REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED
A	RELEASE FOR PRODUCTION	04/14/98	W. Cave
B	ECN #60152	01/31/01	J. McCurry
C	ECN #60216	03/25/04	J. McCurry
D	ECN #69452 LK	03/07/05	M. Senni
E	E30000390	10/12/17	L. Kilgus
F	E30000873	12/12/18	Linda Kilgus
G	E30002200	02/15/2022	Linda Kilgus
H	E30002258	03/24/2022	Linda Kilgus
J	E30004313	10/23/2025	Valen Johnson
K	E30004354	11/13/2025	Valen Johnson
L	E30004443	01/21/2026	Valen Johnson
M	E30004517	03/25/2026	Valen Johnson
N	E30004820 VJ	09/30/2026	M. Sidat
P	E30004828 VJ	10/06/2026	M. Sidat

NON-EXPORT CONTROLLED

THIS DOCUMENT CONSISTS OF INFORMATION THAT IS NOT DEFINED AS CONTROLLED TECHNICAL DATA UNDER ITAR PART 120.33 OR TECHNOLOGY UNDER EAR PART 772.

Project/Production Order #: Indirect

DWN	Linda Kilgus	03/01/05
CKD	N/A	---
EE	N/A	---
ME	M. Senni	02/28/05
PM	N/A	---
PR	N/A	---
PS	N/A	---
MC	N/A	---
MFG	J. McCurry	03/03/05
CE	N/A	---
QA	P. DeFrancesco	03/07/05
TE	N/A	---
BD	N/A	---
SW	N/A	---

L3HARRIS
Telemetry & RF Products
1515 Grundy's Lane
Bristol, PA 19007

MACHINE SHOP STATEMENT OF WORK

SIZE	CAGE CODE	
A	**13923**	**PD158-2012**

FORM NO. FM110-F-0092-1E (12/2019)

1.0 PURPOSE

The purpose of this standard is to establish a uniform and consistent workmanship criteria for all mechanical parts and components manufactured for use in L3Harris Telemetry & RF Bristol Division's products.

This operational procedure establishes the overall requirements for the fabrication and inspection of machined and fabricated components manufactured by L3Harris Telemetry & RF Products and its approved suppliers. The standard will establish the associated instructions and procedures required to produce high quality components for L3Harris Telemetry & RF Product's customers.

2.0 DEFINITIONS

Dimension: a numerical value expressed in appropriate units of measure and indicated on a drawing along with lines symbols and notes to define the geometrical characteristic of an object

Basic Dimension: a numerical value used to describe the theoretically exact size, shape or location of a feature or datum target. If it is the basis from which permissible variations are established by tolerance on other dimensions, in notes or by feature control symbols

True Position: the theoretically exact location of a feature established by basic dimensions

Reference Dimension: a dimension usually without tolerance, used for information purposes only. It does not govern production or inspection operations. A reference dimension is derived from those values shown on the drawing or on related drawings.

Datum: Points, lines, planes or cylinders and other geometric shapes assumed to be exact for purposes of computations, from which the location or geometric relationship (form) of features of a part may be established.

Datum Target: a specified point, line or area on a part used to establish a datum

Feature: a feature is any component portion of a part that can be used as a basis for a datum it may include a plane surface, a single cylindrical or spherical surface or two plane parallel surfaces

Nominal Size: the designation used for the purpose of general identification

Actual Size: the measured size

Limits of size: the applicable maximum and minimum size

Maximum Material Size: the condition where a feature of size contains the maximum (MMC) amount of material within the stated limits of size

Lay: lay is the direction of the predominant surface pattern determined by the production method used (tool marks)

Least Material Condition: (LMC) the condition where a feature of size contains the least amount of material within the stated limits of size

Allowance: the intentional difference between the MMC limits of size of mating parts. It is the minimum clearance (positive allowance) or maximum interference (negative allowance) between such parts

Tolerance: the total amount by which a specific dimension is permitted to vary. The tolerance is the difference between the maximum and minimum limits

Unilateral Tolerance: a tolerance in which variation is permitted in one direction from the specific dimension

Nominal Surface: the nominal surface is the intended surface contour, the shape and extent of which is usually shown and dimensioned on a drawing

Surface Texture: Surface texture is the repetitive or random deviation from the normal surface which forms the three dimensional topography of the surface. Surface texture includes roughness, waviness, lay and flans and may also be preferred to as surface irregularities

Flaws: Flaws are unintended surface imperfections occurring as a direct result of a manufacturing process. They include defects singularly or in groups such as cracks, checks, ridges, scratches, gouges, nicks, cuts, punctures, dimples, chemical corrosion, etc.

Regardless of Feature Size: (RFS) RFS means that a Feature of Size so identified is permitted only the stated position or form tolerance. No additional tolerance is allowed due to size variation

Projected Tolerance Zone: When the Projected Tolerance Zone symbol appears within a frame adjacent to a feature control symbol, the tolerance zone is projected above the indicated surface by the specified amount

Full Indicator Movement: The total movement of the indicator when applied to a surface in an appropriate manner. The term Full Indicator Reading (F.I.R.) and Total Indicator Reading (TIR) were formerly used Introduction of double arrow symbol ↑↑ replaces the TIR and FIM callouts.

Plating Lot The number of parts to be plated on a single purchase order.

3.0 HIERARCHY: ALL L3HARRIS T&RF REQUIREMENTS SHALL BE IN THE FOLLOWING ORDER OF PRECEDENCE

Purchase Order, L3Harris T&RF drawings and specifications, Machine Shop Statement of Work

4.0 REFERENCE DOCUMENT

WI158-3241	Inspection Instruction for Raw Material (Internal L3Harris Use Only)
WI158-3223	General Swaging Process (Internal L3Harris Use Only)
WI158-3329	Metrology Labeling and Tagging (Internal L3Harris Use Only)
WI158-3309	Painted Finishes & Inspection Criteria & Coupon Evaluation
WI158-3242	Touchup of Chromate Parts in Accordance with MIL-C-5541 (Internal L3Harris Use Only)
WI158-3137	Torque Requirements for Fasteners (Internal L3Harris Use Only)
WI158-3312	Electroless Nickel Plate Chassis Inspection Criteria & Coupon Evaluation No longer used in L3harris product
PD156-MEPS-100	Manufacturing Procedure (Internal L3Harris Use Only)
PD156-1013	Process Specification for Product Marking (Internal L3Harris Use Only)
Policy 6-21	Equipment Calibration Policy (Internal L3Harris Use Only)
PD156-1013	Product Specification for Marking (Internal L3Harris Use Only)
WI158-3137	Fastener Torque Requirements (Internal L3Harris Use Only)
QP6-17	Control of Non-Conforming Product (Internal L3Harris Use Only)
PD24296	Marking Specification, Part Identification

Industrial

ASME Y 14.1	Drawing Sheet Size and Format
ASME Y 14.5	Dimensioning & Tolerancing for Engineering Drawings (inch)
ASME Y 14.6	Screwhead Representation & Engineering Drawings
ASME B 94.6	Knurling
ASME B 46.1	Surface Texture, Surface Roughness, Waviness and Lay
SAE/AMS2404	Plating, Electroless Nickel

Military

ANSI/ASQC Z 1.4	Sampling Procedures and Tables
FED STD H28	Screw-Thread Stds.

