



Fabrication Tolerance and Workmanship Standards

Approval release for use

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This document is to provide a uniform dimensional tolerance and workmanship specification that communicates essential quality requirements for raw material, parts, weldments and mechanical assemblies used in Demco products otherwise specified.

This document directly contributes to the configuration of Demco products and is under the control of Demco Engineering through the ECN process. Demco personnel must submit all related change request via RFC. Suppliers must submit change requests through the Demco Purchasing Department. The control of copies resulting from further distribution of this document is the responsibility of each individual distribution activity.



Demco Standard Regarding Outside Processed Anodized Product

- Unless specified otherwise, the supplier's product shall meet the MIL-A-8625F spec for Type II, Class 1 Non-dyed, Class 2 Dyed, & brightness standard.

Demco Standard Regarding International Zinc Plated Product

- Unless specified otherwise, the supplier shall maintain a minimum zinc thickness of .0003" and a zinc process that is able to meet or exceed a minimum of 120 hour salt spray rating. To meet the 120 hour rating, there must be no more than 5% of the surface finish forming white rust. Seams and any area within 1/2" from the edge of the part are not applicable.
- For items requiring 500 hours of salt spray, the supplier shall maintain a minimum zinc thickness of .0008" and a zinc process that is able to meet or exceed a minimum of 500 hours salt spray rating. To meet the 500 hour rating, there must be no more than 5% of the surface finish forming white rust. Seams and any area within 1/2" from the edge of the part are not applicable.
- The supplier shall have an independent lab test result on file, representing the current process being provided to Demco, to validate that the product and processes employed meet Demco's requirements.
- The supplier shall perform random sample tests of each shipment and document the zinc thickness results, which support and validate the product is meeting the requirements.
- The supplier's zinc thickness test records shall be available to Demco upon request for no less than 1 year after the date of processing.

Demco Standard Regarding Outside Processed E-Coated Product

- Unless specified otherwise, Demco requires a minimum thickness of .5 mils on all items requiring an e-coat finish.
- The e-coating product shall be PPG Powercron 640, or equivalent.
- The supplier shall sample test each shipment and maintain a documented record of the e-coat thickness, to support each shipment is meeting requirements.
- The supplier's records are to be available upon request to Demco for no less than one year after the date of processing.

Demco Standard Regarding Outside Processed Galvanized Product

- Unless specified otherwise, Demco requires a galvanizing process that is in compliance with the ASTM A123 spec.
- The supplier shall check and document that parts from each shipment meet the ASTM A123 spec and maintain a certification record on file.
- The supplier's records of each shipment shall be available to Demco upon request for no less than 1 year after the date of processing.

Demco Standard Regarding Heat Treated Product

- The supplier shall heat treat all product as per the print specifications.
- The supplier shall check and document that each shipment has met the specs as required.
- The supplier's records shall be available to Demco upon request for no less than 1 year after the date of processing.



Demco Standard Regarding Domestic Zinc Plated Product

- Unless specified otherwise, the supplier shall maintain a minimum zinc thickness of .0003” and a zinc process that is able to meet or exceed a minimum of 120 hour salt spray rating. To meet the 120 hour rating, there must be no more than 5% of the surface finish forming white rust. Seams and any area within ½” from the edge of the part are not applicable.
- The supplier shall have an independent lab test result on file, representing the current process being provided to Demco, to validate that the product and processes employed meet Demco’s requirements.
- The supplier shall check and document the zinc thickness at random increments each day of production.
- The supplier’s zinc thickness records shall be available to Demco upon request for no less than 1 year after the date of processing.



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1. PURPOSE

To provide a uniform dimensional tolerance and workmanship specification that communicates essential quality requirements for raw material, parts, weldments and mechanical assemblies used in Demco products otherwise specified.

2. SCOPE

- This standard applies to raw material, fabricated parts, minor assemblies and mechanical assemblies manufactured by or for Demco Manufacturing, Inc..
- This standard does not apply to:
 - part dimensions bearing local tolerances
 - reference implications other than raw material dimensions
 - material specifications other than stated allowable substitutions
 - critical process notes in the note section of the drawings.
- This standard is intended to reflect current practice and is not intended to loosen current standards and practices.
- When another specification(s) is invoked, parts must meet the requirements of the specification(s) and/or this standard, whichever is more restrictive.

3. ORDER OF DOCUMENT PRECEDENCE

- 3.1. Detailed purchase orders specification of dimensional tolerances.
- 3.2. Local dimensional tolerances and specifications within the engineering drawing and external to the drawing title block.
- 3.3. This document.
- 3.4. CAD model file
- 3.5. Engineering detail drawing body and title block specifications. Note: Be advised that finished part number drawings are often used to document part numbers having a U prefix.
- 3.6. Note: Suppliers are responsible for checking drawings and purchase/work orders for any special requirements and to insure the correct revision level drawings are used.

4. RESPONSIBILITIES

- 4.1. Demco sourcing to communicate requirements to suppliers and coordinate technical support for resolving issues.
- 4.2. Internal and external suppliers shall meet the requirements of this specification.

5. RELATED DOCUMENTS (This standard assumes latest versions)

- 5.1. ANSI/ASME B1.1 - Unified Inch Screw Threads (UN and UNR Thread Form)
- 5.2. ANSI/ASME B1.13M - Metric Screw Threads - M Profile
- 5.3. ANSI/ASME B94.6 – Knurling
- 5.4. ANSI H35.2 Dimensional Tolerances for Aluminum Mill Products
- 5.5. ASTM A 6 - General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
- 5.6. ASTM A 29 - General Requirements for Steel Bars, Carbon and Alloy, Hot-Wrought
- 5.7. ASTM A 108 - Steel Bar, Carbon and Alloy, Cold-Finished
- 5.8. ASTM A 109 – Standard Specification for Steel Strip, Carbon (0.25 Maximum Percent), Cold Rolled
- 5.9. ASTM A 480 - General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip
- 5.10. ASTM A 484 General Requirements for Stainless Steel Bars, Billets, and Forgings
- 5.11. ASTM A 500 Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
- 5.12. ASTM A 501-Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
- 5.13. ASTM A 505 – General Requirements for Steel Sheet and Strip, Alloy, Hot-Rolled and Cold-Rolled
- 5.14. ASTM A 512 Standard Specification for Cold-Drawn Buttweld Carbon Steel Mechanical Tubing
- 5.15. ASTM A 513 Standard Specification For Electric-Resistance-Welded Carbon and Alloy Steel Mechanical



Tubing

- 5.16. ASTM A 519 Standard Specification for Seamless Carbon and Alloy Steel Mechanical Tubing
- 5.17. ASTM A 568 – General Requirements for Steel Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled
- 5.18. ASTM A 682 – General Requirements for Steel Strip, High-Carbon, Cold Rolled
- 5.19. ASTM A 749 – General Requirements for Steel Strip, Carbon and High-Strength, Low Alloy, Hot-Rolled
- 5.20. ASTM B249 – General Requirements for Wrought Copper and Copper-Alloy Rod, Bar, Shapes and Forgings
- 5.21. AWS D1.1 Welding Standards
- 5.22. AWS D1.3 Welding Standards
- 5.23. Aluminum Association Standard for Aluminum Sand and Permanent Mold Castings MPIFSTD35 Metal Powder Products NADCA
Product Specification Standards for Die Castings Section 4 Standard Tolerances SAEJ2551 - Recommended Practices for Fluid Conductor
Metallic Tubing Applications
- 5.24. SPI - AQ-102 Standards and Practices of Plastic Molders
- 5.25. ISO 2768-1 Tolerances for Linear and Angular Dimensions Without Individual Tolerance Indications.
- 5.26. ISO 2768-2 Tolerances for Feature Without Individual Tolerance Indications.
- 5.27. ISO 8062 System for Dimensional Tolerances and Machining Allowances of Castings
- 5.28. Demco Zinc Plating Specifications

6. GENERAL

- 6.1. Product not meeting the requirements of this technical specification, the material specification, the drawing and/or the purchase order is subject to rejection. Defects may be detected at any point during inspection, post processing or assembly.
- 6.2. In the interest of product compliance with all Demco and industry standards and cost, Demco prefers suppliers who can discern critical part geometry from 3D CAD model and 2D CAD drawing files. This reduces the need to completely define and constrain all features in the 2D drawing, reduces the opportunities for error, and simplifies machine-tool programming. Given this, not all features are dimensioned in 2D drawings but may instead be defined and controlled by geometry in source CAD models and 2D drawing files along with this document, which supplements drawing conveyance of design intent and material expectations.

