

Finish Description	Color	Thickness	Salt Spray Test	Other Applicable Test	Temperature Resistance	Process Flow	Approvals	Advantages	Limitations
Chromium	Bright Silver	.001" 25 micrometers	Red rust 2 hrs 0 base metal corrosion (neutral salt spray) 96 hrs		400F/204C	Clean, nickel, cadmium, copper, chromium	GM 6112 ASTMF-871M ASTM B456	A bright lustrous cosmetic finish	Effluent from process
Zinc Plate	Silver	Various thickness typical .0001" - .0005 3-13 micrometers	Red rust 24 hrs (0001"zinc) red rust 40 hrs (clear chromate) red rust 144 hrs, white corrosion 72 hrs (dichromate) red rust 480 hrs, white corrosion 72 hrs (black chromate) red rust 192 hrs white corrosion 96 hrs (olive drab chromate)		350F/177C	Clean (may be alkaline, acid mechanical or electrical) zinc barrel plate, rinse, bake (if over Rc30) Note: chromate films can be added to provide color and corrosion resistance	GM 4435-M Codes Ford ESF-M1P3-A Through ESF-M1P6-A Ford WSD M1P85-A1, A2 or ASTM-F-871M, ASTM B633	Low cost, consistent thickness uniformity, may be supplied in several colors by chromates or dyes	No white corrosion resistance without chromate conversion coating, requires precautions against hydrogen embrittlement
Nickel Plate	Bright silver	.0001 - .0007" 3-25 micrometers	Red rust 24 hours (.0003" nickel)		200F/93C	Alkaline clean, acid dip rinse, burnish then plate, rinse, dry with heat (automatic operation)	ASTM F-871M, ASTM B689	Cosmetic appearance harder surface than zinc	cost
Copper Plate	Dull Copper	.0001" - .0005 3-13 micrometers	Red rust 1 hour		200F/93C	Alkaline clean, acid dip rinse, burnish then plate, rinse, dry with heat (barrel operation)	ASTM B281	Protects washers during heat treatment base coat for bright nickel	Effluent from process, oxidizes and discolors easily, maybe overcome by lacquer or chromate overcoat
Brass Plate	Yellow	.0001 - .0007" 3-25 micrometers	Red rust 1 hour		200F/93C	Alkaline clean, acid dip, rinse, burnish, plate, dry, electrodeposition, cure		Cosmetic, part conductivity	Cost, cyanide, application oxidizes and discolors easily. Maybe over come by lacquer
Zinc/Colbalt Significantly harder (up to 200 Vickers) than zinc but with better ducticity	Dull Silver	.00015" - .0003 4-8 micrometers	Red rust 800 hrs white corrosion 24 hrs clear, red rust 500 hrs white corrosion 120 hrs (dichromate) red rust 300 hrs white corrosion 144 hrs. (bronze) red rust 500 hrs, white corrosion 120 hrs (black)	Kesternich better than zinc	Continuous 194F/90C intermittent 248F/120C	Alkaline clean, acid clean, electro-clean, rinse, dry bake if over 30Rc	IF-G M6-3528 Ford WSH-M1P86A Chrysler PS8955 & 8956 GM 6280M	Corrosion resistance compatibility with present process equipment, alloy cost, more resistance to methanol fuel blends, usable on parts requiring forming after plating	Galvanic corrosion with zinc
Zinc/Nickel	Bright Silver	.00015" - .0003 4-8 micrometers	Red rust 1000 hrs, white corrosion 400 hrs (clear) red rust 800 hrs, white corrosion 300 hrs (dichromate)	Kesternich: less than zinc, hardness 160-250 Vickers	continuous 248F/120C intermittent 302F/150C	Alkaline clean, acid clean, rinse, electro-clean, rinse plate, rinse, dry, bake (if over 30Rc)	Saturn 21494008 GM 628M	Corrosion resistant, high heat resistant, high hardness and scratch resistant	Process equipment intensive, microcracked deposits, kesterich, results inferior to zinc
Zinc/Iron	Black can be chromated	.00015" - .00034" 4-8 micrometers	Red rust 800 hrs, white corrosion 200 hrs	Kesternich: less than zinc, hardness 100-140 vickers	continuous 140F/60C intermittent 190F/90C	Alkaline clean, acid clean, rinse, electro-clean, rinse plate, rinse, dry, bake (if over 30Rc) barrel electroplate	Ford WSH M1P86-A GM M6-3528, 6280M Chrysler DS 8955 & DS 8956	Better for through, deep or blind holes; corrosion resistant; economical	
Cadmium	silver/gray	.00015" - .0005 3-13 micrometers	red rust 192 hrs, white corrosion, 12hrs (clear chromate) red rust 240 hrs, white corrosion 72 hrs (dichromate) red rust 240 hrs whit corrosion 150 hrs (olive drab)		350F/177C	Barrel electroplate clean, barrel plate, rinse, bake (if over 30Rc)	ASTM - A-165 ASM F871M ASTM B-696 ASTM B766	Lubricity to reduce fastener driving torque provides smaller torque range to produce accurate clamp load	A health hazard, declining in availability due to its negative effect on the economy

