MECHANICAL WORKMANSHIP STANDARDS MANUAL

QA500/M

Revision 02

Communications & Power Industries Canada Inc.

Communications & Medical Products Division
Satcom Division (Manufacturing Operation)

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Canada

The Registered Holder
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Each page shows its page number, revision status, and date.

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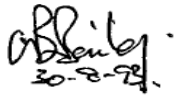
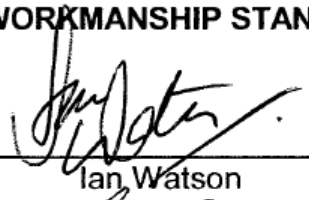
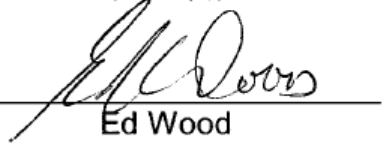
The Manual Revision status and date is shown at the right footer of each page. The Manual will be reissued when the provision of Amendment pages is inappropriate, or when there is a major change in the Standard.

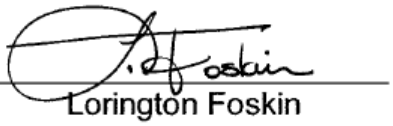
CONFIGURATION PAGE

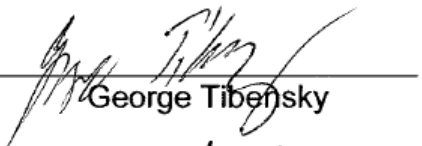
REVISION NUMBER	ISSUE DATE	CHANGE	SECTIONS AFFECTED	CONTENTS	APPROVAL
00	JAN 1987	---	ALL	INITIAL RELEASE	
01	JUL 1993	MAJOR REVISION	ALL	BASED ON VARIAN PA M7-13	
02	March 2007	MAJOR REVISION	ALL	REWRITTEN BASED ON REV 01 RONRRREVISION	

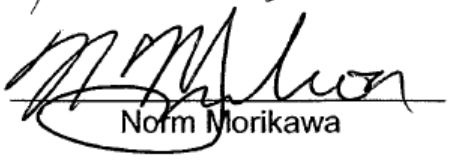
APPROVAL FOR MECHANICAL WORKMANSHIP STANDARDS MANUAL QA500/M REV: 02

Engineering Managers:  Ian Watson — Date: 13 Mar 07

 Ed Wood — Date: 13/May/07

 Lorington Foskin — Date: 13/Mar/2007

 George Tibensky — Date: 3/16/07

Quality Assurance Manager:  Norm Morikawa — Date: 16 MAR 2007

HISTORY PAGE

The original QA 500/M manual was written and released in January 1987. The manual was written for Varian PA as a “FABRICATION STANDARDS M7-13.

Revision 1 of the QA 500/M manual was written and released in July 1993. This was a major revision but was based on the VARIAN PA M7-13 standard. New standards were incorporated in the manual as requirements of CPI Canada. The standards incorporated were: Manufacturing Standards M7-124 and Fabrication Standards Std. No. 302368.

Revision 2 of the QA 500/M manual was written and released in March 2007. This was a major revision as CPI totally moved from the VARIAN PA M7-13 format. The manual was rewritten and the format was change to suite CPI Canada requirements. A number of sections from revision 1 were omitted and new standards were incorporated in the revision 2 manual. Both the imperial and metric system are used side by side in the new revision.

1.0 INTRODUCTION

- This Workmanship Standards Manual defines the mechanical requirements for the materials and processes used in the products of CPI Canada. For the electrical requirements, please refer to QA 500/E. Both QA 500/E and QA 500/M are applicable to suppliers and in-house of CPI Canada.

- CPI Canada shall specify, at the time of order placement, any deviation from the requirements established in this workmanship standard.

- The illustrations in this Workmanship Standards Manual portray requirements that are described in the narrative portion of the document.

- CPI Canada Document Control shall maintain controlled copies of this manual in a current status. CPI Canada Quality Assurance Department will coordinate all activity associated with this Workmanship Standards Manual. All matters concerning this Workmanship Standards Manual shall be addressed to CPI Canada Quality Assurance Manager.

- This Workmanship Standards Manual will be revised periodically by CPI Canada Quality Assurance Department when sufficient revisions to the applicable requirements are necessary. When it is apparent that additional workmanship requirements should be established or that minimum requirements specified should be upgraded or downgraded, a written request should be directed to the Quality Assurance Department. Revised pages will be distributed to all manual holders.

2.0 HIERARCHY OF DOCUMENTS

In the event of conflicting requirements between applicable documents, the documents will take precedence in the following order (2.1 = The highest priority):

2.1 The purchase order.

2.2 Customer Deviation / Authorization

2.3 Applicable assembly and detail drawings including - BOM notes, specifications and ECO's.

2.4 The CPI Canada Mechanical Workmanship Standards Manual.

3.0 WORKMANSHIP AND QUALITY REQUIREMENTS

3.1 MATERIALS

The supplier shall be required to use the material specified on the drawing or on the purchase order to fabricate the required part(s).

USE OF UNAUTHORIZED MATERIAL IS NOT ALLOWED. Violation shall result in removal from the Approved Supplier List. On many purchase orders for machined parts it is customary for CPI Canada to furnish the material because the type of material and its usage is very critical to the operation of the CPI product. In many cases, it is impossible to buy small lots of material to CPI Canada's specifications. If a supplier is fabricating parts with material CPI Canada has supplied, it is strictly forbidden for the supplier to furnish any other material. If CPI Canada does not supply adequate material or there is a need for additional material for any reason, call the responsible Buyer and request additional material. DO NOT USE YOUR OWN MATERIAL TO COMPLETE AN ORDER.

3.2 SUBSTITUTION/REPAIR

The substitution of materials or the repair of parts (welding, brazing, plugging holes, etc.) is not permitted except by written authorization.

3.3 INSPECTION OF PARTS

CPI Canada reserves the right to inspect all parts submitted by suppliers, outside contractors, and parts fabricated by CPI Canada machine shops. Parts that do not meet the requirements of the drawing, purchase order, manufacturing shop order instructions, or the Workmanship Standards will be rejected.

3.4 REJECTION OF PARTS

When parts are rejected, CPI Canada may at its own option

- Return the parts to the supplier for correction or require that the parts be remade at no cost to CPI Canada;
- Return the parts to the supplier without payment, and possibly cancel the contract;
- Rework within the factory and deduct labor plus overhead costs from the supplier's billing. Parts to be reworked at CPI Canada shall be discussed in detail with the supplier prior to starting the rework.

4.0 CERTIFICATION OF MATERIALS AND PROCESSES

4.1 CERTIFICATION

When certification is required by CPI Canada, the type and requirement will be stated on the purchase order. The following types of certification are described in this document:

- Material certification
- Ceramic certification
- Dimensional/test certification
- Special processing certification
- Certification of specific requirements
- Certification of age-dated and environmentally controlled items

When certification requirements in the purchase order are not clear, the supplier shall contact the CPI Canada buyer before proceeding with the work.

4.2 DELIVERY

Certification(s) shall be enclosed with delivery of parts and/or materials and shall be in duplicate. In the event of multiple shipments from the same lot of material (including return replacement orders), each shipment shall include two copies of certification. Failure to include certification shall result in materials or supplies being returned or held at CPI Canada until certification is received.

4.3 DETAIL REQUIREMENTS FOR CERTIFICATION

Listed below are items specified by CPI Canada that require certification. The requirements include the minimum information that must be supplied. If a type of certification is specified on the Purchase Order and is not listed below, the supplier shall contact the CPI Canada buyer before proceeding with the order.

4.3.1 MATERIAL CERTIFICATION

Suppliers of raw material and manufactured parts are required to furnish a certificate of analysis report. Certificate of compliance or records on file in the office of the supplier are not acceptable.

NOTE: If a supplier is required to furnish material certification, approved requirements are defined in the CPI P0-1 document.

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Material certifications shall contain all of the following information:

- Test report(s) stating chemical and/or physical properties by the material manufacturer during lot testing as required per the applicable P-specification or industry (e.g. ASTM) specification per drawing
- Manufacturer's lot number, heat number, or batch number
- Date of manufacture
- CPI Canada purchase order number
- Total order quantity, quantity in current shipment (if different)
- CPI Canada part number
- CPI Canada material procurement specification number as applicable (P-spec) or industry specification identification
- Size and/or shape of raw material
- Date, signature, and title of company representative

If a certificate of analysis is not obtainable, other acceptable criteria must be agreed upon with CPI Canada procurement prior to delivery. Acceptable criteria could be samples of material submitted to CPI Canada for evaluation or documentation from a testing lab stating that the material meets all requirements of applicable procurement specification.

Cathodes, unfired (green) ceramics, and heaters (filaments) contain materials listed as critical in P0-1. They require certification for

- CPI Canada part number and revision level
- Material type
- Material lot number
- Date of manufacture
- Quantity

4.3.2 CERAMIC CERTIFICATION

Critical ceramics materials as defined in P14-7004 shall be acceptable with a certificate of compliance. The certificate of compliance shall contain the following minimum information:

- CPI Canada purchase number
- CPI Canada part number and revision level
- Material type. NOTE: BeO shall have warnings of toxicity
- Material lot number
- Total quantity ordered and quantity in shipment (if different)
- Method of manufacture, i.e., isostatic press, extruded, molded, etc.
- Compliance Statement: Statement or statements certifying that all requirements of the purchase order and accompanying specifications have been satisfied and that the products referenced in the certification meet all requirements specified.
- Date, signature, and title of company representative

4.3.3 DIMENSIONAL/TEST CERTIFICATION

When certified test data or dimensions are required by the purchase order, the certification shall contain the following minimum data:

- CPI Canada purchase number
- CPI Canada part number and revision level
- Actual "as built" dimensions or test results by serial number if applicable
- Lot number and date of manufacture
- Date, signature, and title of company representative

4.3.4 SPECIAL PROCESSING CERTIFICATION

When purchase order requires certification of processing, the certification shall contain the following minimum information:

- CPI Canada purchase number
- CPI Canada part number and revision level
- Total quantity processed
- Lot number and date of manufacture
- Quantity in shipment (if different from total)
- Definition of process performed including specific criteria established by the processing specification and/or drawing requirements
- Any applicable military specification
- Compliance statement: Statement or statements certifying that all requirements of the purchase order end accompanying specification have been satisfied and that the products referenced in the certification meet all requirements specified
- Date, signature, and title of company representative

NOTE: When the purchase order states "processing to be performed at CPI Canada," or "less note(s) xx" (processing notes on drawing), the supplier is relieved of the requirement. However, in cases where material is returned to CPI Canada for intermediate processing (such as annealing) and subsequently returned to supplier for finishing operations, evidence of intermediate processing by CPI Canada must accompany shipment of finished items from supplier.

4.3.5 CERTIFICATION OF SPECIFIC REQUIREMENTS

When purchase order requires certificate of compliance to specific drawing notes, the certification shall contain the following minimal information:

- CPI Canada purchase number
- CPI Canada part number and revision level

- Specific requirement(s) being certified (e.g. drawing Note 2: Hole location must be certified prior to installing thread inserts). Each requirement must be listed.
- Total quantity ordered and quantity in shipment (if different)
- Lot number and date of manufacture
- Compliance Statements: Statement or statements certifying that all requirements of the purchase order and accompanying specifications have been satisfied and that the products referenced in the certification meet all requirements specified.
- Date, signature, and title of company representative

4.3.6 CERTIFICATION OF AGE-DATED AND ENVIRONMENTALLY CONTROLLED ITEMS

CPI Canada shall require certification of age-dated and environmentally controlled items, the certification shall contain the following minimum information:

- CPI Canada purchase number
- CPI Canada part number
- Quantity or amount in shipment
- Material description
- Storage conditions: If storage environment is other than normal ambient conditions, environment must be stated.

NOTE: Special storage conditions must be boldly stated on the outside of the shipping package.

- Manufacturer's lot number and/or batch number
- Date of manufacture and/or expiration date

- Compliance Statement: Statement or statements certifying that all requirements of the purchase order and accompanying: specifications have been satisfied and that the products referenced in the certification meet all requirements specified.

