

# MILITARY SPECIFICATIONS

PROCESS	SPECIFICATION	THICKNESS	REMARKS
<p>ANODIZE TO AEROSPACE MATERIAL SPECIFICATIONS (AMS)</p> <p>AMS anodizing specifications are similar to MIL-A8625.</p> <p>The major differences are in the testing requirements.</p> <p>All AMS specs do not allow production parts to run until preproduction samples have been approved or waived in writing by purchaser. Coating weight test is generally required on a lot basis. Additional and/or specific test may required.</p>	AMS-2468E	Hard coat 0.002"	Salt spray test is not a requirement.
	AMS-2469D	Hard coat 0.002"	Salt spray test is a requirement (when sealed) for 240 hours. No corrosion spots allowed at all.
	AMS-2470H	Chromic acid process Sulfuric acid process-no	
	AMS-2471D	Dye coating	336 hours salt spray test required and controlled on 2024-T3 aluminum.
	AMS-2482A	Hard coat 0.002" with Teflon	336 hours salt spray test required. Coefficient of friction test required.
<p>BLACK OXIDE COATING</p> <p>A uniform black coating for ferrous metals.</p> <p>Mostly a decorative coating. Only very limited corrosion protection under mild corrosion conditions.</p> <p>Black oxide coatings should normally be given a supplementary treatment (i.e. oil displacement)</p> <p>Per MIL-C-16173 Grade 3 protective treatments of MIL-C-16173</p>	MIL-C-13924C	No dimensional Change	For moving parts that cannot tolerate the Dimensional change of a more corrosion resistant finish.
	Class 1 _____		For decorative applications and may also be used to decrease light reflection.
	Class 1 _____		Alkaline, oxidizing.
	Class 3 _____		For wrought iron, cast and malleable irons, plain carbon, and low alloy steels.
	Class 4 _____		For corrosion resistance steel alloys that are tempered at 900F (482C) or higher.
			Fused salt oxidizing Alkaline oxidizing. For 300 series corrosion resistant steel alloys only.
<p>CADMIUM</p> <p>Bright silvery white.</p> <p>Supplementary treatments for type II can be golden, iridescent, amber, black, olive drab. Corrosion resistance is very good especially with type II finish.</p> <p>Type II shall show no surface corrosion products after 96 hours (5%) salt spray exposure.</p> <p>Parts with hardness greater than Rc-40 shall be stress relieved before cleaning and plating. Parts subject to flexure (springs, etc.) Over Rc-40 hardness shall be given a 375±25 F post bake. <u>Salt spray test</u></p> <p>Type II Class 1 test period for White Corrosion products: 96 hours.</p>	QQ-P-416E		No supplementary treatment.
	Type I		Supplementary chrome treatment.
	Type II		Supplementary phosphate treatment.
	Type III		Type II best for corrosion resistance. Type III is used as a paint base.
	Class 1	.0005" min.	Excellent for plating stainless steel that are to be used in conjunction with aluminum to prevent Galvanic corrosion.
	Class 2	.0003" min.	
	Class 3	.0002" min.	

