APPLICATION		REVISION HISTORY			
NEXT ASSY	USED ON	REV	DESCRIPTION	DATE	APPR
N/A	N/A	NC	NEW RELEASE	20180821	MCC

CUST: N/A
PRODUCT: N/A
DESC: N/A

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ARE:

ANGLES	DECIMALS
±0.5°	.XX ± .03
	.XXX ± .010

DO NOT SCALE DRAWING
PARTS SHALL BE FREE OF BURRS
BROKEN EDGES .005-.030
FILLETS R .005-.020
SURFACE ROUGHNESS 125

INTERPRET DRAWING
IN ACCORDANCE WITH
ASME Y14.100-2004 AND
ASME Y14.5M-1994

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DRAWN/PREPARED CS HOWARD	20180821	DRAWING TITLE
CHECKED BY F AVINA	20180821	STANDARD INSPECTION GUIDE FOR SHEET METAL PARTS
MFG ENGR GG GOMEZ	20180821	
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SIZE	ID NO		REV
A	SP-12-05		NC
SCALE	WEIGHT (lb)	CAGE CODE	SHEET
N/A	N/A	32067	1 of 5

1 Purpose

This inspection guide is used to provide guidelines for inspecting sheet metal parts.

2 Scope

This guideline can be used for all parts made from flat or formed sheet metal and for all material types.

3 Responsibilities

QC inspectors: Carry out detailed inspection of all features denoted on a drawing, inspectors must understand the proper uses and limitations of the equipment being considered throughout the inspection process.
Metrology: Provides inspection equipment that is calibrated and maintains calibration intervals.
IPT ME: Provides interpretation of design intent of drawing clarifies ambiguous drawing details and notes.
IPT QE: Interprets customer quality requirements.

4 Equipment

Coordinate Measurement Machine
Romer arm
Calipers
Micrometers
Surface plates
Angle plates
Height gages
Radius gages
Dial indicators
Gage blocks
Gage pins

5 Discussion on inspection process

5.1 Use of Coordinate Measurements Machines (CMMs) and Romer Arms

5.1.1 Appropriate uses of CMMs

Once a CMM program has been created for a given part, a CMM provides a fast inspection report with very little operator input after initial set up of Part Under Inspection (PUI).

5.1.2 Limitations of CMMs

Typical CMM report does not easily match to drawing features. The programmer needs to provide a map so that multiple circular features, linear features, etc. can be correlated to specific features on a dwg. It would better serve the quality community if CMM reports matched up to balloon callouts on balloon dwgs.

CMMs interpolate data (touches on a feature) according to internal algorithms to establish hole size, hole location, orientation of hole axis, datum planes, etc. CMMs tend to report to 4 decimal places. Because of this reporting to 4 places and the algorithms used to interpolate touch data, CMMs tend to provide an impression of precision that may exceed the accuracy of the measurement.

5.1.3 Appropriate uses of Romer arms

Romer arms perform very similarly to CMMs except they do not require a program to begin measurements. Romer arms are manually moved to probe locations. They are acceptable instruments for inspection of forgings.

5.2 Use of Standard Inspection Methods (SIMs)

Many of the bomb racks, ejection systems and missile launcher rails MEC manufactures were designed in the 1940s, 1950s and late 1960s through the mid 1980s. Examples of these programs include MA-4B, MAU-12, MAU-50, BRU-32, LAU-7, LAU-127,128, 129. ASME Y14.5 Geometric Dimensioning and Tolerancing had not yet been widely adopted at the time of design. Also CMMs were not in widespread use and standard inspection tools and go/no go tooling were what the designers anticipated would be used for inspecting parts.

In the mid-1990s through the 2010s is when Y14.5 was widely adopted as the design standard for dimensioning. Programs of this vintage include F-22 and JSF (F-35). In fact, for these programs, Computer Aided Design (CAD) was in widespread use and many of the above programs do not have complete dimensional and tolerance information on the drawings, This information is contained in the CAD models of the parts themselves.

Standard Inspection Methods include calipers, height gages and surface blocks, gage pins, etc., basically everything that is conventional methods of inspection outside of CMM.

5.2.1 Appropriate uses of SIMs

SIMs conforms to the inspection methodology the Original Equipment Manufacturers (OEMs) had in mind when designing our older bomb racks and missile rails. Therefore, SIMs most accurately measure features in accordance with original design intent.

5.2.2 Limitations of SIMs

Using calipers, height gages and surface blocks, joe blocks, pin gages, etc to fully inspect a part will require multiple setups depending on the feature and orientation being inspected. This can increase inspection time compared to CMMs. It also requires a fair amount of operator skill and knowledge to properly use the equipment and interpret the results.