7. RAW STOCK DIMENSIONAL TOLERANCES

For part features that are totally controlled by raw stock dimensions, the tolerances given in this section of the standard supersede tolerance condition provided elsewhere in this standard.

- 7.1. ALUMINUM - All alloys; Unclad; Non-Aerospace Application;
 - 7.1.1. Rolled or Cold Finished Round and Polyagonal Bar Stock shall meet the dimensional tolerance of ANSI H35.2 for diameter, thickness & width, distance across flats, twist, straightness, and angularity.
 - 7.1.2. Sheet and Plate Thickness: All unclad, sheet and plate shall meet the thickness requirements of ANSI H35.2.
 - 7.1.3. Drawn, Extruded and Welded Tubing shall meet the applicable dimensional tolerance requirements of ANSI H35.2 for the tube fabrication process for diameter, width, depth, wall thickness, twist, straightness and flatness.
 - 7.1.4. Extruded Profiles shall meet the cross-section dimensional tolerances of ANSI H35.2 for "Standard Tolerance" for profile features and for twist, straightness, flatness, contour and angularity.
- 7.2. STEEL – Carbon and Alloy



7.2.1. Allowable Material Substitutions:

- 7.2.1.1. When “Mild Steel” or “Low Carbon Steel” material is specified in the drawing notes or title block material section, any low carbon steel alloy of 0.08% to 0.29% carbon content may be used.
- 7.2.1.2. When A36 flat material of ≤ 0.5 ” in thickness is specified in the drawing notes or title block material section, A572 HSLA Gr 42-55 material may be used.
- 7.2.1.3. When AISI 1045 flat or bar material is specified in the drawing notes or title block material section, A572 HSLA Gr 42-55 material may be used.
 - 7.2.1.3.1. Substitutions for AISI 1045 may not be made for:
 - 7.2.1.3.1.1. Parts fabricated from round bar
 - 7.2.1.3.1.2. Parts that are heat treated
 - 7.2.1.3.1.3. Parts that are machined (drilled holes do not constitute “machined

7.2.2. BAR STOCK

- 7.2.2.1. Hot Wrought per ASTM A 29 for all relevant qualities.
- 7.2.2.2. Cold Finished per ASTM A 108 for all relevant qualities

7.2.3. SHEET Hot Rolled and Cold Rolled

- 7.2.3.1. Carbon, Structural and High Strength Low Alloy per ASTM A 568
- 7.2.3.2. Alloy per ASTM A 505

7.2.4. STRIP

- 7.2.4.1. Hot-Rolled, Carbon and High-Strength Low Alloy per ASTM A 749 for all relevant qualities.
- 7.2.4.2. Cold Rolled High Carbon per ASTM A 682 for all relevant qualities
- 7.2.4.3. Cold Rolled Carbon (0.25 Max. Percent) per ASTM A 109 for all relevant qualities

7.2.5. TUBING

- 7.2.5.1. Hot-Formed Welded and Seamless Carbon Steel Structural Tubing per ASTM A501 for all relevant qualities.
- 7.2.5.2. Square and Rectangular Cold-Formed Welded and Seamless Carbon Steel

Structural Tubing

- 7.2.5.2.1. Use only ASTM A-500 Grades B or C.
- 7.2.5.2.2. Half of ASTM A-500 tolerance for straightness.
- 7.2.5.2.3. ASTM A-500 for all other relevant qualities
- 7.2.5.3. 7 X 7 X 1/2 & 3/8, and 5 X 7 X 3/8 shall be within $\leq 1^\circ$ of square on all four corners.
- 7.2.5.4. Cold-Drawn Butt-weld Carbon Steel Mechanical Tubing per ASTM A 512 for all relevant qualities.
- 7.2.5.5. Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing per ASTM A 513 for all relevant qualities.
- 7.2.5.6. Seamless Carbon and Alloy Steel Mechanical Tubing per ASTM A 519 for all relevant qualities.

7.2.6. STRUCTURAL SHAPES per ASTM A 6 for all relevant qualities.

7.3. STAINLESS STEEL

- 7.3.1. Plate, Sheet and Strip per ASTM A 480
- 7.3.2. Bar per ASTM A 484

7.4. BRASS

- 7.4.1. BAR STOCK: ROUND & POLYGONAL per ASTM B 249 for all relevant qualities.



HEX	.150 TO .500 +/- .003	.500 TO 1.00 +/- .004
ROD	.00 TO .150 +/- .0013	.150 TO .500 +/- .0015
	.500 TO 1.00 +/- .002	TO 2.00 +/- .0025
TUBING	≤ .250 OD X ≥ .015 WALL +/- .001	
	.251 - .625 OD X ≥ .050 WALL +/- .0025	
	.626 OD X ≥ .100 WALL +/- .007	

NOTE: ALL RAW-STOCK TOLERANCES ARE INDUSTRY STANDARD FROM THE AMERICAN IRON AND STEEL INSTITUTE AND FROM THE AMERICAN SOCIETY FOR TESTING MATERIALS.

8. STANDARD FOR SCREW THREADS

- 8.1. Allowable tolerances of unified screw threads, both internal and external, are governed by ANSI/ASME B1.1 for the designated thread form, series, and fit. If no form is designated then UN is assumed. If no fit is designated then 2A and 2B are specified.
- 8.2. Allowable tolerances of metric screw threads, both internal and external, are governed by ANSI/ASME B1.13M for the designated thread profile and tolerance grade. If no profile is designate then M is assumed. If no tolerance grade is designated then the loosest applicable grade is assumed.
- 8.3. Unless otherwise designated, threads are right hand.
- 8.4. Tap Drill Size:
 - 8.4.1. Unspecified tap drill diameters shall be sized to provide the specified thread class for the thread generating process used. (e.g. rolled or cut threads)
- 8.5. Tap drill depth:
 - 8.5.1. When not specified the full-diameter blind depth is ≥ one thread pitch plus the length of tap taper.
 - 8.5.2. When tapped holes are shown or specified as blind, no breakout is allowed. In these cases semi-bottoming or bottoming tap must be used to meet the minimum thread depth specification.
- 8.6. Countersinking:
 - 8.6.1. All holes to be threaded shall be countersunk (82° – 120° included angle) to a diameter of 110-120% of thread nominal diameter unless:
 - 8.6.2. Countersinking is not allowed when removal of material would result in less than four remaining full threads. When countersinking is prohibited, any burrs formed during the threading operation shall be removed from the flat surface.
- 8.7. Chamfering:
 - 8.7.1. The entering end of externally threaded parts shall have a 45°-65° chamfer.
 - 8.7.2. Unless otherwise specified on the drawing, the minor chamfer diameter shall be a minimum of 0.015 less Than the thread minor diameter.

TITLE:

- 8.8. Surface texture: Surface texture of threads produced to this instruction shall have a smooth finish and be free from flaws and other defects such as fins, nicks, and burrs that would make them unsuitable for the purpose intended. Thread surface texture shall not exceed 100-microinch (0.00254 mm) arithmetical average roughness (RA) for cut threads and 63-microinch (0.00160 mm) (RA) for rolled and ground threads.
- 8.9. Plating and coating: Unified thread dimensions and tolerances apply to the finished product, after plating or coating, on 2B, 3A, and 3B class threads. When plated or coated, class 2A threads may be increased by the amount of the allowance provided by the Unified thread system. (“Coating”, as used herein, does not include organic finishes such as lacquer, enamel, etc.)
- 8.10. Plating and coating: Unified thread dimensions and tolerances apply to the finished product, after plating or coating, on 2B, 3A, and 3B class threads. When plated or coated, class 2A threads may be increased by the amount of the allowance provided by the Unified thread system. (“Coating”, as used herein, does not include organic finishes such as lacquer, enamel, etc.)



9. SURFACE FINISH

9.1. Unless otherwise noted in this standard, surface roughness as produced by common production methods shall be within the allowable “Average Application” roughness range specified in Table 1 of the Surface Finish section of the Machinery’s Handbook.

10. GENERAL STANDARD FOR MACHINED PARTS

The following tolerances are hereby imposed on all machining operations, unless specified within fabrication drawings in conjunction with critical detail nominal dimensions. All measurements must be taken in an appropriate manner taking into account all accumulated allowable tolerances as part acceptance criteria.

