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Designation: A790/A790M - 12 A790/A790M - 13

Standard Specification for Seamless and Welded Ferritic/Austenitic Stainless Steel Pipe¹

This standard is issued under the fixed designation A790/A790M; 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.

1. Scope*

1.1 This specification² covers seamless and straight-seam welded ferritic/austenitic steel pipe intended for general corrosive service, with particular emphasis on resistance to stress corrosion cracking. These steels are susceptible to embrittlement if used for prolonged periods at elevated temperatures.

1.2 Optional supplementary requirements are provided for pipe when a greater degree of testing is desired. These supplementary requirements call for additional tests to be made and, when desired, one or more of these may be specified in the order.

1.3 Appendix X1 of this specification lists the dimensions of welded and seamless stainless steel pipe as shown in ANSI B36.19. Pipe having other dimensions may be furnished provided such pipe complies with all other requirements of this specification.

1.4 The values stated in either SI units or inch-pound units are to be regarded separately as standard. Within the text, the SI units are shown in brackets. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard. The inch-pound units shall apply unless the M designation of this specification is specified in the order.

NOTE 1-The dimensionless designator NPS (nominal pipe size) has been substituted in this standard for such traditional terms as nominal diameter, size, and nominal size.

2. Referenced Documents

2.1 ASTM Standards:³ A370 Test Methods and Definitions for Mechanical Testing of Steel Products

A923 Test Methods for Detecting Detrimental Intermetallic Phase in Duplex Austenitic/Ferritic Stainless Steels

A941 Terminology Relating to Steel, Stainless Steel, Related Alloys, and Ferroalloys

A999/A999M Specification for General Requirements for Alloy and Stainless Steel Pipe

E213 Practice for Ultrasonic Testing of Metal Pipe and Tubing

E309 Practice for Eddy-Current Examination of Steel Tubular Products Using Magnetic Saturation

E381 Method of Macroetch Testing Steel Bars, Billets, Blooms, and Forgings

E426 Practice for Electromagnetic (Eddy-Current) Examination of Seamless and Welded Tubular Products, Titanium, Austenitic Stainless Steel and Similar Alloys

E527 Practice for Numbering Metals and Alloys in the Unified Numbering System (UNS)

2.2 ANSI Standards:⁴

B1.20.1 Pipe Threads, General Purpose

B36.10 Welded and Seamless Wrought Steel Pipe

B36.19 Stainless Steel Pipe

2.3 SAE Standard:⁵

SAE J 1086

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

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 A01.10 on Stainless and Alloy Steel Tubular Products.

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² For ASME Boiler and Pressure Vessel Code applications see related Specification SA-790 in Section II of that Code.

³ 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.

⁴ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

⁵ Available from Society of Automotive Engineers (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001, http://www.sae.org.



2.4 Other Standard:⁶

SNT-TC-1A Personal Qualification and Certification in Nondestructive Testing

2.5 AWS Standard

A5.9 Corrosion-Resisting Chromium and Chromium-Nickel Steel Welding Rods and Electrodes

3. Terminology

3.1 Definitions—For definitions of terms used in this specification refer to Terminology A941.

4. Ordering Information

4.1 Orders for material under this specification should include the following, as required, to describe the desired material adequately:

- 4.1.1 Quantity (feet, [metres], or number of lengths),
- 4.1.2 Name of material (ferritic/austenitic steel pipe),
- 4.1.3 Process (seamless or welded),
- 4.1.4 Grade (see Table 1),
- 4.1.5 Size (NPS designator or outside diameter and schedule number of average wall thickness),
- 4.1.6 Length (specific or random) (see Section 11),
- 4.1.7 End finish (section on ends of Specification A999/A999M),
- 4.1.8 Optional requirements (product analysis, Section 9; hydrostatic test or nondestructive electric test, Section 14),
- 4.1.9 Test report required (section on certification of Specification A999/A999M),
- 4.1.10 Specification designation, and
- 4.1.11 Special requirements and any supplementary requirements selected.

5. General Requirements

5.1 Material furnished under this specification shall conform to the applicable requirements of the current edition of Specification A999/A999M unless otherwise provided herein.

6. Materials and Manufacture

6.1 Manufacture:

6.1.1 The pipe shall be made by the seamless or an automatic welding process, with no addition of filler metal in the welding operation.

6.1.2 At the manufacturer's option, pipe may be either hot-finished or cold-finished.

6.1.3 The pipe shall be pickled free of scale. When bright annealing is used, pickling is not necessary.

6.2 Discard—A sufficient discard shall be made from each ingot to secure freedom from injurious piping and undue segregation.

6.3 Unless otherwise stated in the order, all pipe shall be furnished in the heat-treated condition as shown in Table 1.

6.3.1 For seamless pipe, as an alternate to final heat treatment in a continuous furnace or batch-type furnace, immediately following hot forming while the temperature of the pipes is not less than the specified minimum solution treatment temperature, pipes shall be individually quenched in water or rapidly cooled by other means, except for UNS S32950, which shall be air cooled.

6.3.2 If the purchaser desires pipe without heat treatment subsequent to welding, the purchase order shall specify the following condition:

6.3.2.1 No final heat treatment of pipe fabricated from plate that has been heat treated as required by Table 1 for the particular grade is required, *provided a sample of that heat of finished pipe or material representative of that heat of pipe as a prolongation of the weld passes the Test Methods A923 Method B or C (See Note 2)*, including base metal, weld metal, and heat affected zone per heat. Each pipe supplied under this requirement shall be stenciled with the suffix "HT-O."

6.3.2.2 For materials not listed in Table 3 of Test Methods A923, the HT-O provision does not apply.

NOTE 2-The Test Methods A923 test method (B or C) is at the manufacturer's option, unless otherwise specified by the purchaser.

7. Chemical Composition

7.1 The steel shall conform to the chemical requirements as prescribed in Table 2.

8. Heat Analysis

8.1 An analysis of each heat of steel shall be made by the steel manufacturer to determine the percentages of the elements specified.

⁶ Available from American Society for Nondestructive Testing (ASNT), P.O. Box 28518, 1711 Arlingate Ln., Columbus, OH 43228-0518, http://www.asnt.org.

