NOTICE OF CHANGE

INCH-POUND

MIL-HDBK-1599A
NOTICE 1
12 March 1999

DEPARTMENT OF DEFENSE
HANDBOOK

BEARINGS, CONTROL SYSTEM COMPONENTS, AND ASSOCIATED HARDWARE USED IN THE DESIGN AND CONSTRUCTION OF AEROSPACE MECHANICAL SYSTEMS AND SUBSYSTEMS

TO ALL HOLDERS OF MIL-HDBK-1599A:

1. THE FOLLOWING PAGES OF MIL-HDBK-1599A, SECTION 100 IS MISSING AND NEEDS TO BE INSERTED:

NEW PAGES	DATE	MISSING PAGES	DATE
Insert after page 5 Pages 101.1 thru 108.5	12 March 1999	Pages 101.1 thru 108.5	2 October 1997

2. RETAIN THIS NOTICE AND INSERT BEFORE TABLE OF CONTENTS.

3. Holders of MIL-HDBK-1599A will verity that the missing pages indicated above have been inserted. This notice page will be retained as a check sheet. This issuance, together with appended pages, is a separate publication. Each notice is to be retained by stocking points until the standard is completely revised or canceled.

Custodians:
Air Force - 99
Army - AT
Navy - AS

Reviewers:
DLA - GS
Army - AV
Navy - SH

Preparing Activity:
Air Force - 84

Agent Activity:
Air Force - 99

(Project 31GP-0200)

AMSC N/A

FSC 31GP

APPROVAL AND RELEASE FOR USE: PARTS

1. Scope. Parts identified and listed in the applicable requirements of this standard are approved parts and shall be given selection priority in new airframe and airborne mechanical and functional systems design. Parts not listed as approved for use herein require a release for use by the procuring activity prior to incorporation into design during engineering development and use in assembly during production. This requirement establishes uniformity in the preparation and submission procedures for justification and engineering documentation necessary for the evaluation and release for use of unapproved parts and references established procedures which may be contractual for a specific aircraft program. This requirement also establishes the point of contact for release requests.

2. Applicable Documents.

MIL-STD-143	Standards and Specifications, Order of Precedence for the Selection of
MIL-STD-965	Parts Control Program

3. Release for use procedure.

3.1 Parts selection.

3.1.1 Approved parts Parts listed in the applicable requirements in this document are considered approved parts. These parts shall be given priority in design or modification programs.

3.1.2 Unapproved parts. Any part not listed in the applicable requirements herein shall be considered an unapproved part. When required, parts shall be selected in the order of precedence specified in MIL-STD-143.

3.2 Determination of approved and receiving approval for unapproved parts.

3.2.1 Contract specifies MIL-STD-969. When the program contract specifies MIL-STD-965, the procedure for determination of approved parts and receiving approval for use in unapproved parts shall follow the procedures contractually selected from and listed in MIL-STD-965 and any specific contract deviations.

3.2.2 Contract details procedures. When the program contract details. specific procedures for determination of approved parts and approvals of non-approved parts, applicable procedures shall be followed.

3.2.3 Contract does not specify MIL-STD-965 or detail procedure. Approved parts listed herein shall be utilized insofar as practicable. Unapproved parts which are required shall be selected in accordance with the precedence specified in MIL-STD-143 and shall be submitted to the procuring activity for release for use on the program. The procedure shall be as coordinated with the procuring activity.

4. Engineering data requirements. Data shall be submitted to the procuring activity as required by MIL-STD-965, or deviations thereto, or by contract agreement with the procuring activity.

APPROVAL AND RELEASE FOR USE: METHODOLOGY

1. Scope. Procedures and methods specified in applicable requirements herein shall be considered required unless options are specifically allowed. When the contractor desires to use procedures or methods other than those specified or cannot use specified procedures or methods for specific applications, the procedure for approval shall be as detailed in this requirement.

2. Applicable Documents.

U. S. Air Force Design Handbook 2-1 Airframe

3. Release for use procedure.

3.1 Procedure or method selection.

3.1.1 Approved methodology. All methodology listed in the applicable requirements herein are considered approved for use with noted restrictions or allowances. Methodology refers to bearing retention methods or load calculation procedures.

3.1.2 Optional methodology. When more than one procedure or method is specifically identified as optional herein, either procedure or method is considered approved.

3.1.3 Unapproved methodology. When procedures or methods are specifically disapproved herein, use is prohibited. Specific approval by the procuring activity is required for use of the procedure or method.

3.1.4 Non-specified methodology. When a procedure or method for accomplishing a required installation or design is neither approved nor disapproved or is not addressed, the contractor shall use the best known design practice from experience or testing.

4. Engineering data required. When procedures or methods not approved herein are required, the contractor shall furnish the data requested by the procuring activity.

5. Approval documentation. The contractor shall maintain a record of procuring activity approvals of methods or procedures used which require procuring activity approval.

6. Notes. MIL-HDBK-1599 takes precedence over applicable document specified in paragraph 2 of this requirement.

EXCHANGEABILITY

1. Scope. This requirement shall govern the selection and use of exchangeable parts in the design and construction of aerospace mechanical systems and related subsystems.

2. Applicable Documents.

MIL-STD-100	Engineering Drawing Practices
MIL-STD-280	Definitions of Item Levels, Item Exchangeability, Models, and Related Items

3. Definitions of elements. Refer to MIL-STD-100 and MIL-STD-280 for definitions of appropriate elements.

4. Design tolerances. During design selection and application, provisions shall be made for dimensional, physical, and functional properties' tolerances, so that parts having dimensional, physical and functional characteristics permitted by the part specification or drawing may be used without selection or departure from the specified equipment performance.

5. Use of approved parts. Approved parts as defined in paragraph 3 of MIL-HDBK-1599 shall be used to the maximum extent practicable. If existing approved parts are not available, the procuring activity may grant authority to substitute a non-approved part. The equipment shall be designed so that the approved part can be used. When provision is made for the use of a substitute non-approved part, the approved part shall be identified on the applicable documentation.

6. Choice of arts. The part having the broadest characteristics and physical and functional tolerances that will fulfill the equipment performance requirements shall be used. However, if delays in development or production are caused by the procurement time required for such parts, approved or released substitute parts may be used if the originally selected, approved, or released part is identified on the applicable documentation.

MATERIALS

1. Scope. This requirement delineates the materials approved for use in the construction of newly designed parts for approval to MIL-HDBK-1599, specifies restrictions of heat treats or applications, and notes materials which are not approved or are approved with specific conditions. This is the general materials requirement for new design and may contain statements which defer material selections and approvals to other specific requirements wherein the materials are more suitably covered in the requirement. This requirement does not address the materials approved on existing military standard (MS) drawings.