- 10.1. Angular dimensions will be $\pm 1/2$ degree of specified nominal.
- 10.2. Right angle (90 degree) configurations need not be specified but will assume 90 degrees as nominal.
- 10.3. Drilled and bored hole diameters will be as follows:

0.0000 to 0.130	+0.004 / - 0.001
0.131 to 0.255	+0.005 / - 0.001
0.256 to 0.505	+0.006 / - 0.001
0.506 to 0.755	+0.008 / - 0.001
0.756 to 1.010	+0.010 / - 0.001
1.011 to 3.000	+0.012 / - 0.001
>3.000	Φ +0.500% / - 0.050%

- 10.4. Counter sink major diameters will be ± 0.010 of specified nominal.
- 10.5. Counter sink minor diameters will be ± 0.010 of nominal as calculated using the major counter sink diameter, included angle, and wall thickness.
- 10.6. Thread depth callouts shall be assumed to be the usable minimum.
- 10.7. Break all sharp edges to prevent personnel injury and/or damage to mating parts.
- 10.8. Polished Parts:
 - 10.8.1. No raw-stock surfaces are allowed on polished surfaces;
 - 10.8.2. Polished surfaces must have a maximum surface roughness of 32 μ in.
 - 10.8.3. Must meet the requirements of the Surface Finish section of this document.

11. STANDARD FOR TURNED PARTS

The following tolerances shall be held on turning operations, unless specified within fabrication drawings in conjunction with critical detail nominal dimensions. All measurements must be taken in an appropriate manner taking into account all accumulated allowable tolerances as part acceptance criteria. These tolerances are based on ISO General Tolerance Standards 2768-1 and 2768-2.

Table 1 – General tolerances for deviations on linear dimensions



Table 1 – General tolerances for deviations on linear dimensions

Tolerance Class	up to 1.25"	> 1.25 up to 5.0"	>5.0" up to 16.0"	> 16.0" up to 40.0"	> 40.0"
Fine, (+/-)	.004	.006	.008	.012	.012 + .001/in up to max of .030
Medium (+/-)	.008	.012	.020	.030	.030 + .001/in up to max of .050

- 11.2. Longitudinal feature locations, and locations of features perpendicular to the axis of turning will comply with the Fine tolerance class as specified in Table 1.
- 11.3. Allowable tolerances on knurled diameters are governed by ANSI/ASME B94.6 for the designated diametral pitch and tolerance class. If no tolerance class is specified Class I is assumed.
- 11.4. Concentricity between features turned from opposite ends of the part will be ≤ 0.005 .
- 11.5. TIR The following guidelines shall be used for tolerances of circular run-out:

General tolerances on circular run-out

Tolerance Class TIR

General tolerances on circular run-out

Tolerance Class	TIR
H	.005"
K	.010"
L	.020"

- 11.5.1. IR between features turned from same end of the part will be Class H, as indicated in Table above.
- 11.5.2. TIR between features turned from opposite ends will be Class K as indicated in Table above.
- 11.6. Parallelism - The general tolerance on parallelism is equal to the numerical value of the size tolerance as Shown in Table 1 above. The longer of the 2 features shall be taken as the datum; if features are of equal nominal length, either may be taken as the datum.
- 11.6.1. Parallelism of features turned from the same side of part will comply with the Fine tolerance class as shown in Table 1.
- 11.6.2. Parallelism of features turned from opposite ends of the part will comply with the Medium tolerance class as shown in Table 1.

12. STANDARD FOR MILLED PARTS

The following tolerances shall be held on milling operations, unless specified within fabrication drawings in conjunction with critical detail nominal dimensions. All measurements must be taken in an appropriate manner taking into account all accumulated allowable tolerances as part acceptance criteria. These tolerances are based on ISO General Tolerance Standards 2768-1 and 2768-2.

Table 1 – General tolerances for deviations on linear dimensions

Tolerance Class	up to 1.25"	> 1.25 up to 5.0"	>5.0" up to 16.0"	> 16.0" up to 40.0"	> 40.0"
Fine, (+/-)	.004	.006	.008	.012	.012 + .001/in up to max of .030
Medium (+/-)	.008	.012	.020	.030	.030 + .001/in up to max of .050



Tolerance Class

- 12.1. Interpolated hole diameter tolerances will comply with Table 1 in Section 12.1, Fine tolerance class. The general tolerance on circularity is equal to the value of the diameter tolerance.
- 12.2. Corner Radii:
 - 12.2.1. Tolerance for external corner radii will be as follows:

Permissible deviation for basic size range

	Permissible deviation for basic size range		
Nominal	≤ .120	.120 up to .250	> .250
Deviation	±0.008	±0.020	±0.030

- 12.2.2. Tolerance for interior corner radii will be as follows:

	Permissible deviation for basic size range		
Nominal	≤ .090	.090 up to .125	> .125
Deviation	±0.008	±0.015	±0.030

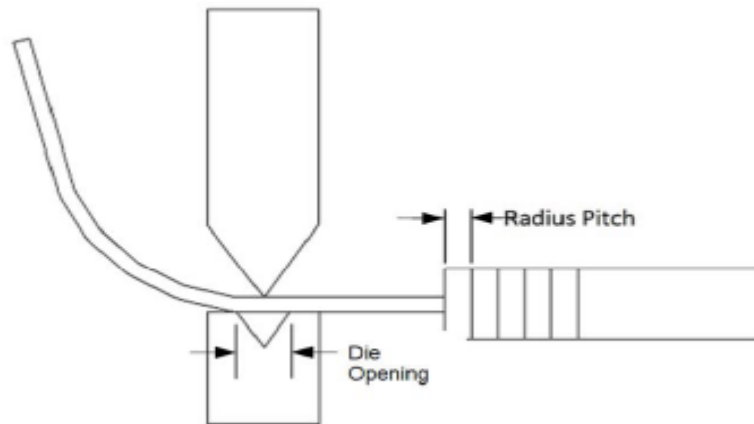
- 12.3. Feature location will comply with Table 1 in Section 12.1 for tolerancing :
 - 12.3.1. Location tolerance for a feature to a mill-finished or machined edge will comply to the Medium tolerance class as shown in Table 1 of Section 12.1.
 - 12.3.2. Feature to feature location will comply to the Fine tolerance class as shown in Table 1 of Section 12.1.
 - 12.3.3. Location tolerance for a feature to a non-mill finished or non-machined cut edge (e.g. sawn, plasma-cut, laser-cut, etc.) will be in accordance to the tolerances of the specified cutting process, as follows:
 - 12.3.3.1. Tolerance for a feature to a laser cut edge will be □0.010
 - 12.3.3.2. Tolerance for a feature to a plasma or torch cut edge will be □0.030
 - 12.3.3.3. Tolerance for a feature to a saw cut edge will be □0.030
 - 12.4. Edge profiles will be □0.010 of specified nominal.
 - 12.5. Surface profiles will be □0.010 of specified nominal.

13. FLAT & FORMED METAL SHEET AND PLATE PARTS

- 13.1. Angular dimensions will be +/- 1 degree of specified nominal.
- 13.2. Right angle (90 degrees) configurations need not be specified but will assume 90 degrees as nominal.
- 13.3. Material thickness will carry the tolerance as specified by governing manufacturing standards. (i.e. ASTM, Manufacturer, Standard Gage, etc..)
- 13.4. Material thickness standard tolerance does not apply to deep drawn parts.
- 13.5. Bend radii will be +/- 0.010 of specified nominal for thicknesses up through 0.25", and +/- 0.030" for all other material thicknesses. Note: On older specifications where 3D CAD models do not exist, the 2D drawing bend radii features and callouts will carry same document precedence as CAD Models. As always, if in doubt – **contact Demco Engineering.**
- 13.6. "Step" bending of parts with a formed radius
 - 13.6.1. Step bending is a procedure in which multiple hits (bends) are made along the entire length of the inside radius of a component part to produce the bend. Step bending is permitted unless otherwise specified, for forming of parts with a bend radius. When step bending is used, the following specifications will apply:
 - 13.6.1.1. For "gauge" material thicknesses, the part profile deviation from nominal will not exceed .060".
 - 13.6.1.2. For material thickness of 1/4" – 3/8", the part profile deviation from nominal will not exceed .075".
 - 13.6.1.3. For material thickness greater than 3/8", the part profile deviation from nominal will not exceed .125".
 - 13.6.2. Parts fabricated with step bends shall have a visually uniform appearance for angles and segment lengths, unless otherwise specified on the drawing. As a guideline, when determining segment lengths, or pitch



between bends, the segment length should be equal to one-half of the "V" die opening on the forming tool (see figure on next page).



