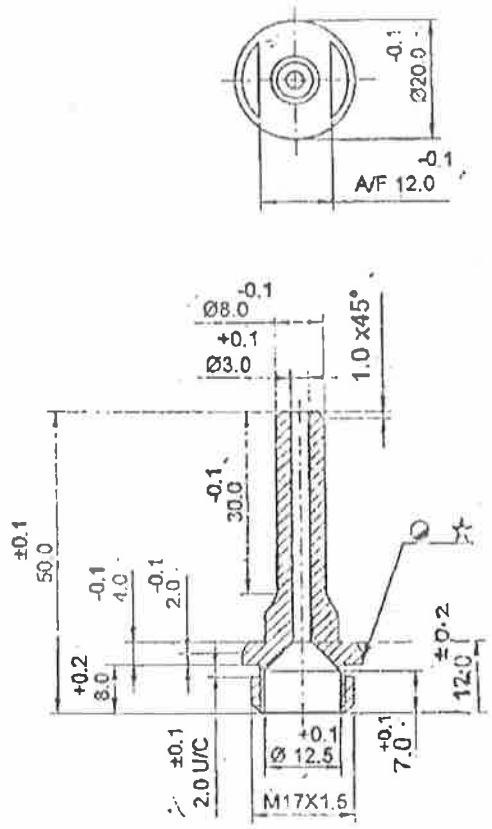

MARKING NOTES:-
THE FOLLOWING MARKING TO BE ENGRAVED ON THE SURFACE HAVING Ø30.0 -0.1

⊘ SERIAL NO. ☆ MANUFACTURER'S LOGO

3.	19-09-19	-	MARKING NOTE AMENDED	ARD 2576	
2.	10 APR 18	B-2,3	MARKING NOTES ADDED	ARD 2547	
1.	13-02-14	B-2	DIMENSION AMENDED	ARD 2453	
	02-06-09		APPROVED	DGNAI	
R.No	DATE	ZONE	BRIEF RECORD	AUTHORITY	INITIALS
SCALE:- 1:1	TOL.		DIMENSIONS ARE IN mm	ASSY DRG No. NASK 1071	
DGN	DRN	TCD	COMP	CHD	ASSY DRG LIST.
PASSED CTO(D)	APPD. DGNAI		THREADS TO CONFIRM IS:4218		
			GEN SPEC :- IS:2102	DTE GEN OF NAVAL ARMAMENT INSPECTION IHQ,MOD (NAVY) N. DELHI	
MATL:-STEEL SS 316			STORE SPEC :-		
MATL SPEC:-			STORE REF No.		
PROTECTIVE FINISH:- CADMIUM PLATING 30 MICRON			GAUGE SCH No.		
			D.S. CAT No.		

END PIECE

DRG No.
NASK 1071/3
(PROVISIONAL)

A-4

USED ON: ROCKET RGB-80

BASED ON:- CNAI(V) DRG NO NA(V) 8010/3 DT.19-02-08

TRIM ON THIS LINE WHEN SUPPLIED TO TRADE

QUALITY ASSURANCE PLAN FOR A/S ROCKET RGB 60 (EMPTY) MOD 1

Item Description	**END PIECE**
Ref. Document	NASK 1071/3 (P)
Material	ASTM A 276-06 Gde 316
Heat Treatment	Annealed condition Hot-finished or Cold-finished

Component name/operations	Characteristics	Class	Type of check	Quantum of check	Reference document	Acceptance norms	Format of record	Inspection Activity Categorisation	Inspection by
End piece (Raw material)	General finish, appearance	Semi critical	Visual	100%	ASTM A 276-06 GDE 316 Annealed condition Hot-finished or Cold-finished	ASTM A 276-06 GDE 316 Annealed condition Hot-finished or Cold-finished	Visual Inspn. Report	Non-Crtical	QC/HEPF
	Chemical properties	Critical	Chemical lab analysis	Three samples per lot or as per the discretion of inspection authority			Test report from NABL Lab / Govt lab		
	Mechanical properties	Critical	Mechanical lab analysis	Three samples per lot or as per the discretion of inspection authority			Test report from NABL Lab / Govt lab		
In process - Rod cutting,turning and milling	Dimensions specified in the inspection report of the component	Critical	Dimensional measurement	As per sampling plan IS 2500 Level II	Tolerance as specified in DRG. NASK 1071/3 (P)	Tolerance as specified in DRG. NASK 1071/3 (P)	Inspection report of End piece	Critical	NAI
Final finish	Cadmium plating 30 Microns	Critical	Visual & Test sample	100%	IS:1572	IS:1572	Test report from NABL Lab / Govt lab or Inspection report of End piece	Non-Crtical	QC/HEPF

Inspection Report

Description of the item	**END PIECE**
Drawing No.	NASK 1071/3 (P)
Date of Inspection	

Sno.	Description of parameter	Nominal dimension as per drawing in mm	Gauge used	Tolerance (As specified in the drg.)	Nature of Parameter	Observed dimension in mm	Deviation in mm	Remarks
1	External thread	M 17 x 1.5	Screw ring 'Go' & 'No Go' gauge sl.no. 157		Major			
2	Internal dia.	12.5	Plug 'Go' & 'No Go' gauge sl.no. 30	+0.1				
3	Length of inner dia.12.5	7.0		+0.1				
4	Outer undercut width	2.0		±0.1	Minor			
5	Outer collar dia.	20.0		-0.1	Major			
6	Diameter and length of inner hole(38mm)	3.0	Plug 'Go' & 'No Go' gauge sl.no. 106	+0.1	Critical			
7	Outer length - End to collar face	8.0	T Plate gauge'Go' & 'No Go' sl.no. 31 & 32	+0.2	Major			
8	Collar length	4.0		-0.1				
9	Collar chamfer length	2.0		-0.1				
10	Outer length	12.0		±0.2				
11	Across flat size	12.0	Snap 'Go' & 'No Go' gauge sl.no. 140	-0.1				
12	Outer step dia.	8.0	Snap 'Go' & 'No Go' gauge sl.no. 141	-0.1				
13	Length of outer step dia.	30.0		-0.1				
14	Chamfer	1 x 45°			Minor			
15	Overall length	50.0	Snap 'Go' & 'No Go' gauge sl.no. 149	±0.1	Major			

Special notes: Check Ø3.0mm hole to be checked with plug gauge No. 106 for free passage on 100% quantity. Light test is to be undertaken to confirm the through hole of end piece prior to assembly.

Sno.	Note	Observations
1	Material: ASTM A 276-06 Gde 316	
2	General Tolerance spec IS 2102 (Medium class) unless specified.	
3	Finish: Cadmium plating 30 micron to spec IS:1572.	
4	Manufacturer's logo and serial No. to be engraved on surface having length 30.0-0.1.	

Designation: A 276 – 06

Standard Specification for Stainless Steel Bars and Shapes[1]

This standard is issued under the fixed designation A 276; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope*

1.1 This specification covers hot-finished or cold-finished bars except bars for reforging (Note 1). It includes rounds, squares, and hexagons, and hot-rolled or extruded shapes, such as angles, tees, and channels in the more commonly used types of stainless steels. The free-machining types (Note 2) for general corrosion resistance and high-temperature service are covered in a separate specification.

NOTE 1—For bars for reforging, see Specification A 314.

NOTE 2—For free-machining stainless bars designed especially for optimum machinability, see Specification A 582/A 582M.

NOTE 3—There are standards covering high nickel, chromium, austenitic corrosion, and heat resisting alloy materials. These standards are under the jurisdiction of ASTM Subcommittee B02.07 and may be found in *Annual Book of ASTM Standards*, Vol. 02.04.