- Date, signature, and title of company representative

5.0 PACKING AND LABELING

Packaging and packing shall be according to contract requirements where stated, or with selected industry standards for all standard products, and all labeling shall conform to regulatory requirements**.**

5.1 PARTS PROTECTION IN PACKING

Parts shall be packaged for shipment so they are protected from damage and contamination, prevented from nesting and entanglement, and easy to unpack**.**

5.1.1 Packing Materials to Avoid

Avoid dusty and linty materials such as sawdust or shredded newspaper or styrene nuts/chips.

5.1.2 Suitable Packing Materials

Suitable packing materials include cellulose wadding, corrugated paperboard, and expanded plastics.

5.1.3 Properly Packed Materials

Pack large shipments and heavy parts in small lots for easier handling. Packaged materials, parts, and assemblies in a single corrugated carton must not exceed 60 pounds (27 kg).

5.2 TEST OR SETUP PIECES

Test or setup pieces shall not be included in the lot, but may be packed with the lot as samples for special testing by agreement.

5.3 SURPLUS CPI CANADA MATERIAL

Notify CPI Canada to pick up surplus materials.

5.3.1 Metals

Do not mix metals.

5.3.2 Scrap

Keep bar ends and scrap separate from chips, etc.

5.4 PACKAGE LABELING

5.4.1 Labeling requirements for suppliers (to CPI Canada):

Label each package as follows:

a) Name of supplier.
b) Part number and Rev. letter.
c) Description.
d) Quantity.
e) Purchase Order number, Line Item, and Rev. level.
f) Vendor reference number when relevant.
g) Supplier Inspector's stamp impression, as required.
h) Item classification (if applicable).

5.4.2 Labeling requirements for shipment (from CPI Canada):

Unless otherwise specified by contract, the sales order (on M2K), or by customer request, exterior packs of all CPI Canada shipments of products shall be marked as follows, by any means which provides legibility and durability:

a) Product model number and serial number and/or part number
b) Contract purchase order and/or sales order number
c) Consignee address
d) Bill of lading, air way bill number, and/or transportation number
e) One copy of the packing slip attached to the outside of the container in a plastic pouch
f) CPI Canada's full address
g) Any relevant caution instructions, including hazardous goods requirements
h) For multiple carton shipments, an indication on each carton of the total quantity of cartons
i) When required, a copy of regulatory declaration/certification, attached to the outside of the container in a plastic pouch.

6.0 DRAWING STANDARDS

All drawing data to be interpreted using the “Drawing Requirements Manual” (ISBN 1-57053-097-1)

6.1 Specified Tolerance

All toleranced limits are considered to be absolute regardless of the number of places involved.

1.22		1.22000…0
1.20	Means	1.20000…0
1.202		1.202000…0
1.200	Means	1.200000…0
	+0.02	1.22000…0
1.200	-0.00 Means	1.20000…0

6.2 Unspecified Tolerance

When the tolerance limit is not specified on the drawing or sketch, the following shall apply:

Decimal: 1 place ± 0.1
2 place ± 0.02
3 place ± 0.005
4 place ± 0.0005

Fraction: ± 1/64

Angles: ± 1^0

6.3 Geometric Dimensioning and Tolerance System

All Geometric Dimensioning And Tolerancing System used on CPI Canada drawings is to be interpreted according to the latest version of ASME Y14.5M.

6.3.1 Unspecified Flatness

When flatness is not specified, it shall not exceed the values in Table 1 and shall not violate the MMC perfect-form boundary.

TABLE 1 FLATNESS TOLERANCE

Surface Finish Required	Unit Variation In any Direction	Total Variation If Length is 1" (25.4 mm) or more
 or better	0.003 in. per in. (mm per mm)	0.003 times the longest element of the feature with a Maximum of 0.012 in. (0.3 mm)
 or rougher	0.005 in. per in. (mm per mm)	0.005 times the longest element of the feature with a Maximum of 0.020 in. (0.5 mm)

6.3.2 Unspecified Cylindricity

When cylindricity is not specified on the drawing, diameters shall be cylindrical within 1/2 the feature size tolerance and shall not violate the MMC (Maximum Material Condition) perfect-form boundary.

6.3.3 Unspecified Perpendicularity

When implied right (90°) angles are not specified in the drawing, they shall be within ± 0° 15' of the intended 90° angle or 0.004 inch per inch (or 0.004 millimeter per millimeter) maximum error and shall not violate the MMC (Maximum Material Condition) perfect-form boundary.

6.3.4 Unspecified Angularity

When surfaces shown as angular are not specified on the drawing, they shall be within ± 0° 15' and shall not violate the MMC (Maximum Material Condition) perfect-form boundary.

6.3.5 Unspecified Parallelism

When surfaces shown in parallel relationship are not specified on the drawing, they shall be parallel within 0.002 inch per inch (or millimeter per millimeter) of width or length and shall not violate the MMC (Maximum Material Condition) perfect-form boundary.

6.3.6 Unspecified Concentricity

When concentricity is not specified on the drawing, the concentricity of any two round features shown on the same centerline shall be equal to 1/2 the arithmetic sum of the feature size

tolerances. The feature having the smallest total tolerance shall be considered datum, if no datum is specified.

Example: The concentricity between D1 and D2

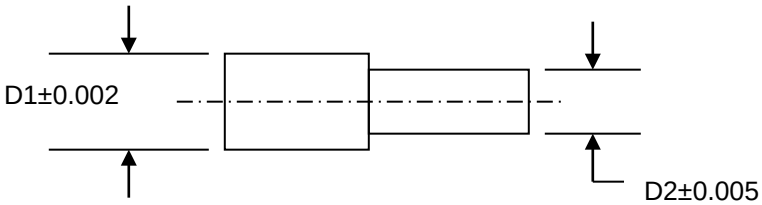
Will be:

Tolerance D1= ±0.002 =0.004 this is datum (smallest total tolerance)

D2= ±0.005 =0.010

Axis of D2 must be concentric to axis of D1 by 0.007 or less.

[(0.004+0.010)/2 = 0.014/2 = 0.007]



6.3.7 Unspecified Position

When positional symmetry is not specified, (⊕ formerly ⌯) features shown as lying on the centerline of a part, e.g., a slot in a screw head, shall be symmetrical within the total width tolerance of the feature.

6.4 Counter Bores

Unless otherwise specified, counter bores are measured for depth from the top of the face or curvature.

6.5 Countersinks In Curved Surfaces

Countersinks in a curved surface area are measured across the shortest distance perpendicular to their axis. Unless otherwise specified, all countersinks shall be 82°±5°.

6.6 Drilled Holes

The measurement for depth of a drilled hole shall be the distance from the surface of entry to the limit of depth of the full diameter (thus excluding the drill point unless otherwise specified).

7.0 COOLANTS, LUBRICANTS AND SOLVENTS

7.1 USE IN FABRICATION

Coolants, lubricants, and solvents used in fabricating parts for CPI Canada products must be free from chlorides, silicones, sulfur, or sulfur containing compounds or not exceed the maximums listed below.

a. All dilution of the commercial materials must be with water or with a sulfur-free, chloride-free, or silicone-free blending oil or solvent.

b. All parts should be wiped clean of excess oils and lubricants prior to delivery.

7.2 PARAMETERS OF ACCEPTABILITY

The following parameters define the acceptability of coolants, lubricants, and solvents for use in manufacturing CPI Canada products:

a. An easy and complete removal by standard cleaning processes.

b. The compound shall not harden, corrode, or deteriorate the parts under prolonged storage conditions.

c. The total chloride content shall not exceed 1 ppm.

d. The total active sulfur content shall not exceed 0.01%.

e. The total sulfur content shall not exceed 0.03%.

f. The concentrations of Hg, Cs, K, P, Na, Mg, Li, Sb, Cd, Zn, Te, Sr, Ca, Pb, and Mn shall not individually exceed 0.01%.

For a list of acceptable and unacceptable coolants, lubricants and solvents refer to the M spec number M7-7670.

8.0 SHEET METAL PRODUCTS FABRICATION REQUIREMENTS

8.1 SHEET METAL

Sheet metal is considered to be sheet stock that has a nominal thickness of 0.250 inch (6.35 mm), or less.

8.2 FEATURES AND SURFACES

Features and surfaces of sheet metal parts shall be within drawing dimensional limits of size in the unrestrained condition unless otherwise specified.

8.3 MACHINED FEATURES

Obvious machined features such as countersinks, chamfers, screw threads, and close-tolerance (0.003 inch / 0.076mm or less) holes shall conform to the body of this standard.

8.4 CIRCULAR RUNOUT

The circular runout of any internal or external diameter shall not exceed the value specified in Table 1 with respect to any other diameter on the same axis. If a datum axis is established by the drawing, the circular runout shall be in relation to that datum axis.

TABLE 1 CIRCULAR RUNOUT OF DIAMETER

DIAMETER (inch)	CIRCULAR RUNOUT TOLERANCE (inch)
Through 6.00	0.040
6.001 through 9.000	0.070
9.001 through 20.000	0.100
20.001 through 36.000	0.150
Over 36.000	0.200
DIAMETER (mm)	**CIRCULAR RUNOUT TOLERANCE (mm)**
Through 152.400	1.016
152.401 through 228.600	1.778
228.601 through 508.000	2.540
508.001 through 914.400	3.810
Over 914.400	5.080

8.5 WASHER-TYPE PUNCHING

The center hole of washer-type punchings shall be located within the position tolerance shown in Table 2 in relation to the outside diameter.

TABLE 2 TRUE POSITION OF WASHER-TYPE PUNCHINGS RELATIVE TO OD AS DATUME FEATURE

INSIDE DIAMETER	POSITION TOLERANCE (MMC)
Through 6.0 in. (152.400 mm)	0.030 DIA
6.001 through 12.000 in. (152.401 through 304.800 mm)	0.060 DIA
12.001 through 24.000 in. (304.801 through 609.600 mm)	0.100 DIA
Over 24.000 in. (609.600 mm)	0.150 DIA

8.6 FLATNESS

Variations in surface flatness shall not exceed the values shown in Table 3 and 4 and shall not violate the dimensional limits of size.

TABLE 3 FLATNESS FOR NONWELDED SURFACES

Nominal Stock Thickness	Unit Variation in Any Direction
Through 0.090 inch (2.286 mm)	0.010 in./in. (mm/mm)
0.091 through 0.250 inch (2.287 through 6.350 mm)	0.007 in./in. (mm/mm)

TABLE 4 FLATNESS FOR WELDED/BRAZED SURFACES

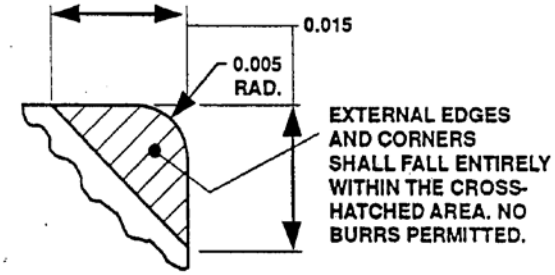
NOMINAL STOCK THICKNESS	UNIT VARIATION IN ANY DIRECTION
Through 0.032 inch (0.813 mm)	0.025 in./in. (mm/mm)
0.033 through 0.060 inch (0.814 through 1.524 mm)	0.020 in./in. (mm/mm)
0.061 through 0.125 inch (1.525 through 3.175 mm)	0.015 in./in. (mm/mm)
0.126 through 0.250 (3.176 through 6.350 mm)	0.005 in./in. (mm/mm)

8.7 PARALLELISM AND PERPENDICULARITY

The elements of flat sheet metal surfaces that are shown as parallel or perpendicular shall be parallel or perpendicular to each other within 3°. The datum shall be the longest adjacent surface that is parallel or perpendicular to the surface being measured.

8.8 EDGES AND CORNERS

Sheared edges are permissible but they, and all other edges and comers, shall be broken per the illustration below. This applies only to finished parts and not to "in-process" pieces of a welded or, brazed assembly.