13.7. Press Hardware Hole diameter must meet the size and tolerance specifications of the hardware manufacturer.

13.8. Counter Sinks:

13.8.1. Counter sink major diameters will be ± 0.010 of specified nominal.

13.8.2. Counter sink minor diameters will be ± 0.010 of nominal as calculated using: Major "C" sink diameter, 82° included angle and material nominal thickness.

13.9. Cut feature profile:

13.9.1. CNC or Class A Die Punched Cut Sheet and Plate Part Profiles:

13.9.1.1. Hole diameters and radii will be ± 0.008 of specified nominal.

13.9.1.2. Hole to hole, hole to cut feature and cut feature to cut feature tolerance is ± 0.008 of nominal.

13.9.1.3. All other cut feature profiles will be ± 0.008 of nominal.

13.9.1.4. Face draft shall be 2° - 5° on all cut surfaces.

13.9.2. Laser Cut Sheet and Plate Parts Profiles:

Note: Laser cutting tolerances will be employed for sheet thicknesses < 0.25 ".

13.9.2.1. Hole diameters and radii will be ± 0.010 of specified nominal.

13.9.2.2. Hole to hole, hole to cut feature and cut feature to cut feature tolerance will be ± 0.010 of nominal.

13.9.2.3. All other cut feature profiles will be ± 0.010 of nominal.

13.9.2.4. Face draft shall be no more than 1° on all cut surfaces.

13.9.3. Plasma Cut Sheet and Plate Part Profiles

Note: Plasma cutting tolerances will be employed for sheet thicknesses ≥ 0.25 " and ≤ 1.00 "

13.9.3.1. Hole diameters and radii will be ± 0.030 of specified nominal.

13.9.3.2. Hole to hole, hole to cut feature and cut feature to cut feature tolerance is ± 0.030 of nominal.

13.9.3.3. All other cut feature profiles will be ± 0.015 of nominal.

13.9.3.4. Face draft shall be no more than 2° on all cut surfaces.

13.9.4. Flame Cut Sheet and Plate Parts

Note: Flame cutting tolerances will be employed for sheet thicknesses ≥ 1.00 ".

13.9.4.1. Hole diameters and radii will be ± 0.050 of specified nominal.

13.9.4.2. Hole to hole, hole to cut feature and cut feature to cut feature tolerance is ± 0.030 of nominal.

13.9.4.3. All other cut feature profiles will be ± 0.050 of nominal.

13.9.4.4. Face draft shall be no more than 2° on all cut surfaces.

13.9.5. Angles will be $\pm 1^\circ$ of specified nominal

13.10. Feature to pre-existing edge:

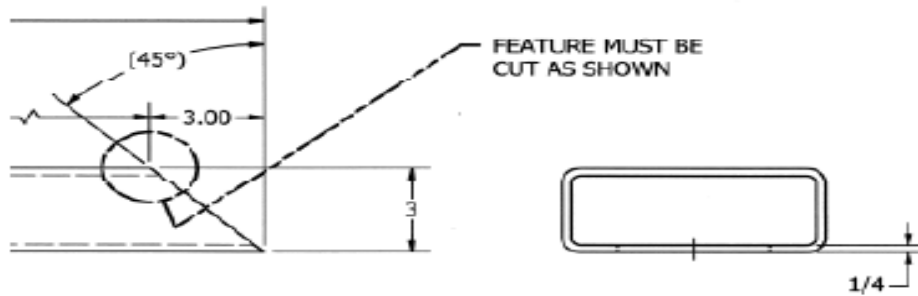
13.10.1. Edge to punched, cut or formed feature tolerance is ± 0.015 of specified nominal.



- 13.11. Hole to hole, hole to punched feature and punched feature to punched/cut feature tolerance is ± 0.010 of nominal. This applies to punched details falling on a common part surface.
- 13.12. Formed feature to adjacent formed feature tolerance is ± 0.015 of nominal. Maximum cumulative formed feature to non-adjacent formed feature location tolerance is ± 0.030 .
- 13.13. Calculate feature to feature location tolerance of punched details falling on non common part surfaces using 13.8 – 13.11 collectively.
- 13.14. Press-in hardware (studs, standoffs, press nuts, etc.) is to be installed using the manufacturer's specified tooling and installation process.
- 13.15. Although Die marks are inherent in the process, they shall not leave sharp burrs or excessively gouge the part.
- 13.16. Sharp radius punches and dies shall be avoided as they leave a more distinct bend line in the work piece and a less smooth outer surface.
- 13.17. Adjustments to provided 2D or 3D flat pattern layouts are allowable as deemed necessary by the manufacturing authority to compensate for process variants as required ensuring finished part compliance to Drawing specifications.
- 13.18. Cut Corner Radii: Many older drawings contain a general note that states "1/8 inch max cut corner radii permissible unless otherwise noted". This will not always yield acceptable parts so it is now supplemented as follows:
 - 13.18.1. Up to through 10 gauge; 0.060" radius on any corner of less than 135 degrees.
 - 13.18.2. 7 gauge through 1/4", 0.100" radius on any corner of less than 135 degrees.
 - 13.18.3. 3/8" and thicker, 0.125" radius on any corner of less than 135 degrees.
- 13.19. Bend orientation relative to material grain:
 - 13.19.1. Mild or Low Carbon Steel
 - 13.19.1.1. $\geq 1/2$ material, always orient grain direction 45-90 degrees to the bend line. If bend is acute, grain direction must be 90 degrees to bend line.
 - 13.19.1.2. 3/8 material, if bending 45 degrees or less then grain direction may be any angle except 0 or parallel to the bend line. If bends are greater than 45 degrees grain direction will be oriented 45-90 degrees to the bend line. If bending an acute angle grain direction shall be 90 degrees to the bend line.
 - 13.19.1.3. 1/4 material, if bending is less than 90 degrees, then the grain direction may be any angle except 0 or parallel to the bend line. Bend angles of greater than 90 degrees, grain direction shall be oriented 45-90 degrees to the bend line.
 - 13.19.1.4. Gauge material, unless specified grain direction is not critical and parts may be nested for best yield.
 - 13.19.2. 36 - All thicknesses, grain direction shall be 45-90 degrees to the bend line for ≥ 90 degrees unless bend is acute angle. For bends < 90 degrees, grain direction must be 90 degrees to the bend line.
 - 13.19.3. High Carbon and HSLA Steel (1045, A572) For any thickness or angle, grain direction shall always be oriented 90 degrees to the bend line. If part has adjacent bends, part should be oriented 45 degrees to bend line.

14. LASER CUT TUBING PARTS

- 14.1. Hole diameters and radii will be ± 0.010 of specified nominal.
- 14.2. Hole to hole, hole to cut feature and cut feature to cut feature tolerance is ± 0.010 of nominal.
- 14.3. Angles will be $\pm 0.5^\circ$ of specified nominal.
- 14.4. Normal to surface cutting will be allowed on parts whose drawings bear the following general note: "All cuts may be made normal to surface except as noted." If in doubt, ask.
- 14.5. Where normal to surface cutting is not allowed the following local note will be applied to the affected detail feature(s): "Feature must be cut as shown."



15. BAND SAW CUT PARTS

- 15.1. Cut to cut lengths will be ± 0.030 of specified nominal.
- 15.2. Angular dimensions will be $\pm 1^\circ$ of specified nominal.

16. BENT TUBING PARTS

Per SAE J2551, with the end points of the tube or tube assembly located within the print dimensions, the tube shall follow an established contour within the tolerance on this table. Applies both fluid and non-fluid related round tubing applications.



