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Designation: A 213/A 213M-07a Designation: A 213/A 213M - 08

Used in USDOE-NE standards

# Standard Specification for Seamless Ferritic and Austenitic Alloy-Steel Boiler, Superheater, and Heat-Exchanger Tubes<sup>1</sup>

This standard is issued under the fixed designation A 213/A 213M; 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 ( $\varepsilon$ ) 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<sup>2</sup> covers seamless ferritic and austenitic steel boiler, superheater, and heat-exchanger tubes, designated Grades T5, TP304, etc. These steels are listed in Tables 1 and 2.

1.2 Grades containing the letter, H, in their designation, have requirements different from those of similar grades not containing the letter, H. These different requirements provide higher creep-rupture strength than normally achievable in similar grades without these different requirements.

1.3 The tubing sizes and thicknesses usually furnished to this specification are  $\frac{1}{8}$  in. [3.2 mm] in inside diameter to 5 in. [127 mm] in outside diameter and 0.015 to 0.500 in. [0.4 to 12.7 mm], inclusive, in minimum wall thickness or, if specified in the order, average wall thickness. Tubing having other diameters may be furnished, provided such tubes comply with all other requirements of this specification.

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

# 2. Referenced Documents

2.1 ASTM Standards:<sup>3</sup>

A262 Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels

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

A1016/A1016M Specification for General Requirements for Ferritic Alloy Steel, Austenitic Alloy Steel, and Stainless Steel Tubes

E112 Test Methods for Determining Average Grain Size 13/A213/M-08

https://standards.iteh.ai/catalog/standards/sist/e71e7020-c574-411c-9c16-0c34971dc7ba/astm-a213-a213m-08 3. Terminology

3.1 Definitions—For definitions of terms used in this specification, refer to Terminology A 941A941.

## 4. Ordering Information

4.1 It shall be the responsibility of the purchaser to specify all requirements that are necessary for products under this specification. Such requirements to be considered include, but are not limited to, the following:

- 4.1.1 Quantity (feet, metres, or number of lengths),
- 4.1.2 Name of material (seamless tubes),
- 4.1.3 Grade (Tables 1 and 2),
- 4.1.4 Condition (hot finished or cold finished),
- 4.1.5 Controlled structural characteristics (see 6.3),
- 4.1.6 Size (outside diameter and minimum wall thickness, unless average wall thickness is specified),
- 4.1.7 Length (specific or random),

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

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<sup>&</sup>lt;sup>1</sup> 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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<sup>&</sup>lt;sup>2</sup> For ASME Boiler and Pressure Vessel Code applications see related Specification SA-213 in Section II of that Code.

<sup>&</sup>lt;sup>3</sup> 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.

Steel
Alloy
Low
for
% <sup>A</sup> ,
Limits,
Composition
Chemical
TABLE 1

Grade	UNS Designation						https	č	Composition, %							
		Carbon	Manga- nese	Phospho- rus	Sul- fur	Silicon	Nickel //sta	Chromium	Chromium Molybdenum	Vana- dium	Boron	Niobium	Nitrogen	Aluminum	Tungsten	Other Elements
T2	K11547	0.10-0.20	0.30-0.61	0.025	0.025 <sup>B</sup>	0.10-0.30	: nd	0.50-0.81	0.44-0.65	:	:	:	:	:	:	:
T5	K41545	0.15	0.30-0.60	0.025	0.025	0.50	i	4.00-6.00	0.45-0.65	:	:	:	:	:	:	:
T5b	K51545	0.15	0.30-0.60	0.025	0.025	1.00-2.00	: rd	4.00-6.00	0.45-0.65	:	:	:	:	:	:	:
T5c	K41245	0.12	0.30-0.60	0.025	0.025	0.50	: s.i	4.00-6.00	0.45-0.65	:	:	:	:	:	:	F
																4xC-0.70
Т9	K90941	0.15	0.30-0.60	0.025	0.025	0.25-1.00	: h.a	8.00-10.00	0.90-1.10	:	:	:	:	:	:	:
T11	K11597	0.05-0.15	0.30-0.60	0.025	0.025	0.50-1.00	: ai/	1.00-1.50	0.44-0.65	:	:	:	:	:	:	:
T12	K11562	0.05-0.15	0.30-0.61	0.025	$0.025^{B}$	0.50	: /ca	0.80-1.25	0.44-0.65	:	:	:	:	:	:	:
T17	K12047	0.15-0.25	0.30-0.61	0.025	0.025	0.15-0.35	: ata	0.80-1.25	:	0.15	:	:	:	:	:	:
T21	K31545	0.05-0.15	0.30-0.60	0.025	0.025	0.50-1.00	: alc	2.65-3.35	0.80-1.06	:	:	:	:	:	:	:
T22	K21590	0.05-0.15	0.30-0.60	0.025	0.025	0.50	:	1.90-2.60	0.87-1.13	:	:	:	:	:	:	:
T23	K40712	0.04-0.10	0.10-0.60	0.030	0.010	0.50	: /S1	1.90-2.60	0.05-0.30 0.20-0.30	20-0.30	0.0005-	0.02-0.08	0.03	0:030	1.45-1.75	:
											0.006					
T24	K30736	0.05-0.10	0.30-0.70	0.020	0.010	0.15-0.45	: nd	2.20-2.60	0.90-1.10 0.20-0.30		0.0015-	:	0.012	0.02	:	F
											0.007					0.06-0.10
T36	K21001	0.10-0.17	0.80-1.20	0.030	0.025	0.25-0.50	<mark>/s1</mark> .00–1.30	0.30	0.25-0.50	0.02	:	0.015-0.045	0.02	0.050	:	Cu 0 50-0 80
T91	K90901	0.07-0.14	0.30-0.60	0.020	0.010	0.20-0.50	0.40	8.0-9.5	0.85-1.05 0.18-0.25	18-0.25	:	0.06-0.10	0.030-	0.02	:	
													0.070			Zr 0.01
T92	K92460	0.07-0.13	0.30-0.60	0.020	0.010	0.50	0.40	8.5-9.5	0.30-0.60 0.15-0.25	15-0.25	0.001-	0.04-0.09	0.030-	0.02	1.5-2.00	
											0.006		0.070			Zr 0.01
T122	K91271	0.07-0.14	0.70	0.020	0.010	0.50	0.50	10.0-11.5	0.25-0.60 0.15-0.30	15-0.30	0.0005-	0.04-0.10	0.040-	0.02	1.50–2.50	Cu Cu
											0.005		0.100			0.30-1.70
																7r 0.01
T911	K91061	0.09-0.13	0.09-0.13 0.30-0.60	020	0.010	0.10-0.50	0.40	8.5-9.5	0.90-1.10 0.18-0.25		0.0003-	0.06-0.10	0.040-	0.02	0.90-1.10	T 0.01
2							<u>\2</u> 574		n		0.006		060.0			Zr 0.01
A Mavin	er aaplant mine	ainin n	coloci ol muc	Mhere c		annear in this	table there	ie po rodilirom	A Maximum unlace rando or minimum is indicated. When allinese (-) annotar in this table there is no varuinament, and analucis for the alament and had determined or removied	eie for the	alament no	top pot po dot	armined or r	portod		
								IS IIO lednieii	letit, atiu atiat			בבח ווחו הב חבו		eporteu.		
d SI 11	7 It is permissible to order 12 and 112 with a sulfur content of 0.045 max	order 12 and	I 12 WITH a S	sultur content	OT U.U45 III	ax. See 15.3.										

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- A 213/A 213M 08
- 4.1.8 Hydrostatic Test or Nondestructive Electric Test (see 10.1),
- 4.1.9 Specification designation and year of issue,
- 4.1.10 Increased sulfur (for machinability, see Note B, Table 1, and 15.3), and
- 4.1.11 Special requirements and any supplementary requirements selected.

# 5. General Requirements

5.1 Product furnished to this specification shall conform to the requirements of Specification A 1016/A 1016MA1016/A1016M, including any supplementary requirements that are indicated in the purchase order. Failure to comply with the general requirements of Specification A 1016/A 1016MA1016/A1016M constitutes nonconformance with this specification. In case of conflict between the requirements of this specification and Specification A 1016/A 1016MA1016/A1016M constitutes are indicated at 1016/A 1016MA1016/A1016M.

# 6. Materials and Manufacture

6.1 *Manufacture and Condition*—Tubes shall be made by the seamless process and shall be either hot finished or cold finished, as specified. Grade TP347HFG shall be cold finished.

6.2 Heat Treatment:

6.2.1 *Ferritic Alloy and Ferritic Stainless Steels* — The ferritic alloy and ferritic stainless steels shall be reheated for heat treatment in accordance with the requirements of Table 3. Heat treatment shall be carried out separately and in addition to heating for hot forming.

6.2.2 *Austenitic Stainless Steels*—All austenitic tubes shall be furnished in the heat-treated condition, and shall be heat treated in accordance with the requirements of Table 3. Alternatively, immediately after hot forming, while the temperature of the tubes is not less than the minimum solution treatment temperature specified in Table 3, tubes may be individually quenched in water or rapidly cooled by other means (direct quenched).

6.3 If any controlled structural characteristics are required, these shall be so specified in the order as to be a guide as to the most suitable heat treatment.