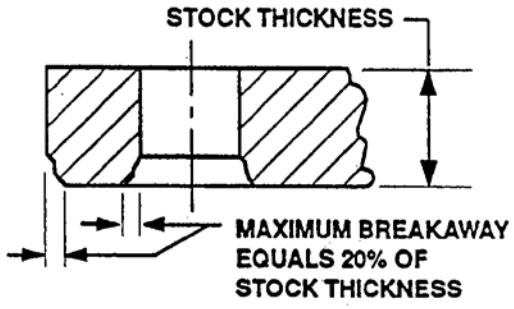


8.9 STOCK THICKNESS AFTER FORMING

Sheet metal thickness in areas affected by forming may be reduced by a maximum of 25 percent of the maximum stock thickness. Local thickening due to the part shape and the forming process is acceptable up to 30 percent of the maximum stock thickness.

8.10 BREAKAWAY

The maximum breakaway of punched or sheared edges shall be not more than 20 percent of the stock thickness as shown below. The dimensional limits of size apply only to those portions of the edge where breakaway has not occurred.



8.11BURRS

The following burr specifications are in addition to those covered in Section 9:

Limitations — under the conditions specified below, maximum burr heights are (see illustration below)

Stock Thickness	Max. Burr Height Allowance
0.004 inch (0.100 mm) under	0.001 inch (0.025 mm)
over 0.004 to 0.014 inch (0.100 to 0.356 mm)	0.0015 inch (0.038 mm)
over 0.014 to 0.039 inch (0.356 to 0.991 mm)	0.002 inch (0.051 mm)
over 0.039 to 0.124 inch (0.991 to 3.150 mm)	0.003 inch (0.076 mm)
over 0.124 to 0.186 inch (3.150 to 4.724 mm)	0.004 inch (0.102 mm)
over 0.186 to 0.311 inch (4.724 to 7.899 mm)	0.005 inch (0.127 mm)
over 0.311 inch (7.899 mm)	0.010 inch (0.250 mm)

Wire and ribbon-burrs on cut lengths of wire and ribbon, including flattening because of shearing pressure, shall not exceed 10 percent of the diameter or thickness, unless otherwise specified.

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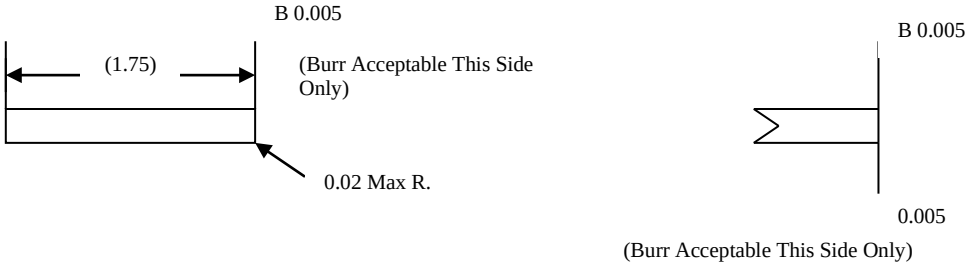
8.12 BURR SYMBOLS AND DRAWING CALLOUTS

- "B" placed on extension lines indicates that burrs are acceptable.
- The maximum height of burr allowed is shown adjacent to the symbol.
- Arrowheads may be used to indicate the side on which burrs may occur.
- Symbols placed on both sides indicate that burrs are acceptable on both sides.
- A radius may be specified on an edge to show the direction of punching.



9.0 BURRS

9.1 DEFINITION

A burr is found at the edge of a stamped or machined feature and is defined as a small projection of material that interrupts the normal contour of the plane or surface.

Note that this definition says a burr can only occur at an edge of a feature. Anything on the surface is a nodule or particle, etc.

9.2 TYPES

Various types of burrs are defined as follows: A feather burr is a very fine or thin burr generally less than 0.001 inch (0.025 mm) thick. A hanging burr is a burr that is not firmly attached to the work piece. A rolled-over burr is a tight burr that is curled over on itself in such a manner that it traps contaminants within itself. IF THE ANGLE FORMED BETWEEN THE BURR AND THE SURFACE OF THE PART IS GREATER THAN 60°, THE BURR IS NOT ROLLED OVER. ROLLED-OVER AND IMBEDDED BURRS ARE NOT ALLOWED.

9.3 HEIGHT

Burr height is defined as the maximum distance the burr projects above the surface of the work piece.

To determine burr height, a microscope capable of 30 power with a calibrated reticle in the eyepiece shall be used to measure the distance from the surface of the work piece to the top of the burr. However, to initially verify the existence of a burr, using a microscope at 10 power maximum shall be our standard procedure.

Unless otherwise specified, maximum burr heights allowed on machined features are shown below.

32 Finish or Better	63 Finish	125 Finish or Worse
0.0005 inch (0.013 mm)	0.002 inch (0.051 mm)	0.003 inch (0.076 mm)

9.4 REMOVAL

It shall be standard practice to remove burrs from the edges of all surfaces, even if this requirement is not noted on the drawing. Burrs shall be removed to the extent that they are not visible without magnification.

When the notation "no burrs" appears on a drawing; burrs shall be removed to the extent that they are not visible with a 10X magnification.

Method of deburring must not introduce any contamination, and all loose particles must be removed.

In no case shall the dimensional tolerance be exceeded as a result of a burr or the removal of a burr.

9.5 EDGES

An edge is defined as the intersection of two planes of base material at an angle greater than 180°.

It' shall be standard practice to remove all sharp edges unless otherwise specified.

Edges shall be broken by either a 45° chamfer or radius. If limits are not specified on the drawing, a 0.005 inch (0.127 mm) maximum chamfer or radius is acceptable for lengths less than 1 inch (25.4 mm), otherwise 0.005 inch/inch (mm/mm) of the smallest adjacent width diameter shall be applied.

A "sharp edge" callout on a drawing shall be interpreted as being limited to a 0.002 inch (0.051 mm) maximum chamfer or radius.

9.6 CORNERS

A corner shall be defined as the intersection of two or more planes of base material at an angle less than 180°.

Unless otherwise specified on the drawing, all corners shall be limited to a 0.010 inch (0.254 mm) maximum radius.
A "sharp corner" callout on a drawing shall be interpreted as being a comer with no greater than a 0.002 inch (0.051 mm) maximum radius.

Undercuts shall be subject to rejection unless otherwise specified on the drawing.

9.7 SHEET METAL

For additional requirements concerning burrs on sheet metal products, see Section 8.11.

10.0 SURFACE FINISH

The finish requirement for machine surfaces shall be 125 √ unless otherwise specified.

Flaws are not included in surface finish measurements.

The surface finish must not exceed the average value shown in the symbol (√). Unless otherwise specified, the general finish in the title block applies only to machined surfaces. Commercial stock surface finish is acceptable when "stock" is specified as a dimension.

Flaws — the following are not acceptable unless otherwise specified:

- Splits, tears, and cracks
- Displaced metal, folds (ironed-in or smeared-over scratches and burrs)
- Inclusions (imbedded particles-chips, burrs, foreign matter)
- Oxide (rust or corrosion)
- Seams

11.0 THREADS

11.1 GENERAL

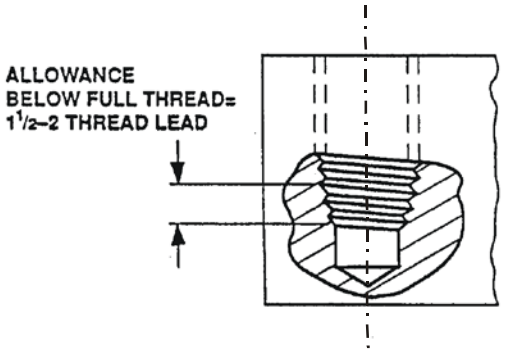
All threads, unless otherwise specified on the drawing, shall conform to ASME B1.1 Through ASME B1.21.

The class of fit for external threads shall be Class 2A (imperial) or 6g (metric) and for internal threads shall be 2B (imperial) or 6H (metric) unless otherwise specified on the drawing. All internal threads shall be tapped using standard machine screw taps or machined.

THREAD-FORMING TOOLS ARE PROHIBITED UNLESS OTHERWISE SPECIFIED.

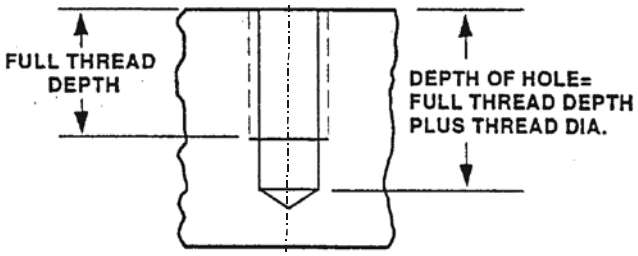
11.2 THREADED HOLES

All threaded holes shall be countersunk 45° ± 5° to a diameter equal to at least the major diameter of the specified thread. In the case of through-holes this requirement shall apply to both ends. The specified depth of a threaded hole shall mean there shall be full threads to that depth.



Where a three-place decimal dimension (± 0.005 tolerance) is used to define thread depth, one full thread shall be allowed beyond the dimension.

The depth of the tap drill shall not be specified unless critical. If the depth of a tap/twist drill hole is not specified, the depth of the hole shall not exceed the full thread depth plus a dimensional allowance equal to the nominal thread diameter.



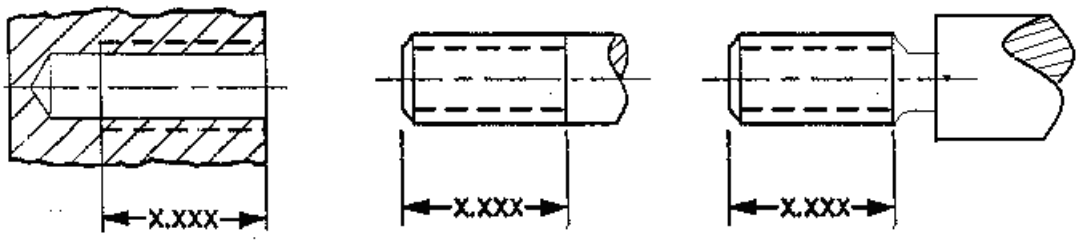
In gauging a threaded hole, the "No-Go" gauge shall not penetrate more than three turns. Exceptionally short thread length (less than 3 pitches) may pass over the plug gauge provided there is a perceptible drag. The "Go" gauge shall freely penetrate the full length of the thread.

11.3 THREADED PARTS

The end of all external threads shall be chamfered at 45° ± 5° to the minor diameter.

11.4 FULL FORM THREADS

The length of fully formed threads is dimensioned. When only one dimension is used to specify the length of 'threads, it is interpreted to mean the length of fully formed threads, excluding runout (incompletely formed threads). Where a chamfer, not exceeding 2-pitch in length, exists at the entering end of the thread, it is included in the length of fully formed threads. The figure below shows methods of delineating the fully formed threads with no limit on runout (incompletely formed threads).



11.5 INCOMPLETELY FORMED THREADS

The length of incompletely formed threads may vary according to the method of manufacture. Whenever the number of incompletely formed threads allowed on the entering end is more restrictive than permitted by ASME B1, dimensions imposing such restrictions shall be specified as follows:

X.XX MAX TO FULL FORM THREAD

11.6 THREADED INSERTS

When inserts with internal threads are to be used on CPI Canada parts, the class of fit for standard and screw-lock inserts for sizes 0.080 through 0.164 shall be 2B (imperial) or for sizes M2 through M4 shall be 6H (metric) and for sizes 0.190 and above shall be 2B or 3B (imperial) or for sizes M5 and above shall be 6H (metric).

12.0 BRAZING - VACUUM AND STRUCTURAL

12.1 CPI CANADA IN-HOUSE USE:

The workmanship standards for brazing – vacuum and structure used by CPI Canada (Microwave) are governed by manufacturing documents (drawings, OS, IS, ECO, BOM) coupled with applicable Engineering Specifications (M3).

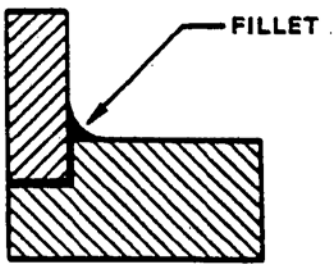
12.2 CPI CANADA SUPPLIER USE:

12.2.1 General Requirements

Acceptable brazes shall fill the-specified joints fully with braze alloy. There shall be no voids, cracks, unmelted braze alloy or any residue of flux.