Tube Diameter	Cut Length							
.1875"	Up to 36.41"	36.41" to 46.81"	46.81" to 57.20"	57.20" to 67.60"	67.60" to 77.99"	77.99" to 88.38"	88.38" to 99.77"	99.77" and up
.250"	Up to 34.88"	34.88" to 44.84"	44.84" to 54.80"	54.80" to 64.76"	64.76" to 74.72"	74.72" to 84.68"	84.68" to 94.64"	94.64" and up
.3125"	Up to 35.70"	35.70" to 45.90"	45.90" to 56.10"	56.10" to 66.30"	66.30" to 76.49"	76.49" to 86.69"	86.69" to 96.88"	96.88" and up
.375"	Up to 37.63"	37.63" to 48.38"	48.38" to 59.13"	59.13" to 69.88"	69.88" to 80.62"	80.62" to 91.37"	91.37" to 102.12"	102.12" and up
.500"	Up to 43.30"	43.30" to 55.66"	55.66" to 68.03"	68.03" to 80.39"	80.39" to 92.75"	92.75" to 105.11"	105.11" to 117.48"	117.48" and up
.625"	Up to 50.19"	50.19" to 64.52"	64.52" to 78.85"	78.85" to 93.18"	93.18" to 107.51"	107.51" to 121.85"	121.85" to 136.18"	136.18" and up
.750"	Up to 57.64"	57.64" to 74.09"	74.09" to 90.55"	90.55" to 107.00"	107.00" to 123.46"	123.46" to 139.92"	139.92" to 156.37"	156.37" and up
.875"	Up to 65.35"	65.35" to 84.01"	84.01" to 102.67"	102.67" to 121.33"	121.33" to 140.00"	140.00" to 158.66"	158.66" to 177.32"	177.32" and up
1.000"	Up to 73.34"	73.34" to 94.33"	94.33" to 115.23"	115.23" to 136.18"	136.18" to 157.12"	157.12" to 178.08"	178.08" to 199.01"	199.01" and up
1.125"	Up to 81.45"	81.45" to 104.72"	104.72" to 127.99"	127.99" to 151.25"	151.25" to 174.25"	174.25" to 197.79"	197.79" to 221.06"	221.06" and up
1.250"	Up to 89.72"	89.72" to 115.35"	115.35" to 140.98"	140.98" to 166.61"	166.61" to 192.24"	192.24" to 217.87"	217.87" to 243.50"	243.50" and up
1.500"	Up to 106.22"	106.22" to 136.61"	136.61" to 166.96"	166.96" to 197.32"	197.32" to 227.67"	227.67" to 258.03"	258.03" to 288.38"	288.38" and up
	+/- .118"	+/- .157"	+/- .197"	+/- .236"	+/- .275"	+/- .315"	+/- .354"	+/- .394"
Positional Tolerance Allowed								

17. CASTINGS

The following requirements and tolerances are imposed on parts formed using permanent molds or mold masters, unless locally specified within fabrication drawings in conjunction with critical detail nominal dimensions. All measurements must be taken in an appropriate manner taking into account all accumulated allowable tolerances as part acceptance criteria.

The casting process used to create the casting (i.e. green sand, ceramic, investment, permanent mold, etc.) shall be agreed upon between Demco and the casting manufacturer and/or defined on the Purchase Order. Major changes in the process are to be communicated through the Demco Buyer to the Demco Engineer and are subject to his/her approval.

17.1. As-Cast Surfaces:

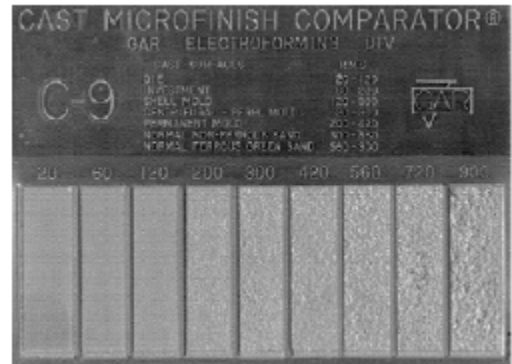
17.1.1. The pattern tooling, casting process and cleaning process shall be capable of producing the surface finishes specified on the Engineering drawing or, if specified, on the Purchase Order.

17.1.2. Except as noted under visual requirements, surfaces will be free of visible surface imperfections and transitions that are not included in the source CAD file



17.1.3. Unless otherwise specified, surface finish shall conform to the ranges of the GAR C-9 comparator for the process used.

Casting Process	Surface Finish μ in RMS	
Die	20	120
Investment	60	200
Shell Mold	120	300
Centrifugal – Permanent Mold	20	300
Permanent Mold	200	420
Normal Non-Ferrous Sand	300	560
Normal Ferrous Green Sand	560	900



17.2. Visual Requirements Unless otherwise specified the following visual requirements apply to all castings.

17.2.1. No cracks are allowed.

17.2.2. Allowable Rounded Discontinuities

Max Dia	Max Depth	Max Qty / Area
1/8"	1/8"	4 per 3" Dia Circle

17.2.3. Allowable linear discontinuities.

Max Width	Max Depth	Max Qty / Area
1/16"	1/8"	4 per 3" Dia Circle

17.3. Machined Surfaces The following visual requirements apply to all machined surfaces in addition to those specifically covered elsewhere in this Specification.

17.3.1. Any discontinuity less than or equal to 1/32" wide, 1/32" long, by 1/32" deep shall not be considered a defect.

17.3.2. Any two discontinuities, regardless of size, separated by less than 1/8" shall be considered as one defect (e.g. - porosity).

17.3.3. Maximum defect dimensions and quantities for machined surfaces and parts

17.3.3.1. Gasket Surfaces

17.3.3.1.1. Any discontinuity less than 1/32" wide, 1/32" long, by 1/32" deep shall not be considered a defect.

17.3.3.1.2. Any two discontinuities, regardless of size, separated by less than 1/8" shall be considered as one defect (e.g. – porosity).

17.3.3.1.3. No defect shall have dimensions that exceed 1/8" wide, 1/8" long, by 1/32" deep.

17.3.3.1.4. Defects shall be separated by at least 1/2"

17.3.3.1.5. No more than three defects are allowed in a 1" diameter circle.

17.3.3.2. O-ring Surfaces

17.3.3.2.1. No discontinuities or defects are allowed on O-ring surfaces.



17.3.3.3. Bearing Contact Surfaces

- 17.3.3.3.1. No defect shall have dimensions that exceed 1/16" wide, 1/16" long, by 1/16" deep.
- 17.3.3.3.2. Any two discontinuities, regardless of size, separated by less than 1/8" shall be considered as one defect (e.g. – porosity).
- 17.3.3.3.3. Defects shall be separated from one another by a linear distance of at least 1".

17.3.3.4. General Machined Mounting Surfaces

- 17.3.3.4.1. No defect shall have dimensions that exceed 1/8" wide, 1/8" long, by 1/16" deep.
- 17.3.3.4.2. Any two discontinuities, regardless of size, separated by less than 1/8" shall be considered as one defect (e.g. – porosity).
- 17.3.3.4.3. Defects shall be separated from one another by a linear distance of at least 1".

17.4. Fins

17.4.1. Parting fins, core print fins, or paste line fins shall be removed to within 1/8" (3 mm) of the intended surface when the surface will later be machined (example: parting faces on upper and lower half casings).

17.4.2. Parting fins, core print fins, or paste line fins shall be removed completely when the surface is a diameter which will be chucked for machining purposes.

Diameters should not be ground more than 1/16" (1.5 mm) below the intended surface.

17.4.3. Rounded smooth fins within 1/8" (3 mm) are acceptable.

17.4.4. External part surfaces that are not machined, but are on surfaces that will obviously affect part appearance, no sharp edges are allowed. Edges shall be blended by the Foundry to within 1/16" (1.5 mm) of the intended surface unless agreed to otherwise.

17.5. Gates and Risers

17.5.1. Gates and risers must be removed to within +/- 1/16" of the part surface unless otherwise specified.

17.6. Burn-In/Penetration

17.6.1. Loose burn-in sand shall be completely removed by the Supplier.

17.6.2. Tight burn-in sand, in non-critical areas not affecting machining, hydraulic or mechanical performance is allowed only if the overall appearance is not a blatant example of sub-standard quality for the casting process.

17.6.3. Solid metal mold or core penetration must be completely removed unless otherwise agreed upon.

17.7. Scabs, Buckles, Rattails, and Irregularities: Any irregular surfaces, which are above the intended casting surface, must be ground off or blended to within 1/16" (1.5 mm) of the original intended surface. Any irregular surface, which is less than 1/16" (1.5 mm) below the intended casting surface, must be blended if the depression **will not be welded or filled**. Any irregular surface more than 1/16" (1.5 mm) below the intended casting surface must be repaired/salvaged using an approved method.

17.8. Mold Wash Streaks or Runs: Mold wash streaks or runs more than 1" (25 mm) long must be ground and blended. Any mold wash streak or run over 1" (25 mm) long and more than 1/16" (1.5 mm) below the intended surface must be repaired/salvaged using an approved method.

17.9. Chill Marks

17.9.1. Chill marks must be ground off and blended to within 1/16" (1.5 mm) of the casting surface unless otherwise agreed upon between the Foundry and Manufacturing Engineering.