5.0 COMSEC CONTROLLED DOCUMENTS

This section is applicable only to suppliers who receive COMSEC controlled documents. Supplier shall maintain a procedure for the management, security, storage, and access for L3Harris TR&F supplied COMSEC documentation. It is the supplier's responsibility to own, implement, and ensure compliance with the requirements defined herein:

i. Maintain ownership and not distribute to anyone.
ii. Keep log of who has documents at all times.
iii. Not to make copies or reproductions.
iv. To secure drawings in an unseen area when not in use.
v. Returned documents to L3Harris TR&F when work has been completed.
vi. No foreign nationals can perform work on any parts or view documentation for these assemblies.

6.0 TRACEABILITY

6.1 Traceability is required for all materials used in the production of product for L3Harris TR&F. Seller shall maintain a traceability system on all materials and consumables used in the manufacture ring from receipt at Seller's facility to shipment of the end product to L3harris TR&F. The system shall provide for two-way traceability.

6.1.1 Traceability forward, where each part can be traced to the next assembly and subsequently to the end product delivered to L3Harris TR&F.

6.1.2 Traceability backward, where each end product can be traced back to an individual part receipt at the Seller's facility, with the original component manufacturer's lot date code.

7.0 SUPPLIER QUALITY SYSTEM REQUIREMENT

The supplier shall maintain a controlled effective quality system meeting AS9100, ISO9001 or an L3Harris TR&F approved quality system In addition, the supplier shall inspect all completed items supplied, to ensure that all L3Harris T&RF purchase order requirements have been met.

8.0 SUPPLIER CALIBRATION

The supplier shall have adequate Controls, Equipment and a Calibration Systems established in accordance with the requirements of NCSL Z540.3. All Measuring, Test and Inspection Equipment used in the production of parts shall be calibrated.

9.0 SUPPLIER RECORDS

The supplier shall maintain adequate, concise records and historical data on each lot and make them readily available to L3Harris or its Customers as detailed in the Q.A. Flow down Requirements for Purchase Orders.

10.0 GENERAL REQUIREMENTS

A. The requirements herein, shall become a portion of the total engineering requirements of each drawing, specification or standard referencing this standard.

B. L3Harris controlled drawing takes precedence over the STP file shared with suppliers.

Note: STP file can be used as reference whereas controlled drawing shall be used for production and inspection to deliver compliant product.

C. Deliverable finished product shall be cleaned and free of FOD, grease/oil and smudge.

10.1 ESD Protection

Protection shall be provided for all electronic parts, devices, subassemblies and assembled, susceptible to damage or degradation from electrostatic discharge (E.S.D.). ESD controls shall be provided whenever this type of electronic material is processed through the Machine Shop either production or rework material. The operator and immediate work area shall be terminated to earth ground to preclude ESD damage.

10.2 Facility Cleanliness

All suppliers are expected to maintain a clean, neat, uncluttered, and orderly work areas. All internal machine shop work areas are to be clean, neat, uncluttered, and orderly..

10.3 Travelers

A. When a supplier uses its own travelers, the supplier may perform steps out of sequence as long as it does not affect the form, fit, or function of the assembly or violate supplier documented processes

B. When required to use and complete L3Harris T&RF travelers, supplier may perform serialization and terminal swaging out of sequence as long as it does not affect the form, fit, or function of the assembly or violate supplier documented processes

10.4 Quality Assurance Codes

A. Quality Assurance (QA) Codes shall be identified on the purchase order line for each part number. Definitions of the individual QA codes shall be found at: http://l3harris.com/all-capabilities/airborne-telemetry. L3Harris Terms and Conditions shall be found at: http://l3harris.com/supply-chain.

B. Quality Assurance Customer Codes (QP) shall be identified on the purchase order line for each part number. Definitions for these codes shall be found at the end of purchase orders

10.5 Supplier Site Inspections

A. In-process inspections may be specified by L3Harris T&RF and may include source inspection prior to shipment

B. Source inspected items shall upon receipt at L3Harris Telemetry & RF Products, be randomly inspected to both Visual Mechanical and Packaging Requirements of the purchase order.

10.6 Packaging and Shipping

A. All parts including painted, finished and plated parts supplied to L3Harris's under the Purchase Order shall be adequately protected and identified by bag or tag methods for smaller piece parts. Larger chassis or plates shall be individually wrapped for protection, using non-contaminating paper. The shipping container and supplier packing slip shall be marked with L3Harris's Purchase Order Number, Vendors Name or Trade Number. Specification/ID Part Number, Vendors Lot Number as a minimum. The material shall be packaged in an approved container in keeping with the best commercial practices to preclude any damage of goods during handling, shipping and storage. Suppliers are required to include documentation stating the thickness results for each lot coupon.

B. A signed C-of-C shall accompany each purchase receipt and shall reference the purchase order number and if applicable, the Traveler Revisions (TR). All product identification information on the certificate of compliance must match information on the PO

   a. Plated Parts

i. Suppliers are required to include documentation stating the thickness results for each lot coupon
ii. All test coupons shall be shipped with parts

b. Painted Parts
i. All painted test coupons shall be shipped with parts to L3Harris
ii. The certificate shall include such details regarding material paint film thickness, bake temperatures, etc.

10.7 Changes or Deviations

1. Suppliers shall not make any changes in design, materials, or specifications which may affect the acceptability (dimension, visually, functionality, durability, etc.) of the items to be delivered to L3Harris TR&F without approval.
2. Changes in the production process used to manufacture the part may require a re-qualification of the part depending on the nature of the change. Advanced notification of process changes shall be communicated to L3Harris TR&F by submitting a Supplier Process Change Notification-Supplied Part Deviation Request Form.
3. All changes to drawings, specifications, materials, or operating requirements of the items on the purchase order must be approved in writing by L3Harris TR&F.
4. Only L3Harris TR&F purchasing personnel have the authority to change the terms of a purchase order. No other L3Harris TR&F personnel have the authority to approve changes. All changes shall be communicated from the purchasing department and shall be confirmed in writing. A change is defined as any deviation from the purchase order quantity, price, delivery, documentation, terms and conditions or the form, fit, or function of the item or service purchased. Any deviation from this requirement will at the supplier's risk and may result in a default of the purchase order at no cost to L3Harris TR&F
5. All deviations from requirements post-build shall require an approved Supplier Proposed Process Change Notification-Supplier Part Deviation Request Form FM110-F0201. This form is found at http://l3harris.com/all-capabilities/airborne-telemetry.