The absence of a fillet at the braze joint indicates that the braze alloy is either missing or did not melt properly.

A fully formed, well radiused fillet usually indicates a sound braze.



12.2.2 Braze Classification

- Class I — Vacuum
- Class Ia — RF
- Class II — Structural

\

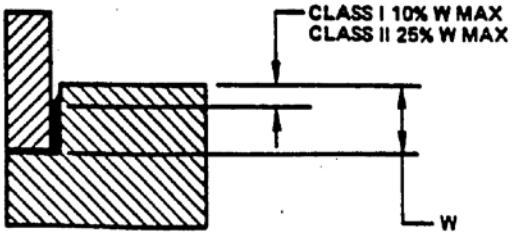
12.2.3 Defects

a. Unmelted (cold) braze — braze alloy did not melt completely.
Class I, Ia, II — Unacceptable.

b. Cracked Braze — fissure in the filler metal of the joint.
Class I, Ia, II —Unacceptable.

c. Blush — flow of braze alloy onto critical surfaces.
Class I, Ia, II — Unacceptable.

d. Reentrant Braze — undercuts in braze fillet.
Class I — 10% depth of seal width maximum is acceptable
Class Ia — Unacceptable in RF areas
Class II — 25% depth of seal width maximum is acceptable



e. Porosity — pinholes or small, smooth pockets in braze fillet
Class I, Ia — Unacceptable
Class II — 25% of braze area maximum is acceptable

f. Overbraze — erosion of base metal or increase in size of braze gap
Class I — 0.005 maximum gap is acceptable
Class Ia — Unacceptable in rf areas
Class II — 5% maximum reduction of base metal is acceptable

g. Orange peel — grainy appearance
Class I, Ia — Acceptable, if vacuum tight
Class II — Acceptable

h. Blockage — braze alloy in hydraulic channels
Class II — 20% maximum blockage

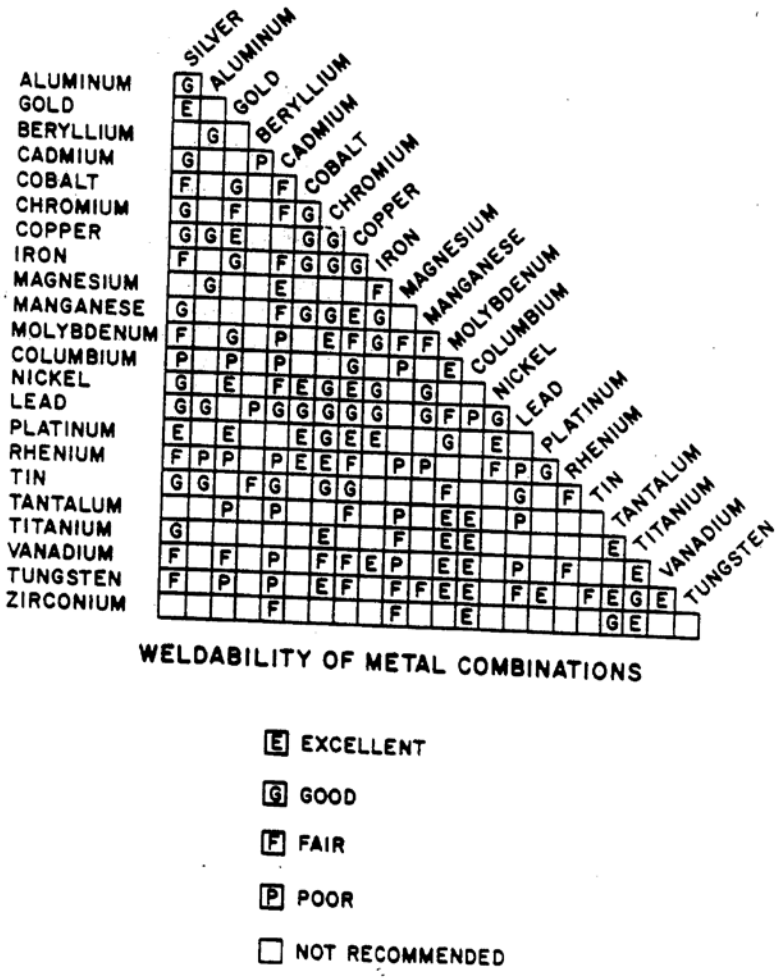
13.0 WELDING

13.1 CPI CANADA IN-HOUSE USE:

The workmanship standards for welding used by CPI Canada (Microwave Operations) are governed by manufacturing documents (drawings, OS, IS, ECO, BOM) coupled with applicable Engineering Specifications (M3).

13.2 CPI CANADA SUPPLIER USE:

13.2.1 Weldability of metal combinations



WELDABILITY OF METAL COMBINATIONS

13.2.2 Spot Welding

13.2.2.1 General Requirement

All material to be welded should be clean and free of dirt, grease, oxides, and any other contaminants. All equipment should be clean and in good working order. Spot-weld electrode tips should be clean and smooth, and free of oxides, burrs, and foreign material. Tips should be checked before each use and redressed periodically during heavy runs. Fine emery cloth or ceramics may be used to dress tips. Weld schedule cards should be maintained for each assembly and used as guidelines for initial setups. Weld energy and pressure may need to be altered slightly. At the start of each run, pull test should be done to insure proper setting. Pull test requirements should be set by appropriate engineer.

13.2.2.2 Criteria

The following defects are not acceptable:

- Cracked Weld
- Insufficient Fusion
- Burns
- Blow Holes
- Weld Splash
- Burrs
- Excessive Oxide (Discoloration)
- Excessive Deformations
- Electrode Deposits

13.2.3 Arc Welding

13.2.3.1 Definitions — Weld Classifications

Class I welds are required for vacuum tight seals and have higher quality requirements than Class II welds.

Class II welds are structural welds and are not involved in vacuum tight seals.

NOTE: Class I welds shall be the standard for all welds and weldments unless specified as Class II.

13.2.3.2 General Standards

The weld bead shall show an even repetitive ripple and fuse smoothly with adjacent material. The ripple height will vary from smooth to 0.05 inch (1.27 mm) and in periodicity from none to 0.12 inch (3.05 mm). No lumps, bulges or bead areas narrower than ± 25% of the typical bead width are allowable.

All visible weld oxide and discoloration in the weld region must be removed from welds prior to shipment or inspection. Where it is not practical to remove the oxide, a straw color, light blue or brown may be acceptable.

13.2.3.3 Class I Weld Standards

Lack of fusion shall be cause for rejection.

(NOTE: This standard does not imply that 100% weld penetration is required unless specified on the drawing.)

Surface cracks or linear porosity of the weld bead that can be visually or non-destructively detected shall be cause for rejection.

Inclusions in the weld bead that can be visually or non-destructively detected shall be cause for rejection.

Uniformly distributed tack welds may be used to position the base metals to be joined.

Fillet and butt weld joints are the preferred joint types. Lap weld joints should be avoided.

Splatter (material ejected from the fusion zone) in the region of the joint shall be cause for rejection.

All welds shall be vacuum tight, when checked with a suitable helium mass spectrometer leak checker. In addition, any indication of leaks detected shall constitute a non-vacuum tight assembly regardless of the extent of the leak.

13.2.3.4 Class II Weld Standards

Intermittent welds, (beads interrupted by recurring unwelded areas) shall be of uniform length and placement along the weld joint when used. The length and the spacing (center to center) of the beads shall be within ± 25% of the specified length and spacing.

Porosity or inclusions (visible or non-destructively detectable) shall be acceptable in all types of welds regardless of the base metal when not in excess of the following:

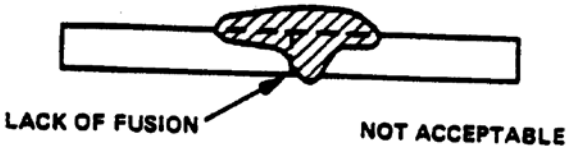
Porosity or inclusions that are less than 1/32 inch (0.8 mm) diameter or length shall not be closer together than 1/64 inch (0.4 mm).

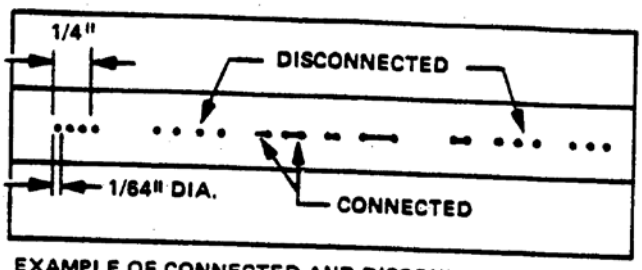
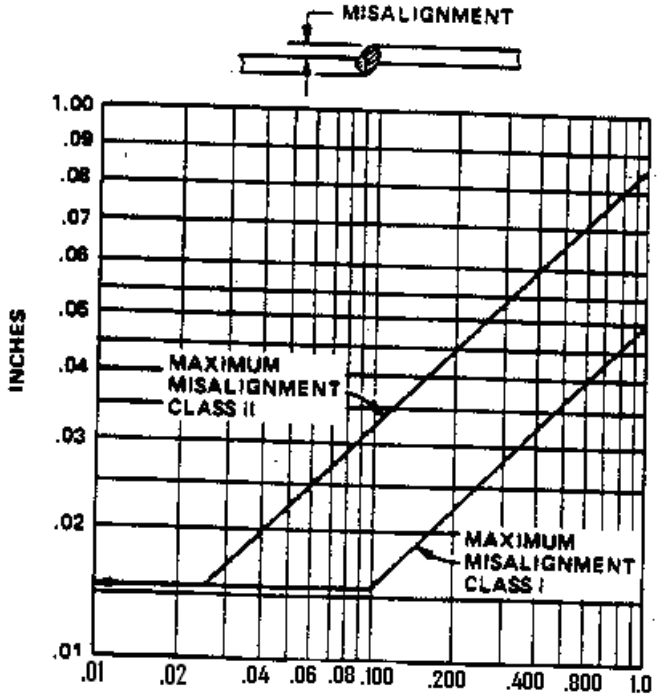
Porosity or inclusions that are 1/32 to 1/16 inch (0.8 mm to 1.6 mm) diameter or length shall not be closer together than 1/16 inch (1.6 mm).

For base metal thickness to 0.12 inch (3.0 mm) the maximum diameter or length of porosity or inclusion, shall not exceed 50% of the base metal thickness.

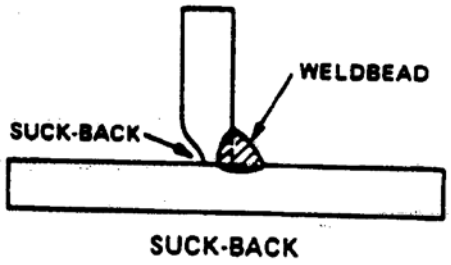
For base metals over 0.12 inch (3.0 mm) in thickness the maximum diameter or length of porosity or inclusion, shall not exceed 3/32 inch (2.4 mm).