1.2 The values stated in inch-pound units are to be regarded as the standard.

2. Referenced Documents

2.1 *ASTM Standards:* [2]

A 314 Specification for Stainless Steel Billets and Bars for Forging

A 370 Test Methods and Definitions for Mechanical Testing of Steel Products

A 484/A 484M Specification for General Requirements for Stainless Steel Bars, Billets, and Forgings

A 582/A 582M Specification for Free-Machining Stainless Steel Bars

A 751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products

E 527 Practice for Numbering Metals and Alloys (UNS)

2.2 *SAE Document:* [3]

SAE J 1086 Recommended Practice for Numbering Metals and Alloys

3. Ordering Information

3.1 It is the responsibility of the purchaser to specify all requirements that are necessary for material ordered under this specification. Such requirements may include but are not limited to the following:

3.1.1 Quantity (weight or number of pieces),

3.1.2 Name of material: stainless steel,

3.1.3 Form (bars, angles, etc.),

3.1.4 Condition (Section 4.1),

3.1.5 Finish (Section 8 of Specification A 484/A 484M),

3.1.6 Surface preparation of shapes (Section 8 of Specification A 484/A 484M),

3.1.7 Applicable dimensions including size, thickness, width, and length,

3.1.8 Cross section (round, square, etc.),

3.1.9 Type or UNS designation (Table 1),

3.1.10 ASTM designation and date of issue, and

3.1.11 Whether bars are to be rolled as bars or cut from strip or plate.

3.1.12 Test for magnetic permeability when specified by customer purchase order when ordering Types 201 and 205.

3.1.13 Special requirements.

NOTE 4—A typical ordering description is as follows: 5000 lb (2268 kg) Stainless Steel Bars, Annealed and Centerless Ground, 1½ in. (38.10 mm) Round, 10 to 12 ft (3.05 to 3.66 m) in length, Type 304, ASTM Specification A 276 dated _____. End use: machined valve parts.

4. Manufacture

4.1 *Condition:*

4.1.1 Bars shall be furnished in one of the following conditions listed in the Mechanical Requirements table:

4.1.1.1 *Condition A*—Annealed

[1] This specification is under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel and Related Alloys and is the direct responsibility of Subcommittee A01.17 on Flat-Rolled and Wrought Stainless Steel.

Current edition approved March 1, 2006. Published March 2006. Originally approved in 1944. Last previous edition approved in 2005 as A 276 – 05a.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from Society of Automotive Engineers (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001.

*A Summary of Changes section appears at the end of this standard.

TABLE 1 Chemical Requirements[A]

UNS Designation[B]	Type	Composition, %									
		Carbon	Manganese	Phosphorus	Sulfur	Silicon	Chromium	Nickel	Molybdenum	Nitrogen	Other Elements
Austenitic Grades											
N08367	...	0.030	2.00	0.040	0.030	1.00	20.0–22.0	23.5–25.5	6.0–7.0	0.18–0.25	Cu 0.75
N08700	...	0.04	2.00	0.040	0.030	1.00	19.0–23.0	24.0–26.0	4.3–5.0	...	Cu 0.50 Cb 8 × C min 0.40 max
S20100	201	0.15	5.5–7.5	0.060	0.030	1.00	16.0–18.0	3.5–5.5	...	0.25	...
S20161	...	0.15	4.0–6.0	0.045	0.030	3.0–4.0	15.0–18.0	4.0–6.0	...	0.08–0.20	...
S20162	...	0.15	4.0–8.0	0.040	0.040	2.5–4.5	16.5–21.0	6.0–10.0	0.50–2.50	0.05–0.25	...
S20200	202	0.15	7.5–10.0	0.060	0.030	1.00	17.0–19.0	4.0–6.0	...	0.25	...
S20500	205	0.12–0.25	14.0–15.5	0.060	0.030	1.00	16.5–18.0	1.0–1.7	...	0.32–0.40	...
S20910	XM-19	0.06	4.0–6.0	0.045	0.030	1.00	20.5–23.5	11.5–13.5	1.50–3.00	0.20–0.40	Cb 0.10–0.30, V 0.10–0.30
S21800	...	0.10	7.0–9.0	0.060	0.030	3.5–4.5	16.0–18.0	8.0–9.0	...	0.08–0.18	...
S21900	XM-10	0.08	8.0–10.0	0.045	0.030	1.00	19.0–21.5	5.5–7.5	...	0.15–0.40	...
S21904	XM-11	0.04	8.0–10.0	0.045	0.030	1.00	19.0–21.5	5.5–7.5	...	0.15–0.40	...
S24000	XM-29	0.08	11.5–14.5	0.060	0.030	1.00	17.0–19.0	2.3–3.7	...	0.20–0.40	...
S24100	XM-28	0.15	11.0–14.0	0.045	0.030	1.00	16.5–19.0	0.50–2.50	...	0.20–0.45	...
S28200	...	0.15	17.0–19.0	0.045	0.030	1.00	17.0–19.0	...	0.75–1.25	0.40–0.60	Cu 0.75–1.25
S30200	302	0.15	2.00	0.045	0.030	1.00	17.0–19.0	8.0–10.0	...	0.10	...
S30215	302B	0.15	2.00	0.045	0.030	2.00–3.00	17.0–19.0	8.0–10.0	...	0.10	...
S30400	304	0.08	2.00	0.045	0.030	1.00	18.0–20.0	8.0–11.0	...	...	...
S30403	304L[C]	0.030	2.00	0.045	0.030	1.00	18.0–20.0	8.0–12.0	...	...	...
S30451	304N	0.08	2.00	0.045	0.030	1.00	18.0–20.0	8.0–11.0	...	0.10–0.16	...
S30452	XM-21	0.08	2.00	0.045	0.030	1.00	18.0–20.0	8.0–10.0	...	0.16–0.30	...
S30453	304LN	0.030	2.00	0.045	0.030	1.00	18.0–20.0	8.0–11.0	...	0.10–0.16	...
S30454	...	0.03	2.00	0.045	0.030	1.00	18.0–20.0	8.0–11.0	...	0.16–0.30	...
S30500	305	0.12	2.00	0.045	0.030	1.00	17.0–19.0	11.0–13.0	...	...	...
S30800	308	0.08	2.00	0.045	0.030	1.00	19.0–21.0	10.0–12.0	...	...	...
S30815	...	0.05–0.10	0.80	0.040	0.030	1.40–2.00	20.0–22.0	10.0–12.0	...	0.14–0.20	Ce 0.03–0.08
S30900	309	0.20	2.00	0.045	0.030	1.00	22.0–24.0	12.0–15.0	...	...	...
S30908	309S	0.08	2.00	0.045	0.030	1.00	22.0–24.0	12.0–15.0	...	...	...
S30940	309Cb	0.08	2.00	0.045	0.030	1.00	22.0–24.0	12.0–16.0	...	...	Cb 10×C-1.10
S31000	310	0.25	2.00	0.045	0.030	1.50	24.0–26.0	19.0–22.0	...	...	...
S31008	310S	0.08	2.00	0.045	0.030	1.50	24.0–26.0	19.0–22.0	...	...	...
S31040	310Cb	0.08	2.00	0.045	0.030	1.50	24.0–26.0	19.0–22.0	...	...	Cb 10×C-1.10
S31254	...	0.020	1.00	0.030	0.010	0.80	19.5–20.5	17.5–18.5	6.0–6.5	0.18–0.22	Cu 0.50–1.00
S31400	314	0.25	2.00	0.045	0.030	1.50–3.00	23.0–26.0	19.0–22.0	...	...	...
S31600	316	0.08	2.00	0.045	0.030	1.00	16.0–18.0	10.0–14.0	2.00–3.00	...	...
S31603	316L[C]	0.030	2.00	0.045	0.030	1.00	16.0–18.0	10.0–14.0	2.00–3.00	...	...
S31635	316Ti	0.08	2.00	0.045	0.030	1.00	16.0–18.0	10.0–14.0	2.00–3.00	0.10	Ti 5×(C+N)-0.70
S31640	316Cb	0.08	2.00	0.045	0.030	1.00	16.0–18.0	10.0–14.0	2.00–3.00	0.10	Cb 10×C-1.10
S31651	316N	0.08	2.00	0.045	0.030	1.00	16.0–18.0	10.0–14.0	2.00–3.00	0.10–0.16	...
S31653	316LN	0.030	2.00	0.045	0.030	1.00	16.0–18.0	10.0–13.0	2.00–3.00	0.10–0.16	...
S31654	...	0.03	2.00	0.045	0.030	1.00	16.0–18.0	10.0–13.0	2.00–3.00	0.16–0.30	...
S31700	317	0.08	2.00	0.045	0.030	1.00	18.0–20.0	11.0–15.0	3.0–4.0	0.10	...
S31725	...	0.030	2.00	0.045	0.030	1.00	18.0–20.0	13.5–17.5	4.0–5.0	0.20	...
S31726	...	0.030	2.00	0.045	0.030	1.00	17.0–20.0	14.5–17.5	4.0–5.0	0.10–0.20	...
S31727	...	0.030	1.00	0.030	0.030	1.00	17.5–19.0	14.5–16.5	3.8–4.5	0.15–0.21	Cu 2.8–4.0
S32053	...	0.030	1.00	0.030	0.010	1.00	22.0–24.0	24.0–26.0	5.0–6.0	0.17–0.22	...
S32100	321	0.08	2.00	0.045	0.030	1.00	17.0–19.0	9.0–12.0	...	...	Ti 5×(C+N)-0.70[D]
S32654	...	0.020	2.0–4.0	0.030	0.005	0.50	24.0–25.0	21.0–23.0	7.0–8.0	0.45–0.55	Cu 0.30–0.60
S34565	...	0.030	5.0–7.0	0.030	0.010	1.00	23.0–25.0	16.0–18.0	4.0–5.0	0.40–0.60	Cb 0.10
S34700	347	0.08	2.00	0.045	0.030	1.00	17.0–19.0	9.0–12.0	...	...	Cb 10×C–1.10
S34800	348	0.08	2.00	0.045	0.030	1.00	17.0–19.0	9.0–12.0	...	...	Cb 10×C–1.10, Ta 0.10 Co 0.20
Austenitic-Ferritic Grades											
S31100	XM-26	0.06	1.00	0.045	0.030	1.00	25.0–27.0	6.0–7.0	...	...	Ti 0.25
S31803	...	0.030	2.00	0.030	0.020	1.00	21.0–23.0	4.5–6.5	2.5–3.5	0.08–0.20	...
S32101	...	0.040	4.0–6.0	0.040	0.030	1.00	21.0–22.0	1.35–1.70	0.10–0.80	0.20–0.25	Cu 0.10–0.80
S32205	...	0.030	2.00	0.030	0.020	1.00	22.0–23.0	4.5–6.5	3.0–3.5	0.14–0.20	...
S32304	...	0.030	2.50	0.040	0.030	1.00	21.5–24.5	3.0–5.5	0.05–0.60	0.05–0.20	Cu 0.05–0.60
S32506	...	0.030	1.00	0.040	0.015	0.90	24.0–26.0	5.5–7.2	3.0–3.5	0.08–0.20	W 0.05–0.30
S32550	...	0.04	1.50	0.040	0.030	1.0	24.0–27.0	4.5–6.5	2.9–3.9	0.10–0.25	Cu 1.50–2.50
S32760[E]	...	0.030	1.00	0.030	0.010	1.00	24.0–26.0	6.0–8.0	3.0–4.0	0.20–0.30	Cu 0.50–1.00 W 0.50–1.00
Ferritic Grades											
S40500	405	0.08	1.00	0.040	0.030	1.00	11.5–14.5	0.50	...	...	Al 0.10–0.30