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	Other Elements	÷	:	V 0.10–0.30 B 0.003–	0.009, V 0.15–0.40	:	: :	: 0	AI 0.003- 0.030, D.0.001	D 0.0010, 0.010, 0.1 2 5, 3 5	B 0.001- 0.004 Cu 2 50-	3.50	:	 AI 0 8–1 5	Ce 0.03-0.08	:	:	: :	B=0.001-0.005	:	:	 <u>W 2.0–4.0</u>	<u>Co 1.0-2.0</u> Cu 2.0-3.5 B 0.002-	0.008	:	: :	Ce :: Ce :: C	0.025-0.070	Cu 0.50-1.00	B 0.004-	Cu 0.50–1.50	:	: :	
	Titanium	÷	:	::		:	: :	:	:		0.10–0.25 <sup>E</sup>		:	:	: :	:	:	: :		:	:	: :			:	: :	:		:	0.30-0.60	:	:	: :	
	Niobium	÷	:	0.10-0.30 0.75-1.25		:	: :	:	0.30-0.60		0.10–0.40 <sup>E</sup>		:	:	: :	:	 10×0_1 10	10xC-1.10	0.50-0.80	:	:	0.30-0.60			10xC-1.10	0.20-0.60	:	:	:	:	:	:	: :	
	Nitrogen <sup>B</sup>	0.25	.025	0.20–0.40 		:	: :	: 10	0.05-0.12		÷		0.10-0.16	0.10-0.10	0.14-0.20	:	:	: :	0.10-0.20	0.10	:	0.15-0.30			:	 0.15–0.35	0.10-0.16 0.18-0.25		0.18022	:	0.30-0.40	:	: :	
	Molybdenum	÷	:	1.50–3.00 0.80–1.20		0.50	: :	:	:		÷		:	:	: :	:	:	: :		0.10	:	: :			:	: :	2.00-3.00		6.0-6.5	1.00–1.40	6.5-8.0		2.00-3.00	
Composition	Nickel	3.5-5.5	4.0-6.0	11.5–13.5 9.0–11.0		22.0-25.0 8.0-11.0	8.0-12.0	8.0-11.0	7.5–10.5		9.0–12.0		8.0-11.0	0.0-11.0 13.5-16.0	10.0-12.0	12.0–15.0	12.0-15.0	12.0-16.0	14.5-16.5	19.0-22.0	19.0-22.0	23.5-26.5			19.0–22.0 19.0–22.0	19.0-22.0	21.0–23.0 10.0–12.5		17.5-18.5	14.0–16.0	26.0-28.0	10.0-14.0	11.0-14.0	
Comp	Chromium	16.0–18.0	17.0–19.0	20.5–23.5 14.0–16.0		8.0-11.5	18.0-20.0	18.0-20.0	17.0-19.0		17.5-19.5		18.0-20.0	17.0-19.5	20.0-22.0	22.0-24.0	22.0-24.0	22.0-24.0	21.0-23.0	24.0-26.0	24.0-26.0	21.5-23.5			24.0-26.0	24.0-26.0	24.0-26.0 22.0-24.0		19.5-20.5	14.0–16.0	20.5-23.0	16.0–18.0	16.0-18.0	
	Silicon	1.00	1.00	1.00 0.20–1.00		6.5–8.0 1 00	1.00	1.00	0.30		CU 00: AST		1.00 1.00	32-40	1.40-2.00	1.00 V	<b>0</b> .0	00: 00: 00:	1-00	0.15	1.00	0.40			1.00	1.00	0.40		0.80	0.30-0.70	0.50	00.1	1.00	
https:	Sulfur	0.030	0.030	0.030		0.010	0:030	0.030	adar 0.00		0100		0.030	0.030	0.030	0.030	0.030	0:030	0:030	0.015	0.030	0.015			0.030	0.030	0.030	astr	0.010	0.015	0.010	0.030	0.030	a- (
	Phospho- rus	0.060	0.060	0.045 0.045		0.025	0.045	0.045	0.040		0.040		0.045	0.030	0.040	0.045	0.045	0.045	0.040	0.020	0.045	0.030			0.045	0.045	0.020	2	0:030	0:030	0.030	0.045	0.045	
	Manga- nese	5.5-7.5	7.5-10.0	4.0–6.0 5.5–7.0		2.00	2.00	2.00	1.00		2.00		2.00	00.7	0.80	2.00	2.00	2.00	2.00	2.00	2.00 2.00	0.60			2.00	2.00	2.00 1.00		1.00	1.50–2.00	3.00	00.2	2.00	
	Carbon	0.15	0.15	0.06 0.06–0.15		0.02	0.035	0.04-0.10	0.07-0.13		0.07–0.14		0.08	0.016-0.24	0.05-0.10	0.08	0.04-0.10	0.04-0.10	0.03-0.10	0.02	0.08	0.04-0.10			0.08	0.04-0.10	0.025 0.05-0.10		0.020	0.08-0.12	0.020	0.08 0.0350	0.04-0.10	
SNU	Designation	S20100	S20200	S20910 S21500		S25700	S30403	S30409	S30432		S30434		S30451	S30615	S30815	S30908	S30909	S30941	S30942	S31002	S31008	<u>S31035</u>			S31040 531041	S31042	S31050 S31060		S31254	S31272	S31277	S31600 S31600	S31609	
	Grade	TP201	TP202	XM-19 <i>C</i>		C TD304	TP304L	TP304H	c		O		TP304N		O	TP309S	TP300Ch	TP309HCb	:		TP3105				TP310Cb TP310HCb	TP310HCbN	TP310MoLN $c$		U	U	0	TD316 TD316	TP316H	