13.2.3.5 Acceptance Standards — Class I and II (except as noted)

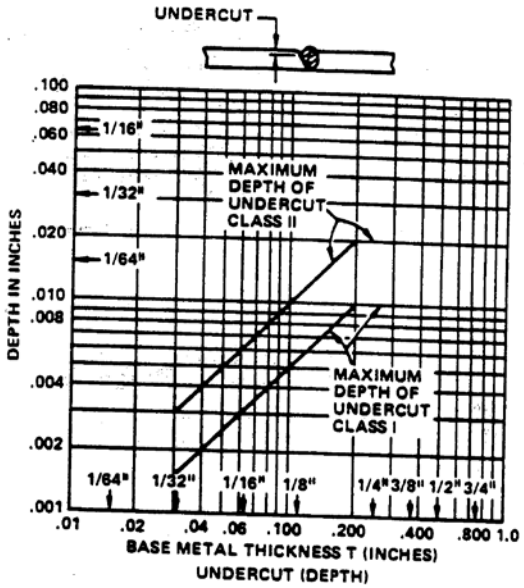
DEFECT	DEFECT DESCRIPTION	DEFECT ACCEPTANCE STANDARDS
a. Lack of fusion	The failure to fuse completely adjacent members of weld joint.	None acceptable
		
b. Linear voids or porosity (visually detectable)	A condition where three or more 1/64 inch (0.4 mm) or larger diameter voids in a line occupy a distance of 1/14 inch (1.8 mm) or less.	Not acceptable on Class I welds

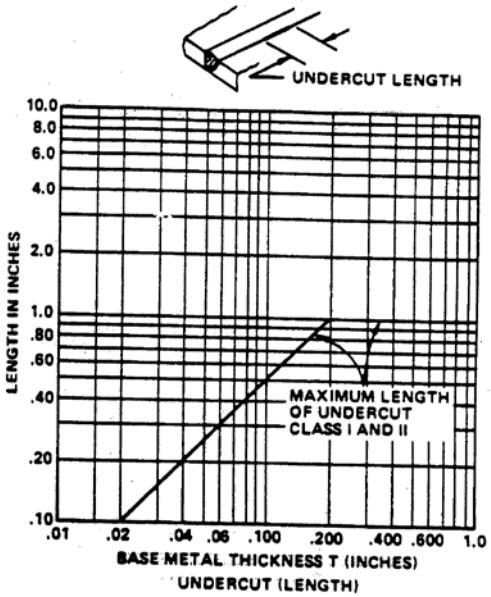
DEFECT	DEFECT DESCRIPTION	DEFECT ACCEPTANCE STANDARDS
 EXAMPLE OF CONNECTED AND DISCONNECTED LINEAR POROSITY OR VOIDS-NONE ACCEPTABLE		
c. Misalignment	Failure of base metals to fit or match properly.	Acceptable if not in excess of the following:
		

d. Metallic inclusions (Visually or non-destructively detectable)	Metal other than weld metal or base metal entrapped in weld metal or between weld metal and base metal.	None acceptable.
e. Non-metallic inclusions (visually or non-destructively detectable)	Non-metallic solid material entrapped in weld metal or between weld metal and base metal.	Shall be considered porosity and inspected to the same standards.
f. Scattered voids or porosity (visually or non-destructively detectable)	Occasional voids occurring in random pattern throughout the weld deposit.	None acceptable on Class I welds. Acceptable on Class II welds (non-vacuum) if not in excess of Section 14.2.3.4.
g. Suck-back	A depression in the backside of weld joint caused by shrinkage of base metal.	None acceptable

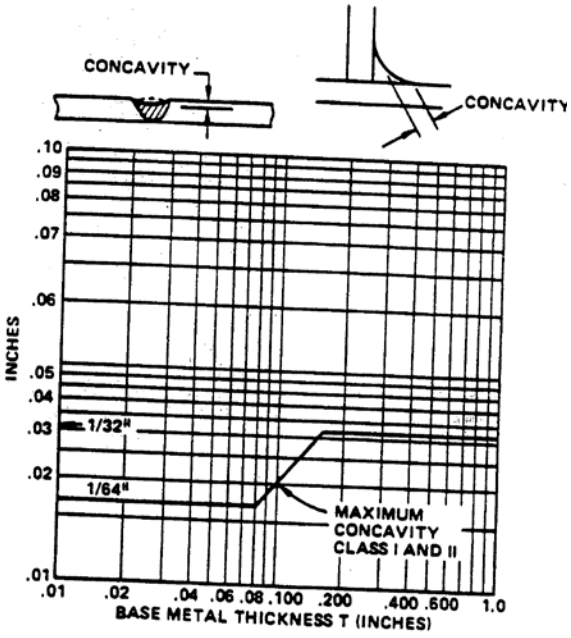


h. Undercut	A groove melted into the base metal adjacent to the weld deposit.	Acceptable if bottom is visible and has a radius greater than 10% of thinnest base metal and depth and length are within the following limits





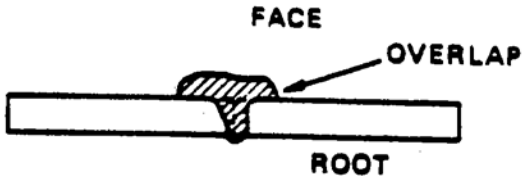
i. Underfill and excessive concavity	The failure to fill a prepared joint with filler metal or excessive distance from the face of a concave weld bead to a line joining the toes.	Acceptable — if not in excess of the following:



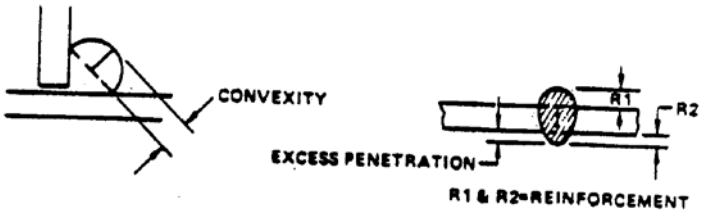
j. Transverse or longitudinal under bead cold-shuts (visually detectable).	Grooves in the weld penetration bead that indicate incomplete fusion.	None acceptable

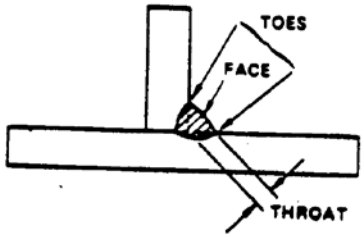
COLD - SHUTS

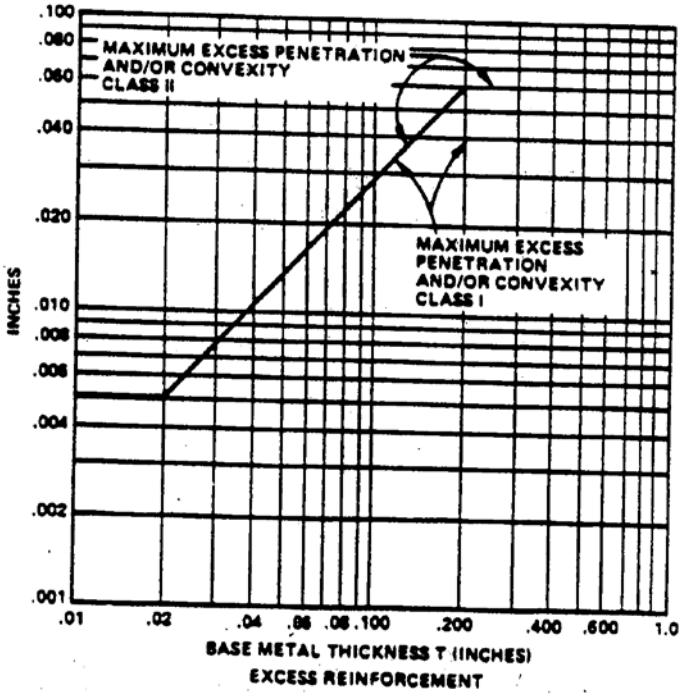
k. Arc stake	Pits or craters in the base metal caused by striking the arc in an area not covered by weld deposit.	None acceptable
l. Crater crack	A depression with cracks at the weld bead termination.	None acceptable

m. Porosity or voids with sharp tails (visually or non-destructively detectable).	Porosity or voids characterized by sharp tails.	None acceptable
 POROSITY OR VOIDS WITH SHARP TAILS - NONE ACCEPTABLE		
n. Cracks (visually or non-destructively detectable).	A parting or cleft due to fracture of the base or weld metal.	None acceptable
o. Overlap	Protrusion of weld metal beyond the limits of fusion at the edge of the weld.	None acceptable
 OVERLAP		

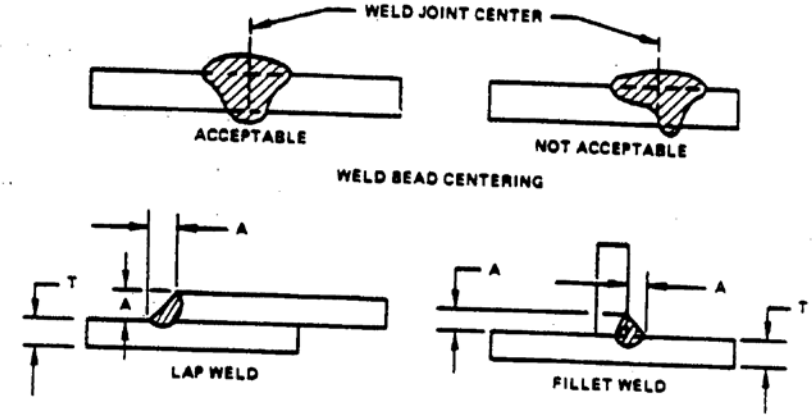
p. Reinforcement	Excessive distance from face of a convex weld perpendicular to a line joining the toes.	Acceptable if not in excess of the following:







q. Weld bead not centered	Weld bead face or root not centered on weld joint.	Not acceptable if in excess of ±0.020 inch (0.5 mm) of metal thickness 0.040 inch (1.0 mm) and above. Not acceptable if in excess of ±0.010 inch (0.25 mm) of metal thickness 0.020 inch (0.5 mm) to 0.040 inch (1.0 mm).

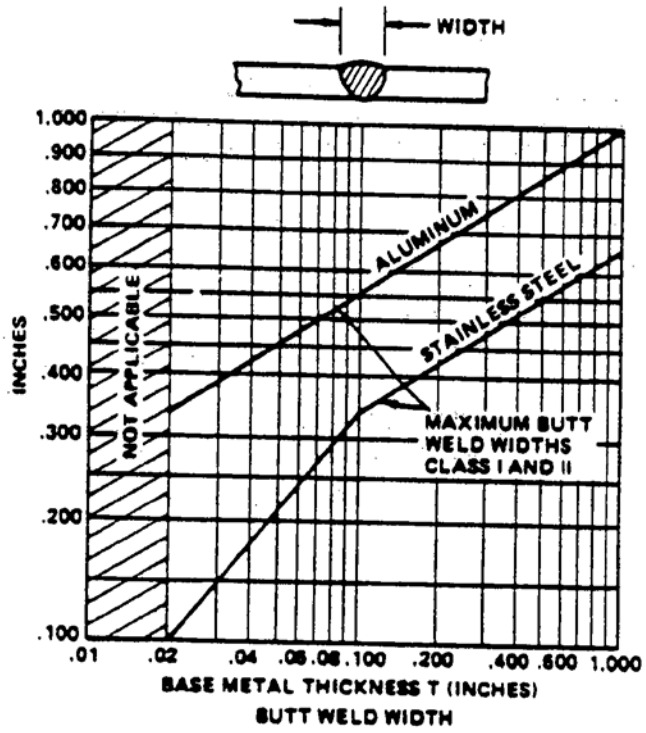


FILLET WELD LEG SIZE FOR LAP AND FILLET WELDS*

T (MATERIAL THICKNESS) (INCHES)	MAXIMUM ALLOWABLE LEG SIZE (A) (INCHES)
0.106 - 0.040	0.10
0.041 - 0.070	0.12
0.071 - 0.100	0.14
0.101 - 0.130	0.16
0.131 - 0.160	0.18
0.161 - 0.190	0.20
0.191 - 0.220	0.22
0.221 - 0.260	0.26
0.261 - 0.300	0.30
0.301 - 0.360	0.36
0.361 - 0.420	0.42
0.421 - 0.500	0.50

*When materials of different thickness are welded together, the weld size shall be determined on the basis of the thinner material.

r. Width of weld	Width of butt weld too narrow or too wide.	Width of weld bead Shall conform to following data:



13.2.4 Laser Welding

13.2.4.1 General

Each laser weld shall be examined under a low power (30 X maximum) microscope to ensure that the weld is uniform in shape, the spot is centered correctly in the joint as specified and the spot is free of cracks (except for molybdenum welds, in which case, follow the procedure specified in the weld card, operation schedule or drawing). The weld area shall be clean and free from excessive metal vapor particles, or braze balls, and abnormal discoloration around the weld. In case of overlapping spot welds for vacuum tight joints, the weld spots shall overlap each other 50%. For non-vacuum tight seam welds, the weld spots can overlap each other 30%. The most preferable approach to a laser weld non-vacuum tight joint is to use individual spot welds equally spaced.

a. Quality of Welds

A burn hole, melted metal, excessive spatter or discoloration is not acceptable. All welds shall receive visual inspection by the operators. Whenever possible, welds shall be given to Process Engineering for evaluation for reasons other than joining.

