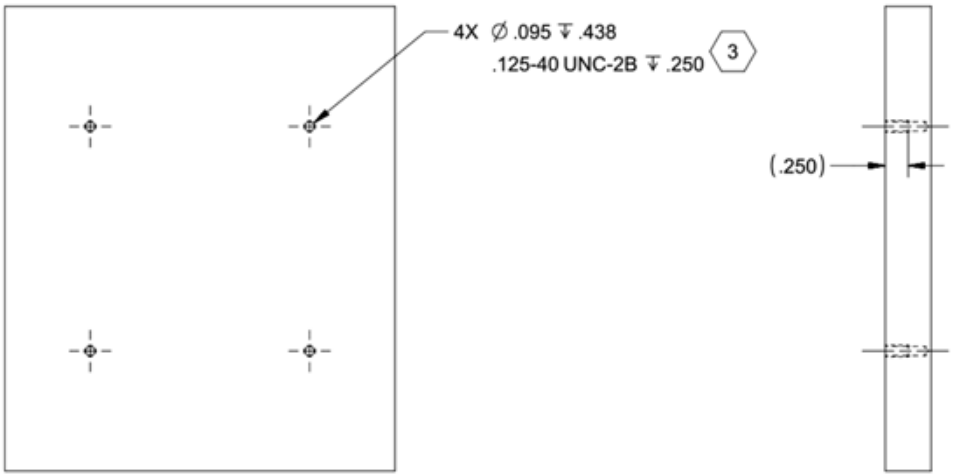


Figure 46 – Example of CTQ for Tapped Holes

7.2 CTQ Data Managed at Supplier

The supplier is required to collect and maintain records for all CTQ data per the workmanship standard, MC-000201/01. Records shall be maintained for the life of the product.

The supplier shall include with delivery of the finished item a letter of certification (Certificate of Conformance (CoC)) to verify CTQ data has been collected and is on file (with or without the data). CTQ data must be made available to DRS on demand. Note that CTQ data is different than First Article Inspections (FAI). First article inspections are required each time a new design is produced or a different supplier produces the item. FAI requires every requirement to be verified, such as notes and dimensions. CTQs shall be done on an on-going basis.

7.3 Receiving Inspection

Incoming inspection shall ensure the CTQ data is certified through a formal CoC or actual inspection report, some form of objective quality evidence (OQE).

See MQP-PD-061 for further information.

8 Sealing Requirements and Standards

The purpose of this section is to help define workmanship standards necessary to create a watertight seal for DRS products when using sealants like epoxy, RTV, etc.

8.1 Recommended Workmanship Specifications

RTV

1. Prepare and clean the surfaces. Surface shall be free of all debris, grease, oil and other contaminants.
2. Apply a continuous bead fully along edge of one of the mating parts. When parts are combined, excess RTV shall expand beyond all the seams in all directions that may be a path of entry for water or other fluid. Add continuous beads along additional edges as required to ensure RTV extends beyond all seams during the joining operation.
    - Where holes are present on the joining surfaces, these should be treated as edges: encircle the holes with a bead of RTV. Protect threaded holes from RTV. Remove excess RTV from holes after assembly.
    - When seam is between coplanar surfaces and/or external angles, final surface should be flat to convex. This shall be at the supplier's discretion to ensure a watertight seal.
    - When seams are between internal angles, create an even radius. This shall be at the supplier's discretion to ensure a watertight seal.
3. Remove excess material after cure. Final appearance shall be consistent and smooth. No gaps allowed.
    - Follow-up application is allowed to address areas that do not meet fill requirements in full. Example cause: Clean-up of excess removed some RTV.
    - Applying RTV after assembly because it was not applied in the first place requires buyer assessment and approval.
4. <When specified in a SOW or PO,> the Seller shall provide Buyer a written procedure for approval detailing where and how the RTV is applied.
    - This documentation shall include bead sizes, all locations that shall receive RTV and how many beads are required at a joint,
    - This document shall identify assembly part number and revision for which it is intended.
    - Seller should expect this document to be used by the Buyer during inspection. This will ensure Seller and Buyer have the right inspection criteria with no ambiguity.

EPOXY

1. Use the same process as RTV but refer to epoxy application instructions concerning additional prep and cure time requirements to ensure a watertight seal.