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$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	$^{-0}$ Sultur         Silicon         Chromium         Nicklei         Molydenum         Nitrogen <sup>6</sup> Niobium         Titanium           0.030         0.75         160–180         10.0–140         200–300         0.10         5X           0.030         100         160–180         10.0–140         200–300         0.10–016             0.030         100         180–200         115.15         200–300         0.10–016             0.0300         100         180–200         115.15         200–300         0.10–016             0.0300         100         150–200         135–175         40–50         0.20–20	$^{\circ}$ Sultur         Silicon         Chromium         Nicklei         Molydenum         Nitrogen <sup>6</sup> Niobium         Titanium           0.030         0.75         16.0-18.0         10.0-14.0         2.00-3.00         0.10         5.X           0.030         100         16.0-18.0         10.0-14.0         2.00-3.00         0.10-016             0.030         100         16.0-18.0         10.0-13.0         2.00-3.00         0.10-016             0.0300         100         18.0-200         11.27-2.00         0.010-0.16   <	Indexist         Nitrogen <sup>6</sup> Nitobium         Titanium           Iconium         10.0-14.0         2.00-3.00         0.10         5.X           0.18.0         10.0-14.0         2.00-3.00         0.10         5.X           0.18.0         10.0-14.0         2.00-3.00         0.10-016         1.           0.18.0         10.0-13.0         2.00-3.00         0.10-016         1.           0.18.0         10.0-13.0         2.00-3.00         0.10-016         1.           0.200         3.0-4.0         3.0-4.0         1.         1.0-15.0           0.200         11.0-15.0         3.0-4.0         1.0-0.16         1.         1.           0.200         13.5-17.5         4.0-5.0         0.10-0.32         1.         0.70           0.2410         9.0-12.0         1.0-1.0.32         1.0-1.0.3         1.0-1.0         1.0           0.190         9.0-12.0         1.0-1.50         1.0-2.0.30         0.100         0.70           0.191         9.0-13.0         1.0-1.50         1.0-0.16         1.         1.0           0.191         9.0-13.0         1.0-1.30         1.0-0.10         0.70         1.0           0.191         9.0-13.0         1.0-1.50		SNU				lard		Comp	Composition					
S31655         0.08         2.00         0.045         0.030         0.75         16.0-16.0         10.0-14.0         2.00-3.00         0.10         10 </th <th><math display="block"> \begin{array}{c c c c c c c c c c c c c c c c c c c </math></th> <th>0.0300         0.75         16.0-18.0         10.0-14.0         2.00-3.00         0.10          SX           0.0300         100         160-18.0         10.0-14.0         2.00-3.00         0.10-01.6   </th> <th><math display="block"> \begin{array}{c ccccccccccccccccccccccccccccccccccc</math></th> <th>Grade</th> <th>Designation</th> <th>Carbon</th> <th>Manga- nese</th> <th>Phospho- rus</th> <th>s. itel Snlfurs</th> <th>Silicon</th> <th>Chromium</th> <th></th> <th>Aolybdenum</th> <th>Nitrogen<sup>B</sup></th> <th>Niobium</th> <th>Titanium</th> <th>Other Elements</th>	$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	0.0300         0.75         16.0-18.0         10.0-14.0         2.00-3.00         0.10          SX           0.0300         100         160-18.0         10.0-14.0         2.00-3.00         0.10-01.6	$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	Grade	Designation	Carbon	Manga- nese	Phospho- rus	s. itel Snlfurs	Silicon	Chromium		Aolybdenum	Nitrogen <sup>B</sup>	Niobium	Titanium	Other Elements
Sites         0.08         2.00         0.045         0.030         1.00         160-180         100-130         200-300         010-016	0.030         1.00         160-180         100-130         200-300         0.10-0.16            0.030         1.00         180-200         11.0-150         30-40	0.030         1.00         160-180         1.00-130         2.00-3.00         0.10-0.16 $m$	$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	ТР316Ті	S31635	0.08	2.00	0.045	0:030	0.75	16.0–18.0	10.0–14.0	2.00-3.00	0.10	÷	5X (C + N)-	÷
Siles         0.005         2.00         0.004 <th0< td=""><td><math display="block"> \begin{array}{cccccccccccccccccccccccccccccccccccc</math></td><td>0.000         1.00         100</td><td>0.000         1.00         &lt;</td><td></td><td></td><td>000</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>0.70</td><td></td></th0<>	$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	0.000         1.00         100	0.000         1.00         <			000										0.70	
Sinter constraint	0.000         1.00         1.00         1.00         1.00         1.00         0.0	0.0000         1000         18.0-200         11.0-150         30.4.0         0.0000         0.0 <th0.0< th=""> <th0.0< th=""></th0.0<></th0.0<>	00000         1000         180-200         110-150         30-40         0.0000         0         0.000         0.000 <th0.000< th=""> <th0.000< th=""> <th0.000< th=""></th0.000<></th0.000<></th0.000<>	TD316N	S31651 C21652	0.08	2.00	0.045	0.030	00.1	16.0-18.0	10.0-13.0	2.00-3.00	0.10-0.16	:	:	:
Siring Siring Siring         0.03 0.03         2.00 0.045         0.030 0.035         100 0.045         100 0.035         100 0.045         100 0.035         100 0.045         100 0.035         100 0.045         100 0.035         100 0.045         100 0.035         100 0.045         100 0.010         100 0.010 </td <td>0.000         1.00         1.60         &lt;</td> <td>0.0300         1.00         18.0-200         11.0-150         3.0-40         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.010-020         0.010-020         0.010-020         0.010-020         0.010         <t< td=""><td>0.0300         1000         18.0-200         11.3-17.5         40-50         0.20         0.20         0.20           0.0300         1000         18.0-200         13.5-17.5         40-50         0.21-0.22         0.0<td></td><td>531700</td><td>0.03</td><td>0.0</td><td>0.045</td><td>0.000</td><td>001</td><td>18.0-20.0</td><td>11 0-15 0</td><td>20-2-00-2</td><td>0.10-0.10</td><td>:</td><td>:</td><td>:</td></td></t<></td>	0.000         1.00         1.60         <	0.0300         1.00         18.0-200         11.0-150         3.0-40         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.010-020         0.010-020         0.010-020         0.010-020         0.010 <t< td=""><td>0.0300         1000         18.0-200         11.3-17.5         40-50         0.20         0.20         0.20           0.0300         1000         18.0-200         13.5-17.5         40-50         0.21-0.22         0.0<td></td><td>531700</td><td>0.03</td><td>0.0</td><td>0.045</td><td>0.000</td><td>001</td><td>18.0-20.0</td><td>11 0-15 0</td><td>20-2-00-2</td><td>0.10-0.10</td><td>:</td><td>:</td><td>:</td></td></t<>	0.0300         1000         18.0-200         11.3-17.5         40-50         0.20         0.20         0.20           0.0300         1000         18.0-200         13.5-17.5         40-50         0.21-0.22         0.0 <td></td> <td>531700</td> <td>0.03</td> <td>0.0</td> <td>0.045</td> <td>0.000</td> <td>001</td> <td>18.0-20.0</td> <td>11 0-15 0</td> <td>20-2-00-2</td> <td>0.10-0.10</td> <td>:</td> <td>:</td> <td>:</td>		531700	0.03	0.0	0.045	0.000	001	18.0-20.0	11 0-15 0	20-2-00-2	0.10-0.10	:	:	:
S31725         0.03         2.00         0.045         0.030         1.00         18.6-20         13.5-17.5         4.0-5.0         0.20 $m$	$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	TP317L	S31703	0.035	2.00	0.045	0.030	1.00	18.0-20.0	11.0-15.0	3.0-4.0	: :	: :	: :	: :
S31726         0.03         2.00         0.045         0.030         1.00         2.16-30         0.10-020 $\cdots$	0030         100         170-200         135-175         40-5.0         0.10-020 $5(-N)$ -           0.0200         1000         170-190         90-120          0.21-0.32 $6.0-6.8$ $0.21-0.32$ $0.70$ $0.70$ 0.030         1000         170-190         90-120 $0.70-100$ $0.70-20$ $0.70-100$ $0.70-100$ 0.030         1000         170-190         90-120 $0.0-120$ $0.0-100$ $0.70-0.0$ 0.010         9.100         170-190         90-120 $0.0-120$ $0.0-100$ $0.70-0.0$ 0.011         0.030         1.00         170-190         90-130 $0.0-100$ $0.010$ $0.0-100$ 0.010         1.00         170-190         90-130 $0.0-10$ $0.010$ $0.00-100$ $0.010$ $0.00-100$ $0.010$ $0.00-100$ $0.010$ $0.010$ $0.00-100$ $0.010$ $0.010-0.00$ $0.010$ $0.00-100$ $0.010$ $0.00-100$ $0.010$ $0.00-0.00$ $0.000-100$ $0.000-100$ $0.$	0.030         100         170–200         135–175 $40-50$ $0.10-020$ $5(C+N)-$ 0.030         7         1.00         170–190         9.0–120 $5(C+N) 0.70$ 0.030         7         1.00         17.0–190         9.0–120 $5(C+N) 0.70$ 0.030         7         1.00         17.0–190         9.0–120 $5(C+N) 0.70$ 0.030         7         1.00         17.0–190         9.0–120 $2.0-250$ $40-100$ $0.10$ $0.70$ 0.010         1.00         17.0–190         9.0–130 $2.0-50$ $9.0-130$ $0.10$ $0.70$ 0.010         1.00         17.0–190         9.0–130 $0.00-0.10$ $0.10$ $0.00-100$ $0.10$ 0.030         1.00         17.0–190         9.0–130 $0.00-20-30^2$ $0.100$ $0.100$ $0.100$ $0.00-100$ $0.00-0.00$ 0.0300         1.00         17.0–190         9.0–130 $0.00-20-30^2$ $0.00-0.00$ $0.00-0.00$ $0.00-0.00$ $0.00-0.00$	$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	TP317LM	S31725	0.03	2.00	0.045	0.030	1.00	18.0-20.0	13.5-17.5	4.0-5.0	0.20	:	:	Cu 0.75