10.8 Supplier Approvals

Approval of L3Harris Telemetry & RF Products suppliers is the responsibility of Quality Assurance. Approvals are based upon the supplier's Quality System, ability to supply products which conform to contractual requirements and maintains a high quality level.

10.9 First Articles

All suppliers are required to perform 100% inspection and record the attributes for the first piece of each purchase order unless a first article report has been done for the same part on a previous purchase order and is still valid per the conditions listed below. The first article(s) shall be representative of the production run, utilizing production tooling processes

1. The design characteristics affecting fit, form, or function of the part have not changed
2. The manufacturing source(s), process(es), inspection methods(s), location of manufacture, tooling, or material that can potentially affect form, fit or function have not changed
3. A change to the numerical control program or translation to another media that can affect fit, form, or function has not occurred
4. A natural or man-event which adversely affects the manufacturing process has not occurred
5. The production of the part(s) has not stopped within 2 years

10.9.1 First Article Data Collection Requirements

10.9.2 Each dimension on the drawing shall be measured and the result recorded along with appropriate tolerance.

10.9.3 If there is multiples of the same measurement on the drawing, each must be measured and individual measurements noted or a range of values given.

10.9.4 The Asset number (or other unique identifier) and calibration due date of every instrument used to make the above measurements shall be recorded.

10.9.5 Each note on the drawing shall have the method of compliance recorded (i.e., verified by inspection, note is a design direction, etc.).

10.9.6 Lot information for any raw materials used in the construction of the part shall be recorded.

10.9.7 Certificates of conformance from the originator of the material shall be included as well as certificates of conformance for all finishing or coating processes.

10.9.8 First Article Inspection Reports

A. The First Article Inspection Report (FAIR) shall be approved by the supplier's quality assurance function. Additionally, the supplier shall perform additional First Article Inspection(s) after every major tooling or process change, every design/revision change, and when there has been a gap in production of the part of more than 2 years. Records of all first article activity will be documented, treated as quality / acceptance records, maintained by the supplier and made available to L3Harris TR&F if requested. A copy of the FAIR shall accompany the delivery of hardware.
B. All FAIR's shall comply to AS9102 requirements and unless otherwise specified shall use AS9102 forms

10.10 Internal Machine Shop Raw Material Receipts

All raw material received by L3Harris Telemetry & RF Products and its Vendors shall be controlled and processed in accordance with the applicable Inspection Instruction for Raw Material. The material shall be identified, inspected, verified and controlled throughout its use on the Fabrication Cycle. All raw material certification (i.e. Mill Certification & Chemical Analysis) shall be supplied with the suppliers standard documentation (packing slip and Certificate of Compliance) at the time of delivery of the product to L3Harris Telemetry & RF Products.

The raw material received shall be of the correct size material type, shall be sound, industrially straight and flat, uniform in quality and grade and free from external defects. Raw material tolerances shall conform to the applicable governing specifications (i.e. AMS, ASME, etc.).

10.11 Internal Machine Shop Terminals/Swaging Operation

Material or items requiring metallization, terminal, or swaging shall be processed in accordance with L3Harris TR&F work instruction WI158-3223, General Swaging Process

10.12 Internal Machine Shop Fasteners

Material or components requiring the installation of fasteners or torquing requirements shall be processed in accordance with L3Harris TR&F work instruction WI158-3137, Fastener Torque Requirements

10.13 Machine Threads

10.13.1 Supplier Thread Requirements

All supplier threads shall be defined on all drawings

10.13.2 Internal Machine Shop Thread Requirements

Thread dimensions and designations shall be in accordance with FED-STD H28, Screw Thread Standards for Federal Services or ASME Y14.6, Screw Thread Representation and Engineering Drawings

10.14 Internal Machine Shop Marking

If the product requires marking product marking shall be processed in accordance with L3Harris TR&F procedure PD156-1013; Process Specification for Product Marking

10.15 Supplier Product Marking

All product markings shall be specified on the drawing unless otherwise specified. Markings shall be in accordance with L3Harris policy PD24296, Marking Specification, Part Identification.

10.16 Internal Machine Shop Nonconforming and Scrap Material

All parts or products in which one or more characteristics do not conform to the requirements specified in the purchase order, contract, specification, drawing or other applicable product standard and/or any material that has been found to be unfit, unusable, or has a major defect that restricts its use in further processing shall be handled in accordance with L3Harris TR&F policy QP6-17, Control of Nonconforming Product.

10.17 Internal Product Repairs

Repairs of received product are not authorized without a documented and approved NCR. Some repairs may require customer approval

10.18 Sampling

10.18.1 Supplier Sampling

L3Harris TR&F may request that suppliers utilize a specific sampling standard or move to a tighter specification of a specific inspection standard

10.18.2 Internal Sampling

When sampling inspection is employed on high count items or products, the requirements found in ASME/ASQC Z1.4 Sampling Procedures and Tables for Inspection by Attributes shall be used. Appropriate acceptable quality levels will be determined by the item classification

11.0 NICKEL PLATING

All plating requirements shall be defined on the fabrication drawings and outlined below

11.1 Plating Processing and Coverage

1. L3Harris TR&F at its discretion may restrict a vendor's approved plating supplier as required by customer or program requirements
2. Small blind and threaded holes prevent full plating coverage and are permitted to be free of plating as follows
   A. Tapped Holes: Threads may be free of plating
   B. Blind Holes:
      a. Hole Diameters less than 0.125" in diameter require plating coverage at a minimum of 25% of the hole depth.
      b. Hole Diameters greater than 0.125" require 100% plating on hole depths less than or equal to hole diameter and 50% on depths greater than the diameter.

11.2 Plating Test and Inspection

All parts and plating test coupons shall be manufactured by the metal works supplier and be sent to an L3Harris TR&F or vendor approved plating supplier for plating to the requirements established on the fabrication.

11.2.1 Plating Test and Inspection Coupons

The plating supplier shall use the plating test coupons provided by the metalwork supplier as replacements for the periodic adhesion test sample quantity found in AMS2404 Section 4.3.2.2.

The plating supplier shall use ASTM B571 Section 9 – Heat-Quench Test an as alternative to AMS2404 3.4.2 adhesion testing

11.2.1.1 Plating Inspection Coupons

The plating inspection coupon requirements are as follows

1. The metal works supplier shall provide 4 total test coupons per plating lot
2. The dimensions of each shall be 1" x 4" and have a minimum thickness of 0.025"
3. All 4 coupons should be plated in the same bath as the parts from each lot and at the same time.
4. All 4 coupons shall be examined at a minimum of 6x for adhesion testing after completion of the Heat-Quench Test
5. 1 Coupon shall be retained by the plating supplier and 3 coupons shall be sent to the metal works supplier'
   a. 1 Coupon shall be examined at a minimum of 6x mag for adhesion testing by the metalworks supplier
6. If the adhesion test passes, all parts in the lot can be released and shipped to L3Harris TR&F along with all 3 coupons

Upon receipt of the plated part(s) from the supplier, the parts shall be processed in accordance with the applicable receiving inspection procedure.