2. Applicable Documents.

L-P-410	Plastic, Polyamide (Nylon), Rigid, Rods, Tubes, Flats, Molded and Cast Parts
L-P-523	Plastic Sheet and Film, FEP-Fluorocarbon, Extruded
QQ-C-390	Copper Alloy Castings (Including Cast Bar)
QQ-C-450	Copper-Aluminum Alloy (Aluminum Bronze) Plate, Sheet Strip and Bar (Copper Alloy Numbers 606, 612, 613, 614 and 628)
QQ-C-530	Copper-Beryllium Alloy Bar, Rod and Wire
QQ-C-533	Copper-Beryllium Alloy Strip (Copper Alloy Numbers 170 and 172)
QQ-S-763	Steel Bars, Shapes and Forgings - Corrosion Resisting
ZZ-R-765	Rubber, Silicone
MIL-M-14	Molding Plastics and Molded Plastic Parts, Thermosetting
MIL-P-997	Plastic Material, Laminated, Thermosetting, Electric Insulation, Sheets, Glass Cloth, Silicone Resin
MIL-S-5000	Steel, Chrome-Nickel-Molybdenum (E4340) Bars and Reforging Stock
MIL-C-6021	Castings, Classification and Inspection of
MIL-H-6088	Heat Treatment of Aluminum Alloys
MIL-T-6736	Tubing Chrome-molybdenum, (4130) Steel, Seamless and Welded, Aircraft Quality
MIL-S-6758	Steel, Chrome-molybdenum, (4130) Bars and Reforging Stock (Aircraft Quality)
MIL-R-6855	Rubber, Synthetic, Sheets, Strips, Molded or Extruded Shapes
MIL-I-6868	Inspection Process, Magnetic Particle
MIL-H-6875	Heat Treatment of Steels, (Aircraft Practice), Process for
MIL-T-8504	Tubing Steel Corrosion-Resistant (304) Aerospace Vehicle Hydraulic Systems, Annealed, Seamless and Welded
MIL-S-8844	Steel Bar, Reforging Stock, and Mechanical Tubing, Low Alloy, Premium Quality
MIL-S-8949	Steel Bars, Plates, Sheets, Billets and Reforging Stock Type D6AC
MIL-T-9046	Titanium and Titanium Alloy, Sheet, Strip and Plate
MIL-T-9047	Titanium and Titanium Alloy - Bars, Forging and Forging Stock
MIL-P-15035	Plastic Sheet, Laminated, Thermosetting, Cotton-fabric-base, Phenolic Resin
MIL-S-25043	Steel Plate, Sheet, and Strip, 17-7 PH. Corrosion Resistant, Precipitation Hardening
MIL-R-25988	Rubber, Fluorosilicone Elastomer, Oil and Fuel-Resistant, Sheets, Strips, Molded Parts and Extruded Shapes
MIL-H-81200	Heat Treatment of Titanium and Titanium Alloys
MIL-T-81556	Titanium and Titanium Alloys, Bars, Rod and Special Shaped Section, Extruded

MIL-T-81915	Titanium and Titanium Alloy Castings, Investment
MIL-R-83248	Rubber, Fluorocarbon Elastomer, High Temperature, Fluid and Compression Set Resistant
MIL-STD-143	Standards and Specifications, Order of Precedence for the Selection of
MIL-STD-810	Environmental Test Methods
MIL-HDBK-5	Metallic Materials and Elements for Aerospace Vehicle Structures
AMS 2300	Premium Aircraft Quality Cleanliness - Magnetic Particle Inspection Procedure
AMS 2301	Aircraft Quality Steel Cleanliness - Magnetic Particle Inspection Procedure
AMS 3651	Polytetraflouroethylpne, (Teflon)
AMS 4890	Copper-Beryllium Alloy Castings, Investment 2 Be - 0.4 Co - 0.3 Si
AMS 5343	Steel Castings, Investment, Corrosion Resistant 16 Cr - 4.0 Ni -3.1 Cu Solution and Precipitation Heat Treated, 150,000 PSI (1034 MPA) Tensile Strength
AMS 5520	Sheet, Strip, and Plate - 15 Cr - 7.1 Ni - 2.5 Mo- 1.1 Al
AMS 5625	Bars High Expansion - 5.5 - Mo - 9-.5 Ni (O - 55 - 0.65 C) Cold Drawn
AMS 5626	Bars and Forgings - Tool, High Speed, 18 W - 4 Cr - 1 V
AMS 5629	Steel Bars, Forging, Tubing and Rings, Corrosion Resistant - 13 Cr - 8 Ni - 2.3 Mo - 1.1 Al Vacuum Induction + Consumable Electrode Melted
AMS 5639	Bars, Forgings, Tubing and Rings - 19 Cr 10 Ni
AMS 5643	Steel Bars, Forgings, Tubing, and Rings Corrosion Resistant 16.5 Cr - 4.0 Ni - 4.0 Cu
AMS 5659	Bars, Forgings and Rings 15 Cr - 5 Ni - 0.30 (Cb + Ta) 4 Cu Consumable Electrode Melted
AMS 5673	Steel Wire, Corrosion Resistant 17CR-7.lNl-l.lAl Precipitation Hardenable, Spring Temper
AMS 6304	Bars, Forgings and Mech. Tubing - 0.95 Cr -0.55 Mo - 0.30 V (0.40 - 0.50 C)
AMS 6440	Bars and Forgings - 1. 45 Cr (98-1. 10C) Bearing Quality
AMS 6441	Tubing, Mechanical - 1.45 Cr (.98-1 10C) Bearing Quality
AMS 6442	Bars and Forgings - .50 Cr (.98-1.10C) Bearing Quality
AMS 6444	Bars, Forgings and Tubing - 1.45 Cr (.98-1.10C) Premium Quality Consumable Electrode Vacuum Melt
AMS 6487	Bars and Forgings - 5.0 Cr - 1.3 Mo - 0.50 V. Premium Quality, Consumable Electrode Vacuum Melted (0.38 - 0.43 C)

3. General requirements.

3.1 General selection criteria. The selection of materials to be used in the design and construction of bearings and control system components for aerospace systems shall be made by the manufacturer and submitted to the prime contractor for approval. Particular attention shall be paid to the selection of standard materials to facilitate interchangeability, stocking and replacement in service. The number of different types, sizes, strengths and consumable bulk materials shall be kept to a minimum. Operational requirements to be considered include, but are not limited to, load distribution and magnitudes, temperature range, environments, reliability requirements and life expectancy. Since rate of deterioration in service is highly significant to the life expectancy of parts, special consideration shall be given to those deterioration modes which largely contribute to service failure. The modes include pitting corrosion, galvanic corrosion, exfoliation corrosion, stress corrosion cracking, corrosion fatigue, thermal embrittlement, creep, fretting fatigue, oxidation, hydrogen embrittlement, weathering and fungus growth. Precautionary measures should be considered which include limitations of design operating stress levels, shot penning, heat treatments which reduce corrosion susceptibility and protective coatings and finishes. Special consideration shall also be given to cost, reliability, reparability, inspectability and maintainability. The

requirements specified herein shall apply only for new design and shall not apply to components covered by existing Military Standard (MS) drawings. The requirements which apply to exempted components shall be as specified in the prime contract or as subsequently negotiated with the prime contractor.

3.2 Material specifications. All end item materials shall be procured to specifications. Procurement of materials to trade names and numbers is prohibited except where such materials are specifically called out in procurement specifications by trade name. The order of precedence for material specifications shall be in accordance with MIL-STD-143.