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<p><b>CHEMICAL FILMS</b> Coatings for aluminum. Color can vary from colorless to golden-iridescent-brown. Materials should conform to MIL-C-81706. Coatings shall be continuous, free from powdery areas, breaks, scratches, etc.</p>	MIL-F-495E	No dimensional changes.	<p>Class 1A is used as a corrosion preventative film (unpainted) or to improve adhesion of paint finish systems. Class 3 is used as a corrosion preventative film for electrical and electronic applications, where low resistance contracts are required.</p>
<p><b>CHEMICAL FINISH; BLACK</b> A uniform black corrosion retardant for copper. Coating has no abrasion resistance.</p>	MIL-F-495E	No dimensional change.	<p>Used as a base lacquer, light oil, or wax. For decorative, optical, and corrosion retardant applications.</p>
<p><b>CHROME</b> Excellent hardness (RC68-74). Were resistance, and erosion resistance. Has low coefficient of friction, and is resistant to heat.</p>	<p>QQ-C-320B Type I Type II Class I  Class 2</p>	<p>.0001" min. chrome on all visible surfaces As specified on drawing. If thickness is not specified, min. thickness shall be 0.002"</p>	<p>Bright Satin Corrosion protection finish or the "decorative" Finish used in a conjunction with copper and nickel as undercoatings prior to the chrome finish Plate directly on base metal.</p>
<p><b>CHROMIC ANODIZE</b> Color will vary from light gray to dark gray depending on alloy. Not as readily dyed as sulfuric anodize. Salt spray requirement is 336 hours (5% solution per method B-117 of ASTM). Minimum weight for Type I &amp; Type IB coatings: Class I 200 mg/sq.ft. Because of thinness will scratch easily. Can be used for inspection of aluminum forgings or castings by noting evidence of chromic acid Bleed out from laps, cracks, seams, etc.</p>	<p>MIL-A-8625F  Type I  Type IB  Class I  Class 2</p>	<p>0.00002"-.00003"</p>	<p>Conventional coatings produced from chromic acid bath. Unless otherwise specified, coating will be sealed. Metal salt sealants should not be used on items that will be panted.  Low voltage chromatic acid anodizing 22V.  Non-dyed (natural, boiling D.I. water sealing). Dyed. Shall not be applied to aluminum alloys with over 5.05 copper 7.0% silicon, or total alloying constituents over 7.5%. When copper content is less than 4.6% and for all suitable casting alloys be sure aluminum is tempered (such as T4 or T6).</p>

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<b>COPPER</b> Copper in color and matte to very shiny finish. Good corrosion resistance when used as undercoat. A number of copper processes are available. Each design for a specific purpose: brightness: (to eliminate the need for buffing) High speed: for electroforming) Fine grain: (to prevent case hardening)	MIL-C-14550B	Unless otherwise specified: 0.001"-0.005" 0.001"  0.0005" 0.0002" 0.0001"	For heat treatment stop-off For carburizing and decarburizing shield, also plated through printed circuit board. As an undercoat for nickel and other platings. To prevent basis metal migration into tin (prevents poisoning solderability).
	Class 0		
	Class 1		
	Class 2		
	Class 3		
Class 4			
<b>ELECTROLESS NICKEL</b> Similar to stainless steel in color. Plates uniformly in recesses and cavities (dose not build up on edges). Corrosion resistance is good for coatings over .001" thickness electroless Nickel is used extensively in salvage of mismachined parts. Also, inside dimensions and irregular shapes (where assembly tolerances need uniformity provided by electroless process). This spec dose not specify the phosphorous content in the EN deposit provided it passes 100 hours salt spray test at 1.0 mil for AL and 1.5 mil for steel. Please note: this specification is provided for reference purpose only as it has been canceled.	MIL-C-26074E	Unless otherwise specified:  0.0010" min. 0.0005" min. 0.0015" min.	As coated Steel and other base metals heat treatable to improve hardness. Aluminum and other base metals not heat treatable. Aluminum alloy, heat treatable of the nickel deposit  Aluminum alloys will be grade A. Cu, Ni and Co alloys will be grade C.
	Class 1		
	Class 2		
	Class 3		
	Class 4		
	Grade A		
	Grade B		
Grade C			
<b>ELECTROLESS NICKEL</b> Low-phosphorus EN Low-phosphorus( 8% max) EN These two AMS spec are similar. AMS-2405 is more specific. Both specs require the N to pass 48 hours salt spray test for steel (at 1.0 mil/min), but no requirement for aluminum. Both specifications require no plating on production parts unless preproduction samples have been approved or waived in writing by purchaser. EN deposit may be hardened by heating at 750 F for steel, but only when specified.	AMS-2404C	As specified on drawing.	AMS-2404C dose not specify the phosphorus content while the AMS-2405B says "P" to be 8% max. No specific hardness numbers defined by these two specs the EN deposit.
	AMS-2405B	As specified on drawing.	