TABLE 1 *Continued*

UNS Designation[B]	Type	Composition, %									
		Carbon	Manganese	Phosphorus	Sulfur	Silicon	Chromium	Nickel	Molybdenum	Nitrogen	Other Elements
S40976	...	0.030	1.00	0.040	0.030	1.00	10.5–11.7	0.75–1.00	...	0.040	Cb 10 × (C+N)-0.80
S42900	429	0.12	1.00	0.040	0.030	1.00	14.0–16.0	...	...	...	...
S43000	430	0.12	1.00	0.040	0.030	1.00	16.0–18.0	...	...	...	...
S44400	444	0.025	1.00	0.040	0.030	1.00	17.5–19.5	1.00	1.75–2.50	0.035	Ti+Cb 0.20+4 × (C+N)-0.80
S44600	446	0.20	1.50	0.040	0.030	1.00	23.0–27.0	0.75	...	0.25	...
S44627	XM-27[F]	0.010[G]	0.40	0.020	0.020	0.40	25.0–27.5	0.50	0.75–1.50	0.015[G]	Cu 0.20 Cb 0.05–0.20
S44700	...	0.010	0.30	0.025	0.020	0.20	28.0–30.0	0.15	3.5–4.2	0.020	C+N 0.025 Cu 0.15
S44800	...	0.010	0.30	0.025	0.020	0.20	28.0–30.0	2.00–2.50	3.5–4.2	0.020	C+N 0.025 Cu 0.15
		Martensitic Grades									
S40300	403	0.15	1.00	0.040	0.030	0.50	11.5–13.0	...	...	...	...
S41000	410	0.08–0.15	1.00	0.040	0.030	1.00	11.5–13.5	...	...	...	...
S41040	XM-30	0.18	1.00	0.040	0.030	1.00	11.0–13.0	...	...	...	Cb 0.05–0.30
S41400	414	0.15	1.00	0.040	0.030	1.00	11.5–13.5	1.25–2.50	...	...	...
S41425	...	0.05	0.50–1.00	0.020	0.005	0.50	12.0–15.0	4.0–7.0	1.50–2.00	0.06–0.12	Cu 0.30
S41500	H	0.05	0.50–1.00	0.030	0.030	0.60	11.5–14.0	3.5–5.5	0.50–1.00	...	...
S42000	420	0.15 min	1.00	0.040	0.030	1.00	12.0–14.0	...	...	...	...
S42010	...	0.15–0.30	1.00	0.040	0.030	1.00	13.5–15.0	0.35–0.85	0.40–0.85	...	...
S43100	431	0.20	1.00	0.040	0.030	1.00	15.0–17.0	1.25–2.50	...	...	...
S44002	440A	0.60–0.75	1.00	0.040	0.030	1.00	16.0–18.0	...	0.75	...	...
S44003	440B	0.75–0.95	1.00	0.040	0.030	1.00	16.0–18.0	...	0.75	...	...
S44004	440C	0.95–1.20	1.00	0.040	0.030	1.00	16.0–18.0	...	0.75	...	...

[A] Maximum, unless range or minimum is indicated.
[B] Designations established in accordance with Practice E 527 and SAE J 1086.
[C] For some applications, the substitution of Type 304L for Type 304, or Type 316L for Type 316 may be undesirable because of design, fabrication, or service requirements. In such cases, the purchaser should so indicate on the order.
[D] Nitrogen content is to be reported for this grade.
[E] % Cr + 3.3 × % Mo + 16 × % N ≥ 40.
[F] Nickel plus copper shall be 0.50 % max.
[G] Product analysis tolerance over the maximum limit for carbon and nitrogen shall be 0.002 %.
[H] Wrought version of CA 6NM.