S32050         0.030         1.50         0.035         0.020         1.00         220-24.0         20.0-28.0         0.034         0.035         0.035         0.036         1.00         1.70-19.0         9.0-120           5(-1N)-           S32109         0.044         0.030         1.00         17.0-19.0         9.0-120             5(-1N)-           S32109         0.04-0.10         2.00         0.045         0.030         1.000         17.0-19.0         9.0-120             5(-1N)-           S32265         0.04-0.08         1.00         0.020         0.010         Y         1.000         17.0-19.0         9.0-15.0	0.020         1.00         220-240         0.0120         0.0120         0.0110         0.000         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.010	0.020         1.00         220-240         0.0120         0.0120         0.0110         0.010         0.010         0.010         0.010         0.010         0.010         0.010         0.010         0.010         0.010         0.010         0.010         0.010         0.010         0.010         0.010         0.010         0.000         0.100         0.100         0.100         0.100         0.100         0.100         0.010         0.000         0.010         0.010         0.010         0.010         0.000         0.010         0.000         0.010         0.010         0.010         0.010         0.010         0.000         0.010         0.010         0.010         0.010         0.000         0.010         0.000         0.010         0.000         0.010         0.000         0.000         0.000         0.010         0.000         0.010         0.000	0.020         1.000         220-24.0 $20.0-23.0$ $6.0-6.8$ $0.21-0.32$ $5(-1^{-}N)$ -           0.030         1.000         17.0-19.0         9.0-12.0 $0.70^{-}$ 0.030         1.000         17.0-19.0         9.0-12.0 $0.70^{-}$ 0.030         1.000         17.0-19.0         9.0-12.0 $0.70^{-}$ 0.030         2.80-28.0         31.0-33.0 $0.30-1.00^{-}$ $0.60-1.00^{-}$ $0.70^{-}$ 0.010         1.00         17.0-19.0 $9.0-13.0^{-}$ $0.30-1.00^{-}$ $0.10^{-}$ $0.70^{-}$ 0.030         1.00         17.0-19.0 $9.0-13.0^{-}$ $0.04-0.60^{-}$ $0.10^{-}$ $0.00^{-}$ 0.030         1.00         17.0-19.0 $9.0-13.0^{-}$ $0.04-0.10^{-}$ $0.10^{-}$ $0.10^{-}$ 0.030         1.00         17.0-19.0 $9.0-13.0^{-}$ $0.0^{-}$ $0.0^{-}$ $0.0^{-}$ 0.030         1.00         17.0-19.0 $9.0-13.0^{-}$ $0.0^{-}$ $0.00^{-}$ $0.00^{-}$	TP317LMN	S31726	0.03	2.00	0.045	0.030	1.00	17.0-20.0	13.5-17.5	4.0-5.0	0.10-0.20	:	:	Cu 0.75
332100         0.08         2.00         0045         0.030         1.00         170-19.0         90-12.0 $\dots$	0.030         1.00         1.70-19.0         9.0-12.0 $5(-h)^{-1}$ 0.030         1.00         17.0-19.0         9.0-12.0 $4(-h)^{-1}$ 0.030         4.8-6.0         16.5-19.5         19.0-22.0         0.30-1.50 $4(-h)^{-1}$ 0.030         4.8-6.0         16.5-19.5         19.0-22.0         0.30-1.50 $4(-h)^{-1}$ 0.030         2.60-28.0         31.0-33.0 $10.0$ 17.0-19.0 $90-13.0$ $4(-1,0)$ $0.70$ 0.030         1.00         1.70-19.0         9.0-13.0 $10.0-1.00$ $10.0-1.100$ $10.0-1.00$ $10.0-1.00$ $10.0-1.100$ $10.0-1.100$ $10.0-1.100$ $10.0-1.100$ $10.0-1.100$ $10.0-1.100$ $10.0-1.100$ $10.0-1.100$ $10.0-1.100$ $10.0-1.100$ $10.0-1.100$ $10.0-1.100$ $10.0-0.100$ $10.0-0.100$ $10.0-0.100$ $10.0-0.100$ $10.0-0.100$ $10.0-0.100$ $10.0-0.100$ $10.0-0.100$ $10.0-0.100$ $10.0-0.100$ $10.0-0.100$ $10.0-0.100$ $1$	0.030         1.00         1.70-19.0         9.0-12.0 $\dots$	0.030         1.00         1.70-19.0         9.0-12.0 $5(-4^{1})^{-1}$ 0.030         1.00         1.70-19.0         9.0-12.0 $4(-1^{1})^{-1}$ 0.030         1.00         1.70-19.0         9.0-12.0 $4(-1^{1})^{-1}$ $0.70^{-1}$ 0.015         0.30         260-28.0         31.0-33.0 $0.60^{-1}$ $4(-1^{1})^{-1}$ 0.010         1.00         1.70-20.0         9.0-13.0 $0.40^{-0.60}$ $0.10^{-1}$ $0.70^{-10}$ 0.020         1.00         1.70-20.0         9.0-13.0 $0.40^{-0.60}$ $0.10^{-10}$ $0.70^{-10}$ 0.030         1.00         1.70-19.0         9.0-13.0 $0.0^{-10}$ $0.6^{-1.10}$ $0.70^{-1.10}$ 0.030         1.00         1.70-19.0         9.0-13.0 $0.0^{-10}$ $0.70^{-1.10}$ $0.70^{-1.10}$ 0.030         1.00         1.70^{-19.0}         9.0-13.0 $0.0^{-10}$ $0.10^{-10}$ 0.030         1.00         1.70^{-19.0}         9.0-13.0 $0.0^{-10}$ $0.0^{-10}$ 0.030	0	S32050	0.030	1.50	0.035	0.020	1.00	22.0-24.0	20.0-23.0	6.0-6.8	0.21-0.32	:	:	Cu 0.40
S22103 $0.04-0.10$ $2.00$ $0.045$ $0.330$ $1.00$ $170-190$ $90-120$ $1.0$ $1.0^{-120}$ S32615 $0.07$ $2.00$ $0.045$ $0.330$ $4.8-60$ $165-195$ $19.0-220$ $0.30-150$ $1.0^{-10}$ S32253 $0.07$ $2.00$ $0.045$ $0.030$ $4.8-60$ $165-195$ $19.0-220$ $0.30-150$ $1.0^{-10}$ S33258 $0.04-0.08$ $1.00$ $0.020$ $0.015$ $0.300$ $4.8-60$ $165-195$ $19.0-220$ $0.30-150^{-100}$ $10^{-10}$ S34565 $0.0330$ $5.0-70$ $0.0330$ $0.010^{-100}$ $100^{-100}$ $10^{-20}$ $0^{-100}$	$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	0.0330         1.000         1.70-19.0         9.0-12.0         9.0-12.0 $$	0.030         1.00         170-19.0         9.0-12.0 $$	TP321	S32100	0.08	2.00	0.045	0.030	1.00	17.0-19.0	9.0-12.0	:	:	:	5(C + N)-	:
S22615 $0.07$ $2.00$ $0.045$ $0.030$ $4.8-6.0$ $16.5-19.5$ $19.0-22.0$ $0.30-1.50$ $\dots$	0.030         4.8-6.0         16.5-19.5         19.0-22.0         0.30-1.50           0.60-1.00           0.70          0.70           0.70          0.70          0.70           0.70          0.70          0.70           0.70         0.70	$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	0.039         4.8-6.0         1619.5         19.0-22.0         0.30-1.50 $\dots$ <	TP321H	S32109	0.04-0.10	2.00	0.045	0.030	1.00	17.0-19.0	9.0-12.0	:	:	:	4(C + N)-	:
S32615 $0.07$ $2.00$ $0.045$ $0.030$ $4.8-6.0$ $16.5-19.5$ $19.0-22.0$ $0.30-1.50$ $\dots$	0.030         4.8-6.0         16.5-19.5         19.0-22.0         0.30-1.50           0.60-1.00             0.60-1.00           0.60-1.00           0.60-1.00           0.60-1.00           0.60-1.00           0.60-1.00           0.60-1.00           0.60-1.00           0.60-1.00           0.60-1.00            0.60-1.00           0.60-1.00           0.60-1.00           0.60-1.100           0.60-1.100           0.60-1.100           0.60-1.100           0.60-1.100           0.60-1.100           0.60-1.100           0.60-1.100           0.60-1.100           0.60-1.100           0.60-1.100           0.60-1.100	0.030         4.8-6.0         16.5-19.5         19.0-22.0         0.30-1.50          0.60-1.00            0.015         0.30         260-28.0         31.0-33.0          0.60-1.00            0.016         1.00         230-25.0         16.0-18.0         4.0-5.0         0.40-0.60         0.10            0.030         1.00         17.0-90.0         90-13.0          8xC-1.10            0.030         1.00         17.0-19.0         90-13.0          0.06-0.10             0.030         1.00         17.0-19.0         90-13.0          0.06-0.10             0.030         1.00         17.0-19.0         90-13.0          0.06-0.10             0.030         1.00         17.0-19.0         90-13.0          0.06-0.10           0.15-0.50          0.15-0.50           0.15-0.50           0.15-0.50           0.15-0.50           0.15-0.50          0.15-0.50         0.050	0.030         4.8-6.0         16.5-19.5         19.0-22.0         0.30-1.50						71	I <b>T</b>	<b>h</b> S1					0.70	
S33228       0.04-0.08       1.00       0.202       0.015       0.300       260-28.0       31.0-33.0        0.60-1.00          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       0.10        0.60-1.00          S34765       0.030       5.0-7.0       0.030       0.010       1.00       23.0-25.0       9.0-13.0        0.60-1.10          S34709       0.030       0.045       0.030       1.00       17.0-19.0       9.0-13.0        8.C-1.10        8.C-1.10        8.C-1.10        8.C-1.10         8.C-1.10        8.C-1.10        8.C-1.10         8.C-1.10        8.C-1.10        8.C-1.10        8.C-1.10        8.C-1.10        8.C-1.10        8.C-1.10        8.C-1.10        8.C-1.10        8.C-1.10        8.C-1.10        8.C-1.10        8.C-1.10        8.C-1.10        8.C-1.10        8.C-1.10	$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	U	S32615	0.07	2.00	0.045	0.030	4.8-6.0	16.5-19.5	19.0–22.0	0.30-1.50	:	:	:	Cu 1.50-