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ELECTROLESS NICKEL 3-13% phosphorous EN deposit. More stringent, specific and detailed than MIL-C-26074 and AMS-2405. Ordering data must be complete.	ASTM-B733-90	Range from 0.0002" 0.0024"	ASTM specification requires the purchaser to well define the "type," "class," "service condition," "composition," etc on ordering documents.
ELECTROPLISHING Process electrolytically removes or diminishes scratches, burns and unwanted sharp edges from most 300 series stainless steel alloy. Finishes from satin to mirror-bright are produced by controlling time, temperature, or both.	(No Mil Spec)	Typical material removal: 0.0002"	Typical dimensional reduction of 0.0002" per surface. Process is not recommended for close tolerance surfaces.
GOLD Yellow to orange color depending on proprietary process used. Will range from matte to bright finish depending on basis metal. Good corrosion resistance and has high tarnish resistance. Provides a low contact resistance, and is a good conductor. Has excellent solderability. Unless otherwise specified, an intermediate nickel plate is required on copper base alloys or copper plated surfaces prior to gold plating.	MIL-G-45204C Type I  Type II Type III Class 00 Class 0 Class 1 Class 2 Class 3 Class 4 Class 5 Class 6	Unless otherwise specified:  0.00002" min. 0.00003" min. 0.00005" min. 0.00010" min. 0.00020" min. 0.00030" min. 0.00050" min. 0.00150" min.	99.7% gold min. 99.0% gold min. 99.9% gold min. Grade a 90 Knoop max. Grade B91-129 Knoop Grade C 130-200 Knoop Grade D above 200 Knoop  Type I (grades A, B or C) Type II (Grade B, C, or D) Type III (Grade A only)
HARD ANODIZE WITH PTFE Similar to hard anodize per MIL-A-8625 Except that PTFE such as Teflon shall be applied onto the hard anodize finish. Must pass 1,000 hours salt spray test.	MIL-A-63576A  Type I	Unless otherwise specified:  0.002"- + 0.0002"	This specification has a Type II (thermoplastic resin) And type III (thermoplastic resin)

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<p><b>HARD ANODIZE</b></p> <p>Color will vary from light tan to black depending on alloy and thickness. Can be dyed in darker colors depending on thickness. Coating penetrates base metal as much as builds up on the surfaces. The term thickness includes both the build-up and penetration. Provides very hard ceramic type coating. Good dielectric properties. Corrosion resistance is good, but recommend seal hard anodize in 5% dichromate solution where increased corrosion resistance is required. When extreme abrasion resistance is required, do not seal as some softening is encountered.</p>	<p>MIL-A-8625F</p> <p>Type III</p> <p>Class I</p> <p>Class II</p>	<p>As specified on drawing. If not specified normal thickness shall be 0.002"+-0.0004"</p>	<p>Most aluminum alloys depending on process used. Where maximum serviceability or special properties are required, consult metal finisher for best alloy choice. Thick coatings (over .004") Will tend to break down sharp edges. Typical applications: Hydraulic cylinders, wear surfaces. Actuating cams, etc. can be used as an electrical insulation coating. Flash "hard anodize" may be used instead of conventional anodize for corrosion resistance and may be more economical in conjunction with other hard anodized areas. Hard coat anodize is available with Teflon impregnation also. Non-dyed. Dyed.</p>
<p><b>LUBRICANT, SOLID FILM</b></p> <p>Used to prevent galling and seizure of metals. Lubricant covered by this specification is intended for use on aluminum, copper, steel and stainless steel titanium, and chromium and nickel bearing surfaces. Useful where conventional lubricants are difficult to apply or retain or where other lubricants may be easily contaminated. Cured lubricant film is highly resistant to conventional fluid lubricants.</p>	<p>MIL-L-46010D</p> <p>Type I (302° F cure)</p> <p>Type II (400° F cure)</p>	<p>Unless otherwise specified:</p> <p>0.0002"-0.0005"</p>	<p>For sliding motion applications such as plain and spherical bearings, flaps tracks, hinges, threads, cam surfaces, etc. Do not use on materials adversely and affected by exposure to temperatures of 300° F for 1 hour- on bearings containing rolling elements-or where there is potential contact with liquid oxygen. Pretreatment of metals such as anodizing, passivation, phosphating, etc. required prior to the solid film process.</p>
<p><b>NICKEL</b></p> <p>There is a nickel finish for almost any need. Nickel can be deposited soft or hard, dull or bright, depending on process used and conditions employed in plating. Hardness can range from 150-500 Vickers. Can be similar to stainless in color, or can be a dull gray or light gray (almost white) color. Corrosion resistance is a function of thickness. Has a low coefficient of thermal expansion- is magnetic. All steel parts having a hardness of Rc-40 or greater require a post bake at 375 + 25 for 3 hours.</p>	<p>QQ-N-290A</p> <p>Class I ---</p> <p>Grade A</p> <p>Grade B</p> <p>Grade C</p> <p>Grade E</p> <p>Grade F</p> <p>Grade G</p> <p>Class II</p>	<p>0.0016" min.</p> <p>0.0012" min.</p> <p>0.0010" min.</p> <p>0.0008" min.</p> <p>0.0006" min.</p> <p>0.0004" min.</p> <p>0.0002" min.</p> <p>0.0002" min.</p> <p>Unless otherwise specified.</p>	<p>NOTE: All steel parts having a tensile strength of 220,000 or greater shall not be nickel-plated without specific approval of procuring agency. For corrosion protection. For typical 0.0002" copper undercoating prior to the nickel plate.</p> <p>For engineering applications.</p>