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TABLE 1 Heat Treatment

UNS Designation	Туре ^д	Temperature °F [°C]	Quench	
S31200		1920–2010 [1050–1100]	Rapid cooling in water	
S31260		1870–2010 [1020–1100]	Rapid cooling in air or water	
S31500		1800–1900 [980–1040]	Rapid cooling in air or water	
S31803		1870–2010 [1020–1100]	Rapid cooling in air or water	
S32003		1850–2050 [1010–1120]	Rapid cooling in air or water	
S32101		1870 [1020]	Quenched in water or rapidly cooled by other means	
S32202		1870–1975 [1020–1080]	Rapid cooling in air or water	
S32205	2205	1870–2010 [1020–1100]	Rapid cooling in air or water	
S32304	2304	1700–1920 [925–1050]	Rapid cooling in air or water	
S32506		1870–2050 [1020–1120]	Rapid cooling in air or water	
S32520		1975–2050 [1080–1120]	Rapid cooling in air or water	
S32550 S32707	255	1900 [1040] min 1975–2050	Rapid cooling in air or water Rapid cooling in air or water	
S32750	2507	[1080–1120] 1880–2060	Rapid cooling in air or water	
S32760		[1025–1125] 1960–2085	Rapid cooling in air or water	
S32808		[1070–1140] 1920–2100	Rapid cooling in air or water	
S32900	329	[1050–1150] 1700–1750	Rapid cooling in air or water	
S32906		[925–955] 1870–2100	Rapid cooling in air or water	
S32950		[1020–1150] 1820–1880	Air cool	
S33207		[990–1025] 1905–2085	Rapid cooling in water or by	
S39274		[1040–1140] 1920–2060	other means Rapid cooling in air or water	
S39277		[1025–1125] 1975–2155	Rapid cooling in air or water	
S81921		[1080–1180] 1760–2010 [960–1100]	Rapid cooling in air or water	
S82011		[960–1100] 1850–2050 [1010–1120]	Rapid cooling in air or water	
S82441		1870 [1020]	Rapid cooling in air or water	

^ACommon name, not a trademark, widely used, not associated with any one producer. 329 is na AISI number.

9. Product Analysis

9.1 At the request of the purchaser's inspector, an analysis of one billet or one length of flat-rolled stock from each heat, or two pipes from each lot, shall be made by the manufacturer. A lot of pipe shall consist of the following number of lengths of the same size and wall thickness from any one heat of steel:

NPS Designator	Lengths of Pipe in Lot
Under 2	400 or fraction thereof
2 to 5, incl	200 or fraction thereof
6 and over	100 or fraction thereof

9.2 The results of these analyses shall be reported to the purchaser or the purchaser's representative and shall conform to the requirements specified in Section 7.

9.3 If the analysis of one of the tests specified in 8.1 or 9.1 does not conform to the requirements specified in Section 7, an analysis of each billet or pipe from the same heat or lot may be made, and all billets or pipe conforming to the requirements shall be accepted.

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TABLE 2 Chemical Requirements^A