Nickel/ Zinc/ Conversion	Black for interior automotive application	.0005" minimum 13 micrometers minimum	Red rust 120hrs	Weathermeter: 200 hrs humidity 24 hrs: water 2 hrs; immersion for blistering		Alkaline clean, acid clean. Burnish, clean, plate, rinse, dry (with heat) bake	GM 7153 ASTM F-871	Will not fill recesses, threads or stick washer uniform black appearance; does not rub off on installers hands	Cost
Tin Plating	Silver	Mid-5 micrometers, mod-10 micrometers severe 20 micro very sever 30 micro	Red rust 4 hours		430F/222C	Hot tin dipping barrel and rack electroplate clean acid dip electroplate, rinse and dry	ASTM B545	Excellent solderability, ductility and softness, not corrosive, and tarnish resistant	Tin plate does not provided same properties to steel as it does to nonferrous metals and alloys easily oxidizes
Phosphate/ electro-organic/ oil type	Black	.0005" - .0007" 13-18 micrometers	Red rust 168 hrs (oil) red rust 96 hrs (no oil) white corrosion 48 hrs (no oil)	Artificial weathering: red rust 1000 hrs humidity	350F/175C	Barrel electroplate zinc phosphate, electrode-position, oil, dip. Spin dry	GM 6047	No recess or thread fill	Limited salt spray not recommended for plastics
E-Coat	Black and Gray	.0008" minimum, 20 micrometers	Red rust 500 hrs	Kesternich; scab corrosion 50 cycles, adhesion stone chip resistance, artificial weathering		Electrodeposition Parts are coated or dipped into a tank of waterborne paint and a current is passed through to charge the paint particles electrically, bake	WSB-M64828-A1, A2, A3	Uniform coating thickness, good edge and recess corrosion resistance, minimum runs and sags	Surface defects in substrate are visible through coating only a single film can be applied changing color is ver expensive
Fluorocarbon post treatment over phosphate or plating	Black or silver	.0003" - .0007" 8-18 micrometers	Red rust 96-336 hrs	ASTM D2714: coefficient of friction maximum 0.15	Comparable to cadmium	Zinc phosphate or zinc plate, dip spin, bake, dip spin bake	GM 6046M	Lubrication, color consistency, torque-tension range, similar to cadmium	Recess and thread fill; sticks to some washers
Zinc electroplate with clear chromate & special topcoat	Clear silver	.0003" - .0005" zinc 8-13 micrometers	Red rust 500 hrs white corrosion 96 hrs	kesternich red rust 5 cycles	400F/205C	Electroplate plus hand dip zinc electroplate; clear chromate dip, s500 dip spin dry		Minimum build up good for fasteners, resists ultraviolet high salt spray	High cost
Aluminum basecoat & organic or inorganic topcoat	Silver gray metallic luster when burnished	.0004" - .0006" 15-25 micrometers (non-threaded parts)	Red rust 1000 hrs white corrosion 168 hrs	Humidity: adhesion 96 hrs with no more than 3.0mm peel back; artificial weathering	Aluminum base coat organic topcoat 230F/110C aluminum base coat 120F/645C	Dip spin aluminum oxide blast dip spin cure dip spin cure burnish	GM 6164-M Ford EST-M21P9 Chrysler PS - 8059 Saginaw steering 7845256, MIL-C-81751, Outboard marine 1723	High salt spray, temperature resistant, this process is not conducive to the creation of hydrogen embrittlement, highly resistant to installation or removal damage	Non-uniform, matty appearance coating thickness build up thread referee test may need to be utilized rather than go/nogo gages
Zinc/Chromate/ Organic type	Silver, black, blue	.0007" - .0015" 7.8-38.1 micrometers	Red rust 1000 hrs white corrosion 216 hrs	Kesternich 20 cycles artificial weathering 5000 hrs adhesion and immersion, ASTM G53, ASTM D2510	Continuous 150C/246C, -160C ALTERNATION 300F, 470F	Electroplate, dip spin clean, plate, bake chromate, dip spin cure, dip spin, cure	Honeywell ES1690; GM 6046, Ford ESB M21P4 A 170A-S Delco 9985501, Microswitch MS048091	Galvanic reaction to steel, stainless steel and aluminum, lubricating for threads comparable to cadmium	May fill recesses or threads and stick washers, must be baked for hydrogen embrittlement
Powder coatings	Any color	.002" - .011" 50-279 micrometers	Red rust 1000+ hrs			Spray fluidized bed clean, zinc phosphate dry coat cure		Meets all current EPA requirements for reduction in VOC emissions; material use can approach 100% if powder can be collected and reused	