All visible weld oxide and discoloration in the weld region must be removed from welds prior to shipment or inspection. Where it is not practical to remove the oxide, a straw color, light blue or brown may be acceptable.

Inclusions in the weld spot that can be visually or non-destructively detected shall be cause for rejection.

Excessive metal deposits in the region of the joint shall be cause for rejection.

See Acceptance Standards, Sections 13.2.4.3 and 13.2.4.4.

The number of welds is specified on the drawing and Weld Schedule.

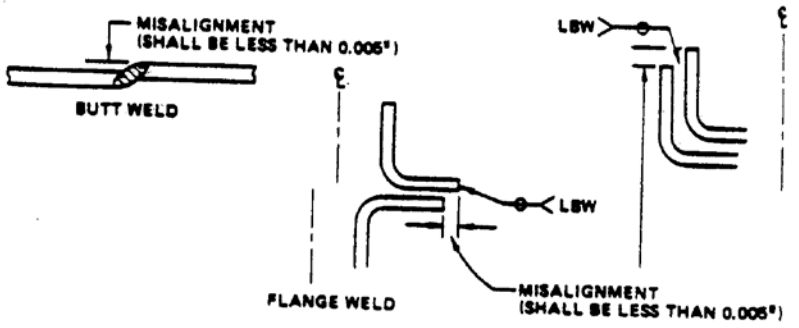
b. Rejections

Welds or weldments which do not conform to the requirements of this specification, applicable drawing and/or Purchase Order shall be rejected.

13.2.4.2 Weld Standards

a. Misalignment

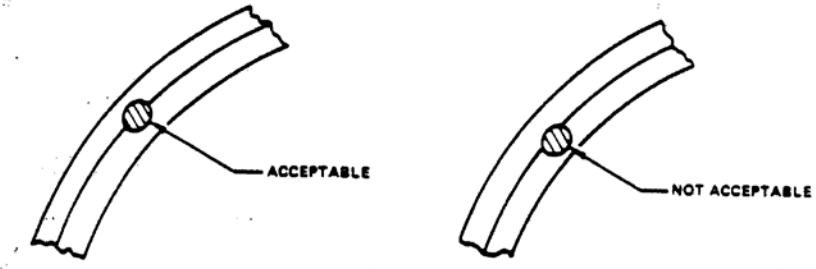
Misalignment of the base metals at the weld point of more than 0.005 inch (0.127 mm) is not acceptable.



MISALIGNMENT

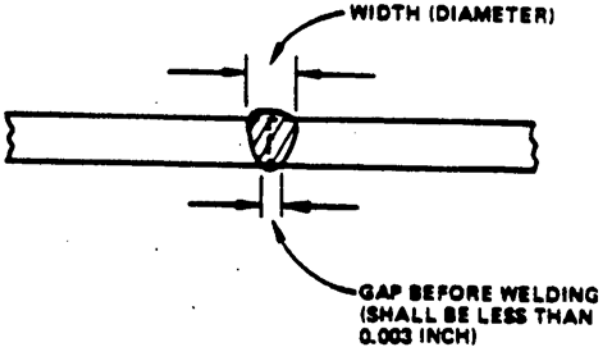
b. Weld Spot Diameter/Centering

Weld spot not centered or weld spot diameter smaller than the thickness of the thinner piece of the base metals shall be cause for rejection. The optimum spot diameter shall be 0.030 inch (0.76 mm). For welding thin gage material, the spot size shall be the same size or slightly larger than the thickness of the thinnest piece of base metals. For edge and flange welds, the spot size shall be about 0.030 inch (0.76 mm) and not larger than 0.040 inch (1.0 mm).



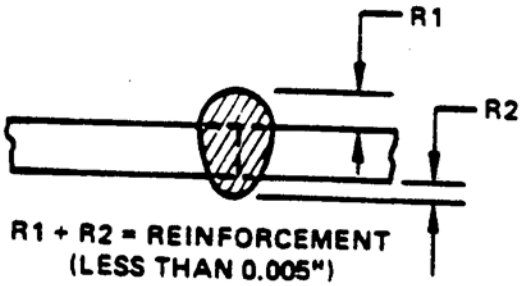
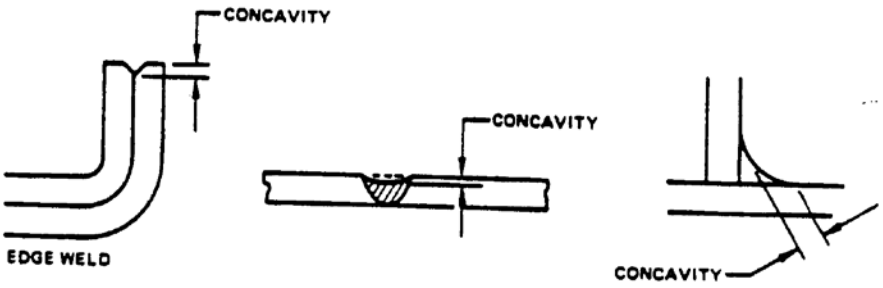
WELD SPOT CENTERING

13.2.4.3 Acceptance Standards — Before Welding

	DEFECT DESCRIPTION	DEFECT ACCEPTANCE STANDARDS
Gap	Excessive separation of materials to be joined before welding.	Acceptable if less than 0.003 inch (0.08 mm)
		
Misalignment	Failure of base metals to fit or match properly	Acceptable if not in excess of 0.005 inch, or specified in OS or print.

13.2.4.4 Acceptance Standards — After Welding

	DEFECT DESCRIPTION	DEFECT ACCEPTANCE STANDARDS
Cracks (visually or non-destructively detectable)	A parting or cleft due to fracture of the base or weld metal.	No crack (except moly or moly alloys) is acceptable. For moly or moly alloys refer .to weld cards or OS for repair instructions.
Overlap	Protrusion of weld metal beyond the limits of fusion at the ease of the weld.	No overlap acceptable

Reinforcement	Excessive distance from face of a convex weld perpendicular to a line joining the toes	Acceptable if not in excess of 0.005 inch (0.127 mm)
		
Excessive concavity	Excessive distance from face of a convex weld perpendicular to a line joining the toes.	Acceptable if not in excess of 0.0058 inch (0.127 mm)
		

14.0 PLATING, PAINTING AND FINISHING

When a part or assembly drawing calls out plating or coating, it shall be implied that dimensions on the drawing are machine/fabrication dimensions, and the part/assembly has been designed to allow for the application of the plating or coating as specified in the applicable note structure on the drawing.

14.1 PLATING

The workmanship standards for plating used by CPI Canada are governed by manufacturing documents (drawings, OS, IS, ECO, BOM) coupled with applicable Engineering Specifications (M3, M4, M5, M6, M8, M24).

14.1.1 General Requirements

The following workmanship standards apply to all types of plating. Where a criterion applies to a specific type of plating that type is so mentioned. This standard applies but it is not limited to gold, silver, copper, nickel, and chromate conversion coating.

14.1.2 Appearance

All plating shall be smooth, continuously uniform in appearance, not coarsely crystalline and free from the following defects:

- Pinholes
- Nodules
- Pits
- indication of burning
- scratches
- voids
- corrosion
- any contamination
- blisters
- deformation.

In the case of surfaces of panels, outside surfaces of chassis and enclosures only — plating shall adhere to the above criteria when viewed from a distance of one foot with the unaided eye.

The following plating defects are unacceptable:

- Scratch: Base metal is exposed, or damage exists on the plated surface (as detected by fingernail)
- Void, Pit Pinhole: Base metal is exposed or a top layer of plating exposes sub-layer
- Plating Too Heavy: Exceeds MMC plus maximum specified thickness of plating
- Plating Too Thin: Base metal color faintly showing through the plating Blisters: Hollow or dome shaped protrusions
- Corrosion: Erosion of metals, or heavy oxidation etching into or removing base metal or alloy
- Wrong Plating: Color or type of plating deviating from drawing or specification
- Incorrect Coverage: Plating does or does not cover specified area
- Contamination: Embedded foreign material or plating surface may have appearance of blisters
- Burning: Appears as a dull grandular surface
- Deformation: Distortion or other damage, particularly mounting surfaces, usually as a result of barrel-plating

14.1.3 Adhesion

Pealing or flaking, which is defined as detachment of plating from the base metal, is unacceptable.

Plating shall be free of blisters and separation from the base metals when test specimens are subjected to the following tests:

- Gold Plating:

  Bend test specimens repeatedly through an angle of 180° or a diameter equal to the thickness of the specimen until fracture of base metal occurs. Following fracture of the base metal, it shall not be possible to detach any areas of the coatings with a sharp instrument.

- Silver Plating:

  Bend test specimens repeatedly through an angle of 180° or a diameter equal to the thickness of the specimen until fracture of base metal occurs. Following fracture of the base metal, it shall not be possible to detach any areas of the coatings with a sharp instrument.

- Copper Plating:

  The test specimen shall be clamped in a vise and the projecting portion bent back and forth 180° until rupture occurs. Following fracture of the base metal, it shall not be possible to detach any appreciable area of the coating with a sharp instrument.

- Nickel Plating:

  The test specimens shall be bent repeatedly through an angle of 180° on a diameter equal to the thickness of the specimen until fracture of the basis metal occurs. Following fracture of the basis metal, it shall not be possible to detach any appreciable areas of the coating with a sharp instrument. When the plated articles are not readily adaptable to the bend test, adhesion may be determined on the plated article by cutting the plating from the basis metal at the interface in a continuous path, and examining at four diameters magnification to determine whether removal has been caused by the cutting away of an adherent plate or by the lifting of a non-adherent plate.

14.2 PAINTING

The workmanship standards for painting used by CPI Canada are governed by manufacturing documents (drawings, OS, IS, ECO, BOM) coupled with applicable Engineering Specifications (M4, M8).

14.2.1 Paint Finish

Painted surfaces shall be uniformly smooth, with no visible imperfections, when viewed from a distance of one foot with the unaided eye. The following conditions are unacceptable:

1. Wrong Color - Color or gloss which deviates from specification or contract requirement.
2. Poor Coverage - Paint which does not cover or extends beyond specified areas. The presence of paint on flanged or heat sink surface.

3. Scratch - Base metal, which is exposed, or damage of the painted surface due to scratching.
4. Smudge, Mar, Blemish - Superficial mark of deformity or physical damage.
5. Blister, Void, Chip - Any degree visible to the naked eye.
6. Orange Peel - Paint which does not level down to a smooth surface but remains rough like the outside of an orange.
7. Sags or Runs - irregularities of the paint due to uneven flow.
8. Rough Coating - Coating surface lacks smooth appearance due to improper spray technique. Roughness of the coating may be detected by running fingertips across the painted surface.
9. Contamination - Paint over sand, grit, metal particles or dirt.
10. Excessive Paint - amount of paint that is more than adequate. Noticeable layering or globule due to touchup.
11. Coating Too Thin - Insufficient hiding power of the coating or base metal faintly showing through the scanty coating. Hiding power is the property of a paint that enables it to obliterate beyond recognition any background over which it may spread.
12. Wet Paint - Wet, tacky, bleed-out, soft, or uncured paint coating.

14.2.2 Paint Adhesion

When areas of paint on a finished product become suspect of a poor quality paint condition, it is permissible in these cases to apply a strip of pressure-sensitive tape to the painted surface using a firm hand pressure on the tape. Then remove the tape in one abrupt motion and examine the tape for any paint particles. If evidence (flakes, chips) of paint adheres to the tape after examination, the unit will be rejected.

14.2.3 Acceptable Noncoated Surfaces

Unless otherwise specified, corrosion resistant alloys, such as stainless steel, nickel-iron alloys need not receive any painting, plating or other protective finish.