UNS Designa- tion ^B	Туре ^С	С	Mn	Ρ	S	Si	Ni	Cr	Мо	Ν	Cu	Others
S31200 S31260		0.030 0.030	2.00 1.00	0.045 0.030	0.030 0.030	1.00 0.75	5.5-6.5 5.5-7.5	24.0-26.0 24.0-26.0	1.20–2.0 2.5–3.5	00 0.14-0.20 0.10-0.30		
201500		0.000	1 00 0 00	0.000	0.000	4 40 0 0		100 100	0 50 0 0	0 0 0 0 0 1	.	0.10-0.5
31500		0.030	1.20-2.00	0.030	0.030	1.40-2.00		18.0–19.0	2.50-3.0		-	
31803		0.030	2.00	0.030	0.020	1.00	4.5-6.5	21.0-23.0	2.5-3.5	0.08-0.2		
32003		0.030	2.00	0.030	0.020	1.00	3.0 4.0	19.5-22.5	1.50 2.0			
32101		0.040	4.0 6.0	0.040	0.030	1.00	1.35 1.70		0.10-0.8		-	θ
32202		0.030	2.00	0.040	0.010	1.00	1.00 2.80		0.45	0.18 0.2		
32205	2205	0.030	2.00	0.030	0.020	1.00	4.5-6.5	22.0-23.0	3.0–3.5	0.14-0.20		
32304	2304	0.030	2.50	0.040	0.040	1.00	3.0-5.5	21.5-24.5	0.05-0.6			
32506		0.030	1.00	0.040	0.015	0.90	5.5–7.2	24.0–26.0	3.0–3.5	0.08-0.20	θ	₩ 0.05-0.
32520		0.030	1.5	0.035	0.020	0.80	5.5-8.0	24.0-26.0	3.0-5.0	0.20-0.3	5 0.5-3.00	
32550	255	0.04	1.50	0.040	0.030	1.00	4.5-6.5	24.0-27.0	2.9-3.9	0.10-0.2	5 <u>1.50-2.5</u>	θ
32707		0.030	1.50	0.035	0.010	0.50	5.5-9.5	26.0-29.0	4.0-5.0	0.30-0.50		Co
												0.5 2.0
32750	2507	0.030	1.20	0.035	0.020	0.80	6.0 8.0	24.0-26.0	3.0-5.0	0.24 0.3	2 0.5	
32760		0.05	1.00	0.030	0.010	1.00	6.0-8.0	24.0-26.0	3.0-4.0	0.20-0.30	0 0.50-1.0	θ₩ 0.50–1.
32808		0.030	1.10	0.030	0.010	0.50	7.0-8.2	27.0-27.9	0.80-1.2	0.30 0.4	θ	_40 mir ₩
32900	329	0.08	1.00	0.040	0.030	0.75	2.5-5.0	23.0–28.0	1.00-2.0	ю —		2.10-2.
32900 32906	525	0.08 0.030	1.00 0.80-1.50	0.040 0.030	0.030	0.75 0.80	2.5-5.0 5.8-7.5	23.0-28.0 28.0-30.0	1.50-2.6		0.80	
32906 32950		0.030 0.030	0.80-1.90 2.00	0.030 0.035	0.030 0.010	0.80 0.60	3.5-7.3 3.5-5.2	28.0-30.0 26.0-29.0	1.00-2.6 1.00-2.5		_	
32950 33207		0.030 0.030	2.00 1.50	0.035 0.035	0.010 0.010	0.80 0.80	3.5-5.2 6.0-9.0	20.0-29.0 29.0-33.0	1.00-2.8 3.0-5.0	0.40-0.6		
39274		0.030 0.030	1.00	0.035 0.030	0.010	0.80	6.0-5.0	29.0-33.0 24.0-26.0	3.0-3.0 2.5-3.5	0.24-0.3		
39277		0.025	0.80	0.025	0.002	0.80	6.5 8.0	24.0 26.0	3.0-4.0	0.23-0.3	3 1.20 2.0	1.50_2 θ₩
81921		0.030	2.00-4.00	0.040	0.030	1.00	2.00 4.00) <u>19.0–22.0</u>	1.00-2.0	0 0.14-0.20	θ	0.8–1.2
82011		0.030	2.0-3.0	0.040	0.020	1.00	1.00-2.00		0.10-1.0			
		0.030	2.5-4.0	0.035	0.005	0.70	3.0 4.5	23.0-25.0	1.00 2.0	0 0.20 0.30	0 0.10 0.8	θ
			2.5 4.0		0.005	0.70			1.00 2.0	00 0.20 0.30	0 0.10 0.8	θ
S82441 JNS Designa-	Туре ^С		2.5 4.0 Mn		0.005				1.00 2.0 Mo			θ hers
82441 INS Designa- on ^B 31200	Type ^C	0.030 C 0.030	Mn <u>2.00</u>	0.035 P	0.005 TABLE 2 C C S UM	0.70 Chemical R Si 1.00	Ni <u>5.5–6.5</u>	ts ^A Cr Cw 24.0-26.0	Mo <u>1.20–2.00</u>	N <u>0.14–0.20</u>	Cu Ot	hers
82441 NS esigna- on ^B 31200	Type ^C	0.030 C	Mn	0.035 P	0.005 TABLE 2 0 S	0.70 Chemical R Si	equiremen	ts ^A Crlew	Мо	N <u>0.14–0.20</u>		hers
NS vesigna- on ^B <u>31200</u> <u>31260</u>	(0.030 C 0.030 0.030	Mn <u>2.00</u>	0.035 P	0.030 0.030 0.030	0.70 Chemical R Si 1.00	Ni <u>5.5–6.5</u>	ts ^A Cr Cw 24.0-26.0	Mo <u>1.20–2.00</u>	N <u>0.14–0.20</u>	Cu Ot	hers
NS vesigna- on ^B <u>31200</u> <u>31260</u> https://	Type ^c	0.030 C 0.030 0.030 ds.iteh.a	Mn <u>2.00</u> <u>1.00</u> //catalog/s	P 0.045 0.030 0.030	0.005 TABLE 2 0 0 5 0.030 0.030 0.030 1s/sist/16ac	0.70 Chemical R Si 1.00 0.75 0/A	equiremen Ni $\frac{5.5-6.5}{5.5-7.5}$	ts ⁴ Cr 24.0–26.0 24.0–26.0 92eb-3198	Mo <u>1.20–2.00</u> <u>2.5–3.5</u> 2904bb9	N 0.14–0.20 0.10–0.30)8/astm-a	Cu Ot	hers
NS vesigna- on ^B 31200 31260 https:// 31500	(0.030 C 0.030 0.030 ds.iteh.a 0.030	Mn <u>2.00</u> <u>1.00</u> <u>1.20–2.00</u>	P 0.045 0.030 0.030	C 0.030 0.030 0.030 0.030 0.030 0.030 0.030	0.70 Chemical R Si 1.00 0.75 1.40–2.00	equiremen Ni 5.5-6.5 5.5-7.5 	ts ^A CrlCW 24.0-26.0 24.0-26.0 9200-3198 18.0-19.0	Mo <u>1.20–2.00</u> <u>2.5–3.5</u> 2904bb 2.50–3.00	N 0.14-0.20 0.10-0.30 X/astm-a 0.05-0.10	Cu Ot	hers
82441 NS esigna- on ^B 31200 31260 31260 https:// 31500 31803	(0.030 C 0.030 0.030 0.030 ds.iteh.a 0.030 0.030	Mn <u>2.00</u> <u>1.00</u> //catalog/s <u>1.20-2.00</u> <u>2.00</u>	P 0.045 0.030 0.030 0.030 0.030	C.030 0.030 0.030 0.030 0.030 0.030 0.030	0.70 Chemical R Si 1.00 0.75 1.40–2.00 1.00	equiremen Ni 5.5-6.5 5.5-7.5 1 0 4.2-5.2 4.5-6.5	ts ^A Cr CV 24.0–26.0 24.0–26.0 24.0–26.0 24.0–26.0 21.0–23.0	Mo <u>1.20-2.00</u> <u>2.5-3.5</u> 29041 <u>2.50-3.00</u> <u>2.5-3.5</u>	N 0.14–0.20 0.10–0.30 0.10–0.30 0.05–0.10 0.05–0.10 0.08–0.20	Cu Ot 0.20-0.80 1790-a79	hers
82441 NS esigna- on ^B 31200 31260 31260 31500 31500 31803 32003	(0.030 C 0.030 0.030 0.030 0.030 0.030 0.030 0.030	Mn <u>2.00</u> <u>1.00</u> /catalog/s <u>1.20-2.00</u> <u>2.00</u> <u>2.00</u>	P 0.045 0.030 0.030 0.030 0.030 0.030 0.030	0.030 0.030 0.030 0.030 0.030 0.020 0.020	0.70 Chemical R Si 1.00 0.75 0.	equiremen Ni 5.5-6.5 5.5-7.5 1 0 4.2-5.2 4.5-6.5 3.0-4.0	ts ^A CrlCW 24.0–26.0 24.0–26.0 9200–3109 18.0–19.0 21.0–23.0 19.5-22.5	Mo <u>1.20-2.00</u> <u>2.5-3.5</u> <u>2904166</u> <u>2.50-3.00</u> <u>2.5-3.5</u> <u>1.50-2.00</u>	N 0.14–0.20 0.10–0.30 0.05–0.10 0.05–0.10 0.08–0.20 0.14–0.20	Cu Ot	hers <u>W</u> 0.10- 0(<u>0.50</u>]
