Designation: A 959 – 01

Standard Guide for Specifying Harmonized Standard Grade Compositions for Wrought Stainless Steels[1]

This standard is issued under the fixed designation A 959; 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 standard provides a guide to ASTM Subcommittees A01.06, A01.10, A01.17, A01.22, and A01.28 for specifying chemical composition limits of wrought stainless steels. It is intended that these recommended grade composition limits be suitable for adoption by other standardization bodies that prepare standards for stainless steel products.

1.2 Included in this guide are the recommendations for determining the number of significant figures for specifying chemical composition from Test Methods, Practices and Terminology A 751.

1.3 All stainless steel UNS numbers and the stainless steel grades in all standards overseen by the aforementioned ASTM subcommittees have been included, except those grades applicable to restricted special end uses and alloys containing less than 10.5 % minimum chromium.

1.4 Not addressed are minor composition modifications which a specific product subcommittee may find necessary to accommodate effects of normal processing or to enhance fabricability by the producer or user, or both.

1.5 Also not generally addressed (except when established by ASTM product subcommittees) is a complete rationalization of all limits, especially when such would conflict with long-standing practices and is not justified by special technical effect.

1.6 Excluded from this guide are cast material and welding filler metal.

2. Referenced Documents

2.1 *ASTM Standards:*

A 751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products[2]

E 527 Practice for Numbering Metals and Alloys (UNS)[2]

2.2 *SAE Standards:*

J 1086 Recommended Practice for Numbering Metals and Alloys[3]

HS-1086 FEB93 Metals and Alloys in the Unified Numbering System[3]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *austenitic grade*, *n*— is a metallurgical term meaning that the material is usually predominantly face-centered cubic in structure and hardenable only by cold working.

3.1.2 *austenitic-ferritic (duplex) grade*, *n*—is a metallurgical term meaning that the material is a mixture of austenitic and ferritic structures, with at least one-fourth of the lesser phase, and hardenable only by cold working.

3.1.3 *ferritic grade*, *n*—is a metallurgical term meaning that the material is body-centered cubic in structure (with little, if any, tempered martensite) and hardenable only slightly by cold working (responding little or only slightly to conventional heat treatment by quenching and tempering).

3.1.4 *martensitic grade*, *n*—is a metallurgical term meaning that the material is capable of being produced in a distorted body-centered cubic structure by conventional heat treating and quenching, and that the quenched structure is capable of conventional tempering. Martensitic grades are delivered in the annealed (ferritic) condition or the hardened and tempered (martensitic) condition.

3.1.5 *precipitation hardening grade*, *n*—is a metallurgical term meaning that the material may be basically austenitic or martensitic in structure and hardenable by precipitation hardening (sometimes called age hardening).

3.1.6 *standard stainless steel grade*, *n*—the listed chemical composition associated with a stainless steel grade identified by a particular UNS number appearing in SAE publication HS-1086 FEB93, except as modified by an ASTM subcommittee having oversight of a wrought stainless steel product where such a modification is justified by a specific technical effect.

[1] This guide is under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel, and Related Alloys and is the direct responsibility of Subcommittee A01.96 on Harmonization of Wrought Stainless Steel Requirements.

Current edition approved Oct. 10, 2001. Published December 2001. Originally published as A 959 – 96. Last previous edition A 959 – 00a.

[2] *Annual Book of ASTM Standards*, Vol 01.01.

[3] Available from Society of Automotive Engineers, Commonwealth Drive, Warrendale, PA 15096.

4. Significance and Use

4.1 It is anticipated that the ASTM Subcommittees A01.06, A01.10, A01.17, A01.22, and A01.28 will use the standard composition limits listed in this guide for the grades identified by the corresponding UNS designation in the product specification unless there is a specific technical justification for doing otherwise. The compositions in this guide shall not be considered as chemical requirements for any particular product until adopted by the subcommittee overseeing that product.

4.2 Assuming that uniform compositions among the many product standards for stainless steel are desirable, the composition limits provided in this standard are to be used as guides in determining limits for each of the elements included in the total composition of each grade. The composition limits have been established with the intent that each product subcommittee will find it necessary to require only a minimum number of changes to reflect specific technical effects. Section 5 lists the general guidelines followed for determining the limits for each element; the limits established in this guide are based on these guidelines.

4.3 Not included in this standard stainless steel grade harmonization effort is an attempt to unify stainless steel compositions in ASTM product standards by any means other than recognizing current industry practices.

5. General Guidelines Used for Determining Composition Limits

5.1 *Carbon*—It is recommended that limits be to only two decimal places for levels of 0.04 % and higher because it is not necessary to control to such precision at levels above 0.04 %. (It should be recognized that limits such as 0.045 % maximum may also be simply stated as 0.04 % maximum.) It is also recommended that three decimal places be used at levels of 0.030 % and lower, unless, for example, it is clearly recognized that 0.03 % maximum means that 0.035 % is satisfactory.

5.2 *Manganese*—Except for the Cr-Ni-Mn grades (S2XXXX), it is recommended that limits of 2 % maximum and 1 % maximum be used for the austenitic and other grades respectively, except for the free machining grades with high sulfur or selenium, or when necessary to promote nitrogen solubility.

5.3 *Phosphorus*—It is recommended that 0.045 % maximum be applied to austenitic grades, and 0.040 % maximum to other grades unless the sponsoring producer recommends a lower limit for specific technical effect. *Exception*—some of the Cr-Ni-Mn austenitic grades have always been produced to 0.060 % maximum.

5.4 *Sulfur*—It is recommended that 0.030 % maximum be applied to all grades except the free-machining grades unless lower limits have been required for specific technical effects.