17.9.2. Crosshatch lines must be ground off as necessary on:

17.9.2.1. Non-machined surfaces to within 1/16" (1.5 mm)

17.9.2.2. Machined surfaces to within 1/8" (3 mm)

17.9.2.3. Internal waterways to the intended surface.

17.9.3. Chill marks must be completely removed in the same manner as fins when the chills are on a surface that will be chucked for machining purposes.

17.10. Miscellaneous Visual Specifications

17.10.1. Weld Repairs - When welding is permitted, welds shall be free of cracks, incomplete fusion, weld spatter, burn marks and reworked by the Foundry to restore the area to the original contour.

17.10.2. Paint and Felt Tip Markings - All marks from paint, felt tip markers or similar devices must be removed before stocking except for order or material identification that will be removed at Assembly.



17.10.3. Investment Castings - All wax flash is to be removed and wax weld lines smoothed to the adjoining surface.

17.11. Sand Cast Aluminum Parts

17.11.1. Refer to Aluminum Association E series Standard for Aluminum Sand and Permanent Mold Castings

17.12. Permanent Mold

17.12.1. Angular dimensions will be $\pm 1/2$ degree of specified nominal.

17.12.2. Right angle (90 degree) configurations need not be specified but will assume 90 degrees as nominal.

17.12.3. Edge profiles will be ± 0.010 of specified nominal.

17.12.4. Surface profiles will be ± 0.015 of specified nominal.

17.12.5. Machined features tolerances shall comply with the tolerances in sections 10-12 of this standard.

18. DIE CAST PARTS

18.1. Refer to NADCA Product Specification Standards for Die Castings Section 4 Standard Tolerances

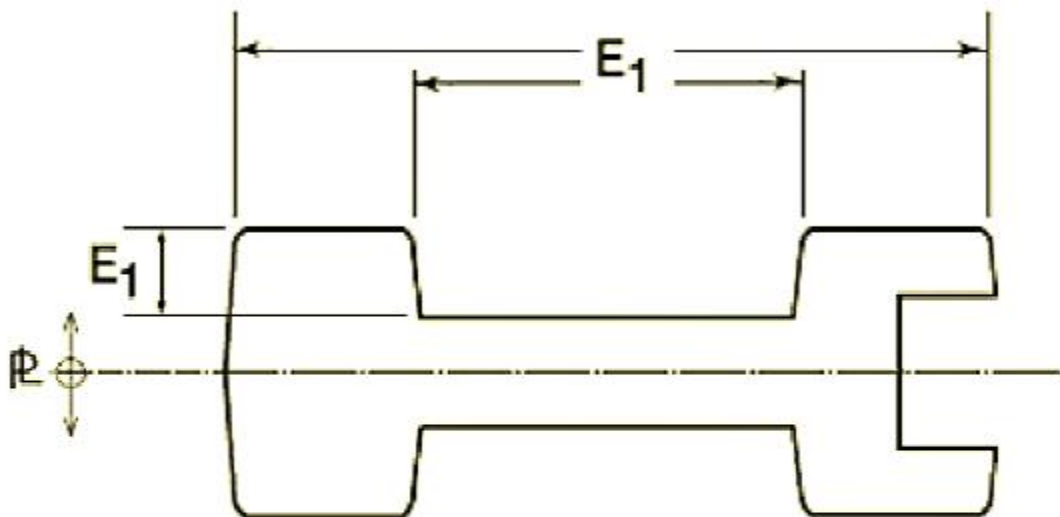


Table S-4A-1 Tolerances for Linear Dimensions (Standard)

In inches, two place decimals (.xx). In millimeters, single place decimals (.x)

Length of Dimension "E ₁ "	Casting Alloys			
	Zinc	Aluminum	Magnesium	Copper
Basic Tolerance up to 1" (25.4mm)	±0.010 (±0.25 mm)	±0.010 (±0.25 mm)	±0.010 (±0.25 mm)	±0.014 (±0.36 mm)
Additional Tolerance for each additional inch over 1" (25.4mm)	±0.001 (±0.025 mm)	±0.001 (±0.025 mm)	±0.001 (±0.025 mm)	±0.003 (±0.076 mm)

19. STEEL RULE DIE CUT PARTS

19.1. Thickness

Inches	RMA Class 2 tolerance
0 to 0.125 incl.	+/-0.032
0.125 to .25 incl.	+/-0.040
0.25 to 0.50 incl.	+/-0.063
0.5 to 1.0 incl.	+/-0.100
Over 1.0 mult. by	+/-0.100



19.2. Length and Width

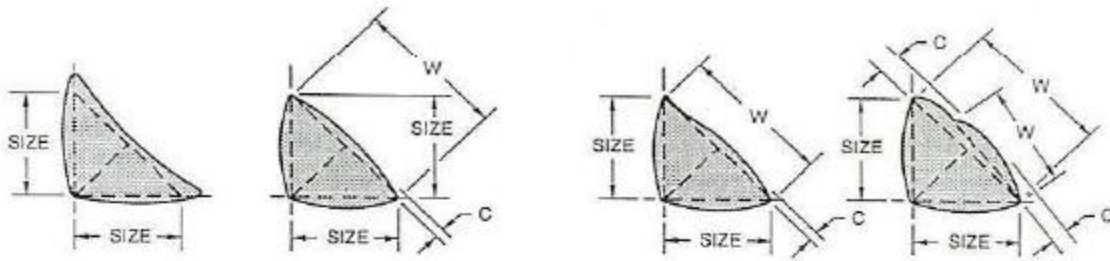
Inches	RMA Class 2 tolerance
For thickness up to 0.25 in.	
Under 1.0	+/-0.032
1.0 to 6.3	+/-0.040
Over 6.3 multiply by	+/-0.01
For thickness over 0.25 to 0.50 in.	
Under 1.0	+/-0.040
1.0 to 6.3	+/-0.050
Over 6.3 multiply by	+/-0.01
For thickness over 0.50 in.	
Under 1.0	+/-0.050
1.0 to 6.3	+/-0.063
Over 6.3 multiply by	+/-0.01



20. WELDMENTS

20.1. All welds must meet visual and dimensional acceptance criteria established by AWS D1.1. & D1.3. The exceptions being that Demco Manufacturing permits no pin holes, and that specified fillet weld size is a minimum with a plus 1/16" tolerance. established an upper tolerance of +1/16" on fillet welds unless otherwise specified.

20.2. Acceptable and Unacceptable Weld Profiles

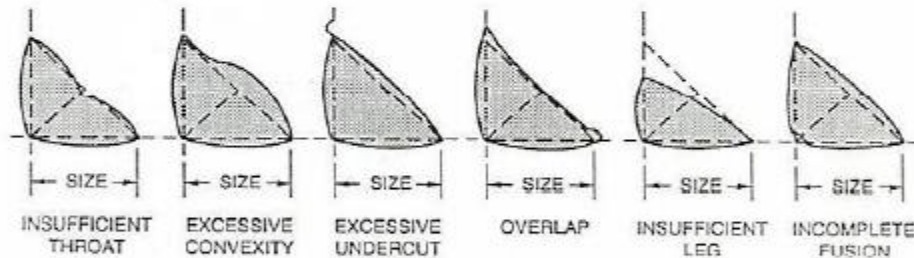


(A) DESIRABLE FILLET WELD PROFILES

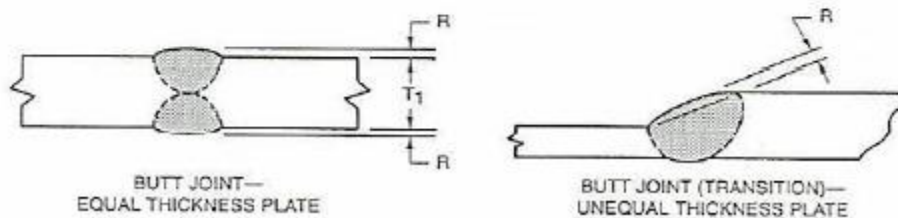
(B) ACCEPTABLE FILLET WELD PROFILES

NOTE: CONVEXITY, C, OF A WELD OR INDIVIDUAL SURFACE BEAD WITH DIMENSION W SHALL NOT EXCEED THE VALUE OF THE FOLLOWING TABLE:

WIDTH OF WELD FACE OR INDIVIDUAL SURFACE BEAD, W	MAX CONVEXITY, C
$W \leq 5/16$ in. (8 mm)	1/16 in. (1.6 mm)
$W > 5/16$ in. TO $W < 1$ in. (25 mm)	1/8 in. (3 mm)
$W \geq 1$ in.	3/16 in. (5 mm)

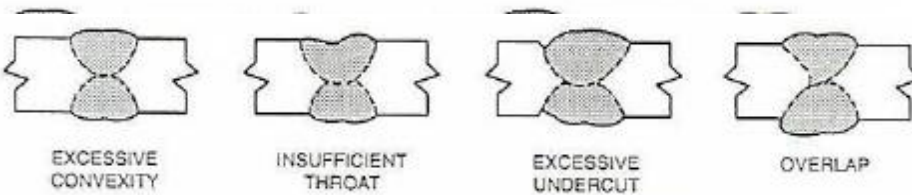


(C) UNACCEPTABLE FILLET WELD PROFILES



NOTE: REINFORCEMENT R SHALL NOT EXCEED 1/8 in. (3 mm). SEE 5.24.4.