82441 NS esigna- on ^B 31200 31260 https:// 31500 31803 322003 32101	(0.030 C 0.030 0.030 ds.iteh.a 0.030 0.030 0.030 0.030 0.040	Mn <u>2.00</u> <u>1.00</u> <u>1.20-2.00</u> <u>2.00</u> <u>2.00</u> <u>4.0-6.0</u>	P 0.035 0.045 0.030 0.030 0.030 0.030 0.030 0.030 0.040	0.030 0.030 0.030 0.030 0.030 0.020 0.020 0.020 0.020 0.030	0.70 Chemical R Si 1.00 0.75 0.75 1.40–2.00 1.00 1.00 1.00 1.00	equiremen Ni 5.5-6.5 5.5-7.5 4.2-5.2 4.5-6.5 3.0-4.0 1.35-1.70	ts ^A CrlCV 24.0-26.0 24.0-26.0 24.0-26.0 26.0 21.0-23.0 19.5-22.5 21.0-22.0	Mo <u>1.20-2.00</u> <u>2.5-3.5</u> <u>2904bb</u> <u>2.50-3.00</u> <u>2.5-3.5</u> <u>1.50-2.00</u> <u>0.10-0.80</u>	N 0.14–0.20 0.10–0.30 0.05–0.10 0.08–0.20 0.08–0.20 0.14–0.20 0.20–0.25	Cu Ot 0.20–0.80 1790–a79 	hers <u>W</u> 0.10- 0.50
82441 NS esigna- on [#] 31200 31260 https:// 31803 32003 32101 32202	/standar	0.030 C 0.030 0.030 0.030 0.030 0.030 0.030 0.040 0.030	Mn <u>2.00</u> <u>1.00</u> (catalog/s <u>1.20-2.00</u> <u>2.00</u> <u>2.00</u> <u>4.0-6.0</u> <u>2.00</u>	P 0.045 0.030 0.030 0.030 0.030 0.030 0.030 0.030 0.040 0.040	0.030 0.030 0.030 0.030 0.030 0.020 0.020 0.020 0.030 0.020 0.030 0.020 0.030 0.010	0.70 Chemical R Si 1.00 0.75 0.75 1.40–2.00 1.00 1.00 1.00 1.00 1.00 1.00	equiremen Ni 5.5-6.5 5.5-7.5 .1) 4.2-5.2 4.5-6.5 3.0-4.0 1.35-1.70 1.00-2.80	ts ^A CrlCW 24.0-26.0 24.0-26.0 9200-399 18.0-19.0 21.0-23.0 19.5-22.5 21.0-22.0 21.5-24.0	Mo <u>1.20-2.00</u> <u>2.5-3.5</u> <u>2.50-3.00</u> <u>2.50-3.00</u> <u>2.5-3.5</u> <u>1.50-2.00</u> <u>0.10-0.80</u> <u>0.45</u>	N 0.14–0.20 0.10–0.30 X /astm-a 0.05–0.10 0.08–0.20 0.14–0.20 0.20–0.25 0.18–0.26	Cu Ot	hers <u>W</u> 0.10- 0.050
82441 NS esigna- on ^B 31200 31260 https:// 31500 31800 338003 32201 32202 32205	standar	0.030 C 0.030 0.030 0.030 0.030 0.030 0.030 0.040 0.030 0.040 0.030 0.030	Mn <u>2.00</u> <u>1.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>4.0-6.0</u> <u>2.00</u> <u>2.00</u> <u>2.00</u>	P 0.035 0.030 0.030 0.030 0.030 0.030 0.030 0.040 0.040 0.040 0.040 0.030	0.030 0.030 0.030 0.030 0.030 0.020 0.020 0.020 0.020 0.010 0.020	0.70 Chemical R Si 1.00 0.75 0.	equiremen Ni 5.5-6.5 5.5-7.5 3.5-7.5 4.2-5.2 4.5-6.5 3.0-4.0 1.35-1.70 1.00-2.80 4.5-6.5	ts ^A CrlCW 24.0-26.0 24.0-26.0 24.0-26.0 200-340 19.5-22.5 21.0-23.0 21.5-24.0 22.0-23.0	Mo <u>1.20-2.00</u> <u>2.5-3.5</u> 2904bb <u>2.50-3.00</u> <u>2.5-3.5</u> <u>1.50-2.00</u> <u>0.10-0.80</u> <u>0.45</u> <u>3.0-3.5</u>	N 0.14–0.20 0.10–0.30 0.5–0.10 0.08–0.20 0.14–0.20 0.18–0.26 0.14–0.20	Cu Ot 0.20–0.80 1790–a79 0.10–0.80 	hers <u>W</u> 0.10- 0.50
82441 NS esigna- on ^B 31200 31260 https:// 31500 31803 32003 32101 32202 32205 32204	/standar	0.030 C 0.030 0.030 0.030 0.030 0.030 0.030 0.030 0.030 0.030 0.030 0.030 0.030	Mn <u>2.00</u> <u>1.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2</u>	P 0.035 0.030 0.030 0.030 0.030 0.030 0.030 0.040 0.040 0.040 0.030 0.040 0.040 0.030 0.040 0.040 0.045 0.045 0.030 0.045 0.030 0.030 0.045 0.030 0.045 0.030 0.030 0.030 0.045 0.030 0.030 0.045 0.030 0.030 0.045 0.045 0.030 0.030 0.045 0.045 0.030 0.045 0.045 0.030 0.030 0.030 0.040 0.040 0.040 0.040 0.030 0.040	0.030 0.030 0.030 0.030 0.020 0.020 0.020 0.020 0.030 0.020 0.030 0.020 0.030 0.020 0.030 0.020 0.020 0.020 0.020 0.020 0.020	0.70 Chemical R Si 1.00 0.75 0.	equiremen Ni 5.5-6.5 5.5-7.5 -1 2-4481- 4.2-5.2 4.5-6.5 3.0-4.0 1.35-1.70 1.00-2.80 4.5-6.5 3.0-5.5	ts ^A CrlCW 24.0-26.0 24.0-26.0 200-340 21.0-23.0 21.0-23.0 21.5-24.0 22.0-23.0 21.5-24.5	Mo <u>1.20-2.00</u> <u>2.5-3.5</u> <u>2.50-3.00</u> <u>2.5-3.5</u> <u>1.50-2.00</u> <u>0.10-0.80</u> <u>0.45</u> <u>3.0-3.5}</u> <u>0.05-0.60</u>	N 0.14–0.20 0.10–0.30 0.05–0.10 0.08–0.20 0.14–0.20 0.14–0.20 0.18–0.26 0.14–0.20 0.14–0.20 0.14–0.20 0.14–0.20	Cu Ot	hers
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82441 NS esigna- on ^B 31200 31260 https:// 31500 31803 32000 32101 32202 32205 32204	standar	0.030 C 0.030 0.030 0.030 0.030 0.030 0.030 0.030 0.030 0.030 0.030 0.030 0.030	Mn <u>2.00</u> <u>1.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2</u>	P 0.035 0.030 0.030 0.030 0.030 0.030 0.030 0.040 0.040 0.040 0.030 0.040 0.040 0.030 0.040 0.040 0.045 0.045 0.030 0.045 0.030 0.045 0.030 0.030 0.045 0.030 0.030 0.030 0.045 0.045 0.030 0.045 0.045 0.030 0.030 0.040 0.040 0.030 0.030 0.040 0.040 0.040 0.030 0.040	0.030 0.030 0.030 0.030 0.020 0.020 0.020 0.020 0.030 0.020 0.030 0.020 0.030 0.020 0.030 0.020 0.020 0.020 0.020 0.020 0.020	0.70 Chemical R Si 1.00 0.75 0.	equiremen Ni 5.5-6.5 5.5-7.5 -1 2-4481- 4.2-5.2 4.5-6.5 3.0-4.0 1.35-1.70 1.00-2.80 4.5-6.5 3.0-5.5	ts ^A CrlCW 24.0-26.0 24.0-26.0 200-340 21.0-23.0 21.0-23.0 21.5-24.0 22.0-23.0 21.5-24.5	Mo <u>1.20-2.00</u> <u>2.5-3.5</u> <u>2.50-3.00</u> <u>2.5-3.5</u> <u>1.50-2.00</u> <u>0.10-0.80</u> <u>0.45</u> <u>3.0-3.5}</u> <u>0.05-0.60</u>	N 0.14–0.20 0.10–0.30 0.05–0.10 0.08–0.20 0.14–0.20 0.18–0.26 0.14–0.20 0.05–0.20 0.14–0.20 0.05–0.20	Cu Ot 0.20–0.80 0.10–0.80 0.05–0.60	hers 0.10- 0.50 W 0.05-