S34565 $0.030$ $5.0-7.0$ $0.030$ $5.0-7.0$ $0.030$ $5.0-7.0$ $0.030$ $5.0-7.0$ $0.030$ $5.0-7.0$ $0.030$ $0.010$ $1.00$ $5.0-7.0$ $0.030$ $0.010$ $1.00$ $5.0-7.0$ $0.030$ $0.010$ $1.00$ $23.0-25.0$ $16.0-18.0$ $4.0-5.0$ $0.04-0.10$ $2.00$ $0.04-0.10$ $2.00$ $0.04-0.10$ $2.00$ $0.04-0.10$ $2.00$ $0.04-0.10$ $2.00$ $0.04-0.10$ $2.00$ $0.04-0.10$ $2.00$ $0.04-0.10$ $0.006-0.10$ $0.02-0.20$ $0.04-0.10$ $0.006-0.10$ $0.02-0.20$ $0.020-0.130$ $0.02-0.130$ $0.02-0.10$ $0.02-0.10$ $0.02-0.10$ $0.02-0.10$ $0.010$ $0.02-0.10$ $0.010$ $0.02-0.10$ $0.010$ $0.02-0.10$ $0.010$ $0.02-0.10$ $0.010$ $0.006-0.10$ $0.010$ $0.006-0.10$ $0.010$ $0.006-0.10$ $0.010$ $0.006-0.10$ $0.010$ $0.006-0.10$ $0.010$ $0.006-0.10$ $0.010$ $0.006-0.10$ $0.006-0.10$ $0.006-0.10$ $0.006-0.10$ $0.006-0.10$ $0.006-0.10$ $0.006-0.10$ $0.006-0.10$	0.010       1.00       23.0-25.0       16.0-18.0       4.0-5.0       0.40-0.60       0.10          0.030       1.00       1.7020.0       9.0-13.0        8xC-1.10          0.030       1.00       1.7020.0       9.0-13.0        8xC-1.10          0.030       1.00       1.7019.0       9.0-13.0        8xC-1.10          0.030       1.00       1.70-19.0       9.0-13.0        8xC-1.10          0.030       1.00       1.70-19.0       9.0-13.0        8xC-1.10          0.030       1.00       1.70-19.0       9.0-13.0        0.06-0.10       0.20-0.50 <sup>r</sup> 0.030       1.00       1.70-19.0       9.0-13.0         8xC-1.10          0.030       1.00       1.70-19.0       9.0-13.0        0.05-0.50 <sup>r</sup> 0.030       1.50-2.50       1.70-19.0       9.0-13.0        0.15-0.60          0.030       1.50-2.50       1.70-19.0       0.75-1.50       0.75-1.50            0	0.010       1.00       0.013       0.010 </td <td>0.010       1.00       1.00       230-25.0       16.0-18.0       4.0-5.0       0.40-0.60       0.10          0.0330       1.00       1.70-20.0       9.0-13.0         8xC-1.10          0.0330       1.00       1.70-19.0       9.0-13.0        8xC-1.10          0.0330       1.00       1.70-19.0       9.0-13.0        8xC-1.10          0.0330       1.00       1.70-19.0       9.0-13.0        0.06-0.10       0.20-0.50<sup>6</sup>          0.0330       1.00       1.70-19.0       9.0-13.0        0.06-0.10       0.20-0.50<sup>6</sup>          0.0330       1.00       1.70-19.0       9.0-13.0        0.06-0.10       0.20-0.50<sup>6</sup>          0.030       1.00       1.70-19.0       9.0-13.0        0.06-0.10       0.20-0.50<sup>6</sup>          0.030       1.00       1.70-19.0       9.0-13.0        0.06-0.10       0.20-0.50<sup>6</sup>          0.0330       1.50       1.70       9.0-13.0        0.06-0.10       0.20-0.50<sup>6</sup>          0.030       1.00       1.70       1.7</td> <td>U</td> <td>S33228</td> <td>0.04-0.08</td> <td>1.00</td> <td>0.020</td> <td>0.015</td> <td>0:30</td> <td>26.0-28.0</td> <td>31.0-33.0</td> <td>:</td> <td>:</td> <td>0.60-1.00</td> <td>:</td> <td>Ce 0.05-</td>	0.010       1.00       1.00       230-25.0       16.0-18.0       4.0-5.0       0.40-0.60       0.10          0.0330       1.00       1.70-20.0       9.0-13.0         8xC-1.10          0.0330       1.00       1.70-19.0       9.0-13.0        8xC-1.10          0.0330       1.00       1.70-19.0       9.0-13.0        8xC-1.10          0.0330       1.00       1.70-19.0       9.0-13.0        0.06-0.10       0.20-0.50 <sup>6</sup> 0.0330       1.00       1.70-19.0       9.0-13.0        0.06-0.10       0.20-0.50 <sup>6</sup> 0.0330       1.00       1.70-19.0       9.0-13.0        0.06-0.10       0.20-0.50 <sup>6</sup> 0.030       1.00       1.70-19.0       9.0-13.0        0.06-0.10       0.20-0.50 <sup>6</sup> 0.030       1.00       1.70-19.0       9.0-13.0        0.06-0.10       0.20-0.50 <sup>6</sup> 0.0330       1.50       1.70       9.0-13.0        0.06-0.10       0.20-0.50 <sup>6</sup> 0.030       1.00       1.70       1.7	U	S33228	0.04-0.08	1.00	0.020	0.015	0:30	26.0-28.0	31.0-33.0	:	:	0.60-1.00	:	Ce 0.05-
S34565 $0.030$ $5.0-7.0$ $0.030$ $5.0-7.0$ $0.030$ $5.0-7.0$ $0.030$ $5.0-7.0$ $0.030$ $5.0-7.0$ $0.030$ $5.0-7.0$ $0.04-0.60$ $0.10$ $5.3-25.0$ $16.0-18.0$ $4.0-5.0$ $0.04-0.60$ $0.10$ $5.3-7.0$ $0.04$ $0.04$ $0.04$ $0.04-0.10$ $2.00$ $0.045$ $0.030$ $1.00$ $17.0-19.0$ $9.0-13.0$ $0.04-0.10$ $2.00$ $0.045$ $0.030$ $1.00$ $17.0-19.0$ $9.0-13.0$ $0.06-0.10$ $0.02-0.50^{4}$ $0.030$ $1.00$ $17.0-19.0$ $9.0-13.0$ $0.06-0.10$ $0.04-0.10$ $2.00$ $0.045$ $0.030$ $1.00$ $17.0-19.0$ $9.0-13.0$ $0.06-0.10$ $0.02-0.50^{4}$ $0.030$ $1.00$ $17.0-19.0$ $9.0-13.0$ $0.06-0.10$ $0.046$ $0.030$ $1.00$ $17.0-19.0$ $9.0-13.0$ $0.06-0.10$ $0.04-0.10$ $0.030$ $1.00$ $17.0-19.0$ $9.0-13.0$ $0.06-0.10$ $0.010$ $0.030$ $1.00$ $17.0-19.0$ $0.06-0.10$	$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$														0.10, ALO 0.25
S34700 $0.08$ $2.00$ $0.045$ $0.030$ $1.00$ $17.0-20.0$ $9.0-13.0$ $\dots$ $10xC-1.10$ $\dots$ S34709 $0.04-0.10$ $2.00$ $0.045$ $0.030$ $1.00$ $17.0-19.0$ $9.0-13.0$ $\dots$ $8xC-1.10$ $\dots$ S34710 $0.06-0.10$ $2.00$ $0.045$ $0.030$ $1.00$ $17.0-19.0$ $9.0-13.0$ $\dots$ $8xC-1.10$ $\dots$ S34710 $0.06-0.10$ $2.00$ $0.045$ $0.030$ $1.00$ $17.0-19.0$ $9.0-13.0$ $\dots$ $8xC-1.10$ $\dots$ $0.010$ $0.010$ $0.010$ $0.020$ $0.030$ $0.030$ $0.030$ $0.030$ $0.030$ $0.030$ $0.030$ $0.030$ $0.030$ $0.030$ $0.010$ $0.020$ $0.010$ $0.020$ $0.000$	$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	U	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	0.10	:	
S34709 $0.04-0.10$ $2.00$ $0.045$ $0.030$ $1.00$ $17.0-19.0$ $9.0-13.0$ $\dots$ $BxC-1.10$ $\dots$ $DxC-1.10$ $DxC-0.10$	$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	0.030         1.00         17.0-19.0         9.0-13.0          BxC-1.10            0.030         1.00         17.0-19.0         9.0-13.0           BxC-1.10            0.030         1.00         17.0-19.0         9.0-13.0           0.15-0.60           0.031         1.00         17.0-19.0         32.0-37.0           0.15-0.60           0.030         1.50-2.50         17.0-19.0         17.5-18.5               0.0200         5.5-6.5         13.0-15.0         0.75-1.50         0.75-1.50         0.15-0.60           0.0200         1.00         17.5-19.5         1.1.55-2.50         0.035	0.030         1.00         1.70-19.0         9.0-13.0          BxC-1.10            0.030         1.00         17.0-19.0         9.0-13.0          BxC-1.10          BxC-1.10             0.030         1.00         17.0-19.0         9.0-13.0          0.06-0.10         0.20-0.50 <sup>6</sup> 0.030         1.00         17.0-19.0         9.0-13.0           BxC-1.10            0.030         1.00         17.0-19.0         9.0-13.0           BxC-1.10            0.030         1.00         17.0-19.0         9.0-13.0           0.15-0.60           0.030         1.50-2.50         17.0-19.0         32.0-37.0           0.15-0.60           0.030         1.50-2.50         17.0-19.0         0.75-1.50         0.35          0.15-0.60           0.020         5.5-6.5         13.0-15.0         1.5.0-17.0         0.75-1.50         0.35             0.020         1.50-4.55         0.020         0.35	TP347	S34700	0.08	2.00	0.045	0:030	1.00	17.0-20.0	9.0-13.0	:	:	10xC-1.10	:	:
S34710 $0.06-0.10$ $2.00$ $0.045$ $0.030$ $1.00$ $17.0-19.0$ $9.0-13.0$ $\dots$ $BxC-1.10$ $\dots$ S34751 $0.005-0.220$ $2.00$ $0.045$ $0.030$ $1.00$ $17.0-19.0$ $9.0-12.0$ $\dots$ $BxC-1.10$ $\dots$ S34751 $0.005-0.220$ $2.00$ $0.045$ $0.030$ $1.00$ $17.0-19.0$ $9.0-13.0$ $\dots$	0.030         1.00         17.0-19.0         9.0-13.0 $8xC-1.10$ $8xC-1$	0.030         1.00         17.0-19.0         9.0-13.0 $8xC-1.10$ $8xC-1$	0.030       1.00       17.0-19.0       9.0-13.0 $m = 0.06 - 0.10$ $m = 0.02 - 0.50^{F}$ $m = 0.030 - 0.100$ $m = 0.030 - 0.100$ $m = 0.00 - 0.000 - 0.000$ $m = 0.00 - 0.000 - 0.000$ $m = 0.00 - 0.000$ $m = 0.000 - 0.000$ $m = 0.0000 - 0.000$ $m = 0.000 - 0.000 - 0.000$	TP347H	S34709	0.04-0.10	2.00	0.045	0.030	1.00	17.0-19.0	9.0–13.0	:	:	8xC-1.10	:	:
S34751 $0.005-0.020$ $2.00$ $0.045$ $0.030$ $1.00$ $17.0-19.0$ $9.0-12.0$ $\dots$ $0.06-0.10$ $0.20-0.50^{-1}$ $\dots$ S34809 $0.04$ $0.045$ $0.030$ $1.00$ $17.0-19.0$ $9.0-13.0$ $\dots$	$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	0.030         1.00         17.0-19.0         9.0-12.0          0.06-0.10         0.20-0.50 <sup>T</sup> 0.030         1.00         17.0-19.0         9.0-13.0          0.06-0.10         0.20-0.50 <sup>T</sup> 0.030         1.00         17.0-19.0         9.0-13.0          0.05-0.10         0.25-0.50 <sup>T</sup> 0.030         1.00         17.0-19.0         9.0-13.0           0.15-0.60           0.030         1.50-2.50         17.0-19.0         9.0-13.0           0.15-0.60           0.030         1.50-2.50         17.0-19.0         9.0-17.0         0.75-1.50          0.15-0.60           0.030         1.50-2.50         17.0-19.0         17.5-18.5               0.030         1.50-2.50         17.0-17.0         0.75-1.150               0.030         1.00         17.5-19.5         /         1.75-2.50         0.035             1 appear in this table, there is no minimum and analysis for the element need not be determined or reported.	0.030       1.00       17.0-19.0       9.0-12.0        0.06-0.10       0.20-0.50 <sup>+</sup> 0.030       1.00       17.0-19.0       9.0-13.0 $H$ 0.030       1.50-2.50       17.0-19.0       9.0-13.0 $H$ 0.030       1.50-2.50       17.0-19.0       0.055-1.50       17.5-18.5 $H$ 0.030       1.50-2.50       17.0-19.0       0.755-1.150 $H$ $H$ 0.030       1.00       17.5-19.5 $I$ $I$ $H$ $H$ $H$ 0.030       1.00       17.5-19.5 $I$ $I$ $I$ $H$ $H$ $H$ 1 appear       in this table, there is no minimum and analysis for the element need not be determined or reported. $H$	TP347HFG	S34710	0.06-0.10	2.00	0.045	0.030	1.00	17.0-19.0	9.0–13.0	:	:	8xC-1.10	:	:
S34800       0.08       Z.00       0.045       0.030       1.00       17.0-19.0       9.0-13.0 <th< td=""><td>0.030       1.00       17.0-19.0       9.0-13.0   <!--</td--><td>0.030       1.00       17.0-19.0       9.0-13.0                                       0.15-0.60       0.033       1.100       25.0-29.0       32.0-37.0         0.15-0.60        0.15-0.60       0.050       25.5-6.5       13.0-15.0       17.5-18.5        0.17.5-18.5         0.15-0.60         0.15-0.60         0.15-0.60         0.15-0.60         0.15-0.60         0.15-0.60         0.15-0.60         0.15-0.60         0.15-0.60         0.15-0.60         0.15-0.60         0.15-0.60         0.15-0.60         0.15-0.60         0.15-0.60      <td>0.030       1.00       17.0-19.0       9.0-13.0         <math>H</math> <math>H</math><!--</td--><td>TP347LN</td><td>S34751</td><td>0.005-0.020</td><td>2.00</td><td>0.045</td><td>0.030</td><td>1.00</td><td>17.0-19.0</td><td>9.0-12.0</td><td>:</td><td>0.06-0.10</td><td>0.20-0.50<sup>r</sup></td><td>:</td><td>H : 0 0</td></td></td></td></th<>	0.030       1.00       17.0-19.0       9.0-13.0 </td <td>0.030       1.00       17.0-19.0       9.0-13.0                                       0.15-0.60       0.033       1.100       25.0-29.0       32.0-37.0         0.15-0.60        0.15-0.60       0.050       25.5-6.5       13.0-15.0       17.5-18.5        0.17.5-18.5         0.15-0.60         0.15-0.60         0.15-0.60         0.15-0.60         0.15-0.60         0.15-0.60         0.15-0.60         0.15-0.60         0.15-0.60         0.15-0.60         0.15-0.60         0.15-0.60         0.15-0.60         0.15-0.60         0.15-0.60      <td>0.030       1.00       17.0-19.0       9.0-13.0         <math>H</math> <math>H</math><!--</td--><td>TP347LN</td><td>S34751</td><td>0.005-0.020</td><td>2.00</td><td>0.045</td><td>0.030</td><td>1.00</td><td>17.0-19.0</td><td>9.0-12.0</td><td>:</td><td>0.06-0.10</td><td>0.20-0.50<sup>r</sup></td><td>:</td><td>H : 0 0</td></td></td>	0.030       1.00       17.0-19.0       9.0-13.0                                       0.15-0.60       0.033       1.100       25.0-29.0       32.0-37.0         0.15-0.60        0.15-0.60       0.050       25.5-6.5       13.0-15.0       17.5-18.5        0.17.5-18.5         0.15-0.60         0.15-0.60         0.15-0.60         0.15-0.60         0.15-0.60         0.15-0.60         0.15-0.60         0.15-0.60         0.15-0.60         0.15-0.60         0.15-0.60         0.15-0.60         0.15-0.60         0.15-0.60         0.15-0.60 <td>0.030       1.00       17.0-19.0       9.0-13.0         <math>H</math> <math>H</math><!--</td--><td>TP347LN</td><td>S34751</td><td>0.005-0.020</td><td>2.00</td><td>0.045</td><td>0.030</td><td>1.00</td><td>17.0-19.0</td><td>9.0-12.0</td><td>:</td><td>0.06-0.10</td><td>0.20-0.50<sup>r</sup></td><td>:</td><td>H : 0 0</td></td>	0.030       1.00       17.0-19.0       9.0-13.0 $H$ </td <td>TP347LN</td> <td>S34751</td> <td>0.005-0.020</td> <td>2.00</td> <td>0.045</td> <td>0.030</td> <td>1.00</td> <td>17.0-19.0</td> <td>9.0-12.0</td> <td>:</td> <td>0.06-0.10</td> <td>0.20-0.50<sup>r</sup></td> <td>:</td> <td>H : 0 0</td>	TP347LN	S34751	0.005-0.020	2.00	0.045	0.030	1.00	17.0-19.0	9.0-12.0	:	0.06-0.10	0.20-0.50 <sup>r</sup>	:	H : 0 0
S34809       0.04-0.10       2.00       0.045       0.030       1.00       17.0-19.0       9.0-13.0   0.15-0.60                     0.15-0.60       0.15-0.60       0.15-0.60       0.15-0.60       0.15-0.60       0.15-0.10       0.15-0.17       0.15-0.17       0.15-0.17       0.15-0.17       0.15-0.160       0.15-0.160       0.15-0.160       0.15-0.160       0.15-0.160       0.15-0.160       0.15-0.17       0.15-0.17 <td>0.030       1.00       17.0-19.0       9.0-13.0         <math>H</math>          0.015       1.00       25.0-29.0       32.0-37.0         0.15-0.60         0.015       1.00       25.0-29.0       32.0-37.0         0.15-0.60         0.020       5.5-6.5       17.0-19.0       17.5-18.5         0.15-0.60         0.020       5.5-6.5       17.0-19.0       17.5-18.5         0.15-0.60         0.020       5.5-6.5       17.0-19.0       17.5-18.5         0.15-0.60         0.020       5.5-6.5       17.0-19.0       17.5-18.5             0.030       1.00       17.5-19.5       /       1.75-2.50       0.035           0.300       0.030       1.00       17.5-19.5       /            1 appear in this table, there is no minimum and analysis for the element need not be determined or reported.            there uniquely identifies these alloys.              appearin this table, there is n</td> <td>0.030       1.00       17.0-19.0       9.0-13.0         <math>H</math>          0.015       1.00       25.0-29.0       32.0-37.0         0.15-0.60         0.015       1.00       25.0-29.0       32.0-37.0         0.15-0.60         0.030       1.50-2.50       17.0-19.0       17.5-18.5         0.15-0.60         0.030       1.50-2.50       17.0-19.0       17.5-18.5         0.15-0.60         0.030       1.50-2.50       13.0-15.0       17.5-18.5         0.15-0.60         0.030       1.50-2.50       13.0-15.0       17.5-18.5         0.15-0.60         0.030       1.50       1.50-17.0       0.755-1.150             1 appear in this table, there is no minimum and analysis for the element need not be determined or reported.             1 appear in this table, there is no minimum and analysis for the element need not be determined or reported.            1 appear in this table, there is no minimum and analysis for the element need not be determined or reported.        </td> <td>0.0301.0017.0-19.09.0-13.0<math>H</math>0.0151.0025.0-29.032.0-37.00.15-0.600.0151.0025.0-29.032.0-37.00.15-0.600.0301.50-2.5017.0-19.017.5-18.50.15-0.600.0301.50-2.5017.0-19.017.5-18.50.15-0.600.0301.50-2.5017.0-19.017.5-18.50.15-0.600.0301.0017.5-19.515.0-17.00.75-1.500.0350.0301.0017.5-19.5/1.75-2.500.0350.00301.0017.5-19.5/1.75-2.500.0350.00301.0017.5-19.5/1.75-2.500.0350.10010.040% is necessary in Grades TP304L, TP304LN, TP316L, and TP316LN.there than 4 times the carbon contente carbon contentthe carbon contentthe carbon contentthe carbon contentthe carbon contentthe carbon conte</td> <td>IF 348</td> <td>534800</td> <td>0.08</td> <td>2.00</td> <td>C40.0</td> <td>0:030</td> <td></td> <td>1/.0-19.0</td> <td>9.0-13.0</td> <td>:</td> <td>:</td> <td>5</td> <td>:</td> <td>CO U.ZU, IA</td>	0.030       1.00       17.0-19.0       9.0-13.0 $H$ 0.015       1.00       25.0-29.0       32.0-37.0         0.15-0.60         0.015       1.00       25.0-29.0       32.0-37.0         0.15-0.60         0.020       5.5-6.5       17.0-19.0       17.5-18.5         0.15-0.60         0.020       5.5-6.5       17.0-19.0       17.5-18.5         0.15-0.60         0.020       5.5-6.5       17.0-19.0       17.5-18.5         0.15-0.60         0.020       5.5-6.5       17.0-19.0       17.5-18.5             0.030       1.00       17.5-19.5       /       1.75-2.50       0.035           0.300       0.030       1.00       17.5-19.5       /            1 appear in this table, there is no minimum and analysis for the element need not be determined or reported.            there uniquely identifies these alloys.              appearin this table, there is n	0.030       1.00       17.0-19.0       9.0-13.0 $H$ 0.015       1.00       25.0-29.0       32.0-37.0         0.15-0.60         0.015       1.00       25.0-29.0       32.0-37.0         0.15-0.60         0.030       1.50-2.50       17.0-19.0       17.5-18.5         0.15-0.60         0.030       1.50-2.50       17.0-19.0       17.5-18.5         0.15-0.60         0.030       1.50-2.50       13.0-15.0       17.5-18.5         0.15-0.60         0.030       1.50-2.50       13.0-15.0       17.5-18.5         0.15-0.60         0.030       1.50       1.50-17.0       0.755-1.150             1 appear in this table, there is no minimum and analysis for the element need not be determined or reported.             1 appear in this table, there is no minimum and analysis for the element need not be determined or reported.            1 appear in this table, there is no minimum and analysis for the element need not be determined or reported.	0.0301.0017.0-19.09.0-13.0 $H$ 0.0151.0025.0-29.032.0-37.00.15-0.600.0151.0025.0-29.032.0-37.00.15-0.600.0301.50-2.5017.0-19.017.5-18.50.15-0.600.0301.50-2.5017.0-19.017.5-18.50.15-0.600.0301.50-2.5017.0-19.017.5-18.50.15-0.600.0301.0017.5-19.515.0-17.00.75-1.500.0350.0301.0017.5-19.5/1.75-2.500.0350.00301.0017.5-19.5/1.75-2.500.0350.00301.0017.5-19.5/1.75-2.500.0350.10010.040% is necessary in Grades TP304L, TP304LN, TP316L, and TP316LN.there than 4 times the carbon contente carbon contentthe carbon contentthe carbon contentthe carbon contentthe carbon contentthe carbon conte	IF 348	534800	0.08	2.00	C40.0	0:030		1/.0-19.0	9.0-13.0	:	:	5	:	CO U.ZU, IA
S35045       0.06-0.10       1.50       0.015       1.00       25.0-29.0       32.0-37.0          0.15-0.60         S3810       0.08       2.00       0.030       0.030       1.50-2.50       17.0-19.0       17.5-18.5              0.15-0.60         S3815       0.030       2.000       0.030       1.50-2.50       17.0-15.0       17.5-18.5                            0.15-0.60          0.15-0.60          0.15-0.60	0.015       1.00       25.0-29.0       32.0-37.0         0.15-0.60         0.030       1.50-2.50       17.0-19.0       17.5-18.5         0.15-0.60         0.020       5.5-6.5       13.0-15.0       17.5-18.5         0.15-0.60         0.020       5.5-6.5       13.0-15.0       17.5-18.5          0.15-0.60         0.020       1.50-2.50       17.0-19.0       17.5-18.5             0.020       1.50-15.0       17.5-17.0       0.755-1.150              0.030       1.00       17.5-19.5       /       1.755-2.50       0.035            1 appear in this table, there is no minimum and analysis for the element need not be determined or reported.              1 are required, a carbon maximum of 0.040% is necessary in Grades TP304L, TP304LN, TP316L, and TP316LN.       reaction content.           1 carbon content.       e carbon content.       