3.2.1 Seller specifications. For materials for which there are no preferred. Federal, Military, AMS or prime contractor material specification counterparts, seller specifications may be used subject to obtaining written approval of the prime contractor. Unique seller specifications may also require approval of the procuring activity. In those cases where the material is proprietary it may be exempted from this requirement if the procurement specification for the component part utilizing the proprietary product contains adequate technical requirements, quality assurance requirements and application limitations.

3.3 Design data and allowable materials properties. Design data and properties of materials shall be obtained from MIL-HDBK-5 or alternately from other sources subject to the approval of the prime contractor. Allowable properties based on static and fatigue test data may be used subject to the approval of the prime contractor. Properties other than those, contained in MIL-HDBK-5 shall be substantiated and analyzed in accordance with procedures used for corresponding data in MIL-HDBK-5.

3.4 Metallic material requirement.

3.4.1 Alloy steel.

3.4.1.1 Alloy steel selection criteria.

3.4.1.1.1 Quality. Alloy steels heat treated above 200 KSI FTU shall be procured as vacuum melt grade and shall meet the cleanliness requirements of AMS 2300. Alloy steels heat treated below 200 KSI FTU may be air melt grades meeting the cleanliness requirements of AMS 3201. Exception: Rolling element braking steels which are primarily used in thin sections loaded in compression may be air melt material, but finished parts must meet the requirements of MIL-I-6868.

3.4.1.1.2 Alloy limitations. Within their hardenability range, the following steels shall not be heat treated higher than the below listed ultimate tensile strength range or level.

41XX 1/, 43XX, 87XX Alloy Steels	<200 KSI
HP9 Ni - 4 Co - .200 -2/	190 - 200 KSI
H-11, AMS 6304	<240 KSI
HP9 Ni - 4 Co - .30C 2/ D6AC	220 - 240 KSI
300 M	280 - 300 KSI

1/ 41XX, when used as rod end body in rolling element rod ends, may have outer raceway case hardened. The affective case depth shall be from a minimum of 25 percent to a maximum of 50 percent of the ring thickness.

2/ Critical components requiring fracture toughness capability.

3.4.1.1.3 Procurement limitations. Alloy steel shall be selected such that the expected service temperature of the part does not violate the following considerations:

a. The ductile to brittle transition temperature of the steel shall be below any temperature likely to be experienced in service.

b. The maximum service temperature shall be at least 50°F below the tempering or aging temperature.

c. The operating temperature of the part shall not be within the temper brittle range for the alloy.

3.4.1.1.4 Hardenability. The hardenability of quench and temper grades shall be sufficient to ensure transformation of quenching to not less than 90% martensite at the center of maximum cross section. Use of compositions that result in excessive hardenability shall be avoided.

3.4.1.2 Recommended alloy steels. Alloy steel heat-treat combinations considered as having demonstrated satisfactory performance in service are listed in table I. Heat treatment shall be in accordance with MIL-H-6875.

3.4.2 Corrosion resistant steel (CRES).

3.4.2.l CRES selection criteria.

3.4.2.1.1 Quality. Heat treated CRES alloys for critical load carrying structures shall be procured as vacuum melted grades; e.g., PH 15-5 shall be procured to AMS 5659, 17-4PH to AMS 5643 (wrought products) or AMS 5343 (castings), and PH 13-8 Mo to AMS 5629. For magnetic particle inspection capability, PH 15-5 is preferred over 17-4PH for critical components.

TABLE l04-I. Recommended alloy steels.

Alloy	Specification	Usage
4130 1/ 4140 1/ 4340 1/ 4340	MIL-S-6758 or equiv 2/ MIL-S-5626 or equiv MIL-S-5000 or equiv MIL-S-8844, CL1	General (<200 KSI)
HP9 Ni-4 Co-.20	AMS 6525	High Toughness
H-11	AMS 6487 AMS 6304	High Strength
D6AC	MIL-S-8949	High Strength
HP9 Ni-4 Co-.30	AMS 6526	High Strength, High Toughness
300 M 50100 52100 GEVM 52100	MIL-S-8844, CL3 AMS 6442 AMS 6440, 6441 AMS 6444	Ultra High Strength High Hardness

1/ Alternately equivalent 86XX, 87XX alloy steel grades may be substituted.

2/ MIL-T-6736 for tubing applications.

3.4.2.1.2 Prohibited CRES alloys/conditions. The use of CRES alloys 431 and 19-9DL is specifically prohibited. The precipitation hardening or managing CRES alloys (PH series, Almar series, Custom series, etc.) shall not be heat treated to their high range of strength conditions, i.e., aged below 1000°F. As examples, this heat treatment restriction prohibits aging the following CRES alloys to the listed conditions: 17-4PH to Condition H900/H925, 17-7PH to Condition H/RH 950, Custom 455 to Condition H900/H950, 15-5PH to H900 and PH13-8 Mo to Condition H950. Martensitic 400 series CRES grades shall not be used in the 150-180 ksi strength range. Precipitation hardening or managing CRES alloys shall not be used in Condition A (solution treated or annealed).

3.4.2.1.3 Service temperature considerations. CRES alloys shall be selected such that the expected service temperature of the part will not violate the following considerations:

a. Maximum service temperature of precipitation hardening stainless steels shall be 750°F for extended periods of time.

b. Maximum service temperature of cold worked CRES shall be 400°F.

c. Maximum service temperature of unstabilized austenitic stainless steel shall be 700°F.

d. Operating temperature during design life (time) shall not soften, as detectable by hardness test, CRES strengthened by cold work.

3.4.2.2 Recommended CRES Alloys. CRES alloy heat treat combinations considered as having demonstrated satisfactory performance in service are listed in table II. While CRES selection is not limited to this list, choice of other alloys and heat treatments shall require justification.

TABLE l04-II. Recommended CRES alloys.

Class	CRES Alloy	Specification	Recommended Condition
Austenitic (Unstabilized)	301 302 304 1/ 301L 310 316 316L	 QQ-S-763	1/4 Hard and 1/2 Hard Cond. A and 1/4 Hard Cond. A & Cond. B
	304 5/	MIL-T-8504	Cond. A
Austenitic (Stabilized)	321 347	 QQ-S-763	 Cond . Q
Semi- Austenitic	17-7PH 4/ PH15-7 Mo	MIL-S-25043 AMS 5673 AMS 5520	CH900 CH900 TH1050
Precipitation Hardening	17-4PH 2/ 15-5PH 3/ PH13-8 Mo	AMS 5643 AMS 5659 AMS 5629	H1025 thru H1150 H1025 thru H1150 H1000
12 Cr Martensitic	410 420 1440C	 QQ-S-763	120 KSI Ftu Min & 180 KSI Ftu Min 120 KSI Ftu Min & 200 KSI Ftu Min Rc, 55 Min & Up

1/ 304 CRES per QQ-S-763 or AMS 5639 preferred when 302 not available.
2/ Except castings, Cond. H1000 is acceptable.
3 / Preferred material for critical applications ever 17-4PH.
4/ Spring Applications. MIL-S-25043 shall be used for leaf spring applications and AMS 5673 shall be used for coil spring applications.
5/ Tubing Applications.