If additional analysis is required, subject test coupons may be sent to an approved contract test analysis lab for independent validation and approval.

11.2.2 Plating Cosmetic Appearance and Workmanship Requirements

Cosmetic appearance and workmanship of the plating shall be in accordance with the requirements established in AMS 2404 and as detailed below.

Interior Surfaces			Outer Surfaces	
Minor Discoloration	Accept		Smooth Texture	Accept
Dark Spots	Reject		Even Coating	Accept
Light Stains	Reject		Stains Removeable by ENSOLV	Reject
Contamination	Reject		Discolorations Removeable by ENSOLV	Reject
Voids	Reject		Pits, Pinholes, Blisters, Bubbles	Reject
Breaks or Measling	Reject		Bulges or Nodules	Reject
Blister or Bulges	Reject		Dents or Handling Damage	Reject
Black Eruptions	Reject		Buffing or Polishing change surface texture	Reject
Nodules	Reject		Dark Areas exceeding 0.06" diameter ring	Reject
Burnt Areas	Reject		Number of Dark Areas > 3 per side or 5 total	Reject

12.0 PAINTED FINSIHES

All supplied products which have a painted finish shall be in accordance with the following sections and WI158-3309, Painted Finishes, Inspection Criteria and Coupon Evaluation.

12.1 Preparatory Cleaning

Prior to the application of any finishing process, all exposed surfaces shall be cleaned, free from dust, dirt, grease, oil, fingerprints, solder fluxes, rust, scale or oxides, that might adversely affect the final product.

12.2 Masking

Plated, non-plated or metal based parts, noted with restricted areas specifically intended for electrical contact, heat transmission and threaded hardware shall have such areas marked, plugged, capped or protected during the finishing process. When masking tape is used, it shall be of a grade which will not adversely affect the finish or leave an adhesive residue on the surface. Noted restricted areas shall be shown on all drawings.

12.3 Filling Material

The use of filling material for the purpose of filling in nicks, dents, gouges, or minor surface damage is prohibited

12.4 Cosmetic Appearance and Workmanship

All finishes shall be built-up or lacquered into films to form an adherent, even and continuous coating. Cosmetic appearance and workmanship shall be in accordance with the criteria below

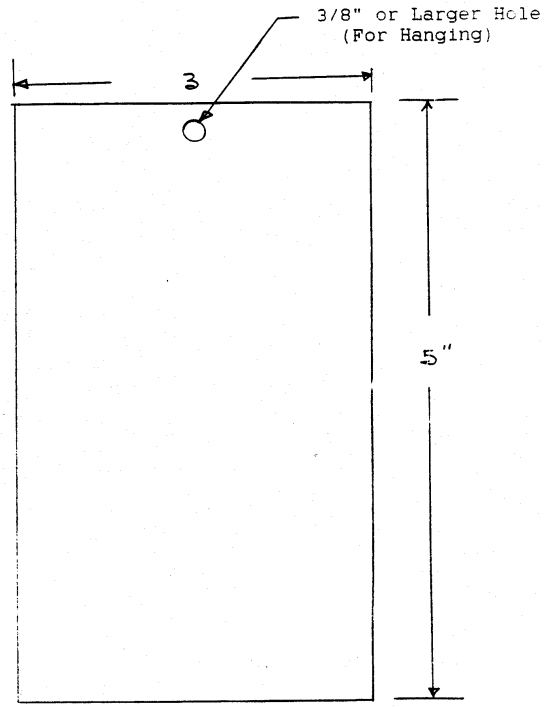
Surface Finish			Surface Finish	
Foreign Debris	Reject		Pits	Reject
Burning	Reject		Runs	Reject
Discoloration	Reject		Orange Peel	Reject
Hazing	Reject		Nodules	Reject
Blisters	Reject		Tape Residue	Reject
Checkmarks	Reject			

12.5 Test Coupons

The finished test coupon is used as the inspection test standard by L3Harris TR&F to verify the overall quality, integrity, and conformance to the stated requirements. Test coupons will be used to accept or reject the entire finished lot received. All coupons will be of the same material as the item being coated and will be chemically treated and painted per the same requirements as the finished product.

Additionally, the coupon shall be processed as the same time as the end item and follow the exact same processing steps. Figure 1 shows a sample paint coupon

FIGURE 1
Paint Coupon
(L3Harris T&RF or Vendor Supplied)



12.6 Supplier Painted Part Inspection

The supplier shall inspect for the following conditions before shipment of parts: Color, Adhesion and Thickness.

12.6.1 Color

The color and gloss of painted parts shall be compared to AMS-STD-595 or an L3Harris TR&F supplied color reference. The inspection shall be under natural lighting condition and viewed in the same plane at a distance of 2-3 ft from the eyes.

12.6.2 Adhesion

The adhesion will be checked by the following

1. The supplied test coupon shall be used as a test piece to verify the adhesion properties of the painted surfaces on the finished product. Using the blade edge of a knife (held 90 degrees vertically to the painted surface) abrade/scrape back and forth with medium pressure on the painted surface 4 to 5 times. The paint should peel evenly from the surface rather than chip or flake off the coupon.

2. On a fresh area on the test coupon, using an Exacto knife, with a new blade, cut a one (1) inch square, through the paint film to the metal surface. Then apply a one (1) inch wide strip of 3M 250 adhesive tape (approximately 3 to 4“ in length) directly over the cut area. Center and press down on the tape, employing firm finger pressure, to set the tape at a 90 degree angle, remove the tape from the coupon in one abrupt pulling motion. After removal then examine the cut test area for film damage, or removal of the paint on the adhesive side of the tape or any general pull off of the paint film. Any failure of paint adhesion after this “pull test” will be cause for lot rejection.

12.6.3 Thickness

Paint thickness shall be verified, by measuring the actual paint film, using a calibrated micrometer, the thickness differential between the overall finish thickness and the base metal thickness, this will give the paint thickness. If required, paint film may be carefully removed from the coupon surface down to the base metal to obtain this measurement. The supplier may use an eddy current device on metal substrates.

13.0 WELDING

All welding requirements shall be found on all drawings.

13.1 Quality Assurance Provisions

13.1.1 Internal Quality Assurance

Quality inspection shall be responsible for assuring that all features of manufacture red items comply with the requirements of engineering drawings, PO’s, and SOW’s.

13.1.1.1 Internal Inspection by Measurement

Dimensional verification shall be by the use of standard gages, measuring devices and inspection tools. Special Inspection Equipment or Inspection/Test Procedures should not be used unless the requirement is specified on the drawing. All fixtures used for Inspection shall be calibrated prior to use. It is generally recognized that certain features on an item such as fillet radii, inside radii, pocket depth, chamfers holes of the same diameter etc., that are created in the same setup with the same tooling may be Sample Inspected at the discretion of the Quality Inspector.