Plating - multiplayer electroplated/ black type	Black	42.0 micrometers	Red rust 500 hrs with corrosion 48 hrs	Artificial weathering:ASTM G233: 1000 hrs		Electroplate and electro deposition alkaline clean, acid dip GM 6138 rinse, burnish, plate dry electro deposition, cure		Good for Exterior, recess fasteners and drill screws	May require referee thread inspection rather than go/nogo gages

Chromate/Zinc/ Organic type	Saton Silver	.0006" - .001" 15-25 micrometers	Red rust 240-400 hrs, red rust up to 1000 hrs with sealers	Humidity: adhesion 96 hrs with no more than 3.0 mm peel back	500F/260C	Dip spin, dip drain, spray, clean mechanically clean, dip spin, bake, dip spin, bake	Caterpillar 1E1675; Chrysler PS5873; Ford ESA-M21P2-A1,A2,A3,A4; GEF71H1-S; GM6173-M Military MIL-C-87115A; Honda HES D2008	Very thin coating, this process is not conducive to the creation of hydrogen embrittlement, solvent resistant	Only available in silver, difficult to top coat, thread referee test may need to be utilized rather than go/nogo, organic top coat
Phosphate / Black Zinc / organic type	Black	.0006" - .0008" 15-20 micrometers	Red rust 120-480 hrs	Humidity		Dip spin, dip drain, spray clean, zinc phosphate, dip spin bake	GM 7112 M; Ford WSD MP21P11-B3,B4,B6	Corrosion resistance, color, this process is not conducive to the creation of hydrogen embrittlement, does not rub off on application or hands	not recommended for internal threads or recessed
Phosphate/ Zinc / organic	Bright silver	.0004"-.00014" 10-35 micrometers	Red rust 120-480 hrs	Kesternich: scab corrosion 40 cycles: humidity		Dip drain, dip spin, spray, flow coat clean: zinc phosphate, dip spin,bake,dip spin,bake	GM7111-M Ford ESA-M21P5-A, WSD-M21P11-B1, WSD-M21P11-B2, WSD-M21P11-B5; Chrysler PS7626	Corrosion resistance, this process is not conducive to the creation of hydrogen embrittlement, substitute for cadmium on nuts	Thread referee test may need to be utilized rather than go/nogo gages
Inorganic, Zinc rich epoxy / phenoxy topcoat	Black	.0006"-.0008" 10-20 micrometers	Red rust 240-480 hrs, white corrosion 240-336 hrs	Humidity		Dip spin, dip drain, flow coat, spray clean, zinc phosphate, dip spin, bake, dip spin, bake	Ford WSD-M21P11-B7 (S310)	Dry to touch finish, consistent torque/tension, this processes not conducive to the creation of hydrogen embrittlement	Not recommended for internal threads or recesses, may require thread referee test rather than go/nogo gauges
Phosphate/ Zinc / Organic	Gray Metallic	.0004" - .00014" 10-35 micrometers	Red rust 400 hrs	Humidity		Dip spin, clean, zinc phosphate, dip spin, bake, dip spin and bake	GM 6111M; Ford ESA-M21P5-A; Chrysler PS7626; Volkswagen TLVW57029-US	Good replacement for mechanical zinc and cadmium	Flakes & powders, will require thread referee test rather than go/nogo gauges on threads
Phosphate/ organic/ oil type	Black	.0004" - .001" 10-25 micrometers (threaded products)	Red rust 168 hrs	Humidity		Dip spin clean, zinc phosphate, dip spin, bake	Ford ESA-M7C69-A	Costs	Uses thread referee test than go/nogo gauges
Waterborne auto deposits	Black	.0001" - .0003" over .0003" - .0004" zinc/nickel 10-13 micrometers (plated substrate)	Red rust 504+ hrs. white corrosion 312 hrs	Artificial weathering: red rust 400 hrs drill screw drive time; 3 seconds; APGE: without red or white rust 30 cycles	700 series 500F/260C	Auto deposition clean, rinse, activation rinse, di rinse autophoretic dip, rinse, seal, bake		Compatible with sealants and prevailing torque patches, good resistance to uv color change. Will not fill threads or recesses nor freeze washers	touch points may produce pin hole corrosion
Phosphate/ organic/Oil	Black green others	.0005" - .0007" 13-18 micrometers	Red rust 168 hrs (oil) red rust 96 hrs (no oil), white corrosion 48 hrs (no oil)	Artificial weathering: red rust 1000 hrs. humidity	350/F/175C	Dip spin zinc phosphate, dip spin cure, dip spin cure, oil dip, spin dry	GM 6174-M	Low cost, several colors available	Limited salt spray thread and recess fill, assembly or application problems, not recommended for plastics, heavy oil may cause feed bowl inefficiencies