3.4.3 Aluminum alloys.

3.4.3.1 Aluminum alloy selection criteria. Maximum corrosion resistance of aluminum alloy components is required. The limited general and stress corrosion resistance of high strength aluminum alloys (see paragraph 3.6, Definitions) require careful selection of composition, heat treatment, processing and mill product form. Stress corrosion resistant alloy/tempers shall be used for all parts fabricated from thick (0-5 and over) section mill products. While the use of special heat treatments and tempers (T611, T651, T652, polyalkalene glycol quench, etc.) may be desirable to reduce distortion or residual stresses, in no case shall it be considered to impart stress corrosion resistance to the base alloy.

3.4.3.2 Recommended aluminum alloys. Aluminum alloy/temper combinations considered as having demonstrated satisfactory performance in service are listed in table III. While aluminum alloy selection is not limited to this list, choice of other alloys/tempers shall require justification. Heat treatment of aluminum alloys shall be in accordance with MIL-H-6088.

TABLE 104-III. Recommended aluminum alloys.

Mill Product	Alloy	Temper
Hand & Die Forgings	7075	T73, T735X (<3.0")
	7175	T736, T736532 (<3.0")
	7049	T73, T735X (>3.0")
	7050	T736, T7365X
	6061	T6, T652
	2219	T6, T852
Tube	2024	T62
	6061	T4, T6, T62
Extrusions & Bar Stock	7075	T76, T7651X (<0.5")
	7075	T73, T7351X (>0.5")
	7049	T73, T7351X
	6061	T6, T651X
	2024	T62, TB51X
	2219	
Plate	7075	T7351
	7475	T7351 1/
	2024	T851
	2124	T851 (>1.5)

1/ High Fracture Toughness

3.4.4 Titanium alloys.

3.4.4.1 Titanium selection criteria. The use of titanium shall be limited to applications where cost and weight effectiveness can be demonstrated. Mill annealed Ti-6Al-4V shall be the primary alloy considered. For fracture critical applications, consider mill or beta annealed Ti-6Al-4V ELI; for higher strength applications, consider mill annealed Ti-6Al-6V-2Sn.

3.4.4.2 Recommended titanium alloys. Titaniun alloy/mill product combinations considered as having demonstrated satisfactory performance in service are listed in table IV. While titanium alloy selection is not limited to this list, choice of other alloys shall require justification. The specifications listed shall be used for procurement of the materials listed. Heat treatment of titanium alloys shall be in accordance with MIL-H-81200.

TABLE 104-IV. Recommended titanium alloys.

Alloy	Mill Product	Condition	Specification
Ti-6Al-4V	Sheet, Plate 1/	Annealed	MIL-T-9046
	Bar, Forging 1/	Annealed	MIL-T-9047
Ti-6A1-4V	Extrusion	Annealed	MIL-T-81556
	Casting	Annealed	MIL-T-81915
Ti-6Al-6V-2Sn	Sheet, Plate	Annealed	MIL-T-9046
	Bar, Forgings	Annealed	MIL-T-9047
Commercially Pure	Sheet	Annealed	MIL-T-9046
	Tube	Annealed	2/

1/ Beta Annealed Ti-6AI-4V ELI - No known MIL, Fed, AMS Fed, AMS Spec. use Company Specification.

2/ CP.40 Tubing per ASTM B-338 (GR2)

3.4.5 Copper base alloys.

3.4.5.1 Beryllium copper. For high bearing load applications, critical wear applications, and wear applications here good structural load capability is required, the use of beryllium copper is recommended. The preferred alloy is CA172. Wrought beryllium copper shall be procured to QQ-C-530 or QQ-C-533. Beryllium copper castings shall be procured to AMS 4890, classified (class and grade) per MIL-C-6021. Beryllium copper alloys are corrosion resistant and generally do not require a corrosion protection surface treatment. Beryllium copper will form a dark natural oxide (tarnish) which is generally considered to be beneficial to wear performance.

3.4.5.2 Aluminum bronze, bearing alloys. For moderate bearing loads, wrought CA630 aluminum-nickel bronze per QQ-C-450 is the preferred alloy. For lighter duty, the other wrought aluminum bronze alloys per QQ-C-450 will be acceptable. Aluminum bronze (alloys 952-958) and manganese bronze (alloys 861-868) castings are acceptable and, where used, shall be classified (class and grade) per MIL-C-6021, and procured per QQ-C-390. The use of bronze alloys other than those discussed above shall require justification.

3.4.6 Other alloys.

3.4.6.1 Nickel & cobalt base (superalloy) alloys. The use of nickel and cobalt base superalloys is acceptable. Castings shall be classified (class and grade) per MIL-C-6021. Nickel and cobalt base alloys do not require corrosion protection surface treatments.

3.5 Non-metallic materials.

3.5.1 General selection criteria.

3.5.1.1 Selection considerations. Organic materials shall have maximum practicable resistance to degradation and aging, This resistance shall include resistance to ozone, polymer reversion, hydrolysis, aircraft and GSE fluids and lubricants, fuel, heat aging, low and high temperature and weapons systems propellants. Organic materials shall also be selected so as to minimize the dangers resulting from smoke or fire hazards. The organic materials used shall be compatible with other materials they contact and, in particular, shall not induce or accelerate corrosion of metal structure they contact. Decomposition and other products, including volatile and reachable constituents, released by organic materials under normal operating conditions or curing shall not be injurious or otherwise objectionable with respect to materials, components, or personnel with which they come in contact. The aircraft parts and equipment shall be designed so that the materials are not nutrients for fungi except when used In permanent, hermetically sealed assemblies and other accepted and qualified parts such as paper capacitors and treated transformers. Other necessary fungi nutrient material applications require treatment by a method which will render the resulting exposed surface fungi resistant. Moisture resistance shall be considered as no permanent degradation of properties. The criteria for the determination of fungi and moisture resistance shall be that contained in MIL-STD-810.

3.5.1.2 Selection limitations. The use of polyester polyurethane elastomers for molded components, potting or sealing is prohibited. All organic materials having ester linkages shall be tested for hydrolytic stability. The use of natural leather and wood is prohibited.

3.5.2 Seals and molded elastomers.

3.5.2.1 Silicone. Molded silicone rubber products shall be procured to ZZ-R-765 class IIIB. Silicone rubber may be used to 500°F and shall not be used where contact with fuel or lubrication oil is likely. The long term weatherability of silicone rubber is excellent and its use is preferred over Neoprene.

3.5.2.2 Neoprene. Where used, Neoprene shall be procured to MIL-R-6855, class II, type A. Neoprene shall not be used above 220°F or for applications involving exposure to fuel or oil. Silicone rubber is preferred over Neoprene.

3.5.2.3 Fluorocarbon. Fluorocarbon (Viton) products shall be procured to MIL-R-83248. Fluorocarbon may be used within the temperature range -40°F to +450°F. Fluorocarbons are fuel and oil resistant.

3.5.2.4 Fluorosilicone. Fluorosilicone products shall be procured to MIL-R-25988. Fluorosilicone may be used in the temperature range -70°F to 400°F. Fluorosilicone is resistant to aircraft, fuels and oils.