(D) ACCEPTABLE GROOVE WELD PROFILE IN BUTT JOINT



(E) UNACCEPTABLE GROOVE WELD PROFILES IN BUTT JOINTS

20.3.3. Fillet weld leg sizes shall not be less than specified nominal and be no greater than 1/16 inch of the required leg sizes.



- 20.3.4. Fillet weld profile shall meet the requirements of Figure A.
- 20.3.5. Undercut shall not exceed a 1/32 inch.
- 20.3.6. Any porosity, regardless of size or type, shall be unacceptable.
- 20.3.7. Legs must be uniform within 1/8 inch
- 20.3.8. On high carbon steels preheat is required if material thickness is 1 inch or greater.
- 20.3.9. Fillet welds should not exceed 3/8 of an inch in a single pass.
- 20.3.10. No overlap will be accepted.
- 20.3.11. Concave is allowed as long as required throat size is achieved.

- 20.4. Tack Welds
 - 20.4.1. Tack welds and construction aid welds, not incorporated into welds, shall be removed unless otherwise specified.
- 20.5. Control of Distortion and Shrinkage
 - 20.5.1. Procedures and Sequence- In assembling and joining parts of a structure or of built up members and in welding reinforcing parts to members, the procedure and sequence shall be such as will minimize distortion and shrinkage.
 - 20.5.2. Sequencing- In so far as practicable, all welds shall be made in a sequence that will balance the applied heat of welding while the welding progresses.
 - 20.5.3. Minimized Restraint- In assemblies, joints expected to have significant shrinkage should be usually be welded before joints expected to have lesser shrinkage. They should also be welded with as little restraint as possible.
- 20.6. Tolerances
 - 20.6.1. Joint Dimension Tolerance
 - 20.6.1.1. Fillet Weld Assembly- The parts to be joined by fillet welds shall be brought into as close contact as practicable. The root opening shall not exceed 3/16 inch except in cases involving either shapes or plates 3in or greater in thickness if after straightening and in assembly, the root opening cannot be closed sufficiently to meet the tolerance. In such cases a maximum opening of 5/16 inch may be used, provided suitable backing is used. Backing may be of flux, glass tape, iron powder, or similar materials, or welds using a low hydrogen process compatible with the filler metal deposited. If separation is greater than a 1/16 inch, the legs of the fillet shall be increased by the amount of the opening.
 - 20.6.1.2. Groove Weld Assembly-Partial Joint Penetration Groove Weld Assembly- The parts to be joined by PJP groove welds parallel to the length of the member shall be brought into close contact as practicable. The root opening between parts shall not exceed 3/16 inch except in cases involving rolled shapes or plates 3 in or greater in thickness if, after straightening and in assembly, the root opening cannot be closed sufficiently to meet this tolerance. In such cases a maximum gap of 5/16 inch may be used, provided suitable backing is used and the final weld meets the requirements of the weld size. Tolerances bearing joints shall be in conformance with the applicable contract specifications.
 - 20.6.1.3. Butt Joint Alignment- Parts to be joined at butt joints shall be carefully aligned. Where the parts are effectively restrained against bending due to eccentricity in alignment, the offset from the theoretical alignment shall not exceed 10 % of the thickness of the thinner part joined, or 1/8 inch whichever is smaller. In correcting misalignment, the offset in such cases, the parts shall not be drawn in to a greater slope than 1/2 inch in 12 inch. Measurement of offset shall be based upon the centerline of parts unless otherwise shown on the drawings.
 - 20.6.2. Part/Feature Location Tolerance
 - 20.6.2.1. Weldment dimensioned feature locations shall be within +/-0.030" of specified nominal unless locally toleranced.
 - 20.6.2.2
- 20.7 Down-hill welds should be avoided whenever possible and completely avoided on .25 and thicker. However, in certain instances due to the location of a weld joint, the position of a weld fixture etc., the only possible way to place a weld is by using the down-hill



technique. If a down-hand weld must be used, it shall meet the acceptance criteria of AWS D1.1. & D1.3.

- 20.8 Weld spatter is not acceptable. Essential variables of the process should be adjusted to minimize or eliminate spatter. Any loose spatter (BB's) must be removed from product. Small amounts of burned-in spatter may be acceptable, but process variables must be adjusted to eliminate recurrence. Demco Quality Assurance is responsible for determination and communication of acceptance/rejection for burned-in spatter.
- 20.9. When welding a joint on each side, unless otherwise required by print or work instruction, welds must wrap the ends on members less than 1 inch thick. Features 1 inch or larger will require a weld symbol.

21. FLAT & BRAKE-FORMED PLASTIC SHEET & LAMINATE PARTS

The following tolerances are hereby imposed unless specified within fabrication drawings in conjunction with critical detail nominal dimensions. All measurements must be taken in an appropriate manner taking into full account all accumulated allowable tolerances as part acceptance criteria.

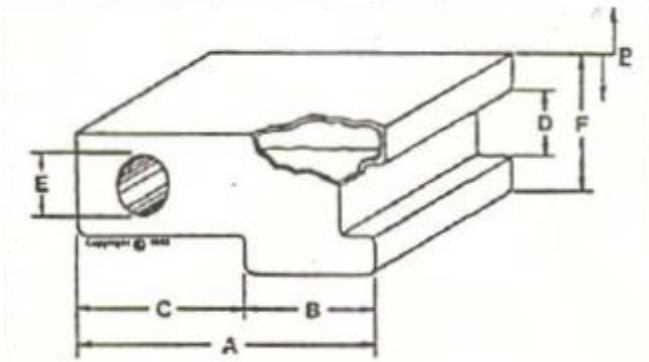
- 21.1. Angular features will be +/- 1 degree of specified nominal.
- 21.2. Right angle (90 degrees) coordinates need not be specified but will assume 90 degrees as nominal.
- 21.3. Material thickness will carry the tolerance as specified by governing manufacturing standards. (I.e. ASTM, NEMA, Manufacturer, Standard Gage, etc.)
- 21.4. Hole diameters and punched radii will be +0.010/- 0.005 of specified nominal.
- 21.5. Counter sink major diameters will be +/- .010 of specified nominal.
- 21.6. Counter sink minor diameters will be +/- .010 of nominal as calculated using: Major "C" sink diameter, 82° included angle and material nominal thickness.
- 21.7. Edge to punched or formed feature tolerance is +/- 0.015 of specified nominal.
- 21.8. Hole to hole, hole to punched feature and punched feature to punched feature tolerance is +/- 0.010 of nominal.
- 21.9. Bend angles will be $\pm 5^\circ$ of specified nominal.

22. INJECTION MOLDED PLASTIC PARTS

- 22.1. Injection Molding General tolerances
 - 22.1.1. For material specific tolerancing of walls and features reference SPI AQ-102 Standards and Practices of Plastic Molders
 - 22.1.2. Run out general tolerance is 0.007 in per inch
- 22.2. Gate protrusion tolerances are as follows:
 - 22.2.1. Breaking – 0.025 in
 - 22.2.2. Clipping – 0.010 in
 - 22.2.3. Machining – 0.005
 - 22.2.4. Parting Line mismatch - ≤ 0.030 "

23. ROTO-MOLDED PLASTIC PARTS

- 23.1. Wall thickness will be $\pm 10\%$ of specified nominal.
- 23.2. Dimensional Tolerances – Commercial Grade is assumed unless otherwise specified.