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82441 NS esigna- on ^B 31200 31200 31200 31803 32003 32101 32202 32205 32304 32506	standar	0.030 C 0.030 0.030 0.030 0.030 0.030 0.030 0.030 0.030 0.030 0.030 0.030 0.030	Mn <u>2.00</u> <u>1.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>1.20-2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>1.20-2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.00</u> <u>2.50</u> <u>1.00</u>	P 0.045 0.030 0.030 0.030 0.030 0.030 0.040 0.040 0.040 0.040 0.040 0.040 0.040 0.040 0.040 0.040 0.040 0.040 0.040 0.045 0.030 0.045 0.030 0.045 0.030 0.030 0.045 0.030 0.045 0.030 0.030 0.045 0.045 0.030 0.045 0.045 0.045 0.045 0.030 0.040	0.030 0.030 0.030 0.030 0.020 0.020 0.020 0.020 0.020 0.040 0.015 0.020	0.70 Chemical R Si 1.00 0.75 0.	equiremen Ni 5.5-6.5 5.5-7.5 -1 2-4481- 4.2-5.2 4.5-6.5 3.0-4.0 1.35-1.70 1.00-2.80 4.5-6.5 3.0-5.5	ts ^A CrlCW 24.0-26.0 24.0-26.0 200-340 21.0-23.0 21.0-23.0 21.5-24.0 22.0-23.0 21.5-24.5	Mo <u>1.20-2.00</u> <u>2.5-3.5</u> <u>2.50-3.00</u> <u>2.5-3.5</u> <u>1.50-2.00</u> <u>0.10-0.80</u> <u>0.45</u> <u>3.0-3.5}</u> <u>0.05-0.60</u>	N 0.14–0.20 0.10–0.30 0.5–0.10 0.08–0.20 0.14–0.20 0.18–0.26 0.14–0.20 0.05–0.20 0.08–0.20 0.08–0.20 0.08–0.20 0.08–0.20	Cu Ot 0.20-0.80 0.10-0.80 0.05-0.60 0.5-3.00	hers 0.10- 0.50 W 0.05- 0.30
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82441 NS esigna- on ^B 31200 31200 31260 https:// 31500 331803 32003 32101 32202 32205 32205 32205 32205 32304 32506 32550 32750 ^D	/standar <u>2205</u> <u>2304</u> <u>255</u>	0.030 C 0.030 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.00000 0.00000 0.00000 0.00000000	Mn 2.00 1.00 2.00 2.00 2.00 2.00 2.00 2.00 2.00 2.00 2.00 2.00 2.00 2.00 1.5 1.50 1.50 1.20	P 0.045 0.030 0.030 0.030 0.030 0.040 0.040 0.040 0.040 0.040 0.040 0.040 0.040 0.040 0.040 0.040 0.040 0.040 0.040 0.045 0.045 0.045 0.030 0.045 0.030 0.045 0.030 0.045 0.030 0.045 0.030 0.045 0.030 0.045 0.030 0.045 0.030 0.045 0.030 0.045 0.030 0.045 0.030 0.045 0.030 0.045 0.040 0.040 0.040 0.040 0.045 0.040 0.040 0.040 0.040 0.040 0.040 0.040 0.040 0.035 0.040 0.035 0.040 0.035 0.040 0.035 0.045	0.030 0.030 0.030 0.030 0.020 0.020 0.020 0.020 0.020 0.040 0.015 0.020 0.030 0.010 0.020 0.040 0.015	0.70 Chemical R Si 1.00 0.75 0.75 1.40-2.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 0.90 0.90 0.80 1.00 0.50 0.80	equiremen 5.5-6.5 5.5-7.5 3.5-7.5 3.0-4.0 1.35-1.70 1.00-2.80 4.5-6.5 5.5-7.2 5.5-8.0 4.5-6.5 5.5-9.5	ts ^A CrlCW 24.0-26.0 24.0-26.0 22.0-23.0 21.0-23.0 21.0-23.0 21.5-24.0 22.0-23.0 21.5-24.0 22.0-23.0 21.5-24.5 24.0-26.0 24.0-26.0 24.0-26.0 24.0-26.0	Mo <u>1.20-2.00</u> <u>2.5-3.5</u> <u>2.50-3.00</u> <u>2.5-3.5</u> <u>1.50-2.00</u> <u>0.10-0.80</u> <u>0.45</u> <u>3.0-3.5</u> <u>0.05-0.60</u> <u>3.0-3.5</u> <u>3.0-5.0</u> <u>2.9-3.9</u> <u>4.0-5.0</u> <u>3.0-5.0</u>	N 0.14-0.20 0.10-0.30 0.8-0.20 0.14-0.20 0.20-0.25 0.14-0.20 0.05-0.20 0.08-0.20	Cu Ot 0.20–0.80 1790–a79 0.10–0.80 0.10–0.60 0.05–0.60 1.50–2.50 1.0 0.5	hers
82441 NS esigna- on ^B 31200 31200 31260 https:// 31500 33100 32003 32101 32202 32205 32205 32205 32205 32304 32506 32550 32707	/standar <u>2205</u> <u>2304</u> <u>255</u>	0.030 C 0.030 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.00000 0.00000 0.00000 0.00000000	Mn 2.00 1.00 2.00 2.00 2.00 2.00 2.00 2.00 2.00 2.00 2.00 2.00 2.00 2.00 1.5 1.50 1.50 1.20	P 0.045 0.030 0.030 0.030 0.030 0.040 0.040 0.040 0.040 0.040 0.040 0.040 0.040 0.040 0.040 0.040 0.040 0.040 0.040 0.045 0.045 0.045 0.030 0.045 0.030 0.045 0.030 0.045 0.030 0.045 0.030 0.045 0.030 0.045 0.030 0.045 0.030 0.045 0.030 0.045 0.030 0.045 0.030 0.045 0.030 0.045 0.040 0.040 0.040 0.040 0.045 0.040 0.040 0.040 0.040 0.040 0.040 0.040 0.040 0.035 0.040 0.035 0.040 0.035 0.040 0.035 0.045	0.030 0.030 0.030 0.030 0.020 0.020 0.020 0.020 0.020 0.040 0.015 0.020 0.030 0.010 0.020 0.040 0.015	0.70 Chemical R Si 1.00 0.75 0.75 1.40-2.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 0.90 0.90 0.80 1.00 0.50 0.80	equiremen Ni 5.5-6.5 5.5-7.5 .] 2.4481 4.2-5.2 4.5-6.5 3.0-4.0 1.35-1.70 1.35-1.70 1.35-1.70 1.35-5.5 5.5-7.2 5.5-8.0 4.5-6.5 5.5-9.5 5.5-9.5 6.0-8.0	ts ^A CrlCW 24.0-26.0 24.0-26.0 22.0-23.0 21.0-23.0 21.0-23.0 21.5-24.0 22.0-23.0 21.5-24.0 22.0-23.0 21.5-24.5 24.0-26.0 24.0-26.0 24.0-26.0 24.0-26.0	Mo <u>1.20-2.00</u> <u>2.5-3.5</u> <u>2.50-3.00</u> <u>2.5-3.5</u> <u>1.50-2.00</u> <u>0.10-0.80</u> <u>0.45</u> <u>3.0-3.5</u> <u>0.05-0.60</u> <u>3.0-3.5</u> <u>3.0-5.0</u> <u>2.9-3.9</u> <u>4.0-5.0</u> <u>3.0-5.0</u>	N 0.14-0.20 0.10-0.30 0.8-0.20 0.14-0.20 0.20-0.25 0.14-0.20 0.05-0.20 0.08-0.20	Cu Ot 0.20–0.80 1790–a79 0.10–0.80 0.10–0.60 0.05–0.60 1.50–2.50 1.0 0.5	hers