3.5.2.5 Buna-N. Buna-N rubber products shall be procured to MIL-R-6855, class Buna-N rubber is resistant to aircraft oils and fuels. The maximum continuous service temperature for Buna-N shall be 220°F. Buna-N elastomers may be subjected to intermittent exposures in the 220° to 275°F range when specific military specifications or standards define service temperatures above 220°F. For example, the MS (Buna-N) "O" rings may be used for exposures up to 275°F and are acceptable for use in hydraulic systems. Buna-N elastomers per MIL-R-6855, class I or MIL-P-25732 are acceptable for low temperature service to -65 °F.

3.5.3 Plastics.

3.5.3.1 Fluorocarbon, Fluorocarbon, tetrafluoroethylene (TFE) and fluorinated ethylene propylene (FEP) plastics are recommended for low friction and chemical inertness requirements. TFE shall be procured to AMS 3651 and FEP shall be procured to L-P-523. Bonding of TFE and FEP products shall require etching of the TFE and FEP surface to be bonded.

3.5.3.2 Polyamide. Polyamide plastic is recommended for seals, bushings, guides and similar parts. The preferred material is Nylon 6/6 per L-P-410 in weather or wear grade for use up to 200°F. For applications up to 300°F use the heat resistant grade of Nylon 6/6. For electrical applications the low strength, low water absorption Nylon 6/10 grade per L-P-410 is recommended.

3.5.3.3 Reinforced plastic laminates. Reinforced plastic laminates may be used for guides, wear blocks, and similar parts. For exposures up to 200°F phonemic cotton laminates per MIL-P-15035 shall be used. For higher temperatures, up to 450°F, silicone fiberglass laminates per MIL-P-997 shall be used.

3.5.4 Lubricants. See requirement 203.

COATINGS, PLATINGS, AND FINISHES

1. Scope. This requirement establishes engineering criteria and requirements for the selection and application of optimum corrosion resistant procedures or processes for bearings and control system components for aerospace systems.

2. Applicable Documents.

QQ-N-290	Nickel Plating (Electrodeposited)
QQ-P-416	Plating, Cadmium (Electrodeposited)
TT-P-1757	Primer Coating, Zinc Chromate, Low Moisture Sensitivity
MIL-S-5002	Surface Treatments and Inorganic Coatings for Metal Surfaces of Weapons Systems
MIL-C-5541	Chemical Conversion Coatings on Aluminum and Aluminum Alloys
MIL-T-5544	Thread Compound, Antisieze, Graphite-Petrolatum
MIL-F-7179	Finishes and Coatings, Protection of Aerospace Weapons Systems, Structures and Parts; General Specification for
MIL-B-7949	Bearing, Ball, Airframe, Anti-friction
MIL-A-8625	Anodio Coatings, for Aluminum and Aluminum Alloys
MIL-C-8837	Coating, Cadmium (Vacuum Deposited)
MIL-T-10727	Tin Plating; Electrodeposited or Hot Dipped, for Ferrous and Nonferrous Metals
MIL-C-11796	Corrosion Preventative Compound, Petrolatum, Hot Application
MIL-C-16173	Corrosion Preventative Compound, Solvent Cutback, Cold Application
MIL-P-16232	Phosphate Coatings, Heavy, Manganese or Zinc Base (for Ferrous Metals)
MIL-C-23217	Coating, Aluminum, Vacuum Deposited
MIL-P-23377	Primer Coatings, Epoxy Polyamide, Chemical and Solvent Resistant
MIL-C-26074	Coating, Nickel-Phosphorous, Electroless Nickel, Requirements for
MIL-S-81733	Sealing and Coating Compound, Corrosion Inhibitive
MIL-C-81751	Coating Metallic-Ceramic
MIL-C-83488	Coating, Aluminum, Ion Vapor Deposited
MIL-STD-870	Cadmium Plating, Low Embrittlement, Electrodeposition
MIL-STD-1568	Materials and Processes for Corrosion Prevention and Control in Aerospace Weapons Systems
AMS 2419	Cadmium-Titanium Alloy Plating

3. Requirements.

3.1 General. All new weapon system contracts require the submittal of a finishing corrosion control document of the complete system for approval by the procuring activity. In general, the corrosion control document as required by MIL-STD-1568 must conform to the requirements of MIL-S-5002 and MIL-F-7179 but with some exceptions as modified by each individual contract. With some functional components such as bearings, the requirements of MIL-S-5002 and MIL-F-7179 cannot be met or are not practical and specific deviations must be obtained. The following specific requirements are intended to clarify or modify the corrosion control procedures for bearings and other control system components.

3.2 Finished bearings or other components. In those cases where the bearings (or other components) are covered by a military specification, the specified finish shall be acceptable even though it does not meet all of the requirements of MIL-S-5002 and MIL-F-7179. For bearings (or other components) not covered by a military specification, the following deviations shall be considered on a case-by-case basis.

3.2.1 Rolling element bearings.

3.2.1.1 Cadmium plate per QQ-P-416, type I, class 2 is acceptable for use in place of type, II, class 2 plating in those cases where subsequent machining and handling will result in damage to the dichromate conversion coating and lead to rejections due to appearance characteristics. Examples of such components are ball, roller, and needle bearing races and ball and roller bearing rod end bodies.

3.2.1.2 Grease or oil lubricated bearings fabricated of AISI 440C steel require no supplemental corrosion protection and no supplemental corrosion protection is required on the raceways, balls, rollers, or needles of low alloy steel bearings when grease or oil lubricated.

3.2.2 Plain and plain spherical bearings.

3.2.2.1 Grease lubricated bearings shall require no supplemental corrosion protection on the functional wear surface. The nonfunctional surfaces shall be cadmium plated per QQ-P-416, type II, class 2, except when in contact with titanium in which case the nonfunctional surfaces shall be tin plated per MIL-T-10727. For plain spherical bearings where the inner race (ball) is either beryllium copper or aluminum bronze, no supplemental corrosion protection shall be required on any surface of the inner race.

3.2.2.2 For TFE lined plain spherical bearings where the inner race (ball) is AISI 440C steel, no supplemental corrosion protection shall be required on any surface of the inner race.

3.2.2.3 Dry film coated bearings shall require no supplemental corrosion protection on the functional wear surfaces where these surfaces are AISI 440C steel, beryllium copper, or aluminum bronze.

3.3 Installation of bearings/bushings in housing. The interface between the bearing/bushing OD and housing ID involves a number of different metal and coating/plating combinations and all must be adequately treated for corrosion resistance in order to prevent corrosion of the housing. The bearing/bushing OD will be either a corrosion resistant material or will be plated/coated with an appropriate material at the time of fabrication. The housing material can be any of the structural metals presently used for aerospace applications and if not properly protected will result in unacceptable dissimilar metal combinations. Table I is a listing of dissimilar metals and table II is a corrosion rating sheet for materials used in aerospace system. The required corrosion protection for the various combinations of metals are described in the following paragraphs. In all cases except where adhesive bonding is used, or where the bearing OD has lubrication grooves and holes, both the bearing OD and housing ID shall be coated with zinc chromate primer per TT-P-1757, epoxy primer per MIL-P-23377, or sealant per MIL-S-81733 and the bearing installed wet. The remaining surfaces of the parts shall be finished in accordance with the applicable finish documents and engineering requirements. For bearings with lubrication grooves, the housing ID and bearing OD shall be coated with the grease specified for the bearing. The requirements for adhesively bonded bearings are controlled by other specifications.