14.2.4 Unacceptable Non-coated Surfaces

Unless otherwise specified, all unpainted aluminum parts or assemblies are rejectable unless they are corrosion resistant treated. Parts fabricated from aluminum 1100, alloys 3003, 5052, 6053, 6063, or 7072 shall be cleaned with a deoxidizing solution other than an uninhibited caustic dip, and may be used with or without other surface treatment. Other aluminum alloys shall be anodized in accordance with MIL-A-8625 or be given a chemical treatment in accordance with MIL-C-5541.

14.3 FINISHING

The workmanship standards for finishing used by CPI Canada are governed by manufacturing documents (drawings, OS, IS, ECO, BOM) coupled with applicable Engineering Specifications (M8).

Finished surfaces shall be uniformly smooth, with no visible imperfections, when viewed from a distance of two feet with the unaided eye. The following conditions are unacceptable:

1. Flaking, peeling, chipping of paint or other coatings
2. Cuts and abrasions, etc., with exposure of base metal
3. Corrosion on plated or other surfaces
4. Tarnish on solderable areas, such as contact area of terminals, etc.
5. Improper Masking — Plating or paint applied to areas designated as not to be plated or painted
6. Bleeding — Trapped solutions bleeding from seams, welds, etc.
7. Foreign Material - Captivated foreign objects which must be removed and when removed would expose the base material
8. Noticeable non-uniformity of color on surfaces which form the exterior surface of the end product

15.0 CASTING AND FORGING REQUIREMENTS

15.1 POSITION

The position of coaxial or coplanar cast or forged features shall be in accordance with Table 1 with respect to each other; it should be noted that position does not include out-of-roundness. If a cast or forged datum axis is established by the drawing, the position control shall be in relation to that datum axis.

Table 1 POSITION OF COAXIAL-COPLANAR FEATURES

	Feature Dia / Width	Position Tol. RFS
Sand Casting	Up to 6.000 inches (152.4000 mm)	0.060 inches (1.524 mm)
	6.001 to 12.000 inches (152.425 to 304.800 mm)	0.090 inches (2.286 mm)
	Over 12.000 inches (304.800 mm)	0.120 inches (3.048 mm)
Die Castings	Up to 6.000 inches (152.4000 mm)	0.020 inches (0.508 mm)
	6.001 to 12.000 inches (152.425 to 304.800 mm)	0.040 inches (1.016 mm)
	Over 12.000 inches (304.800 mm)	0.060 inches (1.524 mm)
Shell, Plaster, Ceramic, Permanent Mold, or Investment Castings	Up to 6.000 inches (152.4000 mm)	0.040 inches (1.016 mm)
	6.001 to 12.000 inches (152.425 to 304.800 mm)	0.060 inches (1.524 mm)
	Over 12.000 inches (304.800 mm)	0.080 inches (2.032 mm)
Forgings	Up to 6.000 inches (152.4000 mm)	0.060 inches (1.524 mm)
	6.001 to 12.000 inches (152.425 to 304.800 mm)	0.090 inches (2.286 mm)
	Over 12.000 inches (304.800 mm)	0.120 inches (3.048 mm)

15.2FLATNESS

Surface flatness shall not exceed the values specified in Table 2 except in the area of a parting line.

Table 2 FLATNESS

		FLATNESS TOLERANCE	
	Surface Finish	Variation In Any Direction	Total Variation (Lengths of More Than 1 inch or 254. mm)
Castings	250 and Finer	0.020 in./in. (0.508 mm/mm)	0.010 Times the Element Length (0.060 inch or 1.524 mm) Total
	251 Through 500	0.015 in./in. (0.381 mm/mm)	0.015 Times the Element Length (0.080 inch or 2.032 mm) Total
Forgings	500 and Over	0.020 in./in. (0.508 mm/mm)	0.010 Times the Element Length (0.100 inch or 2.540 mm) Total
	500 and Finer	0.010 in./in. (0.254 mm/mm)	0.010 Times the Element Length (0.060 inch or 1.524 mm) Total

15.3 CLEANUP

Gates, risers, flash, runners, and parting lines on surfaces not subject to subsequent machining shall be trimmed and blended smooth with the part contour. Surfaces subject to subsequent machining shall be cleaned up according to normal industry practice.

15.4MISMATCH

Parting line mismatch for forgings shall not exceed 0.05-inch (1.27 mm) maximum. See Figure 1 for definition of mismatch. The mismatch of castings shall be contained within the applicable position requirements.

15.5DRAFT

Draft shall be applied as additional material to the dimensions shown on the drawing and shall not exceed the limits specified in Table 3.

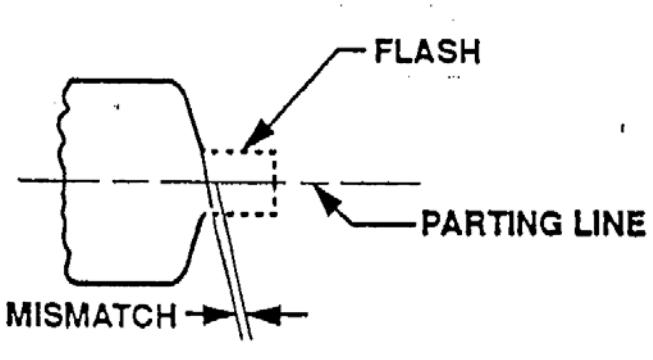
15.6REPAIR

Castings and forgings shall not be repaired by welding, plugging, Impregnating, peening, or any other methods except as permitted by specific drawing notes. Castings that shall be subsequently welded or brazed shall not be impregnated. Surface conditioning using standard shop practice for removal of surface defects is permissible within drawing dimensional limits.

Table 3 Draft Angle

	DRAFT ANGLE	
	Internal	External
Sand, Shell Mold, and Ceramic Mold Castings	3° Max.	3° Max.
Plaster Mold Castings	3° Max.	1° 30' Max.
Investment Castings	1° 30' Max.	1° 30' Max.
Permanent Mold and Semiperm Mold Castings	4° Max.	4° Max.
Forgings	10° Max.	8° Max.

Figure 1 Mismatch

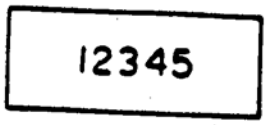


16.0 HARDWARE MARKING AND LABELING

16.1 ORIENTATION AND LEGIBILITY

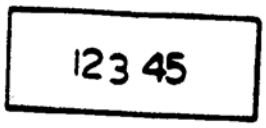
NOTE: When hand marking is required, such as identification or serialization of circuit boards, the ink used shall be a permanent type that is not readily removed during cleaning. A prefilled cartridge pen should be used, i.e., black marker. Hand marking must be clean and legible.

16.1.1 Spacing and Alignment



ACCEPT

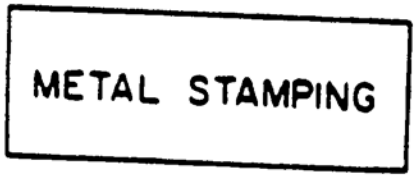
All characters are in line and are evenly spaced.



REJECT

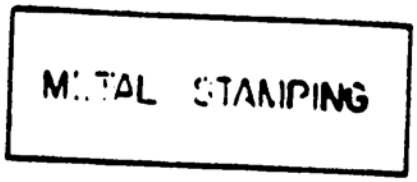
Characters are out of line and/or are unevenly spaced. (Subject to engineering disposition.)

16.1.2 Metal Stamping



ACCEPT

Letters are uniform in thickness and depth.



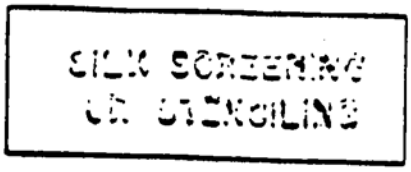
REJECT

Letters are hard to read and/or not uniform in thickness and depth.

16.1.3 Silk Screening

ACCEPT

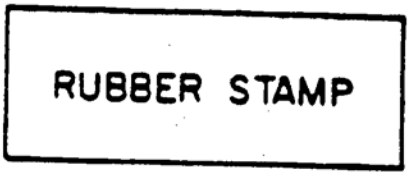
Characters are uniform and evenly spaced.



REJECT

Characters are not uniform and/or are smeared.

16.1.4 Rubber Stamping



ACCEPT

Rubber stamp was clean; letters are clear and have a protective coating.

REJECT

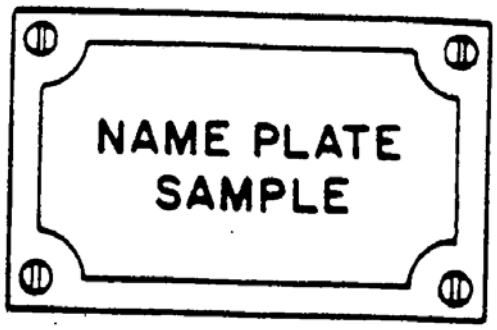
Stamp was not clean. Characters are smudged. (Subject to engineering disposition.)

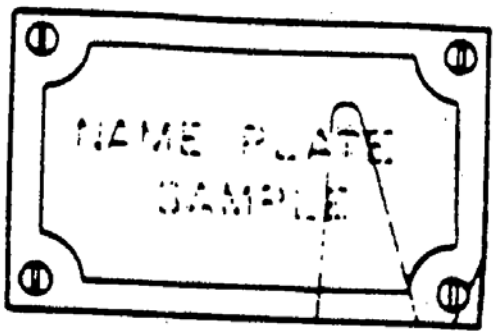
16.1.5 Stenciling

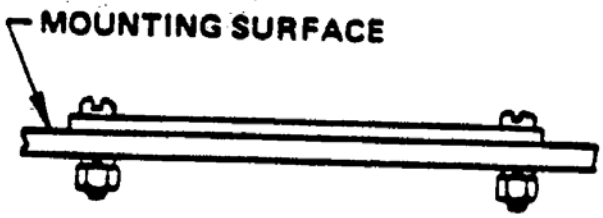
ACCEPT

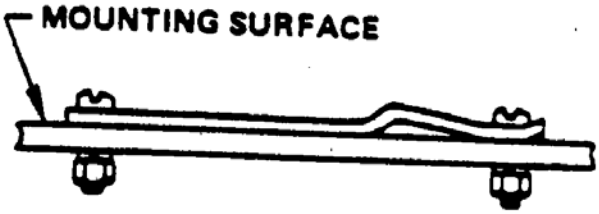
REJECT

16.2 METAL NAMEPLATES









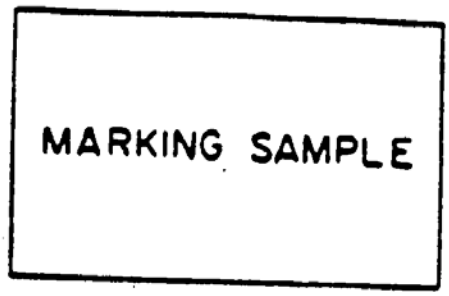
ACCEPT

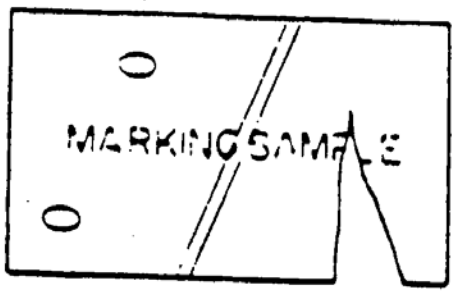
A. Plate is mounted squarely.
B. Plate is flat.
C. Marking is legible.

REJECT

A. Plate is not mounted squarely.
B. Plate is bent or buckled and corner is turned out.
C. Marking is not legible.

16.3 DECALS





ACCEPT

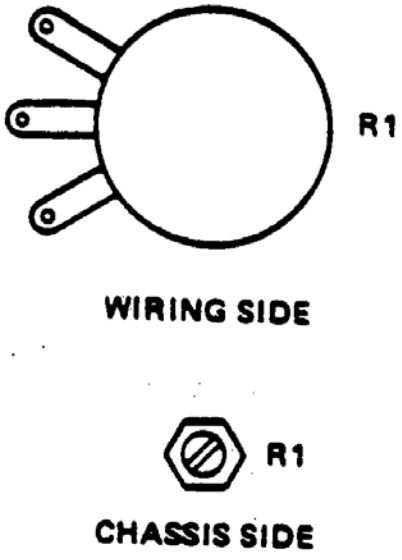
A. Decal is applied flat to mounting surface.
B. Decal has no wrinkles, tears or bubbles.
C. Marking is legible.