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82441 NS esigna- on ^B 31200 31260 https:// 31500 31200 31200 31200 31200 32003 32101 32202 32205 32304 32550 32550 327707 32750 ^P	/standar <u>2205</u> <u>2304</u> <u>255</u>	0.030 C 0.030 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.00000 0.00000 0.00000 0.00000000	Mn 2.00 1.00 2.00 1.5 1.50 1.50 1.50	P 0.045 0.030 0.030 0.030 0.030 0.040 0.040 0.040 0.040 0.040 0.040 0.040 0.040 0.040 0.040 0.040 0.040 0.040 0.040 0.045 0.045 0.045 0.030 0.045 0.030 0.045 0.030 0.045 0.030 0.045 0.030 0.045 0.030 0.045 0.030 0.045 0.030 0.045 0.030 0.045 0.030 0.045 0.030 0.045 0.030 0.045 0.040 0.040 0.040 0.040 0.045 0.040 0.040 0.040 0.040 0.040 0.040 0.040 0.040 0.035 0.040 0.035 0.040 0.035 0.040 0.035 0.045	0.030 0.030 0.030 0.030 0.020 0.020 0.020 0.020 0.020 0.040 0.015 0.020 0.030 0.010 0.020 0.040 0.015	0.70 Chemical R Si 1.00 0.75 0.75 1.40-2.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 0.90 0.90 0.80 1.00 0.50 0.80	equiremen Ni 5.5-6.5 5.5-7.5 .] 2.4481 4.2-5.2 4.5-6.5 3.0-4.0 1.35-1.70 1.35-1.70 1.35-1.70 1.35-5.5 5.5-7.2 5.5-8.0 4.5-6.5 5.5-9.5 5.5-9.5 6.0-8.0	ts ^A CrlCW 24.0-26.0 24.0-26.0 22.0-23.0 21.0-23.0 21.0-23.0 21.5-24.0 22.0-23.0 21.5-24.0 22.0-23.0 21.5-24.5 24.0-26.0 24.0-26.0 24.0-26.0 24.0-26.0	Mo <u>1.20-2.00</u> <u>2.5-3.5</u> <u>2.50-3.00</u> <u>2.5-3.5</u> <u>1.50-2.00</u> <u>0.10-0.80</u> <u>0.45</u> <u>3.0-3.5</u> <u>0.05-0.60</u> <u>3.0-3.5</u> <u>3.0-5.0</u> <u>2.9-3.9</u> <u>4.0-5.0</u> <u>3.0-5.0</u>	N 0.14-0.20 0.10-0.30 0.8/astm-a 0.05-0.10 0.08-0.20 0.14-0.20 0.18-0.26 0.14-0.20 0.05-0.20 0.08-0.	Cu Ot 0.20–0.80 1790–a79 0.10–0.80 0.10–0.60 0.05–0.60 1.50–2.50 1.0 0.5	hers 0.10- 0.50
82441 NS esigna- on ^B 31200 31260 https:// 31500 31800 32003 32003 32003 32003 32003 32202 32205 32304 32550 32550 327707 32750 ^P	/standar <u>2205</u> <u>2304</u> <u>255</u>	0.030 C 0.030 0.055	Mn 2.00 1.00 1.20-2.00 2.00 2.00 2.00 2.00 2.00 2.00 2	P 0.035 0.030 0.030 0.030 0.030 0.030 0.030 0.040 0.040 0.040 0.040 0.040 0.040 0.040 0.040 0.040 0.040 0.040 0.040 0.040 0.045 0.045 0.030 0.030 0.045 0.030 0.030 0.030 0.030 0.030 0.030 0.030 0.030 0.030 0.030 0.030 0.030 0.030 0.045 0.030 0.030 0.030 0.045 0.030 0.030 0.045 0.030 0.045 0.030 0.045 0.045 0.030 0.045 0.045 0.045 0.030 0.045 0.040 0.040 0.040 0.040 0.040 0.040 0.040 0.040 0.040 0.040 0.040 0.040 0.040 0.040 0.040 0.040 0.035 0.040 0.035 0.035 0.030 0.035 0.035 0.035 0.030 0.035 0.035 0.035 0.030 0.035 0.035 0.035 0.030 0.035 0.035 0.035 0.030 0.035 0.035 0.030 0.035 0.035 0.035 0.030 0.035 0.035 0.030 0.035 0.030 0.035 0.030 0.035 0.035 0.030 0.035 0.030 0.035 0.035 0.030 0.035 0.035 0.030 0.035 0.035 0.030 0.035 0.030 0.035	0.005 TABLE 2 C 0.030 0.030 0.030 0.030 0.030 0.030 0.030 0.030 0.020 0.020 0.020 0.020 0.020 0.020 0.020 0.020 0.020 0.040 0.015 0.020 0.020 0.020 0.020 0.010 0.020 0.010	0.70 Chemical R Si 1.00 0.75 0.75 0.40 1.40–2.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 0.90 0.80 1.00 0.50 0.80 1.00 0.50 0.80 1.00 0.50 0.80 1.00 0.50 0.80 1.00 0.50 0.50 0.80 1.00 0.50 0.50 0.80 1.00 0.5	equiremen Ni 5.5-6.5 5.5-7.5 -])-4481- 4.2-5.2 4.2-5.2 4.5-6.5 3.0-4.0 1.35-1.70 1.00-2.80 4.5-6.5 3.0-5.5 5.5-7.2 5.5-8.0 4.5-6.5 5.5-9.5 5.5-9.5 6.0-8.0 6.0-8.0	$\begin{array}{c} \mathbf{ts}^{A} \\ \mathbf{Cr}^{1} \mathbf{C}^{A} \\ \mathbf{ts}^{A} \\ $	Mo 1.20-2.00 2.5-3.5 2904bb 2.50-3.00 2.5-3.5 1.50-2.00 0.10-0.80 0.45 3.0-3.5 0.05-0.60 3.0-3.5 3.0-5.0 2.9-3.9 4.0-5.0 3.0-4.0	N 0.14-0.20 0.10-0.30 0.8/astm-a 0.05-0.10 0.08-0.20 0.14-0.20 0.18-0.26 0.14-0.20 0.05-0.20 0.08-0.	Cu Ot 0.20–0.80 0.10–0.80 0.10–0.80 0.10–0.60 0.15–3.00 1.50–2.50 1.0 0.50–1.00	thers 0.10- 0.5
82441 NS esigna- on ^B 31200 31200 31200 31200 31200 31200 31200 31200 31200 31200 32101 32202 32205 32304 32506 32550 32520 32550 32707 32760 ^E 32808	2205 2304 255 2507	0.030 0	Mn 2.00 1.00 2.00 2.00 2.00 2.00 2.00 2.00	P 0.045 0.030 0.030 0.030 0.030 0.030 0.040 0.040 0.040 0.040 0.040 0.040 0.040 0.040 0.040 0.035 0.040 0.035 0.040 0.035 0.040 0.035 0.030 0.035 0.030 0.035 0.030 0.03	Comparison of the second	0.70 Chemical R Si 1.00 0.75 0.	equiremen Ni 5.5-6.5 5.5-7.5 - 1)-4481 4.2-5.2 4.2-5.2 4.2-6.5 3.0-4.0 1.35-1.70 1.35-1.70 1.35-1.70 4.5-6.5 3.0-5.5 5.5-7.2 5.5-8.0 4.5-6.5 5.5-9.5 6.0-8.0 6.0-8.0 6.0-8.0 7.0-8.2	ts ^A CrlCW 24.0-26.0 24.0-26.0 920-3998 18.0-19.0 21.0-23.0 19.5-22.5 21.0-22.0 21.5-24.0 22.0-23.0 21.5-24.0 22.0-23.0 21.5-24.5 24.0-26.0 24.0-26.0 24.0-26.0 24.0-26.0 24.0-26.0 24.0-26.0 24.0-26.0 24.0-26.0 24.0-26.0 24.0-26.0	Mo <u>1.20-2.00</u> <u>2.5-3.5</u> <u>2.50-3.00</u> <u>2.5-3.5</u> <u>1.50-2.00</u> <u>0.10-0.80</u> <u>0.45</u> <u>3.0-3.5</u> <u>0.05-0.60</u> <u>3.0-3.5</u> <u>3.0-5.0</u> <u>2.9-3.9</u> <u>4.0-5.0</u> <u>3.0-4.0</u> <u>0.80-1.20</u>	N 0.14–0.20 0.10–0.30 0.10–0.30 0.10–0.30 0.14–0.20 0.14–0.20 0.14–0.20 0.14–0.20 0.18–0.20 0.18–0.20 0.18–0.20 0.14–0.20 0.05–0.20 0.05–0.20 0.05–0.20 0.05–0.20 0.05–0.20 0.14–0.20 0.05–0.20 0.14–0.20 0.05–0.20 0.10–0.25 0.30–0.50 0.30–0.50 0.30–0.50	Cu Ot 0.20–0.80 0.10–0.80 0.10–0.80 0.10–0.60 0.15–3.00 1.50–2.50 1.0 0.50–1.00	hers 0.10- 0.50
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UNS Designa- tion ^B	Type ^C	С	Mn	Ρ	S	Si	Ni	Cr	Мо	N	Cu	Others
<u>S39277</u>		0.025	<u>0.80</u>	0.025	<u>0.002</u>	<u>0.80</u>	<u>6.5–8.0</u>	24.0-26.0	<u>3.0–4.0</u>	0.23-0.33	1.20-2.00	<u>0</u> <u>W</u> <u>0.8–</u> <u>1.2</u>
<u>S81921</u> <u>S82011</u> <u>S82441</u>		0.030 0.030 0.030	2.00-4.00 2.0-3.0 2.5-4.0	0.040 0.040 0.035	0.030 0.020 0.005	<u>1.00</u> <u>1.00</u> <u>0.70</u>	2.00-4.00 1.00-2.00 3.0-4.5	19.0–22.0 20.5–23.5 23.0–25.0	1.00-2.00 0.10-1.00 1.00-2.00	0.14-0.20 0.15-0.27 0.20-0.30	0.50 0.10-0.80	<u></u>