e carbon content. <td><math display="block"> \begin{array}{c c c c c c c c c c c c c c c c c c c </math></td> <td><math>0.015</math> <math>1.00</math> <math>25.0-29.0</math> <math>32.0-37.0</math> <math>\dots</math> <math>\dots</math> <math>0.15-0.60</math> <math>0.030</math> <math>1.50-2.50</math> <math>17.0-19.0</math> <math>17.5-18.5</math> <math>\dots</math> <math>\dots</math> <math>0.15-0.60</math> <math>0.020</math> <math>5.5-6.5</math> <math>17.0-19.0</math> <math>17.5-18.5</math> <math>\dots</math> <math>\dots</math> <math>\dots</math> <math>\dots</math> <math>0.020</math> <math>5.5-6.5</math> <math>13.0-15.0</math> <math>17.5-18.5</math> <math>0.75-1.50</math> <math>0.035</math> <math>\dots</math> <math>\dots</math> <math>0.020</math> <math>1.50</math> <math>1.75-19.5</math> <math>1.75-2.50</math> <math>0.035</math> <math>\dots</math> <math>\dots</math> <math>0.030</math> <math>1.00</math> <math>17.5-19.5</math> <math>1.75-2.50</math> <math>0.035</math> <math>\dots</math> <math>\dots</math> <math>0.031</math> <math>1.00</math> <math>17.5-19.5</math> <math>1.75-2.50</math> <math>0.035</math> <math>\dots</math> <math>\dots</math> <math>0.031</math> <math>1.00</math> <math>1.75-2.50</math> <math>0.035</math> <math>\dots</math> <math>\dots</math> <math>\dots</math></td> <td>TP348H</td> <td>S34809</td> <td>0.04-0.10</td> <td>2.00</td> <td>0.045</td> <td>0.030</td> <td>1.00</td> <td>17.0-19.0</td> <td>9.0-13.0</td> <td>:</td> <td>:</td> <td>н</td> <td>:</td> <td>0.10 Co 0.20, Ta</td>	$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	$0.015$ $1.00$ $25.0-29.0$ $32.0-37.0$ $\dots$ $\dots$ $0.15-0.60$ $0.030$ $1.50-2.50$ $17.0-19.0$ $17.5-18.5$ $\dots$ $\dots$ $0.15-0.60$ $0.020$ $5.5-6.5$ $17.0-19.0$ $17.5-18.5$ $\dots$ $\dots$ $\dots$ $\dots$ $0.020$ $5.5-6.5$ $13.0-15.0$ $17.5-18.5$ $0.75-1.50$ $0.035$ $\dots$ $\dots$ $0.020$ $1.50$ $1.75-19.5$ $1.75-2.50$ $0.035$ $\dots$ $\dots$ $0.030$ $1.00$ $17.5-19.5$ $1.75-2.50$ $0.035$ $\dots$ $\dots$ $0.031$ $1.00$ $17.5-19.5$ $1.75-2.50$ $0.035$ $\dots$ $\dots$ $0.031$ $1.00$ $1.75-2.50$ $0.035$ $\dots$ $\dots$ $\dots$	TP348H	S34809	0.04-0.10	2.00	0.045	0.030	1.00	17.0-19.0	9.0-13.0	:	:	н	:	0.10 Co 0.20, Ta
S35045       0.06-0.10       1.50       0.045       0.015       1.00       250-29.0       32.0-37.0         0.15-0.60         S38100       0.08       2.00       0.030       1.50-2.50       17.0-19.0       17.5-18.5          0.15-0.60         S38115       0.030       2.00       0.040       0.020       5.5-6.5       13.0-15.0       17.5-18.5             0.15-0.60         S38815       0.030       2.00       0.040       0.020       5.5-6.5       13.0-15.0       17.6                 0.15-0.60         S38815       0.030       2.00       0.040       0.020       5.5-6.5       13.0-15.0	0.015       1.00       25.0-29.0       32.0-37.0        0.050       0.15-0.60         0.030       1.50-2.50       17.0-19.0       17.5-18.5        0.055        0.15-0.60         0.020       5.5-6.5       17.0-19.0       17.5-18.5        0.15-0.60        0.15-0.60         0.020       5.5-6.5       13.0-15.0       17.0-17.0       0.755-1.50            0.030       1.00       17.5-19.5       /       1.75-2.50       0.035            0.030       1.00       17.5-19.5       /       1.75-2.50       0.035            0.030       1.00       17.5-19.5       /       1.75-2.50       0.035            1 appear in this table, there is no minimum and analysis for the element need not be determined or reported.	0.015       1.00       25.0-29.0       32.0-37.0        0.15-0.60         0.030 $150-2.50$ $17.0-19.0$ $17.5-18.5$ 0.15-0.60         0.020 $5.5-6.5$ $17.0-19.0$ $17.5-18.5$ 0.15-0.60         0.020 $5.5-6.5$ $13.0-15.0$ $17.5-18.5$ 0.15-0.60         0.020 $5.5-6.5$ $13.0-15.0$ $17.5-19.5$ $1.75-2.50$ $0.035$ $$ 0.030 $1.00$ $17.5-19.5$ $1.75-2.50$ $0.035$ $$ $$ 0.030 $1.00$ $17.5-19.5$ $1.75-2.50$ $0.035$ $$ $$ 0.030 $1.00$ $17.5-19.5$ $$ $1.75-2.50$ $0.035$ $$ $$ appear in this table, there is no minimum and analysis for the element need not be determined or reported. $$ $$ $$ $$ $$ $$ $0.030$ $1.00$ $0.75-2.50$ $0.035$ $$ $$ $$ $$ $$ $$ $$ $$ $$	0.015       1.00 $25.0-29.0$ $32.0-37.0$ $0.15-0.60$ 0.030 $150-2.50$ $17.0-19.0$ $17.5-18.5$ $0.15-0.60$ 0.020 $5.5-6.5$ $17.0-19.0$ $17.5-18.5$ $0.15-0.60$ 0.020 $5.5-6.5$ $12.0-15.0$ $17.5-18.5$ $0.75-1.50$ $0.035$ $$ 0.020 $1.50-1.50$ $1.75-2.50$ $0.035$ $$ $$ $$ 0.030 $1.00$ $17.5-19.5$ $1.75-2.50$ $0.035$ $$ $$ 0.030 $1.00$ $17.5-19.5$ $1.75-2.50$ $0.035$ $$ $$ 0.101 $17.5-19.5$ $1.75-2.50$ $0.035$ $$ $$ $$ 1 appear in this table, there is no minimum and analysis for the element need not be determined or reported. $$ $$ $$ $$ 1 appear in the purchaser and the producer. $$ $$ $$ $$ $$ 1 apper uniquely identifies these alloys. $$ $$ $$ $$ $$ a				1		5-(		e						0.10
S38100       0.08       2.00       0.030       0.030       1.50-2.50       17.0-19.0       17.5-18.5	$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	:	S35045	0.06-0.10	1.50	0.045	0.015	1.00	25.0-29.0	32.0-37.0	:	:	:	0.15-0.60	AI 0.15-0.60 Cu 0.75
S38815 0.030 2.00 0.040 0.020 5.5–6.5 13.0–15.0 15.0–17.0 0.75–1.50	0.020       5.5-6.5       13.0-15.0       15.0-17.0       0.75-1.50	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	XM-15	S38100	0.08	2.00	0:030	0:030	1.50-2.50	17.0-19.0	17.5-18.5	:	:	:	:	:
	0.030 1.00 1.7.5–19.5 <sup>1</sup> 1.75–2.50 0.035 <sup>J</sup> appear in this table, there is no minimum and analysis for the element need not be determined or reported. when the purchaser and the producer. The uniquely identifies these alloys. There than 4 times the carbon content. the carbon content and not more than 1.10%.	0.0301.0017.5-19.511.75-2.500.035J1 appear in this table, there is no minimum and analysis for the element need not be determined or reported.etween the producer.after uniquely identifies these alloys.are required, a carbon maximum of 0.40% is necessary in Grades TP304L, TP304LN, TP316L, and TP316LN.the carbon content.e carbon content and not more than 1.10%.the carbon content and not more than 1.10%.	0.030 1.00 1.7.5–19.5 <sup>1</sup> 1.75–2.50 0.035 <sup>J</sup> appear in this table, there is no minimum and analysis for the element need not be determined or reported. tween the producer. Ther uniquely identifies these alloys. The required, a carbon maximum of 0.40% is necessary in Grades TP304L, TP304LN, TP316L, and TP316LN. The rearbon content. the carbon content and not more than 1.10%.	:	S38815	0.030	2.00	0.040	0.020	5.5-6.5	13.0-15.0	15.0–17.0	0.75-1.50	÷	:	:	Cu 0.75–1.50
	<sup>4</sup> Maximum, 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. <sup>6</sup> The method of analysis for Nitrogen shall be a matter of agreement between the purchaser and the producer. <sup>7</sup> For these alloys, there is no common grade designation. The UNS number uniquely identifies these alloys. <sup>7</sup> For small diameter or thin walls, or both, where many drawing passes are required, a carbon maximum of 0.040% is necessary in Grades TP304L, TP304LN, TP316L, and TP316LN. <sup>6</sup> For small diameter or thin walls, or both, where many drawing passes are required, a carbon content. <sup>6</sup> For and the tot the the and not less than 2 times and not more than 4 times the carbon content. <sup>6</sup> Grade TP34TLN shall have (TI + ½ Nb) of not less than 15 times the carbon content. <sup>6</sup> Grade TP348 shall have an Nb content of not less than 10 times the carbon content and not more than 1.10%.	<sup>A</sup> Maximum, 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. <sup>B</sup> The method of analysis for Nitrogen shall be a matter of agreement between the purchaser and the producer. <sup>C</sup> For these alloys, there is no common grade designation. The UNS number uniquely identifies these alloys. <sup>C</sup> For small diameter or thin walls, or both, where many drawing passes are required, a carbon maximum of 0.040% is necessary in Grades TP304L, TP304LN, TP316L, and TP316LN. <sup>C</sup> For small diameter or thin walls, or both, where many drawing passes are required, a carbon maximum of 0.040% is necessary in Grades TP304L, TP304LN, TP316L, and TP316LN. <sup>C</sup> For anal diameter or thin walls, or both, where many drawing passes are required, a carbon content. <sup>C</sup> For and TP34S shall have (Ti + ½ Nb) of not less than 15 times the carbon content. <sup>C</sup> Grade TP348 shall have an Nb + Ta content of not less than 10 times the carbon content. <sup>C</sup> Grade TP348 shall have an Nb + Ta content of not less than 8 times the carbon content and not more than 1.10%.	<sup>A</sup> Maximum, 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. <sup>B</sup> The method of analysis for Nitrogen shall be a matter of agreement between the purchaser and the producer. <sup>C</sup> For these alloys, there is no common grade designation. The UNS number uniquely identifies these alloys. <sup>C</sup> For small diameter or thin walls, or both, where many drawing passes are required, a carbon maximum of 0.040% is necessary in Grades TP304L, TP316L, and TP316LN. <sup>E</sup> Grade S30434 shall have (Ti + ½ Nb) of not less than 12 times the carbon maximum of 0.040% is necessary in Grades TP304L, TP304LN, TP316L, and TP316LN. <sup>E</sup> Grade TP34TLN shall have an Nb or not less than 12 times the carbon content. <sup>E</sup> Grade TP348 shall have an Nb + Ta content of not less than 10 times the carbon content. <sup>H</sup> Grade TP348 shall have an Nb + Ta content of not less than 8 times the carbon content. <sup>H</sup> Grade TP348 shall have an Nb + Ta content of not less than 8 times the carbon content. <sup>H</sup> Grade TP348 shall have Ni + Cu = 1.00 max. <sup>H</sup> Grade TP444 shall have T1 + Nb = 0.20 + 4/C + N1-0.80.	TP444	S44400	0.03	1.00	0.040	0:030	1.00	17.5-19.5	1	1.75-2.50	0.035	:	ſ	00.0 IA