13.1.2 Inspection Requirements Supplier and Internal

Unless otherwise stated or agreed, internal and supplier inspections shall follow the following guidelines

13.1.2.1 Visual Inspection

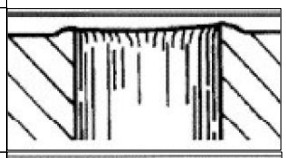
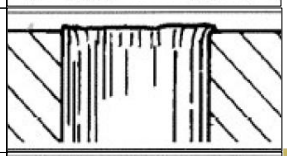
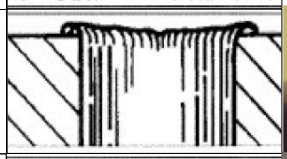
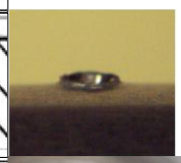
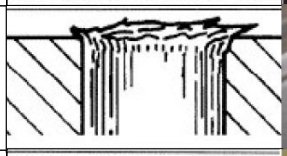
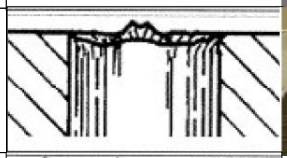
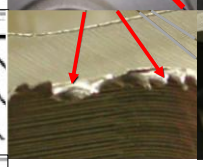
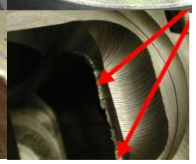
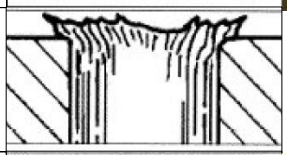
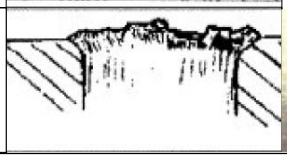
- Inspect item for damage: cracks, contamination deterioration material and processes not in conformance with the drawing.
- Inspect item (s) for required markings and protective coverings
- Inspect for correct process documentation and revisions
- Parts are to be inspected at 8x magnification

13.1.2.2 Visual Inspection Burr Guidelines

- All parts shall have burr-free edges and surfaces unless otherwise specified on the drawing.

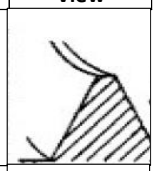
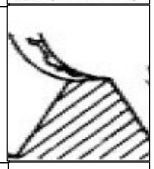
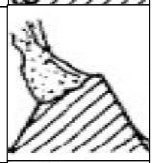
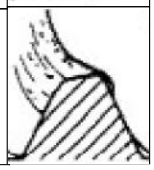
13.1.2.2.1 Failure Mode Burs at Holes and Edges

- Burrs on parts are difficult to detect if not inspected at varying directions/angles. Parts should not be viewed by looking straight down (see below for types of burrs)

Burr Type	Description	Accept/Reject	
Extended Burr	Raised material that does not exibit evidence of material that can break away	Accept	
Feathered Burr	Loose Burr found on an edge where two dissimilar surface finishes meet; Remove	Reject	
Doughnut Burr	Material tends to flatten and blend it into adjacent surfaces; Remove	Reject	 
Loose/Sliver Burr	Loose sliver of material attached to the edge of a feature; Generally forms on edges adjacent to a milled or turned surface; Remove	Reject	
Hinged Burr	Loose material typically formed in holes and features located on surfaces that have been milled; Remove	Reject	  
Crowned Burr	Loosely attached material typically formed around a hole that has been countersunk; Remove	Reject	
Rough Burr	Remove	Reject	

13.1.2.2.2 Failure Mode Thread Burrs

- Threads are subject to burrs on thread crests (see below)

Description of Burr	Accept/Reject	X-Sectional View
Reference as designated thread	Standard (Accept)	
Tool marks/ribbed sidewall	Accept	
Rolled over material on Crest	Reject	
Stepped sidewall and crest	Accept	
Torn sidewall and crest	Reject	
Burr turned down loosely on sidewall	Reject	

13.2 Dimensional Requirements and Guidelines

- All dimensions for measuring and inspections shall be taken at a standard temperature of 68° F ± 5° F. Parts may be measured at temperatures other than this standard during fabrication, if proper compensation is made for the change effect on the parts and measuring tools are taken into consideration.

- All dimensioning tools used during internal fabrication and inspection shall be calibrated and controlled in accordance with MIL-STD-45562 and/or L3Harris T&RF QP6-21
- All dimensioning tools used by suppliers during internal fabrication and inspection shall be calibrated and verified per the supplier's calibration standard

- Reference (REF) dimensions delineated on drawings are not to be used for verification by inspection, but are to serve as a guide for the machinist during fabrication.

- Unless otherwise specified, all dimensions on parts must be met after all machining process have been completed. Processing includes all manufacturing operations such as stabilizing, heat treating, curing, deburring, grinding, lapping and polishing.

- Where rating, chemical finishes, painting lacquers or electro film treatments are required all dimensions must be met prior to the applications, unless otherwise specified on the drawing.

- Dimensions on a hole or a C' Base depth that is listed in a hole chart, that measurement shall be taken from the "O" datum. When a hole or a C' Base is called out on the field of the drawing it is assumed that the depth of the same is from the level of the surface where the dimension is called out.

- Positional tolerancing shall be in accordance with American National Standard ASME Y 14.5 Dimensions and Tolerancing for Engineering Drawings. Dimensioning and tolerancing are used to define the required condition of a part or component as stated on an engineering drawing.

- Dimensions are to be expressed as decimals or common fractions, decimal dimensioning is preferred.

- <u>Restraint During Measuring:</u> All dimensions shall be met when the item is free from external forces ("Free State") except that in aided direct hand pressure will be permissible.

- <u>Tolerances:</u> Tolerances shall be interpreted as establishing absolute available limits (minimum and maximum values). Measurements shall not be rounded off in inspecting the item. There is no tolerance on a tolerance. Example: Specific value 2.50 ± .03 desired value 2.50, accepted values 2.47" to 2.53". Any deviation, however small, outside the specified limiting values is to be interpreted as non-conformance.

- <u>Angular Tolerance:</u> The tolerance on all angles shall be ± ½ ° (or ± 0° 30 or ± .5°) unless otherwise specified on the drawing. Tolerances on angles specified on the drawing shall be expressed in fractions of a degree (i.e. xx.x° ± .x°). Tolerances on sheet metal flange angles shall be ± 2°

- <u>Unspecified Angles:</u> When the drawing depicts two edges or lines at right angles without being specifically dimensioned, the edges or lines shall be considered to be 90° ± ½ ° with respect to each other.

- Symmetry: Any feature shown as symmetrical about a centerline, but not directly dimensioned, shall not deviate from symmetry about the centerline, more than ½ the total tolerance of the width dimension, up to a maximum of .03 inches.