REJECT

A. Decal is not applied flat to mounting surface.
B. Decal has wrinkles, tears or bubbles.
C. Marking is not legible.

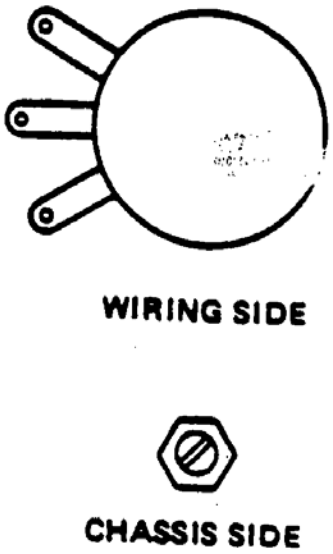
16.4 LOCATION OF REFERENCE DESIGNATION

16.4.1 Chassis or Panels



ACCEPT

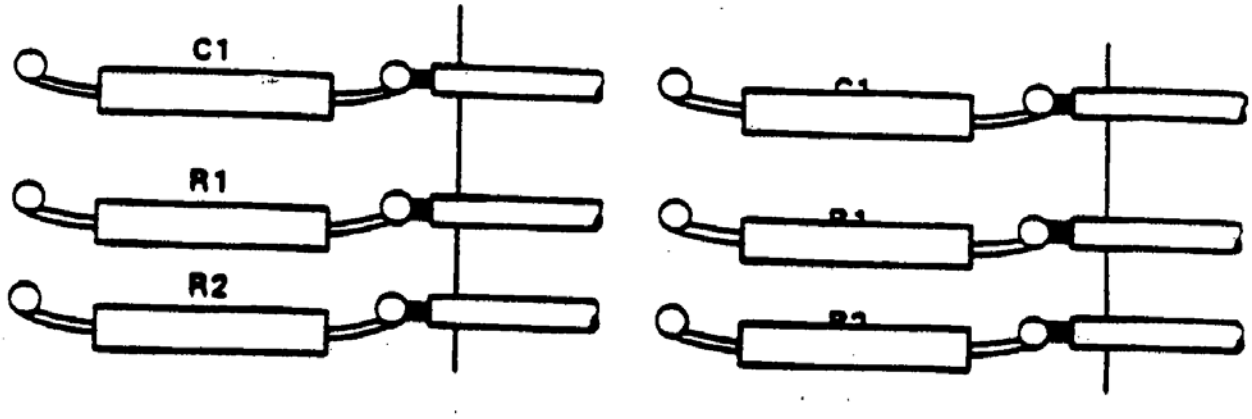
Parts such as tube sockets, switches, variable resistors, etc., which are accessible from both sides of the chassis must have the proper reference designation marked on both sides.



REJECT

Designation is omitted on control side of chassis.

16.4.2 Visibility



ACCEPT

Reference designation is visible without moving or removing parts.

REJECT

Reference designation is obscured by parts.

NOTE: Rejection is applicable only when space permits.

17.0 USE OF EPOXIES

All use of epoxies shall be governed by applicable assembly drawings. Epoxy shall not be used unless called for in an assembly drawing or by approved repair disposition. Epoxies shall be mixed and cured according to manufacturing use documents and assembly drawings. The following conditions are unacceptable:

- Improper curing, as indicated by tackiness, softness, crumbling or cracks
- Presence of adhesive on areas not designated in the applicable drawing
- Parts misaligned beyond drawing tolerances
- Epoxies with expired shelf life.

18.0 HEAT SHRINKABLE TUBING

Heat shrinkable tubing shall not be used where the application of heat will damage any assembly components.

Heat shrinkable tubing shall not interfere with any soldered joint or mechanical operation.

All use of shrinkable tubing shall be governed by applicable drawings. Heat shrinkable tubing shall not be used unless called for in an assembly drawing or by approved rework disposition.

The following characteristics are unacceptable:

- Trapped contamination
- Penetration of the tubing from the inside due to a burr
- Cut in the outside of the tubing
- Burrs or stringers on the tubing ends
- Contamination on the outside of the tubing that cannot be dislodged using 40-psi air pressure or applicable cleaning methods.

19.0 PERMANENT MAGNET

This section is designed to complement a magnet fabrication drawing to ensure consistent tolerances and quality of CPI Canada's purchased permanent magnets.

19.1 PHYSICAL CHARACTERISTICS

19.1.1 Surface Conditions

All magnet surfaces shall be free of foreign materials, which would tend to hold or collect extraneous particles of the magnet surface in the unmagnetized condition.

19.1.2 Chips and Burrs

Magnets shall be free of loose chips and burrs. They shall be free of imperfections which will result in loose chips or particles under normal conditions of handling, shipping, assembly and service.

19.1.2.1 Acceptable Chipped Edge or Surface

A chipped edge or surface shall be acceptable if no more than 10 percent of the edge or 1 percent of the surface is removed, provided no loose particles remain at the edge or surface, and further provided the magnet under examination meets the magnetic specification as defined on the drawing or purchase order.

19.1.3 Other Physical Defects

Imperfections such as minor hairline cracks, porosity, voids, cold flow, shrinkage, pipe and others, all of the type commonly found in cast or sintered metallic magnets, or sintered ceramic magnets, shall be judged acceptable if the following conditions are met.

19.1.3.1 Minimum Magnet Performance Criteria

The magnet meets the minimum magnetic performance criteria as defined on the drawing on purchase order and as tested by the magnet manufacturer in concurrence with CPI Canada.

19.1.3.2 The Imperfection Criteria

The imperfections do not create loose particles or other conditions which will interfere with proper functioning of the end device.

19.1.3.3 Visible Cracks or Imperfection Criteria

In the case of visible cracks or imperfections, they do not extend through more than ten percent (10%) of any cross section, fifteen percent (15%) in the case of Alnico 9.

19.1.4 Other Conditions

Inspection methods such as the use of penetrants, magnetic particle analysis, ultrasonics, or x-ray shall not be acceptable methods for judging quality of cast or sintered Alnico magnets or sintered ceramic magnets, except as provided in 22.1.4.1 below.

19.1.4.1 Abnormal Conditions or Stress Criteria

In cases where the magnet is expected to withstand abnormal conditions or stresses such conditions must be previously specified and a mutually acceptable service test devised to assure the magnet shall not fail under the specified service conditions. Such tests should duplicate service conditions with appropriate safety factors.

19.1.4.2 Magnets Made of Alnico 5-7 and Alnico 9

Magnets made of Alnico 5-7 and Alnico 9, which are particularly crack-prone due to their columnar grain, shall be judged acceptable if they maintain their physical integrity satisfactorily for the application.

20.0 USE OF OXYGEN-FREE HIGH CONDUCTIVITY COPPER (OFHC)

20.1.1 This specification sheet is released for the purpose of informing suppliers of the uses of oxygen-free copper (OFHC). All OFHC copper used at CPI Canada must comply with CDA-101 Class 1 or 2 or better including ASTM-F68.

20.1.2 Copper for the construction of microwave devices is usually of the OFHC type with oxygen contents held to less than .0007% during the melting and casting processes. No additional elements are added. This is in contrast to deoxidized coppers containing active scavengers which react with and remove oxygen from solution.

20.1.3 The main reason OFHC copper is used in the production of microwave products is that hydrogen atmospheres are used in processing. Other types of copper contain enough oxygen in the form of copper oxide to form voids and intergranular cracks when fired at temperatures in the region of 900°C or higher. The hydrogen combines with the oxygen to form steam that in turn builds up tremendous pressures in microscopic cavities and forces the copper to open up between grains. This often results in leaks through the material.

20.1.4 Some advantages of OFHC Copper are:

- Hydrogen embrittlement will not occur which is an aid in brazing.
- OFHC copper remains soft, therefore preventing a seal from fracturing. Other types of copper become work hardened.

20.1 CONCLUSION

- The use of OFHC copper is mandatory in the machining of microwave parts. Whenever a CPI print specifies the use of OFHC copper, under no conditions must the material be substituted.
- If material is supplied by CPI, and a supplier requires additional stock the CPI purchasing agent should be contacted.

20.2 CERTIFICATION AND TEST SAMPLES

Piece parts machined from OFHC copper purchased by the supplier will require a Certification of Chemical and Physical Analysis showing the heat number to be shipped in with the first lot. Subsequent lots delivered against the same purchase order will require a Certificate of Conformance.

21.0 TORQUE

This section specifies the workmanship standards for torquing metal hardware to metal surfaces, and nylon hardware to printed wiring assemblies.

These standards are to apply whenever the product build/inspection instructions identify the need for a controlled torque without further specification of that torque requirement.

21.1 TORQUE REQUIREMENTS FOR METAL HARDWARE

Because of the many variables involved to determine absolute torque values, Table 21.1.1 and Table 21.1.2 specify minimum torque values applicable to this standards manual for metal-to-metal applications.

Table 21.1.1

Installation Torque (Inch-Pound) Steel (Plated)			
Thread size (American Standard)	Min	Max	Nominal
#2-56	2.0	2.2	2.1
#3-56	3.6	4.0	3.8
#4-40	4.2	4.7	4.5
#6-32	7.8	8.7	8.0
#8-32	16.0	17.8	17.0
#10-32	26.7	29.7	28.0
1/4″-20	58.5	65.0	61.0
Inspection Torque (Inch-Pound) (Based on 80% of Maximum Torque)			
Thread size (American Standard)	Steel (Plated)		
#2-56	1.75		
#3-56	3.20		
#4-40	3.75		
#6-32	7.0		
#8-32	14.2		
#10-32	23.8		
1/4″-20	52.0		

Table 21.1.2

Installation Torque (Newton-Meter) Steel (Plated)			
Thread size (Metric Standard)	Min	Max	Nominal
2.2x0.45	.226	.249	.237
2.5x0.35	.407	.452	.429
3.0x0.5	.475	.531	.509
3.5x0.6	.881	.983	.904
4.0x0.7	1.808	2.011	1.921
5.0x0.5 or 0.75	3.017	3.356	3.164
6.3x1.0	6.611	7.345	6.893
Inspection Torque (Newton-Meter) (Based on 80% of Maximum Torque)			
Thread size (Metric Standard)	Steel (Plated)		
2.2x0.45	.198		
2.5x0.35	.362		
3.0x0.5	.424		
3.5x0.6	.791		
4.0x0.7	1.605		
5.0x0.5 or 0.75	2.689		
6.3x1.0	5.876		

21.2 TORQUE REQUIREMENTS FOR MIXED HARDWARE (METAL AND NYLON)

When there is a combination of metal and nylon hardware requiring torque, use the lesser torque values for both metal and nylon hardware per table 21.2.1 and 21.2.2.

21.3 TORQUE REQUIREMENTS FOR NYLON HARDWARE

Table 22.2.1 and 22.2.2 specifies torque values applicable to this standards manual for nylon externally threaded fasteners.

Table 21.2.1

Torque Values Mixed Hardware and Nylon Externally Threaded Fasteners		
Thread size (American Standard)	Nominal Torque (Inch Pounds)	Max. Torque (Inch Pounds)
2-56	.26	.33
4-40	.56	.71
6-32	1.34	1.68
8-32	2.56	3.20
10-32	3.71	4.64
10-24	3.58	4.48
¼-28	11.52	14.40
¼-20	11.50	14.37
5/16-18	17.41	21.76
3/8-16	30.72	38.40
½-13	92.16	115.20

Table 21.2.2

Torque Values Mixed Hardware and Nylon Externally Threaded Fasteners		
Thread size (Metric Standard)	Nominal Torque (Newton-Meter)	Max. Torque (Newton-Meter)
2.2x0.45	.029	.037
3.0x0.5	.063	.080
3.5x0.6	.151	.190
4.0x0.7	.289	.362
5.0x0.5 or 0.75	.419	.524
5.0x0.8	.405	.506
6.0x0.5 or 0.75	1.302	1.627
6.3x1.0	1.300	1.624
8.0x1.25	1.967	2.459
10.0x1.5	3.471	4.339
12.0x1.75	10.414	13.018