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# 7. Chemical Composition

#### 7.1 Composition Requirements:

7.1.1 The alloy steels shall conform to the chemical requirements given in Table 1.

7.1.2 The stainless steels shall conform to the chemical requirements given in Table 2.

7.2 Product Analysis:

7.2.1 An analysis of either one billet or one tube shall be made from each heat. The chemical composition thus determined shall conform to the requirements specified.

7.2.2 If the original test for product analysis fails, retests of two additional billets or tubes shall be made. Both retests, for the elements in question, shall meet the requirements of the specification; otherwise all remaining material in the heat shall be rejected or, at the option of the producer, each billet or tube may be individually tested for acceptance. Billets or tubes that do not meet the requirements of the specification shall be rejected.

#### 8. Grain Size

8.1 Grain size shall be as given in Table 3, as determined in accordance with Test Methods E 112E112.

8.2 Grain size determinations, to demonstrate compliance with 8.1, shall be made on one end of one finished tube from each lot. See 14.1.

# 9. Mechanical Properties

9.1 Tensile Requirements:

9.1.1 The material shall conform to the requirements as to tensile properties given in Table 4.

9.1.2 Table 5 gives the computed minimum elongation values for each  $\frac{1}{32}$ -in. [0.8-mm] decrease in wall thickness. Where the wall thickness lies between two values shown in Table 5, the minimum elongation value shall be determined by the following equations. For Grades T23, T24, T91, T92, T122, T911, and S44400: E = 32t + 10.00 [E = 1.25t + 10.00]. For Grade T36: E = 32t + 5.0 [E = 1.25t + 5.0]. For all other ferritic alloy grades: E = 48 t + 15.00 [E = 1.87t + 15.00].

#### where:

E = elongation in 2 in. [50 mm], %, and

t =actual thickness of specimen, in. [mm].

9.1.3 One tension test shall be made on a specimen from one tube for lots of not more than 50 tubes. Tension tests shall be made on specimens from two tubes for lots of more than 50 tubes. See 14.2.

9.2 Hardness Requirements:

9.2.1 The material shall conform to the hardness requirements given in Table 4. See 14.2.

9.2.2 Brinell, Vickers, or Rockwell hardness tests shall be made on specimens from two tubes from each lot. See 14.2.

9.3 *Flattening Test*—One flattening test shall be made on specimens from each end of one finished tube, not the one used for the flaring test, from each lot. See 14.1.

9.4 *Flaring Test*—One flaring test shall be made on specimens from each end of one finished tube, not the one used for the flattening test, from each lot. See 14.1.

9.5 Mechanical property requirements do not apply to tubing smaller than  $\frac{1}{8}$  in. [3.2 mm] in inside diameter or

thinner than 0.015 in. [0.4 mm] in thickness.

# 10. Hydrostatic or Nondestructive Electric Test

10.1 Each tube 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.

## **11. Forming Operations**

11.1 Tubes, when inserted in a boiler or tube sheet, shall stand expanding and beading without showing cracks or flaws. Superheater tubes when properly manipulated shall stand all forging, welding, and bending operations necessary for application without developing defects. See Note 1.

NOTE 1—Certain of the ferritic steels covered by this specification will harden if cooled rapidly from above their critical temperature. Some will air harden, that is, become hardened to an undesirable degree when cooled in air from high temperatures, particularly chromium-containing steels with chromium of 4% and higher. Therefore, operations that involve heating such steels above their critical temperatures, such as welding, flanging, and hot bending, should be followed by suitable heat treatment.

# 12. Permissible Variations from the Specified Wall Thickness

12.1 Permissible variations from the specified minimum wall thickness shall be in accordance with Specification A 1016/A 1016MA1016/A1016M.

12.2 Permissible variations from the specified average wall thickness are  $\pm 10$  % of the specified average wall thickness.

#### **13. Surface Condition**

13.1 Ferritic alloy cold-finished steel tubes shall be free of scale and suitable for inspection. A slight amount of oxidation is not considered scale.

13.2 Ferritic alloy hot-finished steel tubes shall be free of loose scale and suitable for inspection.

13.3 Stainless steel tubes shall be pickled free of scale. When bright annealing is used, pickling is not necessary.

13.4 Any special finish requirement shall be subject to agreement between the supplier and the purchaser.

# 14. Sampling

14.1 For flattening, flaring, and grain size requirements, the term lot applies to all tubes, prior to cutting, of the same size (see 4.1.6) that are produced from the same heat of steel. When final heat treatment is in a batch-type furnace, a lot shall include only those tubes of the same size and from the same heat that are heat treated in the same furnace charge. When the final heat treatment is in a continuous furnace or when the heat-treated condition is obtained directly by quenching after hot forming, the number of tubes of the same size and from the same heat in a lot shall be determined from the size of the tubes as prescribed in Table 6.

14.2 For tensile and hardness test requirements, the term lot applies to all tubes prior to cutting, of the same size (see 4.1.6) that are produced from the same heat of steel. When final heat treatment is in a batch-type furnace, a lot shall include only those tubes of the same size and the same heat that are heat treated in the same furnace charge. When the final heat