4.1.1.2 *Condition H*—Hardened and tempered at a relatively low temperature

4.1.1.3 *Condition T*—Hardened and tempered at a relatively high temperature

4.1.1.4 *Condition S—Strain Hardened*—Relatively light cold work

4.1.1.5 *Condition B*—Relatively severe cold work

5. Chemical Composition

5.1 The steel shall conform to the requirements for chemical composition specified in Table 1.

5.2 Methods and practices relating to chemical analysis required by this specification shall be in accordance with Test Methods, Practices, and Terminology A 751.

6. Mechanical Properties Requirements

6.1 The material shall conform to the mechanical test requirements specified in Table 2.

6.2 The martensitic grades shall be capable of meeting the hardness requirements after heat treating as specified in Table 3.

6.3 Hardness measurements, when required, shall be made at a location midway between the surface and the center of the cross section.

7. Magnetic Permeability

7.1 When required by the purchase order, the magnetic permeability of Types 201 and 205 in the annealed condition shall not exceed 1.2 as tested by a Severn-type indicator.

8. General Requirements

8.1 In addition to the requirements of this specification, all requirements of the current edition of Specification A 484/A 484M shall apply. Failure to comply with the general requirements of Specification A 484/A 484M constitutes nonconformance to this specification.

9. Certification

9.1 Upon request of the purchaser in the contract or order, the producer's certification that the material was manufactured and tested in accordance with this specification, together with a certified report of the test results shall be furnished at the time of the shipment.

10. Keywords

10.1 austenitic stainless steel; austenitic-ferritic duplex stainless steel; ferritic stainless steel; martensitic stainless steel; stainless steel bars; stainless steel shapes

TABLE 2 Mechanical Requirements

Type	Condition	Finish	Diameter or Thickness, in. (mm)	Tensile Strength, min		Yield Strength,[A] min		Elongation in 2 in. (50 mm)[B] or 4D min %	Reduction of Area,[C,D] min, %	Brinell Hardness,[E] max
				ksi	MPa	ksi	MPa			
Austenitic Grades										
N08367	A	hot-finished or cold-finished	all	95	655	45	310	30	50	...
N08700	A	hot-finished or cold-finished	all	80	550	35	240	30	50	...
201, 202	A	hot-finished or cold-finished	all	75	515	40	275	40	45	...
S20161	A	hot-finished	all	125	860	50	345	40	40	255
		cold-finished	all	125	860	50	345	40	40	311
S20162	A	hot-finished or cold finished	all	100	690	50	345	50	60	...
205	A	hot-finished or cold-finished	all	100	690	60	414	40	50	...
XM-19	A	hot-finished or cold-finished	all	100	690	55	380	35	55	...
	As hot-rolled	hot-finished or cold-finished	up to 2 (50.8), incl	135	930	105	725	20	50	...
			over 2 to 3 (50.8 to 76.2), incl	115	795	75	515	25	50	...
			over 3 to 8 (76.2 to 203.2), incl	100	690	60	415	30	50	...
S21800	A	hot-finished or cold-finished	all	95	655	50	345	35	55	241
XM-10, XM-11	A	hot-finished or cold-finished	all	90	620	50	345	45	60	...
XM-29	A	hot-finished or cold-finished	all	100	690	55	380	30	50	...
XM-28	A	hot-finished or cold-finished	all	100	690	55	380	30	50	...
S24565	A	hot-finished or cold-finished	all	115	795	60	415	35	40	...
S28200	A	hot-finished or cold finished	all	110	760	60	410	35	55	...
302, 302B, 304, 304LN, 305, 308, 309, 309S, 309Cb, 310, 310S, 310Cb, 314, 316, 316LN, 316Cb, 316TI, 317, 321, 347, 348	A	hot-finished	all	75[F]	515	30[F]	205	40[G]	50	...
		cold-finished	up to ½ (12.70) incl	90	620	45	310	30	40	...
			over ½ (12.70)	75[F]	515	30[F]	205	30	40	...
304L, 316L	A	hot-finished	all	70	485	25	170	40[G]	50	...
		cold-finished	up to ½ (12.70) incl	90	620	45	310	30	40	...
			over ½ (12.70)	70	485	25	170	30	40	...
304N, 316N	A	hot-finished or cold-finished	all	80	550	35	240	30	...	...
202, 302, 304, 304N, 316, 316N	B	cold-finished	up to ¾ (19.05) incl	125	860	100	690	12	35	...
304L, 316L			over ¾ (19.05) to 1 (25.40)	115	795	80	550	15	35	...
			over 1 (25.40) to 1¼ (31.75)	105	725	65	450	20	35	...
			over 1¼ (31.75) to 1½ (38.10)	100	690	50	345	24	45	...
			over 1½ (38.10) to 1¾ (44.45)	95	655	45	310	28	45	...
304, 304N, 316, 316N 304L, 316L	S	cold-finished	up to 2 (50.8) incl	95	650	75	515	25	40	...
			over 2 to 2½ (50.8 to 63.5) incl	90	620	65	450	30	40	...
			over 2½ to 3 (63.5 to 76.2) incl	80	550	55	380	30	40	...
XM-21, S30454, S31654	A	hot-finished or cold-finished	all	90	620	50	345	30	50	...
XM-21, S30454 S31654	B	cold-finished	up to 1 (25.40) incl	145	1000	125	860	15	45	...
			over 1 (25.40) to 1¼ (31.75)	135	930	115	795	16	45	...
			over 1¼ (31.75) to 1½ (38.10)	135	895	105	725	17	45	...