3.3.1 Titanium versus titanium. No additional corrosion protection required.

NOTE: Coating, plating, or other surface treatment to produce adequate antifretting characteristics shall be considered for each application and provided when deemed necessary.

3.3.2 Titanium versus Corrosion resistant alloys. No additional corrosion protection required other than passivation of the CRES.

3.3.3 Titanium versus aluminum alloys. The aluminum alloy shall be anodized per MIL-A-8625, type I or type 11, or coated per MIL-C-5541, class IA, depending upon the surface treatment required by the finish document for the alloy in question. The edges shall be touched up after installation with the MIL-P-23377 epoxy primer or other equivalent primer or sealant so that all nonfunctional surfaces of the aluminum are primed or sealed.

3.3.4 Titanium versus low alloy steels. Where practical, the low alloy steel shall be electroless nickelplated per MIL-C-26074, grade C, class I or electroplated nickel per QQ-N-290, class II. Where plating is not practical, the low alloy steel shall be phosphate coated per MIL-P-16232.

3.3.5 Magnesium. Magnesium and magnesium alloys are prohibited from general use in these applications. Approval by the procuring activity is required for each application for which use of these materials is proposed. Approval of the appropriate corrosion protection for the application is also required.

3.3.6 Aluminum versus aluminum. Both the bearing OD and the housing ID shall be anodized per MIL-A-8625, type I or type II; or coated per MIL-C-5541, class IA, depending upon the surface treatment required by the finish document for the alloy in question. The edges shall be touched up after installation with the MIL-P-23377 epoxy primer or other approved primer or sealant so that all nonfunctional surfaces of the aluminum are primed or sealed.

3.3.7 Aluminum versus corrosion resistant alloys. The aluminum alloy shall be anodized per MIL-A-8625, type I or type II; or coated per MIL-C-5541, class IA, depending upon the surface treatment required by the finish document for the alloy in question. The edges shall be touched up after installation with the MIL-P-23377 epoxy primer or other approved primer or sealant so that all nonfunctional surfaces of the aluminum are primed or sealed.

TABLE I. Dissimilar metals.

Group 1	Group 2	Group 3	Group 4	Group 5
3000, 5000 and 6000 series aluminum alloys	Aluminum alloys (all)			
Tin	Tin	Tin		
	Zinc			
	Cadmium			
	Tin-lead (solder)			
	Beryllium			
		Low alloy steel		
		CRES	CRES	
		Lead		
		Nickel alloys	Nickel alloys	
		Titaniun	Titanium	
			Chromium	
			Copper	Copper
			Brass	Silver
			Bronze	Graphite
			Beryllium	Gold
			Copper	Palladium
			Aluminum	
			Bronze	

NOTES:
1. Of the metals listed, those appearing in any one group are considered similar; those appearing in different groups only are dissimilar.

2. In the case of plated metal, the identity of the plate determines similarity; for example, cadmium plated steel is “similar” to aluminum, nickel plated steel is not.

TABLE II. Corrosion rating sheet.

Poor	Fair	Good	Excellent
Aluminum	Aluminum	PH Steels	300 Series CRES
Bare 2000 Series	Bare 1100	17-4PH	
Bare 7000 Series	Bare 3003	17-7PH	A286
	Bare 5000	15-7PH	
	Bare 6000	13-8PH	
	Clad 2000		
Low Alloy Steel	Clad 7000	Nickel	Inconel
PH 9-4-20			
PH 9-4-30	400 Series CRES		Rene 41
AM-355			
AISI 4340			
AISI 4130			Titanium
AISI 52100			

3.3.8 Aluminum versus low alloy steels. The aluminum alloy shall be anodized per MIL-A-8625, type I or type II; or coated per MIL-C-5541, class IA, depending upon the surface treatment required on the finish document for the alloy in question. The low alloy steel shall be plated (coated) with one of the following:

a . Cadmium plate per QQ-P-416, type II, class 2 where tensile strength is less than 180,000 psi

b. Vacuum deposition cadmium plate per MIL-C-8837, type II, class 2 where tensile strength is over 180,000 psi

c. Ti-cad plate per AMS 2419-3

d. Metallic ceramic coat per MIL-C-81751, type I. class 4

e. Ion vapor deposited aluminum per MIL-C-83488

f. Low embrittlement cadmium plate per MIL-STD-870.

The edges shall be touched up after installation with the MIL-P-23377 epoxy primer or other equivalent primer or sealant so that all nonfunctional surfaces of the aluminum are primed or sealed.

3.3.9 Corrosion resistant alloy versus corrosion resistant alloy. No additional corrosion protection required other than passivation.

3.3.10 Corrosion resistant alloy versus low alloy steel. The low alloy steel shall be plated (coated) with one of the following:

a. Electroplated nickel per QQ-N-290, class 2, grade A

b. Metallic-ceramic coat per MIL-C-81751, type 1, class 4

c. Electroless nickelplate per MIL-C-26074, grade C, class I.

The edges shall be touched up after installation with the MIL-P-23377 epoxy primer.

3.3.11 Low alloy steel versus low alloy steel. Both bearing OD and housing ID shall be plated (coated) with one of the following:

a. Cadmium plate per QQ-P-416, type II, class 2 where tensile strength is less than 180,000 psi.

b. Vacuum deposition cadmium plate per MIL-C-8837, type II, class 2 where tensile strength is over 180,000 psi,

c. Ti-Cad plate, per AMS 2419-3

d. Metallic ceramic coat per MIL-C-81751, type 1, class 4,

e. Electroless nickelplate per MIL-C-26074, grade C, class 1,

f. Electroplated nickel per QQ-N-290, class 2, grade A

g. Ion vapor deposited aluminum per MIL-C-83488

h. Low embrittlement cadmium plate per MIL-STD-870

The edges shall be touched up after installation with the MIL-P-23377 epoxy primer.

NOTE: The combination of cadmium plate versus nickelplate, shall be avoided.

3.4 Installation of shafts (pins) into bearing bores. The shafts (pins) that are installed through the bearing bores will be either standard military or industry type fasteners; or special company designs because of specific design requirements. In all cases where corrosion protection is required because of the specific shaft (pin) material, the appropriate plating (coating) will be specified by the military or industry standard; or the individual company print. No additional corrosion protection is required on the bearing bores regardless of the metal involved. For example, airframe control ball bearing fabricated in accordance with specification MIL-B-7949 are supplied with bare (unplated) low alloy steel (AISI 52100) inner race bores but no added corrosion protection is required. In some cases, certain requirements may necessitate the use of added corrosion protection at the time of shaft installation. This will be called out as a specific requirement on the assembly drawing.

3.5 Adjustable parts. Threads of adjustable parts such as tie rods, cable terminals, rod end clevis' turn buckles, and cam followers shall be protected both before and after assembly with antisieze compound conforming to MIL-T-5544; or protected with corrosion-preventative compound conforming to MIL-C-16173, grade 2 or grade 4, or MIL-C-11796, class 3 unless otherwise called out on the applicable drawing.