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<b>PASSIVATE</b> A process designed to remove foreign metals from the surface of stainless and corrosion resistant steels and to promote natural tendency of surface to oxidize. Does not change the appearance of the base metal. Process purifies surface and therefore improves corrosion resistance.	QQ-P-35C ASTM A 967  Type II  Type VI Type VII Type VIII	No dimensional change	Medium temperature with sodium dichromate. Low temperature. Medium temperature. Medium temperature with high concentration of nitric acid. 24-hour high humidity test required. Salt spray test may be required, if specified in addition to humidity test.
<b>PHOSPHATE COATING: LIGHT</b> Specification covers cleaning methods and pretreatment processes. This chart contains only a partial listing.	TT-C-490D  Cleaning Methods: Method I -- Method III' Method V	Typical  0.0002" - 0.0005"	Light coating for use as paint base.  Mechanical or abrasive cleaning. Hot alkaline. Alkaline derusting. Customer supplied test coupons required on coating weight test. Coating weight test required.
<b>PHOSPHATE COATING: HEAVY</b> Type Z can be used up to 200 F, to prevent galling in extrusion and deep drawing. Class 2 is good for corrosion resistance. Salt spray and coating weight test requires. (with customer supplied test coupons). NOTE: This specification list a type M.	DOD-P-16232F  Type Z  Class I Class 2  Class 3  Class 4	0.0002"  0.0005"	Zinc phosphate base coating (min. 11g/m2) Supplementary preservative treatment or coating. As specified. Supplementary treatment with preservative conforming to MIL-C-16173. Grade 3 of MIL-L-3150 as alternate for very small parts. No supplementary treatment. Chemically converted.
<b>RHODIUM</b> Metallic and similar to stainless steel in color. Excellent corrosion resistance. Almost as hard as chromium. Very good abrasion resistance. Good solderability. Low contact resistance. Thicker coatings are very brittle. Has high reflectivity.	MIL-R-40685B  Type I -- Type II --  Class I Class 2 Class 3 Class 4 Class 5	0.000002" min. 0.00001" min. 0.00002" min. 0.00010" min. 0.00025" min.	Over nickel, silver, gold, or platinum. Over other metals (requires nickel undercoat). Used on silver for tarnish resistance. Applications, range from electronics to nose cones-wherever ware, corrosion resistance, solderability, and reflectivity are important.