TABLE 2 *Continued*

Type	Condition	Finish	Diameter or Thickness, in. (mm)	Tensile Strength, min		Yield Strength,[A] min		Elongation in 2 in. (50 mm)[B] or 4D min %	Reduction of Area,[C,D] min, %	Brinell Hardness,[E] max
				ksi	MPa	ksi	MPa			
			over 1½ (38.10) to 1¾ (44.45)	125	860	100	690	18	45	...
S30815	A	hot-finished or cold-finished	all	87	600	45	310	40	50	...
				87	600	45	310	40	50	...
S31254	A	hot-finished or cold-finished	all	95	650	44	300	35	50	...
S31725	A	hot-finished or cold-finished	all	75	515	30	205	40	...	...
S31726	A	hot-finished or cold-finished	all	80	550	35	240	40	...	...
S31727	A	hot-finished or cold-finished	all	80	550	36	245	35	...	217
S32053	A	hot-finished or cold-finished	all	93	640	43	295	40	...	217
S32654	A	hot-finished or cold-finished	all	109	750	62	430	40	40	250
			Austenitic-Ferritic Grades							
XM-26	A	hot-finished or cold-finished	all	90	620	65	450	20	55	...
S31803	A	hot-finished or cold-finished	all	90	620	65	448	25	...	290
S32056	A	hot-finished or cold-finished	all	90	620	65	450	18	...	302
S32101	A	hot-finished or cold-finished	all	94	650	65	450	30	...	290
S32205	A	hot-finished or cold-finished	all	95	655	65	450	25	...	290
S32304	A	hot-finished or cold-finished	all	87	600	58	400	25	...	290
S32550	A	hot-finished or cold-finished	all	109	750	80	550	25	...	290
S32550	S	cold-finished	all	125	860	105	720	16	...	335
S32760	A	hot-finished or cold-finished	all	109	750	80	550	25	...	290
S32760	S	cold-finished	all	125	860	105	720	16	...	335
			Ferritic Grades							
405[H]	A	hot-finished	all	...	...	...	...	...	...	207
		cold-finished	all	...	...	...	...	...	...	217
429	A	hot-finished	all	70	480	40	275	20	45	...
		cold-finished	all	70	480	40	275	16	45	...
430	A	hot-finished or cold-finished	all	60	415	30	207	20	45	...
S40976	A	hot-finished or cold-finished	all	60	415	20	140	20	45	244
S44400	A	hot-finished	all	60	415	45	310	20	45	217
		cold-finished	all	60	415	45	310	16	45	217
446, XM-27	A	hot-finished	all	65	450	40	275	20	45	219
		cold-finished	all	65	450	40	275	16	45	219
S44700	A	hot-finished	all	70	480	55	380	20	40	...
		cold-finished	all	75	520	60	415	15	30	...
S44800	A	hot-finished	all	70	480	55	380	20	40	...
		cold-finished	all	75	520	60	415	15	30	...
			Martensitic Grades							
403, 410	A	hot-finished	all	70	480	40	275	20	45	...
		cold-finished	all	70	480	40	275	16	45	...
403, 410	T	hot-finished	all	100	690	80	550	15	45	...
		cold-finished	all	100	690	80	550	12	40	...
XM-30	T	hot-finished	all	125	860	100	690	13	45	302
		cold-finished	all	125	860	100	690	12	35	...
403, 410	H	hot-finished	all	120	830	90	620	12	40	...
		cold-finished	all (rounds only)	120	830	90	620	12	40	...
XM-30	A	hot-finished	all	70	480	40	275	13	45	235
		cold-finished	all	70	480	40	275	12	35	...
414	A	hot-finished or cold-finished	all	...	...	...	...	...	...	298
414	T	hot-finished or cold-finished	all	115	790	90	620	15	45	...

TABLE 2 *Continued*

Type	Condition	Finish	Diameter or Thickness, in. (mm)	Tensile Strength, min		Yield Strength,[A] min		Elongation in 2 in. (50 mm)[B] or 4D min %	Reduction of Area,[C,D] min, %	Brinell Hardness,[E] max
				ksi	MPa	ksi	MPa			
S41425	T	hot-finished	all	120	825	95	655	15	45	321
S41500	T	hot-finished or cold-finished	all	115	795	90	620	15	45	295
420	A	hot-finished	all	...	...	...	...	...	...	241
		cold-finished	all	...	...	...	...	...	...	255
S42010	A	hot-finished	all	...	...	...	...	...	...	235
		cold-finished	all	...	...	...	...	...	...	255
431	A	hot-finished or cold-finished	all	...	...	...	...	...	...	285
440A, 440B, and 440C	A	hot-finished	all	...	...	...	...	...	...	269
		cold-finished	all	...	...	...	...	...	...	285

[A] Yield strength shall be determined by the 0.2 % offset method in accordance with Test Methods and Definitions A 370. An alternative method of determining yield strength may be used based on a total extension under load of 0.5 %.

[B] For some specific products, it may not be practicable to use a 2-in. or 50-mm gage length. The use of sub-size test specimens, when necessary, is permissible in accordance with Test Methods and Definitions A 370.

[C] Reduction of area does not apply on flat bars 3/16 in. (4.76 mm) and under in thickness as this determination is not generally made in this product size.

[D] The material shall be capable of meeting the required reduction of area where listed, but actual measurement and reporting of the reduction of area are not required unless specified in the purchase order.

[E] Or equivalent Rockwell hardness.

[F] For extruded shapes of all Cr-Ni grades of Condition A, the yield strength shall be 25 ksi (170 MPa) min and tensile strength shall be 70 ksi (480 MPa) min.

[G] For shapes having section thickness of ½ in. (12.5 mm) or less, 30% min. elongation is acceptable.

[H] Material shall be capable of being heat treated to a maximum Brinell hardness of 250 when oil quenched from 1750°F (953°C).

TABLE 3 Response to Heat Treatment

Type[A]	Heat Treatment Temperature[B] °F (°C), min	Quenchant	Hardness HRC, min
403	1750 (955)	Air	35
410	1750 (955)	Air	35
414	1750 (955)	Oil	42
420	1825 (995)	Air	50
S42010	1850 (1010)	Oil	48
431	1875 (1020)	Oil	40
440A	1875 (1020)	Air	55
440B	1875 (1020)	Oil	56
440C	1875 (1020)	Air	58

[A] Samples for testing shall be in the form of a section not exceeding 3/8 in. (9.50 mm) in thickness.

[B] Temperature tolerance is ±25°F (14°C).

SUMMARY OF CHANGES

Committee A01.17 has identified the location of selected changes to this standard since the last issue, A 276 – 05a, that may impact the use of this standard. (Approved March 1, 2006.)

(*1*) Added 304L and 316L to Table 2 for condition B and condition S.

Indian Standard

SPECIFICATION FOR ELECTROPLATED COATINGS OF CADMIUM ON IRON AND STEEL

(Second Revision)

0. FOREWORD

0.1 This Indian Standard (Second Revision) was adopted by the Indian Standards Institution on 10 September 1986, after the draft finalized by the Metallic and Non-metallic Finishes Sectional Committee had been approved by the Structural and Metals Division Council.

0.2 This standard was first published in 1960, revised in 1968 and covered three grades of cadmium plating depending on thickness of the coating. In the first revision of the standard, thickness requirements had been modified keeping in view the utility of the coatings and the trade practices followed in the country. Efforts have been made to include many details left out in the first revision to make the second revision a comprehensive one. Additional terms have also been included under terminology and limitations are referred to regarding finish and appearance under coating requirements. More details have been incorporated under information to be given by the purchaser and information regarding materials and manufacture, chromate passivation, test for coating, handling, inspection and packaging. A reference to barrel-plated items has also been made under Table 1, Note 2.

0.3 In view of its toxicity, cadmium should not be used as a coating for any article used as a food container or cooking utensil or for any article likely to come in contact with food or beverages.

0.3.1 Cadmium vapours and cadmium oxide fumes are highly toxic when inhaled. Therefore, cadmium plated articles must not be welded, spot-welded, soldered or otherwise strongly heated without adequate ventilation which will efficiently remove all toxic fumes.

0.3.2 Cadmium is subjected to corrosion by vapours which may be released by cardboard, wood, plastics, certain electrical insulating materials, paints and other organic substances.

0.3.3 Attention is drawn to the fact that electroplated cadmium is more readily soldered than electroplated zinc.

0.4 Like zinc, cadmium also protects steel cathodically, that is, by sacrificial protection in most environments. It is superior to zinc coatings in purely marine atmospheres. Chromate conversion coatings on cadmium provide additional protection against corrosion and should be applied unless there is a reason to the contrary. Cadmium-plated articles to be painted may require alternative treatment such as phosphating to provide good adhesion.

0.4.1 Cadmuim dissolves in most mineral acids but unlike zinc, does not react with alkalis.

0.4.2 Chromate passivated cadmium coatings contain hexavalent chromium which may irritate the skin and cause ulcers on the skin. Cotton, nylon or rubber hand-gloves may be used to prevent skin ulceration while handling chromated cadmium-plated parts. This will also prevent finger-print corrosion on cadmium coatings.

0.5 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

0.6 General Information — This specification includes the whole range of iron and steel products as basis metals. Designers are advised, however, that all forms of iron and steel are not equally readily electroplated. Many castings can be satisfactorily plated, but are considered to be more difficult than forgings. Cadmium is mostly plated from a cyanide bath. Suitable pretreatments must be used to satisfactorily electrodeposit cadmium on difficult-to-plate substrates. Adequate precautions must be taken against the danger of hydrogen embrittlement.