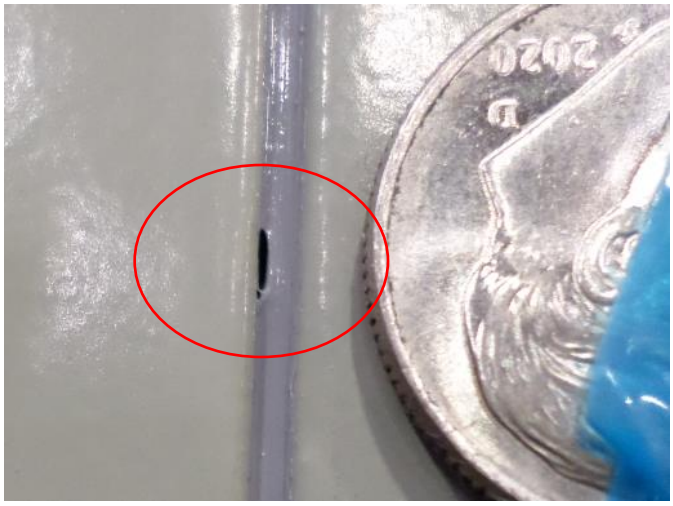
8.2 Visual Objective Evidence of Sealed Joints (Good and Bad)

Good Seals with no voids or gaps.

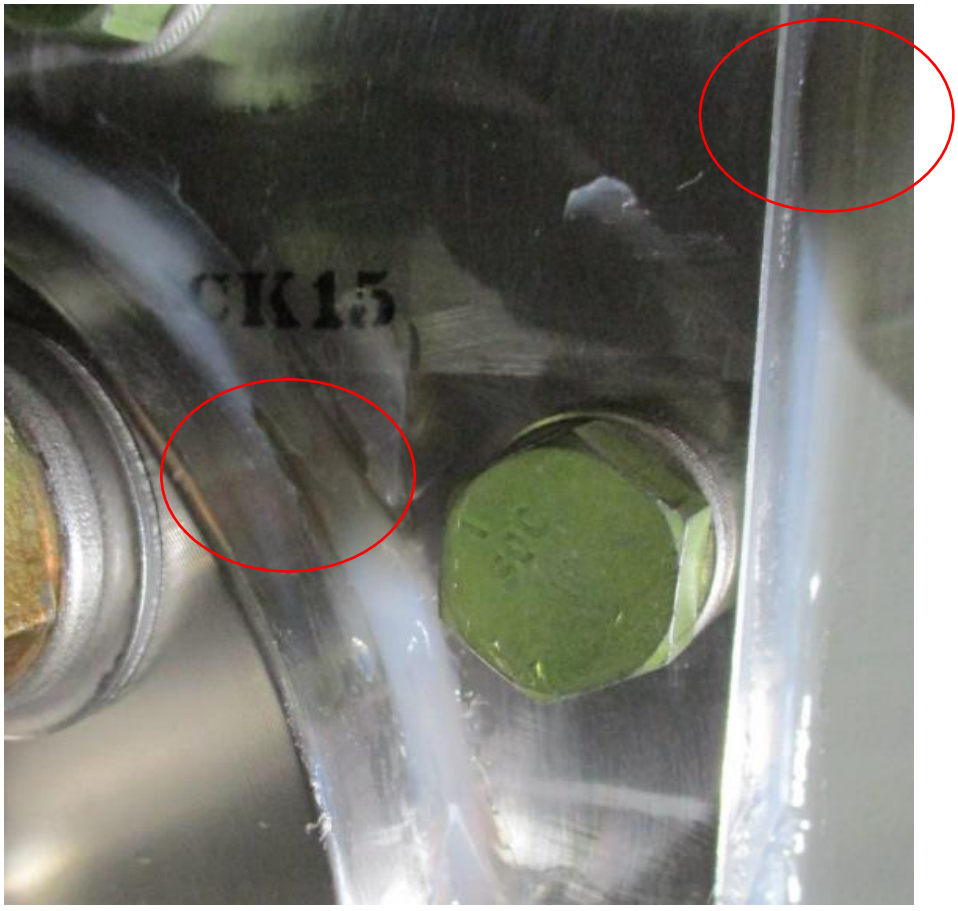
Good Seal after compression but before removal of excess material.

Bad Seals - Incomplete formation of seal.

Bad Seals - Visible Gaps



Bad Seal - Incomplete Seal Formation – Must be a continuous stream to complete seal between two surfaces.



Bad Seal – Remove Excess Sealant and Ensure Complete Seal after compression