^AMaximum, unless a range or minimum is indicated. Where ellipses (...) appear in this table, there is no minimum and analysis for the element need not be determined or reported.

^B New designation established in accordance with Practice E527 and SAE J 1086.

^cCommon name, not a trademark, widely used, not associated with any one producer. 329 is naan AISI number.

^{*D*} $\xrightarrow{\text{O}}$ Cr $\xrightarrow{\text{Cr}}$ + 3.3 × % Mo + 16 × $\xrightarrow{\text{W}}$ N ≥ 41.

 $E_{\rm N} \, {\rm Cr} + 3.3 \times {\rm N} \, {\rm Mo} + 16 \times {\rm N} \, {\rm N} \ge 40.$

10. Tensile and Hardness Properties

10.1 The material shall conform to the tensile and hardness properties prescribed in Table 3.

11. Lengths

11.1 Pipe lengths shall be in accordance with the following regular practice:

11.1.1 Unless otherwise agreed upon, all sizes from NPS ¹/₈ to and including NPS 8 are available in a length up to 24 ft (see Note 3) with the permissible range of 15 to 24 ft (see Note 3). Short lengths are acceptable and the number and minimum length shall be agreed upon between the manufacturer and the purchaser.

NOTE 3—This value applies when the inch-pound designation of this specification is the basis of purchase. When the *M* designation of this specification is the basis of purchase, the corresponding metric value(s) shall be agreed upon between the manufacturer and purchaser.