Attention is also drawn to the effects of the contour of the article to be plated. In general, the requirements for minimum thickness apply only to those portions of the article which may be described as significant surfaces. It helps to reduce process cost if the designer of an electroplated part consults a plating specialist before the design is finally issued for production.

*Rules for rounding off numerical values (*revised*).

1. SCOPE

1.1 This standard covers requirements for electrodeposited cadmium coatings applied to iron or steel articles except for coatings applied to components having threads of basic major diameter from 1·25 to 12·5 mm and coatings applied to sheet or wire in the unfabricated form or to close-coiled springs.

1.2 Requirements are specified for appearance, thickness, adhesion, heat treatment before or after plating, precleaning standards and if the coating is chromate-passivated, the corrosion resistance.

2. TERMINOLOGY

2.0 For the purpose of this standard, the following definitions shall apply.

2.1 Surface — The part of the surface on which the electroplater has to work.

2.2 Significant Surface — Significant surfaces are those surfaces, normally visible directly or by reflection, which are essential to the appearance or serviceability of the article when assembled in normal position, or which can be the source of corrosion products that deface visible surfaces on the assembled article and are subject to wear or corrosion or both, or surfaces on which the coating is otherwise functionally necessary.

NOTE 1 — The significant surface may be generally defined as that part of the visible surface which can be touched with a ball of diameter 20 mm or a diameter agreed upon by the manufacturer and the purchaser.

NOTE 2 — The designation of significant surface shall be agreed upon by the manufacturer and the purchaser and may be indicated in the drawings.

2.3 Non-significant Surfaces — Surfaces such as holes, recesses, bases of angles and similar areas where a controlled deposit ordinarily cannot be obtained, are designated as non-significant surfaces.

2.4 Minimum Local Thickness — This is defined as the lowest value of the coating thickness at any point on the significant surfaces.

2.5 Minimum Average Thickness — This is the average of thicknesses at a number of points on the significant surfaces.

2.6 Iridescent Passivation — When a stable and adherent chromate coating is formed over cadmium electrodeposits by reaction with an acidified dichromate solution under suitable *p*H and duration of passivation, producing more than one or two interference colours, the passivation is termed as iridescent passivation.

2.7 Post-Plating Treatment — Heat treatment for relief of hydrogen embrittlement, bright dipping, chromate passivation, dyeing, lacquering, painting or other organic coatings after plating, are termed post-plating treatments.

2.8 Hydrogen Embrittlement — Embrittlement caused by the entry of hydrogen into a metal.

3. COATING CLASSIFICATION NUMBER

3.1 Manner of Specifying Requirements — When ordering the electroplating of articles, the purchaser shall state the number of this standard, the date of issue, the class or service condition number and type (*see* Table 1). If necessary, the purchaser shall include, on his part, if specified, the following.

3.1.1 *Electroplating Application to High-Strength Steel, If Specified*

3.1.2 *Thickness, If Other than that Specified in This Standard*

3.1.3 *Lustre*

3.1.4 *Location of Significant Surface*

3.1.5 *Corrosion Resistance Test, If Specified*

3.1.6 *Hydrogen Embrittlement Test, If Required*

3.1.7 *Sample Size for Inspection, If Other than the Specified*

3.1.8 *Supplementary Requirements, If Applicable*

3.2 Grading of Service Conditions — In order of increasing severity of service conditions, numbers 1 to 3 have been allotted, to be referred to as Service Grade Numbers. The purchaser shall specify the service grade number and, if desired, also the classification number (*see* **3.3**). Typical service conditions which correspond to various service grade numbers have been explained in Appendix A, for guidance.

3.3 Classification of Coatings — The classification number comprises:

a) Chemical symbol for the basis metal (iron or steel), Fe, followed by an oblique stroke;

b) Chemical symbol for cadmium, Cd;

c) A number indicating the minimum local thickness (micrometres) of the cadmium coating; and

d) If appropriate, symbols indicating the presence of, and type (if required), of the chromate conversion coating (*see* IS : 9839-1981*).

3.3.1 *Example of Complete Classification Number* — Fe/Cd 8 CA shall denote a coating on iron or steel consisting of 8 micrometres of cadmium followed by A type chromate conversion coating, where

C refers to the chromate conversion coating, and

A is the type of chromate conversion coating.

4. COATING REQUIREMENTS

4.1 Finish and Appearance

4.1.1 Over the significant surface, the plated article shall be free from clearly visible plating defects such as blisters, pits, roughness, nodules, cracks, burning or unplated areas and shall not be stained or discoloured. On articles, usually where a contact mark is inevitable, this contact mark is excluded for inspection of appearance. Superficial stains that result from rinsing or slight discolouration resulting from drying or heating operation to relieve hydrogen embrittlement shall not be the cause for rejection.

NOTE 1 — Unless otherwise specified, the finish shall be bright, semi-bright or dull. The plated article shall, however, be clean and free from any damage.

NOTE 2 — Defects on the surface of the basis metal, such as scratches, porosity, pits, inclusions, cracks, roll marks and die marks may adversely affect the appearance of coatings applied thereto, despite the observance of the best electroplating practices. Accordingly, the electroplater's responsibility for defects in the coating resulting from such conditions shall be waived.

4.2 Thickness and Type of Cadmium Coating

4.2.1 *Thickness* — The minimum thickness of cadmium coating is designated by the classification number (*see* **3.3**).

4.2.2 *Local Thickness* — The minimum local thickness of the cadmium coating shall be measured at points on the significant surface as agreed to between the purchaser and the supplier and shall satisfy the requirements of Table 1.

4.2.3 *Average Thickness* —In cases where it is not possible to measure local thickness, the average thickness of cadmium coating shall satisfy the appropriate requirements of Table 1.

*Specification for chromate conversion coatings on electroplated zinc and cadmium coatings.

TABLE 1 REQUIREMENTS OF CADMIUM COATING ON IRON AND STEEL

(*Clauses* 0.2, 3.1, 4.2.2, 4.2.3 *and* 4.6)

Sl No.	Service Grade Number	Classification Number	Minimum Local Thickness	Average Thickness
(1)	(2)	(3)	(4)	(5)
			µm	µm
i)	3	Fe/Cd 12	12	18
ii)	2	Fe/Cd 8	8	12
iii)	1	Fe/Cd 5	5	8

NOTE 1 — In any particular environment, the protective value of a cadmium coating is directly proportional to its mass per unit area. The marked superiority shown by cadmium coatings over zinc coatings of equal thickness in the standard salt spray test cannot be taken as a fact valid for all the environments (zinc is superior in industrial environments whereas cadmium is superior in humid/marine atmospheres).

NOTE 2 — Barrel-plated items like screws, nuts, bolts, etc, are usually plated according to classification Fe/Cd 5 and Fe/Cd 8.

NOTE 3 — Average thickness is determined for small parts and fasteners where minimum local thickness cannot be determined.

4.3 Adhesion — The coating shall continue to adhere to the basis metal.

4.4 — Unless otherwise specified by the purchaser, a bright, semi-bright or dull lustre shall be acceptable.

4.5 Corrosion Resistance — Corrosion resistance shall be carried out on parts which have not been after-treated with protective substances such as waxes, greases and oils or on parts chromized by the methods given in **7.2.**

4.6 Coatings Appropriate to Each Service Grade Number — Table 1 gives the coating classification number, minimum local thickness and minimum average thickness appropriate for each service condition number.