TESTING

The quality and reliability of bearings used in aerospace mechanical systems is directly related to the testing of those components to verify their capability to perform as required.

MODIFICATION OF PARTS

1. Scope. This requirement establishes the procedures which shall be used when an activity, either in the Government or an Original Equipment Manufacturer (OEM), proposes to create a new part through modification of a standard part. While it is always preferable to use approved standard parts in the design and construction of aircraft, and equipment, it is recognized that there will be cases when special parts are required. In some of those special cases, the desired part can be obtained through a simple modification of an existing approved standard part. This requirement describes the conditions which must be met for modification of parts, methods of their identity, and the part approval process.

2. General information on modification of parts.

2.1 Modified part. A modified part or altered part is a standard approved part, listed in the appropriate requirement in MIL-HDBK-1599, which is subjected to a physical change after manufacture and certification to the requirements of the applicable standard or specification; which conforms to the requirements of Section 3 of this Requirement 107; and which has been approved in accordance which Section 4.

2.2 Examples of acceptable alterations. The following are examples of alterations to approved standard parts which may be considered for acceptance under the approval procedures of Section 4 of the requirement. This is not an all inclusive list of examples, consequently, the absence of a particular alteration should not preclude its consideration. Conversely, the presence of an alteration in this listing does not assure its approval in any given situation

a. The part is altered to provide selected tolerances within the tolerance range of the standard approved part.

b. Internal clearances of bearings are held to lower requirements than the standard approved bearing.

c. Holes for safetying are produced in the part without detrimentally affecting physical strength of the part.

d. Existing lightening holes in parts are filled with material after parts are manufactured.

e. The length of rod ends or other threaded parts are shortened after parts are manufactured.

f. Removal of small amounts of material from non-functional surfaces, such as the ball face of spherical bearings.

g. Relubrication of bearing with the same or alternate grease listed on specification sheet.

2.3 Examples of unacceptable alternations. The following are alternations which shall not be permitted for modification of parts under this requirement. This list may be amended from time to time.

a. The change of grease specification of a bearing to one not listed on specification sheet.

b. Any of the materials from which the part is manufactured is changed.

c. Any dimensional change which may affect the function, load carrying capability or life of the component which would therefore require requalification of the part.

2.4 Preference for approved standard parts. Use of approved standard parts listed in MIL-HDBK-1599 is required whenever a part can be found in the standardization system which has the required characteristics and attributes. Modification of parts shall be considered only when use of a standard part is not practicable. (The modification of parts process shall never be used to bypass the standardization parts system or a parts control program, rather it shall be used as one element of the standardization and parts control program.)

3. Requirements of modification of parts. In order for a part to be considered for approval as a modified part under the terms of this requirement it must meet the specific requirements of this section. An altered part which does not meet these requirements, or which has not been approved in accordance with procedure of Section 4, is an unapproved part.

3.1 Effect on performance. The modification shall have no effect on the performance characteristics of the part.

3.2 Effect of physical properties. The modification shall not detrimentally effect the material properties such as heat treat condition, strength, ductility, etc.

3.3 Refinishing modified parts. Parts modified in such a manner that original platings, coating, or finishes are removed or altered shall be replaced, recoated, or refinished to the same specifications required for the original part when possible, or finished sufficiently to serve the protective or lubrication function served by the original finish, plating, or coating. Any procedures such as post baking to prevent hydrogen embrittlement shall be required for the modified part.

3.4 Responsibility for modification, part integrity, and qualification. The modification must be accomplished by (1) the original part manufacturer, (2) the agency or OEM specifying the modification, or (3) a sub-contractor selected and monitored by the agency or OEM specifying the modification. Parts modified in accordance with this Requirement 107 are considered qualified by similarity to the standard approved parts from which they are made. The activity specifying the modification shall assume responsibility for ensuring that the performance and integrity of the part is unimpaired by the physical performance of the modification except when the modification is accomplished by the original part manufacturer. In that case, the original manufacturer shall assume responsibility for the performance and integrity of the modification part.

4. Approval of modified parts. The activity seeking approval of a part as a modified part shall show that the modification meets the requirements of Section 3 and that the modification is not by any of the means specified in paragraph 2.3. The approval procedure shall be that specified in Requirements 101 for unapproved parts.

5. Identification of modified parts. Standard approved parts which are modified in accordance with this requirement shall be reidentified. The parts shall not be identified by altering the standard part number. Parts may be identified by manufacturer's new part number, company standard part number, or drawing number of a specific engineering project. The original part manufacturer's logo must be obliterated and reidentified with a modifier when the part is not modified by the original part manufacturer.

SCREW THREADS, APPLICATIONS IN AIRFRAMES AND SYSTEMS

1. Scope. Thread forms and specifications defined as standards approved herein or in specifications cited by standards approved herein, or specifically directed by other requirements herein shall apply as specified. This requirement establishes criteria for the selection and use of thread forms, specifications, and applications for use in design or modification of bearings, rod ends, and control system hardware and directly mating components, and in the selection of mating components.

2. Applicable Documents.

MIL-S-7742	Screw Threads, Optimum Selected Series
MIL-B-7838	Bolt, Internal Wrenching, 160 KSI FTU
MIL-S-8879	Screw Threads, Controlled Radius Root
FED-STD-H28/2	Screw-Thread Standards for Federal Services
MIL-STD-1312	Fasteners, Test Methods
MS 14198	Look, Rod End, Extra Strength, High Profile Lug
NAS 513	Washer, Rod End Looking
NAS 1348	Threaded Alloy Steel

3. Requirements.

3.1 Basic thread data.

3.1.1 Standard, optimum selected series. Basic data for standard, optimum selected series shall be as specified in MIL-S-7742 and FED-STD-H28/2.

3.1.2 Controlled radius root with increased minor diameter. Basic data for controlled radius root with increased minor diameter shall be as specified in MIL-S-8879.

3.1.3 External threads.

3.1.3.1 External thread generation. External threads on solid shank rod ends, links and control rods made of material with strength levels of 150 KSI or greater shall be rolled in accordance with 3.1.3.4 and shall conform to MIL-S-8879. External threads of bearing races, retaining nuts and hollow shank rod ends shall be in accordance with MIL-S-7742 or preferably MIL-S-8879, and shall be machined or ground. External threads on materials with strength levels of less than 150 KSI may be rolled in accordance with 3.1.3.4 or machines to form. Machined threads shall be smooth and devoid of abrupt tool marks. For future standards preparation, consideration may be given to rolling all external threads in accordance with MIL-S-8879 regardless of strength levels.

3.1.3.2 Lead threads. The threaded end of the rod or shank shall be flat and chamfered approximately 0.5 pitch. The lead threads may be less than the minimum diameter size limits of the thread form for a length not to exceed two pitches including the lead chamfer as specified in MIL-B-7838 (see figure 108-1).

3.1.3.3 Thread run out (imperfect threads). Run-out threads are permissible next to grip section. Run out shall fair into the shank or fillet, eliminating an abrupt change in the cross-sectional area, and shall terminate not less than 0.25 pitch from the grip dimension, as specified in MIL-B-7838 and MIL-S-7742 (see figure 108-1). If fatigue failure may be considered A probability, a thread relief with generous radii should be used.