11.1.2 If definite cut lengths are desired, the lengths required shall be specified in the order. No pipe shall be less than the specified length and no more than $\frac{1}{4}$ in. [6 mm] over it.

11.1.3 No jointers are permitted unless otherwise specified.

12. Workmanship, Finish, and Appearance CUMENT Preview

12.1 The finished pipes shall be reasonably straight and shall have a workmanlike finish. Imperfections may be removed by grinding, provided the wall thicknesses are not decreased to less than that permitted, in the Permissible Variations in Wall Thickness Section of Specification A999/A999M. <u>ASTM A790/A790M-13</u>

13. Mechanical Tests Required

13.1 *Transverse or Longitudinal Tension Test*—One tension test shall be made on a specimen for lots of not more than 100 pipes. Tension tests shall be made on specimens from 2 pipes for lots of more than 100 pipes.

13.2 *Mechanical Testing Lot Definition*— The term *lot* for mechanical tests applies to all pipe of the same nominal size and wall thickness (or schedule) that is produced from the same heat of steel and subjected to the same finishing treatment as defined as follows:

13.2.1 Where the heat treated condition is obtained, consistent with the requirements of 6.3, in a continuous heat treatment furnace or by directly obtaining the heat treated condition by quenching after hot forming, the lot shall include all pipe of the same size and heat, heat treated in the same furnace at the same temperature, time at heat, and furnace speed or all pipe of the same size and heat, hot formed and quenched in the same production run.

13.2.2 Where final heat treatment is obtained, consistent with the requirements of 6.3, in a batch-type heat-treatment furnace equipped with recording pyrometers and automatically controlled within a 50 $^{\circ}$ F [30 $^{\circ}$ C] or smaller range, the lot shall be the larger of (a) each 200 ft [60 m] or fraction thereof or (b) that pipe heat treated in the same batch furnace charge.

13.2.3 Where the final heat treatment is obtained, consistent with the requirements of 6.3, in a batch-type heat-treatment furnace not equipped with recording pyrometers and automatically controlled within a 50 °F [30 °C] or smaller range, the term *lot* for mechanical tests applies to the pipe heat treated in the same batch furnace charge, provided that such pipe is of the same nominal size and wall thickness (or schedule) and is produced from the same heat of steel.

13.3 *Flattening Test*—For pipe heat treated in a batch-type furnace, flattening tests shall be made on 5 % of the pipe from each heat-treated lot. For pipe heat treated by the continuous process, or by direct quenching after hot forming, this test shall be made on a sufficient number of pipes to constitute 5 % of the lot, but in no case less than two lengths of pipe.

13.3.1 For welded pipe with a diameter equal to or exceeding NPS 10, a transverse guided face bend test of the weld may be conducted instead of a flattening test in accordance with the method outlined in the steel tubular product supplement of Test Methods and Definitions A370. The ductility of the weld shall be considered acceptable when there is no evidence of cracks in

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TABLE 3 Tensile and Hardness Requirements

UNS	Туре	Tensile Strength,	Yield Strength,	Elongation in 2 in. or	Hardness,	max
Designation	21	min, ksi [MPa]	min, ksi [MPa]	50 mm, min, %	HBW	HRC
S31200		100 [690]	65 [450]	25	280	
S31260		100 [690]	65 [450]	25		
S31500		92 [630]	64 [440]	30	290	30
S31803		90 [620]	65 [450]	25	290	30
S32003		95 [655]	65 [450]	25	290	30
S32101						
t ≤		101 [700]	77 [530]	30	290	
0.187 in.						
[5.00 mm]						
t >		94 [650]	65 [450]	30	290	
0.187 in.						
[5.00 mm]						
S32202		94 [650]	65 [450]	30	290	30
S32205	2205	95 [655]	65 [450]	25	290	30
S32304	2304	87 [600]	58 [400]	25	290	30
S32506		90 [620]	65 [450]	18	302	32
S32520		112 [770]	80 [550]	25	310	
S32550	255	110 [760]	80 [550]	15	297	31
S32707		133 [920]	101 [700]	25	318	34
S32750	2507	116 [800]	80 [550]	15	300	32
S32760 ^B		109 [750]	80 [550]	25	300	
S32808		116 [800]	80 [550]	15	310	32
S32900	329	90 [620]	70 [485]	20	271	28
S32906						
t below		116 [800]	94 [650]	25	300	32
0.40 in.						
[10 mm]						
t 0.40 in.		109 [750]	80 [550]	25	300	32
[10 mm]						
and above		100 [000]	70 [406]	~~~		
S32950		100 [690]	70 [480]	20	290	30
S33207			S. CI			
t below		138 [950]	112 [770]	15	336	36
0.157 in. [4 mm]				45	000	00
t 0.157 in.		123 [850]	101 [700]	15	336	36
[4 mm] and above		110 [000]	00 [550]	45	010	00
S39274		116 [800]	80 [550]	15	310	32
S39277		120 [825]	90 [620]	25	290	30
S81921		79 90 [620] M	-1365 [450]	25	290	30
S82011 -		101 [700] 4 4		00000111	0000	2100 70
t below 0.187 in. [5.00 mm]		9101 [700]_4	75 [515]	982 30)466	9293 ₁₅ tm	- 3190- a79
t 0.187 in. [5.00 mm] and above		95 [655]	65 [450]	30	293	31
S82441 t < 0.4 inches		107 [740]	78 [540]	25	290	
		101 [110]	10[010]			

4 -					
[10mm]					
S82441 t > 0.4 inches	99 [680]	70 [480]	25	290	
[10 mm]					
S82441 t < 0.4 inches	107 [740]	78 [540]	25	290	
and above					

^ACommon name, not a trademark, widely used, not associated with any one

producer. 329 is na AISI number.

^B Prior to A790/A790M - 04, the tensile strength value for UNS 32760 was

109–130 ksi [750–895 MPa].

the weld or between the weld and the base metal after bending. Test specimens from 5 % of the lot shall be taken from the pipes or test plates of the same material as the pipe, the test plates being attached to the end of the cylinder and welded as a prolongation of the pipe longitudinal seam.

13.4 Hardness Test—Brinell or Rockwell hardness tests shall be made on specimens from two pipes from each lot (see 13.2).

14. Hydrostatic or Nondestructive Electric Test

14.1 Each pipe shall be subjected to the nondestructive electric test or the hydrostatic test. The type of test to be used shall be at the option of the manufacturer, unless otherwise specified in the purchase order.

14.2 The hydrostatic test shall be in accordance with Specification A999/A999M, except that the value for S to be used in the calculation of the hydrostatic test pressure shall be equal to 50 % of the specified minimum yield strength of the pipe.

14.3 Nondestructive Electric Test: Nondestructive electric tests shall be in accordance with Practices E213 or E309.