[Values in inches/inch]						
	A	B	C	D	E	F
Polyethylene						
Ideal	±.020	±.020	±.020	±.015	±.010	±.020*
Commercial	±.010	±.010	±.010	±.008	±.008	±.010*
Precision	±.005	±.005	±.005	±.004	±.004	±.005*
Polyvinylchloride						
Ideal	±.025	±.025	±.025	±.015	±.015	±.025*
Commercial	±.020	±.020	±.020	±.010	±.010	±.020*
Precision	±.010	±.010	±.010	±.005	±.005	±.010*
Nylon						
Ideal	±.010	±.010	±.010	±.008	±.008	±.010*
Commercial	±.006	±.006	±.006	±.005	±.005	±.005*
Precision	±.004	±.004	±.004	±.003	±.003	±.004*
Polycarbonate						
Ideal	±.008	±.008	±.008	±.005	±.005	±.008*
Commercial	±.005	±.005	±.005	±.003	±.003	±.005*
Precision	±.003	±.003	±.003	±.002	±.002	±.003*
Note:	Ideal Tolerance = Min. care required.					
	Commercial Tolerance = Possible with reasonable care.					
	Precision Tolerance = Possible with difficulty & added cost.					
	*Plus .010 Inch for parting line variations.					

24. VACU-FORM PLASTIC PARTS

24.1. All features will be ± 0.030 of nominal.

25. ZINC PLATED PARTS & HARDWARE

25.1. Refer to Demco Zinc Plating Specifications

26. HYDRAULIC CYLINDERS

26.1. Barrel, cap and head gland threads

26.1.1. Internal threads pitch, major and minor diameters will be +0.004/-0.000 of specified nominal.

26.1.2. External threads pitch, major and minor diameters will be +0.000/-0.004 of specified nominal.

26.2. Barrel ID dimension

2" or 2-1/2"	+0.002/-0.000
3" to 4-1/2"	+0.003/-0.000

Head gland

26.3.1. OD chamfer diameter will be +0.000/-0.003 of specified nominal.

26.3.2. Bore diameter will be +0.002/-0.000 of specified nominal.

26.4. Cylinder rod turned diameters in the piston area will be +0.000/-0.003.

26.5. Pistons

26.5.1. All turned diameters will be 0.001 larger than nominal rod diameter with a tolerance of +0.002/-0.000.



- 26.5.2. OD will be ± 0.002 of specified nominal
- 26.5.3. Seal cross section diameter will be $+ 0.003/ -0.001$ of specified nominal.
- 26.6. Rephrasing port hole diameter will be ± 0.002 of specified nominal.

27. ELECTRICAL ENCLOSURES

- 27.1. Workmanship
 - 27.1.1. PCB assembly workmanship shall meet commercial grade IPC 610 Class II requirements.
 - 27.1.2. PCBs and deliverable modules shall be designed to prevent ESD/EOS damage in their assembled state, and shall be processed a manner that prevents ESD/EOS component damage throughout the entire manufacturing process.

28. WIRE HARNESES

- 28.1. Wire Covering
 - 28.1.1. All cables will be covered in either corrugated loom or braided covering.
- 28.2. Interconnects
 - 28.2.1. All terminals should be crimped to the manufacturer's specification.
 - 28.2.2. All fork and ring type terminals will be solder type.
 - 28.2.3. If a wire size is used in conjunction with a terminal that does not support that wire size solder will be used.
- 28.3. Routing

29. HANDLING, STORAGE, PACKAGING AND PRESERVATION

- 29.1. All parts are to be handled and packaged in a manner that prevents them from being damaged in stacking, storage or transport. Parts that exhibit damage from handling must be identified and dispositioned.
- 29.2. Parts that are identified as being deficient, will be identified as nonconforming product until physically scrapped. If improperly handled, parts that we might otherwise be able to rework cannot be recovered.
- 29.3. Prior to shipping or storage, all metal surfaces not otherwise protected by paint or plating shall be coated with a preservative suitable to prevent corrosion in expected conditions for 2 years.

30. GENERAL WORKMANSHIP

- 30.1. Painting
 - 30.1.1. No paint is allowed on machined surfaces unless otherwise specified.
 - 30.1.2. Surface coatings shall measure 3-5 mil in thickness, with the reading being the average of three readings taken on the best wide, flat surface available.
 - 30.1.3. The painted surface shall exhibit no runs, drips, sags or blisters.
- 30.2. Assembly
 - 30.2.1. Dimensioned feature locations shall be within ± 0.030 " of specified nominal unless locally toleranced.
 - 30.2.2. Electrical wiring that does not terminate, must be capped and secured in a manner that prevents free movement and will ensure no possible contact with any other wire or metal surface. All hoses and wiring not connected at either end must be secured in place.
 - 30.2.3. Exposed caulk must present a smooth consistent bead. Caulk must fill the intended area completely and all excess caulk must be smoothed over and/or removed.
 - 30.2.4. No hoses or wiring may be pulled through any tube or access, until it has been verified that no sharp edges or burs are present.
- 30.3. General
 - 30.3.1. **All employees and suppliers are responsible for ensuring the workmanship and conformance of components they are processing. If you process deficient parts, you own responsibility.**
 - 30.3.2. It is required that all specified drawings inspection and work instructions are available at the work station, and that the documents are strictly adhered to. It is the responsibility of each individual to notify the appropriate department of any existing errors or discrepancies that make following the instructions



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- impractical.
- 30.3.3. Care should be taken to ensure that the seams of tubing are oriented with the seam facing the least visible direction when assembled to the finished product.
 - 30.3.4. No process may leave a burr or sharp edge. Sharp edges must be broken, and burrs must be removed.
 - 30.3.5. Rough and sharp edges, slugs and debris must be removed from torch cuts.
 - 30.3.6. Components that have burrs and/or sharp edges anywhere, cannot be assembled. Wires and hoses are pulled through most components, which could be severely damaged by sharp edges.
 - 30.3.7. Excess grease and lubricants must be removed from all grease fittings and joints. All drips and spills must be removed.
 - 30.3.8. First part approval – all new articles require first article approval by Demco. This is parts that have never been run at the current facility or Demco has requested first article before production run.
 - 30.4. Fastener torque unless otherwise specified: (see following page)



BOLT TORQUE

TORQUE DATA FOR STANDARD NUTS, BOLTS, AND CAPSCREWS.

Tighten all bolts to torques specified in chart unless otherwise noted. Check tightness of bolts periodically, using bolt chart as guide. Replace hardware with same grade bolt.

NOTE: Unless otherwise specified, high-strength Grade 5 hex bolts are used throughout assembly of equipment.



Torque Specifications

Bolt Torque for Standard bolts *

"A"	GRADE 2		GRADE 5		GRADE 8	
	lb-ft	(N.m)	lb-ft	(N.m)	lb-ft	(N.m)
1/4"	6	(8)	9	(12)	12	(16)
5/16"	10	(13)	18	(25)	25	(35)
3/8"	20	(27)	30	(40)	45	(60)
7/16"	30	(40)	50	(70)	80	(110)
1/2"	45	(60)	75	(100)	115	(155)
9/16"	70	(95)	115	(155)	165	(220)
5/8"	95	(130)	150	(200)	225	(300)
3/4"	165	(225)	290	(390)	400	(540)
7/8"	170	(230)	420	(570)	650	(880)
1"	225	(300)	630	(850)	970	(1310)

Torque Lug Nuts to 120 FT/LBS

Bolt Torque for Metric bolts *

"A"	CLASS 8.8		CLASS 9.8		CLASS 10.9	
	lb-ft	(N.m)	lb-ft	(N.m)	lb-ft	(N.m)
6	9	(13)	10	(14)	13	(17)
7	15	(21)	18	(24)	21	(29)
8	23	(31)	25	(34)	31	(42)
10	45	(61)	50	(68)	61	(83)
12	78	(106)	88	(118)	106	(144)
14	125	(169)	140	(189)	170	(230)
16	194	(263)	216	(293)	263	(357)
18	268	(363)	--	--	364	(493)
20	378	(513)	--	--	515	(689)
22	516	(699)	--	--	702	(952)
24	654	(886)	--	--	890	(1206)

Torque figures indicated are valid for non-greased or non-oiled threads and heads unless otherwise specified. Therefore, do not grease or oil bolts or capscrews unless otherwise specified in this manual. When using locking elements, increase torque values by 5%.

* GRADE or CLASS value for bolts and capscrews are identified by their head markings.

Torque 11MM calliper bolts to 40 ft/lbs