3.1.3.4 Thread rolling. Rolled threads shall be fully formed by a single rolling process, at room temperature or elevated temperature compatible with material properties, after all thermal treatment except the bake after plate as specified in MIL-B-7838.

3.1.3.5 Rolled thread discontinuities. Multiple laps are not permissible regardless of location. A single lap is permissible on either the pressure or nonpressure flank if it is above the pitch diameter and extends toward the thread crest. A single crest lap is permissible (figure 108-2). Maximum permissible depth of discontinuities is shown in table 108-1.

3.1.3.6 Grain flow. The grain flow in the threads shall be continuous and shall follow the general thread contour with the maximum density at the root radius, as specified in MIL-B-7838 (see figure 108-3).

3.1.4 Internal threads.

3.1.4.1 Internal thread generation. Internal threads shall conform to MIL-S-8879. Flanks and roots shall be smooth and free of abrupt tool marks.

3.1.4.2 Thread path. The internal thread entry surface shall be chamfered 1 to 2 pitches deep. Blind threads shall have 1.5 to 2 runout threads at the bottom of the hole, extending beyond the required perfect thread depth requirement.

3.1.5 Load determination. Load determination shall be as specified in MIL-STD-1312.

3.1.6 Tensile stress areas. Tensile stress areas for MIL-S-8879 threads on solid shanks for external threads shall be as specified in NAS 1348. Tensile stress areas for MIL-S-7742 threads shall be in accordance with FED-STD-H28.

3.1.7 Metallurgical examination. Metallurgical examination shall consist of macro or micro examination of threads as follows:

Thread grain flow	Micro 5OX or greater
Discontinuities	Micro 5OX or greater

3.1.8 Threaded keyways. Threaded keyways shall conform with table 108-II and shall meet requirements of NAS513 and MS14198.

3.1.8.1 Keyways in external threads shall be generated after threading is complete and shall be deburred to allow free passage into receiving member without catch or bind.

4. Selection.

4.1 External threads. External threads shall conform to 3.1.3.1.

4.2 Internal threads. Internal threads shall conform to 3.1.4.1 and 3.1.4.2.

4.3 Exceptions.

4.3.1 Threaded components of assemblies. Threaded components of assemblies used on or attached to the airframe or systems of the aircraft may be to the standard of the manufacturer of the assembly if such threads are not, subjected to the stresses impressed directly on the airframe or system. This exception applies to such articles as electrical switch gear or flight instruments.

4.3.2 Other thread forms. Special thread forms, multiple threads not conforming with MIL-S-7742 or MIL-S-8879, as noted in 4.1, 4.2, and 4.3.1, used directly in structures or systems shall require approval of the prime contractor.

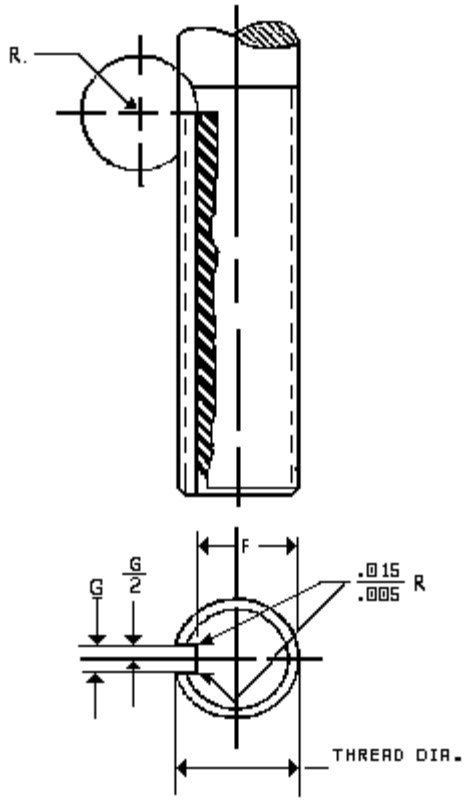
4.3.3 Ground equipment and structure. Unless otherwise specified, ground equipment and structures shall not be bound by this requirement.

TABLE 108-I. Permissible discontinuities.

	Max depth normal to surfaces						
Thread size	.1300 to .1900	.2500 to .3750	.4375 to .5000	.5625 to .6250	.7500 to	.8750 to	1.000 & larger
Depth	.004	.005	.006	.007	.008	.009	.011

TABLE 108-II. Threaded rods or shanks using NAS 513 lock washer

Thread Dia. (Ref)	G +.005 -.000	F +.000 -.005	R
.250	.062	.201	1/4
.312	.062	.260	1/4
.375	.093	.311	1/4
.437	.093	.370	1/4
.500	.093	.436	1/4
.562	.125	.478	1/4
.625	.125	.541	1/4
.750	.125	.663	1/4
.875	.156	.777	5/16
1.000	.156	.900	5/16
1.125	.187	1.010	3/8
1.250	.187	1.136	3/8
1.375	.250	1.236	7/16
1.500	.250	1.361	7/16
1.625	.250	1.477	7/16
1.750	.312	1.589	1/2
1.875	.312	1.714	1/2
2.000	.312	1.839	1/2
2.125	.312	1.955	1/2
2.250	.312	2.080	1/2



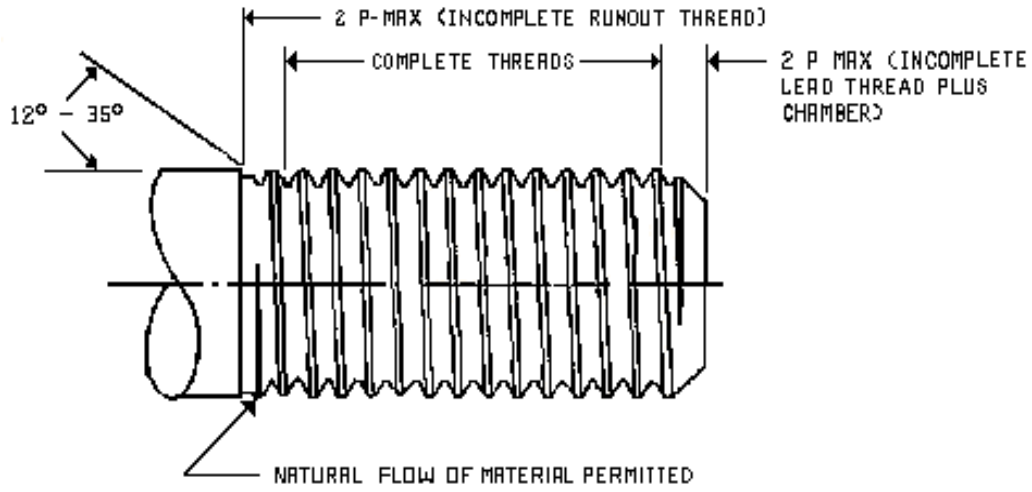


FIGURE 108-1. Thread pitch.

FIGURE 108-2. Laps and surface discontinuities.

FIGURE 108-3. Rolled Thread flow lines.