5. BASIS METAL

5.1 Cleaning of Basis Metal — This standard does not specify requirements for the surface of the basis metal prior to electroplating but proper preparatory procedures and thorough cleaning of the basis metal shall be done in accordance with the procedure given in IS : 3194-1980* to ensure satisfactory adhesion and corrosion resistance performance of the coating.

*Recommended practice for cleaning metals prior to electroplating (*first revision*).

6. HEAT TREATMENT

6.1 Heat treatment shall be performed on certain basis metals to reduce the risk of damage by hydrogen embrittlement. In all cases, the duration of heat treatment shall commence from the time at which the whole of each part attains the specified temperature.

6.1.1 Parts made from steels with maximum specified tensile strengths of 1 050 MPa or higher (corresponding hardness values of approximately 34 HRC, 340 HV or 325 HB) and surface-hardened parts shall require heat treatment. It is recommended that unless otherwise specified, steels having tensile strength greater than 1 450 MPa (corresponding hardness 45 HRC, 440 HV or 415 HB) should not be electroplated with cadmium by conventional methods.

6.2 With the exception of surface-hardened parts, the heat treatment conditions shall be selected on the basis of the specified maximum tensile strength. Steels shall be categorized according to specified maximum tensile strength according to Table 2. If the steel specification is only in terms of minimum tensile strength, the corresponding maximum tensile strength shall be determined from Table 2.

TABLE 2 CATEGORIES OF STEELS AND MAXIMUM TENSILE STRENGTH CORRESPONDING TO SPECIFIED MINIMUM TENSILE STRENGTH

Sl No.	Minimum Specified Tensile Strength, *Rm Min*	Corresponding Maximum Tensile Strength, *Rm Max*
(1)	(2)	(3)
	MPa	MPa
i)	*Rm Min* $\leq$ 1 000	*Rm Max* $\leq$ 1 050
ii)	1 000 $<$ *Rm Min* $\leq$ 1 400	1 050 $<$ *Rm Max* $\leq$ 1 450
iii)	1 400 $<$ *Rm Min* $<$ 1 750	1 450 $<$ *Rm Max* $<$ 1 800
iv)	1 750 $<$ *Rm Min*	1 800 $<$ *Rm Max*

6.3 Stress-Relief Before Plating — All steel parts having an ultimate tensile strength of 1 050 MPa (corresponding hardness 34 HRC, 340 HV or 325 HB approx) and above, and that have been machined, ground or cold-formed, or cold-strengthened, shall be heat-treated for stress-relief. As a guide, they may be heat-treated at the highest temperature within the limit imposed by the tempering temperature for 30 minutes or maintained at a temperature of 190 to 220°C for not less than 1 hour.

NOTE 1 — If stress-relief is given after shot-peening or other cold-working processes, the temperature shall not exceed 230°C.

NOTE 2 — Some steels which have been carburized, flame-hardened or induction-hardened, and subsequently ground would be impaired by the treatment given in Note 1 and should instead be stress-relieved at a lower temperature, for example, at 170°C for not less than 1 hour. Guidance is given in Table 3.

TABLE 3 GUIDANCE OF HEAT TREATMENT FOR STRESS-RELIEF BEFORE ELECTROPLATING

(excluding surface-hardened parts)

SL No.	MAXIMUM SPECIFIED TENSILE STRENGTH, *Rm Max*	TEMPERATURE	TIME
(1)	(2)	(3)	(4)
	MPa	°C	h
i)	*Rm Max* ≤ 1 050	Not required	—
ii)	1 050 < *Rm Max* ≤ 1 450	190-220	1
iii)	1 450 < *Rm Max* ≤ 1 800	190-220	18
iv)	1 800 < *Rm Max*	190-220	24

6.4 Heat-Treatment After Plating Hydrogen Embrittlement Relief — Components subject to fatigue or sustained loading stress in service and made from severely cold-worked steels or nitrided steels or steels of tensile strength of 1 050 MPa (corresponding hardness 34 HRC, 340 HV or 325 HB approx) or greater should be heat-treated after plating. Guidance is given in Table 4.

TABLE 4 GUIDANCE OF HEAT TREATMENT FOR HYDROGEN EMBRITTLEMENT RELIEF AFTER ELECTROPLATING

(excluding surface-hardened parts)

SL No.	MAXIMUM SPECIFIED TENSILE STRENGTH, *Rm Max*	TEMPERATURE	TIME
(1)	(2)	(3)	(4)
	MPa	°C	h
i)	*Rm Max* ≤ 1 050	Not required	—
ii)	1 050 < *Rm Max* ≤ 1 450	190-220	8
iii)	1 450 < *Rm Max* ≤ 1 800	190-220	18
iv)	1 800 < *Rm Max*	190-220	24

6.4.1 In case the heat-treatment temperature would be harmful, for example, to surface-hardened steels (except for nitrided steels), it may be necessary to apply a lower temperature for a longer time.

NOTE 1 — The baking should be done as soon as possible after electroplating and before any supplementary chemical treatment of the plated surfaces. The best time and temperature in some cases shall be established by experiment.

NOTE 2 — Electroplated springs and other parts subject to flexure shall not be flexed before hydrogen embrittlement relief treatment. Steel springs shall be treated in boiling water for not less than 2 hours. The spring rating may be affected at a higher temperature.

NOTE 3 — Other conditions of time and temperature may be specified and used if they have been shown to be effective for the particular part and are acceptable to the purchaser but parts shall not be heat-treated above their tempering temperature.

6.5 Activation Treatment — Electroplated surfaces passivated as a result of the baking operation shall be reactivated before receiving a supplementary treatment. Surface intended for supplementary treatment, namely A, B, C and D types may by activated by immersion in a dilute acid solution. Surfaces shall be activated as soon as possible following baking and should be handled carefully to avoid contamination.

7. SUPPLEMENTARY TREATMENTS

7.1 Chromate passivation of cadmium plating should always be applied unless there is an agreement to the contrary. As it increases the protective value of cadmium plating, the articles are passivated after cadmium plating. If it is to be heat-treated, this should be done before passivation.

7.1.1 *Chromate Conversion Coating* — Chromate conversion coating on cadmium plating shall be done in accordance with IS : 9839-1981*. If specified by the purchase order, chromate conversion coatings shall be further protected by organic protective coatings like water soluble lacquer, nitrocellulose lacquer or paint.

7.1.2 *Phosphate Conversion Coating* — Phosphate conversion coating shall be done in accordance with IS : 3618-1974†. If specified by the purchase order, this coating shall also be covered by painting.

7.2 Corrosion Resistance of Chromate Coating — The protective value of a chromate coating shall be determined by exposing the clean specimen to a 5 percent solution of salt spray and conducting the test in accordance with

*Specification for chromate conversion coatings on electroplated zinc and cadmium coatings.

†Specification for phosphate treatment of iron and steel for protection against corrosion.

IS : 6910-1985*. The white corrosion product which is easily determinable by eyes, shall not emerge on the chromate coating surface within 48 hours.

7.2.1 Alternatively, other method, such as exposure to a humidity environment shall be used as given in IS : 8602-1977†. Break-down of the film, or the appearance of white corrosive products after 2 cycles of the test constitute failure to comply with this standard.

7.3 Appearance of Chromate Coating — The appearance of a chromate film on cadmium-plated parts may vary from olive drab, olive green shading to brown or bronze, iridescent yellowish green to practically colourless. In the case of iridescent passivation, the combination of colours may vary according to the process conditions like *p*H, conditions of the basis metal and cadmium deposit, temperature, time of reaction, agitation and composition of the passivation bath.