- Machining Tolerances: Tolerances on machined surfaces or features shall be as specified in the following paragraphs.

- Concentricity: The concentricity of cylindrical, conical or spherical part surfaces which have various diameters and are machined on a common axis (common center in the case of concentric spherical surfaces) shall be within a full indicator measurement (F.I.M.) of .010; TIR (Total Indicator Reading).

- Machined Diameters: Except deep drilled holes (3 x's hole dia.) shall be concentric to a diameter called out a "Stock Size" within the tolerances shown below. Machined diameters for deep drilled holes shall be concentric with the stock size diameter within 105 times the tolerance.

Stock Size Diameter	Concentric Within F.I.M.
thru 1.50	.015
1.51 thru 3.00	.020
3.01 thru 5.50	.025
5.51 and over	.030

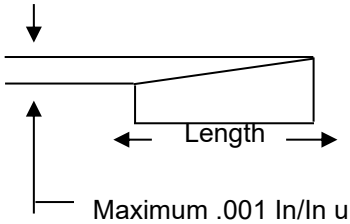
- Deviation from Flatness, Straightness or Contour Tolerance: Machined surfaces with a maximum roughness of 125 shall not deviate from the nominal flatness, straightness or contour by more than .010 inches in any 12 inch increment. Rougher surfaces shall not deviate more than .020" on any 12 inch increment. However, deficiencies in flatness, straightness or contour shall in no case exceed the nominal shape tolerance zone of .020".

- Waviness: The waviness (in full indicator measurement) of a machined surface shall not exceed 20 times the surface roughness requirement in micro inches. The basic increment for measurement shall be in 1.00 inch intervals.

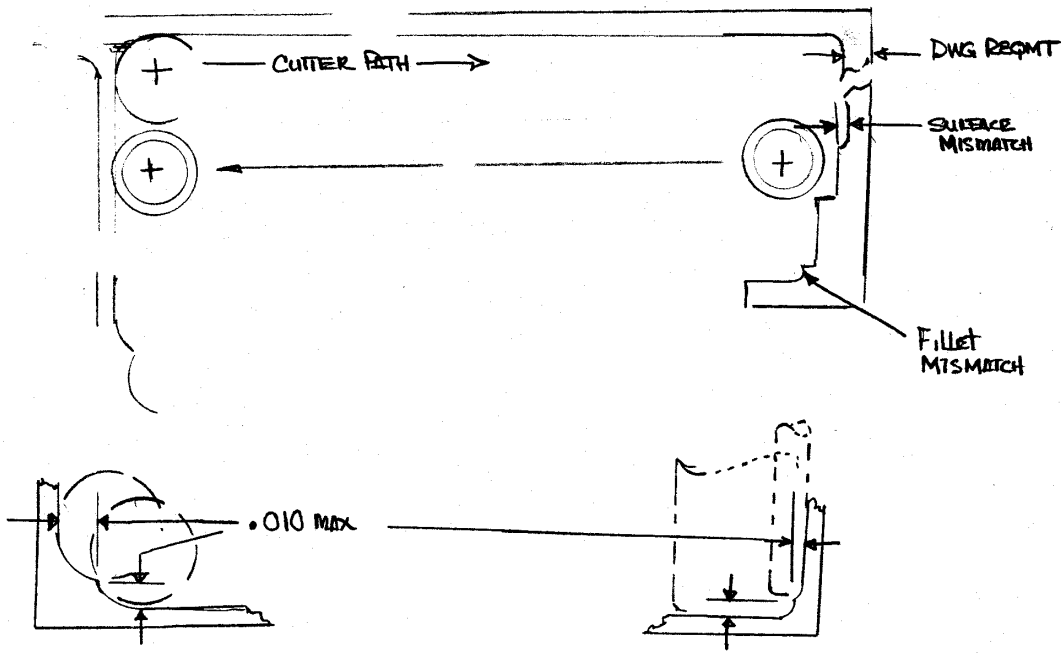
  Example:

  $$\sqrt{125} = .000125 \times 20 = .00250 \text{ total waviness height allowed per inch}$$

- Parallelism: Machined surfaces shall be parallel to the degree specified below, unless otherwise specified. Deficiencies of parallelism shall no case exceed the shape permitted by dimensional tolerance of size, regardless of feature size tolerance



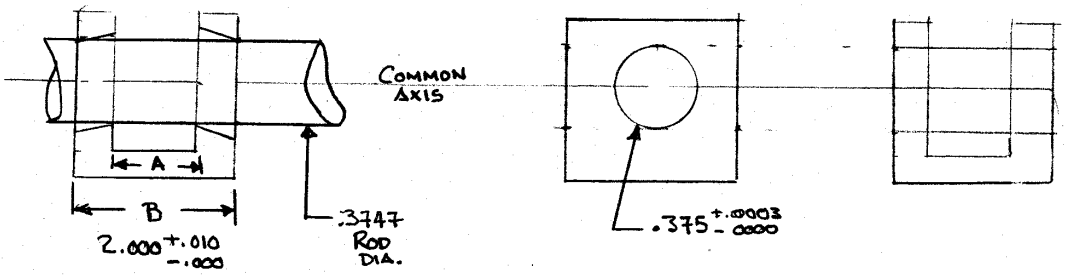
Maximum .001 In/In up to 12 inches, plus .0005 In/In over 12 inch length. Cumulative maximum shall not exceed tolerance on the part.



- Mismatch: Acceptable machined surface mismatch and limits are as follows:

  Except where cutter path direction changes surfaces or radius mismatch in web areas along paths of cutter travel shall be limited to .002 inch maximum. Where cutter path direction changes, a limit of .003 inch maximum is allowable in an area one cutter diameter from the center line of the cutter path. Surface mismatch on other than web areas shall be limited to .005 inch maximum. Mismatch on "2" depth pocket machining shall be .002. Fillet mismatch shall be limited to .005 inches maximum. Mismatch not permitted if cutter corners have a radius of less than .03 inches.
- Alignment: Machined holes which have a common axis shall permit the passage (without force) a drill rod whose diameter is equal to the minimum diameter of each hole minus ¼ (one fourth) the sum of the total tolerance of the holes, times the basic dimension.

Example: Diameter of Hole .375 +.0003, -.000
Dimension given on Dwg. B = 2.000 +.010, -.000



Minimum Diameter of Hole .3750
Minus one-fourth of the sum of the tolerance of holes $\frac{.0006}{4}$ = .00015
Times the basic dimension corresponding to A or B .00015 x 2 .0003
Diameter of rod .3747

Misalignment between two or more machined surfaces on the same part in the same dimensional plane shall not exceed .002" inch unless otherwise specified or unless the dimensional tolerance is less than ± .001 inch.