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<p>SILVER</p> <p>White matte to very bright in appearance. Good corrosion resistance, depending on base metal. Will tarnish easily. Hardness varies from about 90 Brinnell to about 135 Brinnell depending on process and plating conditions. Solderability is excellent, but decreases with age. Best electrical conductor. Has excellent lubricity and smear characteristics for anti-galling uses on static seals,</p>	<p>bushings, etc. QQ-S-365D</p> <p>Type I Type II Type III Grade A Grade B</p>	<p>0.0005" min. Unless otherwise specified</p>	<p>Increasing use in both decorative and engineering fields, including electrical and electronic fields.</p> <p>Matte. Semi-bright. Bright. Chromate post treatment to improve tarnish resistance. No chromate treatment.</p>
<p>SULFAMAE NICKEL</p> <p>The plating conforming to this specification is intended to facilitate the formation of a seal between two metallic surfaces. Plating hardness: Note to exceed 150 Knoop hardness (500 gm. load) after annealing (or 300 Knoop before annealing).</p>	<p>MIL-P-27418</p>	<p>Unless otherwise specified: 0.0020" +-0.0003" on all surfaces that can be touched by .0625" dia. Ball.</p>	<p>The nickel plating shall have a columnar crystalline structure before annealing.</p>
<p>SULFURIC ANODIZE</p> <p>Color will vary with alloy. Aluminum with low alloying elements will show practically no color change. Best coating on aluminum for dyeing. Can be dyed practically any color or shade (black, blue, red, gold, orange, green, etc.) Salt spray requirement is 336 hours (5% NaCl solution) per method B-117 of ASTM. Minimum weight for type II coatings: Class I 1,000 mg/sq.ft.</p>	<p>MIL-A-8625F</p> <p>Type II Type IIB Class 1 Class 2</p>	<p>0.000070"-0.0010"</p> <p>Light coating</p>	<p>All aluminum alloys, but do not use where solution will entrap.</p> <p>Non-dyed. Dyed</p> <p>Unless "clear" is specified on a sealing will result in a yellow-pale green appearance. FED-STD-No 595 may be used as a guide for specifying color (approx. comparison only).</p>

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<b>TIN</b> Color is gray-whit in a plated condition. Had very high luster in fused condition. Soft but is very ductile Corrosion resistance is good. (coated items should meet 24 hr 5% salt spray requirement). Solderability is excellent. Tin is not good for low temperature applications (changes. Structure and loses adhesion when exposed to temperature below 40 C). Plate directly on steel substance (no undercoating for steel unless otherwise specified).	MIL-T-10727C	As specified on drawing. Thickness guide (not part of spec.) as follows:  .0001-.00025" .0002-.0004" .0003 min. .0002-.0006"	Electrodeposited. Use ASTM-B-545 as guideline. Flash for soldering. To prevent galling and seizing. Where corrosion resistance is important. To prevent formation of case during nitriding.
	Type I		
<b>TIN LEAD</b> Either a matte or bright luster is acceptable. Has excellent solderability. 0.0002" copper plate generally required on copper base alloys. No undercoating required on steel substrates unless otherwise specified.	MIL-P-81728A	Unless otherwise specified: .0003"-.0005"	50%-70% tin, remainder is lead Nominal 90% tin, remainder is lead (this composition only when specified).
	Stander composition 60/40 Sn-Pb Optional composition 90/10 Sn-Pb		
<b>ZINC</b> Either a bright or dull finish Is acceptable. Bright zinc plating closely resembles bright chromium. Bright zinc dose not have the permanence of surface appearance, however. Zinc coated steel will not rust even when exposed scratches because of the galvanic protection of the zinc. On weathering, zinc turns to a drab gray color. Zinc should be deposited directly on the base metal. (nickel is permissible undercoat of base metal is a corrosion resisting steel.) Parts having a hardness greater than Rc-40 must be given a heat treatment prior to plating. Springs having a hardness over c-40 must be given an after plating baking at 375 +-25F for 3 hours.	ASTMB633-85	.0010"	The Primary used of chromate finishes on zinc is to retard or prevent formation of whit corrosion products on zinc surface. The primary purpose of phosphate coating on zinc is to provide a paint base. With supplementary treatment. With supplementary chromate treatment. With supplementary colorless chromate treatment. With phosphate conversion treatment. Corrosion resistance requirements: Type II – 96 hours Type III – 12 hours
	Fe/Zn25 Sc4 (very severe)	.00050"	
	Fe/Zn13 SC3 (Severe)	.00030"	
	Fe/Zn8 SC2 (moderate)	.00020"	
	Fe/Zn5 SC1 (Mild)		
Type I	Type II	Type III	Type IV

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