6 Inspection process

6.1 Using Coordinate Measurements Machines (CMMs)

6.1.1 When CMM program available

When a part to be inspected has an MEC QC approved CMM program available, it is recommended to use a CMM for speed and efficiency.

6.1.2 When discrepancies are noted

If the CMM inspection process finds certain features to be Out Of Tolerance (OOT), the feature must be verified using SIMs. Use of SIMs is considered the gold standard and is the accepted value of the inspected dimension.

6.2 Using Standard Inspection Methods (SIMs)

6.2.1 No CMM program available

Use Standard inspection Methods when no CMM program is available for inspecting the parts.

6.2.2 Verification of CMM discrepancies

Use SIMs as noted in 1.2 above when there are features that are found to be OOT with the CMM.

NOTE: CMM program needs to be re-validated to ensure the accuracy of the program..

7 Detailed inspection process using SIMs

7.1 Calipers

Use calipers to measure OD of bosses and simple linear dimensions where the jaws can fit across the feature being inspected.

7.2 Height gages and surface plates

Use height gages with dial indicators and surface plates where linear dimensions cannot be measured with calipers.

Height gages and surface plates can also be used to determine true position location of holes.

This equipment is also very suitable for determining flatness, parallelism, etc

7.3 Gage pins

Class ZZ minus pins shall be used for inspecting all holes that have 3 place dimensions. These are also called standard pins. Standard pins come in increments of .001 and have a tolerance of +.0000/-.0002. The acceptance criteria is if the maximum hole size minus pin goes in but the next size up does not, the hole meets Dwg requirements. For example, if a hole is called out as .188 +.002/-.000 then if a .190 minus pin goes into the hole but a .191 minus pin does not, the hole meets requirements. In an AS9102 inspection sheet, the hole size as measured would be listed as .190.

Class X minus pins shall only be used when inspecting holes that have 4 place dimensions. These are also known as Deltronic pins. They come in increments of .0001 and have a tolerance of +.00000/-.000040

7.4 Angle or Sine plates

Use angle plates in conjunction with surface plates and right angle blocks to inspect angular dimensions.

8 Inspection processes specific to sheet metal parts

8.1 Material condition

8.1.1 Scratches and abrasions

Scratches and abrasions which do not cause the sheet thickness to fall below the minimum thickness permitted by the applicable material specification after smooth and blending shall be acceptable. Scratches and abrasions which after cleanup would reduce the sheet below the minimum material thickness permitted by the applicable material specification shall be subject to rejection. The scratched or abraded surface shall not be reworked unless specifically authorized by the QE or ME.

8.1.2 Surface finish requirements

Except for specific surface finish requirements designated in the drawing,areas of bare aluminum alloy parts that are roughened by forming or sixing operations shall be sanded with 180 grit of finer abrasive to achieve a finish of 250 Ra (Roughness average) or finer IAW ASME B46.1.

8.2 Changes in metal thickness due to forming

8.3.1 Reduction

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

a) 10 percent for sheet metal parts of 2024, 2219, 6013 and 7000 series aluminum alloys, and for corrosion resistant steels, ¼ H and harder.

b) 30 percent in sheet metal parts of 3003, 5052, 6061 aluminum and annealed corrosions resistant steels.

8.3.2 Spin forming

If spin forming results in thinning which exceeds the above allowances, the starting amterial thickness may be increased providing finished part thicknesses are in compliance with engineering requirements.

8.3.3 Increase

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

8.3 Tolerances for Formed and Fabricated parts and Roll-Formed sheet metal shapes

8.**3.1 Formed and Fabricated Parts**

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

a) Where dimensional requirements for parts can be met during application of localized pressure in a manner simulating actual attachment in the assembly. The maximum localized pressure and its application requirements shall be as follows:
   1) 2 pounds for metal thickness less than 0.045 inch.
   2) 5 pounds for metal thickness 0.045 inch and greater.
   3) The force shall be applied at 12 inch intervals or at an equivalent smaller force to smaller interval (e.g. ½ the specified weight on a 6 inch interval, or ¼ the specified weight on on a 3 inch interval).
   4) Any number of force units may be applied providing the appropriate intervals are maintained.
   5) Each load shall be applied over a minimum area of 0.5 square inches.

b) Where such deflection of parts does not produce permanent set in the material.

c) Where such deflection does not cause detrimental deformation of mating parts and specified dimensions and tolerances are met after installation and assembly.

9 Drawing interpretation and ambiguity issues

Drawings are not always clear on their intention, are frequently double dimensioned, call out obsolete materials and processes. In these instances it the IPT ME and QE are the authorities as to how the dwg shall be interpreted and the feature inspected to meet the requirements of the dwg and our customers. QC inspectors should not hesitate to call in the IPT ME and QE to understand the requirements.