- Reference Planes: When reference planes are used to locate design features on details or assemblies, or to locate parts on an assembly or installation, they are specified in chemical inches. On installations they are understood to be the indicated distance from the basic 0.000 datum plane established for the specific end item. For details and assemblies the basic datum plane (No. Tolerance) is the reference plane with the lowest numerical value indicated on the drawing. the location tolerance, implied by the reference plane callout shall be in the number of decimal places used, in accordance with the drawing standard tolerance block.

- Machined Surface Quality: The control for surface quality on machined surfaces is noted on the part drawing by the following symbols for the total surface area indicated. Roughness is the relatively finely spaced surface irregularities that occur during machining.

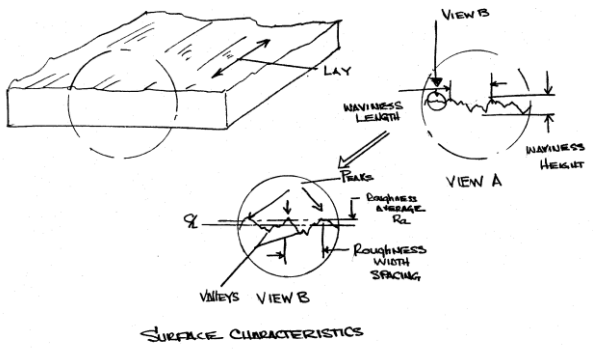
8 Maximum surface roughness 8 micro-inches

.0005
63 Maximum surface roughness 63 micro inches
Maximum surface waviness height .0005 inches

32 Maximum 32 micro inches
16 Minimum 16 micro inches

.0003
32 Maximum surface roughness 32 micro inches
Maximum surface waviness height .0003 inches

Lay direction of tool marks or grain



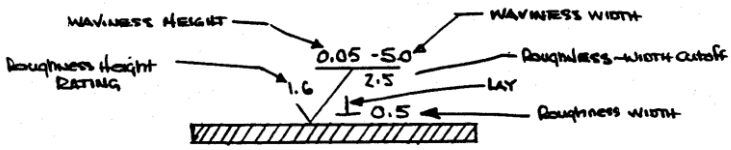
Surface roughness for machined surfaces as outlined below are considered minimum good Machine Shop Practices and shall apply prior to the application of plating's or coatings.

Dimensions Having a Total Tolerance	Maximum Micro-inch Finish
under .0003	16
.0003 - .0005	32
.0005 - .002	63
.002 - .005	125
.005 - .020	250
.020 or over	500

- The entire surface designated for a given RMS value shall receive the required finish or finer. No partial or residual areas shall receive a finish coarser than that specified.

  Waviness is the surface irregularities which are of spacing than the roughness and constitutes a deviation from a perfect plane.

  Lay designations show the direction of the tool marks or surface grain with reference to the line that represents the surface.



EXAMPLE OF SURFACE TEXTURE SYMBOLS

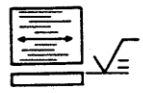
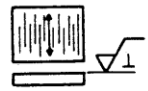
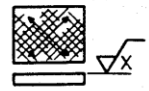
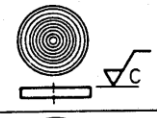
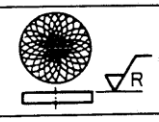
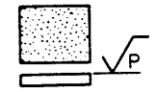
  Machining Operations: When the drawing specifies a machining operation but does not call out the maximum surface roughness for that operation the following values are implied:

  Surfaces produced by the callout of drill, tap drill counter drill bore or counter bore shall not exceed a maximum surface roughness of 63 micro inches if the total hole tolerance is equal to or less than .003 or 125 micro inches if the total hole tolerance in over .003.

  Surfaces produced by the call out of chamber, spot face, countersink center drill, break sharp edge or turning center shall not exceed a maximum surface roughness of 125 micro inches.

  Surfaces produced by the callout of a ream or broach shall not exceed a maximum surface roughness of 32 micro inches if the total hole tolerance is equal to or less than .003 or 63 micro inches if the hole tolerance is over .003.

  Alternate fabrication methods are acceptable for use providing that the maximum surface roughness values specified for the machining operation noted above are not exceeded.

LAY SYM-BOL	MEANING	EXAMPLE SHOWING DIRECTION OF TOOL MARKS
=	Lay approximately parallel to the line representing the surface to which the symbol is applied.	
⊥	Lay approximately perpendicular to the line representing the surface to which the symbol is applied.	
X	Lay angular in both directions to line representing the surface to which the symbol is applied.	
M	Lay multidirectional.	
C	Lay approximately circular relative to the center of the surface to which the symbol is applied.	
R	Lay approximately radial relative to the center of the surface to which the symbol is applied.	
P*	Lay particulate, non-directional, or protuberant.	

* The "P" symbol is not currently shown in ISO Standards. American National Standards Committee B46 (Surface Texture) has proposed its inclusion in ISO 1302 - "Methods of indicating surface texture on drawings."

LAY SYMBOLS

Surfaces produced by the callout of drill, tap drill counter drill bore or counter bore shall not exceed a maximum surface roughness of 63 micro inches if the total hole tolerance is equal to or less than .003 or 125 micro inches if the total hole tolerance in over .003.

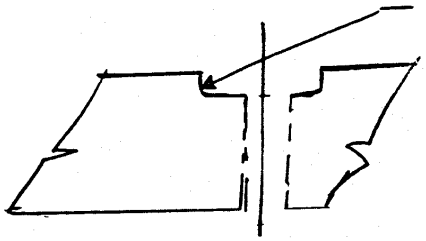
Surfaces produced by the callout of a ream or broach shall not exceed a maximum surface roughness of 32 micro inches if the total hole tolerance is equal to or less than .003 or 63 micro inches if the hole tolerance is over .003.

- Spot face and Counterbore: All spot face and counterbore corner (fillet) Radii shall be .06 ± .01° inches up to 1.25 diameter. For 1.25 diameter and over the radius shall be .9 ± .01.

.015 ± DIR (to 1.25 dia.)

0.02 ± DIR (1.25 dia. & over)

Sharp edges: All burrs and sharp edges on machined parts, except for some beading installations shall be removed in the edge removal form of a radius, rounding chamfer or their combinations, not to exceed .010 unless otherwise specified.



NOTE: For breaking edges in material less than .150 edge removal shall not exceed .005 inches.

- Blind Holes: the shape (bevel, rounding, flat, stepped, etc.) at the blind end of a machined nonthrough hole shall be as produced by the standard tool).

- Chamfers and Countersinks for Threads:

For internal threads .875 and smaller, the entrance end shall be countersunk 100 degrees x the major thread diameter. Internal threads larger than .875 shall be chamfered 45 degrees x the major thread diameter. The

For external threads, the starting end shall be chamfered 45 degrees x the major thread chamfer.

NOTE: Unless otherwise specified on the drawing, drilled hole location shall be maintained within plus or minus 0.010 inch, unless otherwise specified on the part drawing.

When holes are drilled or tapped on a circle and are designated on the drawing as “equally spaced” the tolerance on the chordal distance between any two holes, shall not exceed the tolerance specified for the diameter of the locating circle.