7.4 Covering — A chromate film should be free from bare patches. The presence of the film is verified by the test methods, for colourless and bleached passivation as prescribed in IS : 8602-1977†.

7.5 Adhesion for Chromated Coatings — A chromate film shall be adherent. Its adhesion shall be tested by the method prescribed in IS : 8602-1977†.

NOTE 1 — The cadmium surface is attacted by supplementary treatments, thereby diminishing the amount of metallic cadmium present. Therefore, it is recommended that no supplementary treatments be applied to cadmium coatings, having a minimum thickness of less than about 3 micrometres.

NOTE 2 — Since cadmium surface is soft, the coloured chromate films are likely to be scratched when chromated cadmium plated articles rub each other. Adequate case is taken to minimize such damages to the passivated film.

8. SELECTION OF SAMPLES

8.1 Out of each lot of similar parts, a number of samples shall be selected at random. The size of the lot and the number of samples to be selected shall be agreed upon between the manufacturer and the purchaser. All the samples selected shall be visually examined for any defects referred to in.

9. TEST SPECIMENS

9.1 If separate test specimens are used to represent the coated articles in a test, the specimens shall be same in nature, size and number and be processed as required in the purchaser's order.

NOTE — Unless a need can be demonstrated, separately prepared specimens shall not be used in place of production items for non-destructive and visual examinations.

*Method of testing corrosion resistance of electroplated and anodized aluminium coatings by acetic acid salt spray test (*first revision*).

†Methods of tests for chromate conversion coatings on zinc and cadmium surfaces.

9.2 Thickness and Adhesion Test Specimens — If separate specimens for thickness and adhesion tests are required, they shall be strips approximately 25 mm wide, 100 mm long and 1 mm thick.

9.3 Corrosion Resistance Test Specimens — If separate specimens for corrosion resistance tests are required, they shall be panels not less than 150 mm long, 100 mm wide and approximately 1 mm thick.

9.4 Hydrogen Embrittlement Test Specimens — If specimens are required, the configuration shall be specified by the purchaser.

10. TEST METHODS

10.1 Thickness

10.1.1 The local thickness of coating may by determined by the methods prescribed in IS : 3203-1982*.

10.1.2 The method as given in Appendix B shall be used for determining average thickness in the case of cadmium coating on small articles as prescribed in **4.2.3**.

NOTE 1 — Other methods may also be used if it can be demonstrated that the uncertainty of the measurement with these methods is less than 10 percent.

NOTE 2 — If the coatings are rough or matt, the microscopical and profilometric methods may give unreliable results, and magnetic/eddy current methods may give measurements which are somewhat greater than those obtained on smooth coatings of the same mass.

10.1.3 Thickness measurements of cadmium coatings may be made after application of the supplementary treatments. When methods as per IS : 3203-1982* (BNF jet test method) are used, remove the supplementary treatment prior to testing. The chromate film may be removed by using a very mild abrasive (a paste of levigated alumina rubbed on with the finger). Phosphate coating is to be treated with a concentrated (28 %) ammonia solution to quickly dissolve the phosphate coating without affecting the underlying cadmium.

10.2 Adhesion — Adhesion of the coating shall be such that when examined in accordance with Appendix C, the coating shall not show separation from the basis metal at the interface.

10.3 Visual Examination — Examine material for compliance with requirements of lustre (**4.4**) and appearance (**4.1** and **7.3**) after electroplating and passivation.

*Methods of testing local thickness of electroplated coatings (*first revision*).

10.4 Conversion Coatings — Conversion coatings, if applied, shall be tested for the requirements and the methods given in **7.2** to **7.5**.

11. REJECTION

11.1 Coatings not conforming to this specification or to authorized modification shall be rejected.

12. PACKAGING AND PACKING

12.1 Presentation, packaging and packing methods for cadmium electroplated parts or articles employed by a supplier shall be such as to preclude damage during shipment and handling.

13. MARKING

13.1 The marking related to the coating shall include service grade and classification numbers as specified in this standard and the name or trademark of the manufacturer.

13.1.1 The coated article may also be marked with the Standard Mark which shall relate to the coating of the article.

NOTE — The use of the Standard mark is governed by the provisions of the Bureau of Indian Standards Act, 1986 Rules and Regulations made thereunder. The BIS Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well-defined system of inspection, testing and quality control which is devised and supervised by BIS and operated by the producer. BIS marked products are also continuously checked by BIS for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the BIS Certification Mark may be granted to manufacturers or processors may be obtained from the Bureaa of Indian Standards.

APPENDIX A

(*Clause* 3.2)

EXAMPLES OF SERVICE CONDITIONS CORRESPONDING TO EACH SERVICE NUMBER

A-1. SERVICE GRADE NO. 3

A-1.1 Severe service conditions involving exposure to marine atmospheres and tropical conditions of high humidity. Some examples of articles subjected to such conditions are aircraft components and defence electronic components.

A-2. SERVICE GRADE NO. 2

A-2.1 Moderate service conditions involving outdoor exposure under dry conditions. Some examples of articles subjected to such conditions are automobile parts and barrel-plated items.

A-3. SERVICE GRADE NO. 1

A-3.1 Mild service conditions involving indoor dry conditions. Some examples of articles subjected to such conditions are domestic radio chassis and barrel-plated items.

NOTE 1 — The conditions of exposure and use of electroplated steel are so varied that it is not possible to predict the average life of articles electroplated in accordance with Grades 3, 2 and 1. Such a selection should be based upon the experience of the manufacturers and users.

NOTE 2 — It is recognized that uses exist for which coatings thicker than those of Grade 3 may be required.

APPENDIX B

(*Clause* 10.1.2)

METHOD FOR DETERMINATION OF AVERAGE THICKNESS

B-1. STRIPPING SOLUTION

B-1.1 Dissolve 20 g of antimony trioxide in 1 000 ml of cold, concentrated hydrochloric acid (sp gr 1·16).

B-2. PROCEDURE

B-2.1 Accurately determine the area of the plated part. Degrease it with an organic solvent, such as trichloroethylene, dry thoroughly and weigh to an accuracy of one part in 10 000. Then totally immerse it and turn it over so that the reagent has free access to all surfaces. After the effervescence has eased, remove the sample, immediately wash, wipe to remove the loose coating of antimony and immerse in clean acetone to remove any trapped water. Then remove the sample, dry by the process previously used and reweigh.

NOTE 1 — If the article is of a complex shape, an area should be agreed to between the contracting parties.

NOTE 2 — The presence of a chromate passivation film can be ignored in this test.

B-3. CALCULATION

B-3.1 The thickness of cadmium coating in micrometres is given by

$$\frac{116 - 10^3 (m_1 - m_2)}{A}$$

where

m_1 = original mass in g of the sample,

m_2 = final mass in g of the sample, and

A = area in mm² of coating.

NOTE — The above calculation assumes a density of 8·65 g/cm³ for cadmium.

APPENDIX C

(*Clause* 10.2)

BURNISHING TEST FOR ADHESION

C-1. PROCEDURE

C-1.1 Rub an area of not more than 650 mm² of the plated surface, selected at the discretion of the inspector, rapidly and firmly with a smooth metal implement for 15 seconds.

C-1.2 A suitable burnishing implement is a copper disc (for example, a copper coin) used edgewise, and broadside. The pressure shall be sufficient to burnish the film at every stroke, but not so great as to cut the deposit. A poor adhesion will be shown by the appearance of a loose blister which grows as the rubbing is continued. If the quality of the deposit is also poor, the blister may crack and the plating will peel away from the base metal.

C-1.3 More than one area may be tested, if desired.