To insure the removal of sharp edges and/or burrs on drilled holes the edges should be broken. Edges on both sides of through holes (thru) shall be broken, unless otherwise specified on the drawing.

All final holes shall be free of all foreign matter, obstructions and fabricating oils or chemicals.

- Knurls: The standard knurls used are the support, diamond and diagonal. Knurls are dimensioned in accordance with ANSI-B94.6 and used to provide a rough surface for gripping or for a press fit between mating parts. Standard pitches are 64, 96, 128 and 160.

- Part Discontinuities: Parts and components shall be free of cracks, surface damage, corrosion and contaminating materials. Surface discontinuities shall not exceed the following paragraphs.
- Clad Surface Discontinuities: Part surfaces shall contain no discontinuities which penetrate through the clad.

- Bare Surface Discontinuities: Except as permitted below, parts shall be free of surface continuities.

Y = smallest of the width or length dimensions in inches
Z = Largest of the width or length dimensions in inches

A) .001 (max) surface scratches. On parts with 4 material gage of .020 to .040 inches, scratches shall not exceed .001 inches in depth and .2Y inches in accumulative total length per surface.

B) .003 (max) surface scratches. On parts with a material gage of .040 inches or greater, scratches shall not exceed .003 inches in depth (including approved rework) and .2Y inches in accumulative total length per surface. Limitations applicable to scratches more than .001 inches up through .003 inches are

1. No scratches in area of flanges, bosses and corner type bends
2. No X (crossing) type scratches
3. Scratches on back to back surfaces shall be a minimum of .3z inches apart.
4. Rework on scratches shall not be performed on finished Electroless Nickel parts.
5. Rework shall remove the sharp edges of the scratch and the surfaces be smooth and match the original surface finish as close as possible.

- Impressions: Surface impressions shall not exceed .005" inches in depth and .010 inches in diameter. The number of surface imperfections shall not exceed 2 on a surface within an area of 5 inches or less. Four (4) per surface on a surface with an area greater than 10 inches.

- Creases: Surface creases shall not exceed .003 inches in depth and shall not exceed

  2Y inches in length for individual creases

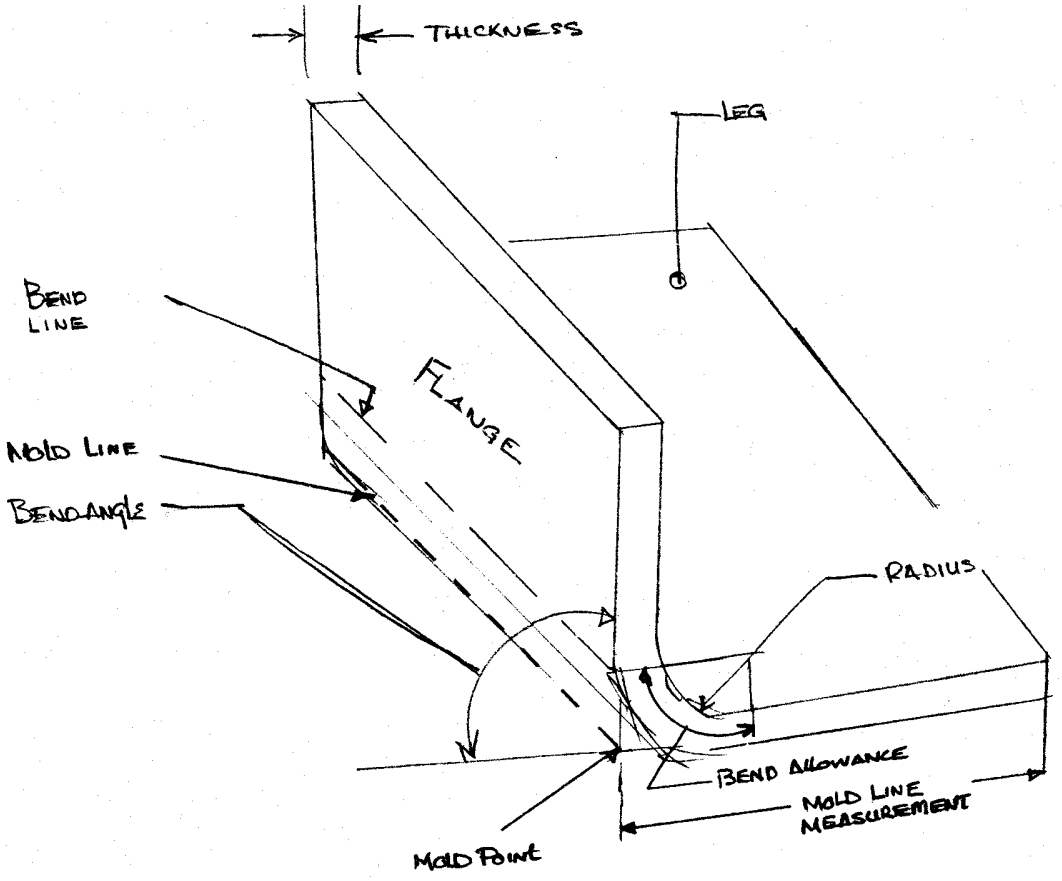
  4Y inches in accumulative total length per surface

  2Z inches in accumulative total length in any area formed by half width x half-length dimensions

- Minor Discontinuities: Minor surface discontinuities such as slight discoloration and minor handling marks are acceptable.

13.3 Sheet Metal Fabrication

The fabrication of sheet metal parts involves methods which are quite different from those used for fabricating machine parts. Parts may be made from flat blanks and deep drawn or formed into complex contours by dies in a press. These parts are usually trimmed after forming to produce the finished part.



SHEET METAL TERMS

Sheet metal requirements applicable to all parts fabricated from sheet metal (rolled stock up to .250 inches in thickness) are as specified in the following paragraphs:

<u>Sharp edges</u> - busses and sharp edges caused by manufacturing operations shall be removed in the edge removal form of a Radius, Rounding Chamfer or their combinations when they may cause 1) a safety hazard to personnel 2) damage to other parts ,such as scratches gouges, etc. 3) cracking or other failures in areas which are bent or 4) gaps or interferences between mating parts or assemblies unless otherwise specified on the drawing edges of sheet metal shall not exceed $\sqrt{}$ finish. Edge removal form dimensions limits are as follows:

1) For the edge of holes with a total diameter tolerance of .005 inches or less the edge removal shall not exceed 10% of the material thickness or .005 whichever is the smaller dimension.

2) For the edge of holes with a total diameter tolerance of .006 inches or greater and for all other part edges, the edge removal shall not exceed10% of the material thickness or .020 inches whichever is the smaller.

The finished sheet metal parts shall be free of cracks, splits and other stress hazards after bending or stamping operations have been completed.

Inside radii less than two (2) times the thickness of the material thickness shall not be acceptable unless otherwise stated on the drawing.