5.5 *Silicon*—Past practice has been to establish 0.75 % maximum for tubular related products such as flat rolled and tubulars, and 1.00 % maximum for long products and forgings. For grades produced both as long and flat-rolled products, 1 % maximum was chosen since it will also include products melted to lower limits. Use of lower or higher limits should be based on specific technical effect.

5.6 *Chromium*—A composition spread of 2 % is recommended; existing broader limits were not reduced to less than a 3 % spread.

5.7 *Nickel*—It is recommended that the composition spread not exceed 3 % unless a broader (generally higher) spread is justified by specific technical effect.

5.8 *Molybdenum*—It is recommended that the composition spread not exceed 1 %, unless a broader range is justified by specific technical effect. Molybdenum limits having only a maximum limit but no minimum should not be used unless justified by specific technical effect.

5.9 *Nitrogen*—It is recommended that nitrogen limits having only a maximum limit but no minimum should not be used unless justified by specific technical effect.

5.10 *Copper*—It is recommended that copper limits having only a maximum limit but no minimum should not be used unless justified by specific technical effect.

5.11 *Columbium and Tantalum*—Except for special applications requiring positive identification of tantalum, it is recommended that prior listings of these two elements together be limited to listing only columbium. The words “columbium” and “niobium” refer to the same element.

6. Harmonized Standard Grade Stainless Steel Compositions

6.1 The harmonized composition limits are shown in Table 1, grouped by metallurgical classification, that is, austenitic, austenitic-ferritic, etc. Within those groups, grades are listed by UNS designation, in numerical order.

6.2 Unless adopted by the appropriate product subcommittee in a product standard, the compositions described in this guide shall not be used for specifying an ASTM product.

7. Keywords

7.1 austenitic stainless steels; austenitic-ferritic or ferritic-austenitic stainless steels; duplex stainless steels; ferritic stainless steels; harmonized stainless steel compositions; martensitic stainless steels; precipitation hardening stainless steels; standard stainless steel grade compositions

TABLE 1 Chemical Composition Limits, %[A]

UNS Designation	Type[B]	Carbon	Manganese	Phos-phorus	Sulfur	Silicon	Chromium	Nickel	Molybdenum	Nitrogen	Copper	Other Elements
						Austenitic Grades						
S16800	16-8-2H[C]	0.05–0.10	2.00	0.045	0.030	1.00	14.5–16.5	7.5–9.5	1.50–2.00	. . .	. . .	. . .
S20100	201	0.15	5.5–7.5	0.060	0.030	1.00	16.0–18.0	3.5–5.5	. . .	0.25	. . .	. . .
S20103	201L	0.03	5.5–7.5	0.045	0.030	1.00	16.0–18.0	3.5–5.5	. . .	0.25	. . .	. . .
S20153	201LN[C]	0.03	6.4–7.5	0.045	0.015	1.00	16.0–17.5	4.0–5.0	. . .	0.10–0.25	. . .	Cu 1.00
S20161	. . .	0.15	4.0–6.0	0.045	0.030	3.0–4.0	15.0–18.0	4.0–6.0	. . .	0.08–0.20	. . .	. . .
S20200	202	0.15	7.5–10.0	0.060	0.030	1.00	17.0–19.0	4.0–6.0	. . .	0.25	. . .	. . .
S20300	XM-1[D]	0.08	5.0–6.5	0.045	0.18–0.35	1.00	16.0–18.0	5.0–6.5	. . .	. . .	. . .	Cu 1.75–2.25
S20400	. . .	. . .	0.030	7.0–9.0	0.045	0.030	1.00	15.0–17.0	1.50–3.00	. . .	0.15–0.30	. . .
S20430	. . .	0.15	6.5–9.0	0.060	0.030	1.00	15.5–17.5	1.50–3.50	. . .	0.05–0.25	2.0–4.0	. . .
S20500	205	0.12–0.25	14.0–15.0	0.060	0.030	1.00	16.5–18.0	1.00–1.75	. . .	0.32–0.40	. . .	. . .
S20910	XM-19[D]	0.06	4.0–6.0	0.045	0.030	1.00	20.5–23.5	11.5–13.5	1.50–3.00	0.20–0.40	. . .	Cb 0.10–0.30, V 0.10–0.30
S21400	XM-31[D]	0.12	14.0–16.0	0.045	0.030	0.30–1.00	17.0–18.5	1.00	. . .	0.35 min	. . .	. . .
S21460	XM-14[D]	0.12	14.0–16.0	0.060	0.030	1.00	17.0–19.0	5.0–6.0	. . .	0.35–0.50	. . .	. . .
S21500	. . .	0.06–0.15	5.5–7.0	0.045	0.030	0.2–1.0	14.0–16.0	9.0–11.0	0.80–1.20	. . .	. . .	Cb 0.75–1.25, V 0.15–0.40, B 0.003–0.009
S21600	XM-17[D]	0.08[D]	7.5–9.0	0.045	0.030	1.00	17.5–20.5	5.0–7.0	2.00–3.00	0.25–0.50	. . .	. . .
S21603	XM-18[D]	0.03[D]	7.5–9.0	0.045	0.030	1.00	17.5–20.5	5.0–7.0	2.00–3.00	0.25–0.50	. . .	. . .
S21800	. . .	0.10	7.0–9.0	0.060	0.030	3.5–4.5	16.0–18.0	8.0–9.0	. . .	0.08–0.18	. . .	. . .
S21900	XM-10[D]	0.08	8.0–10.0	0.045	0.030	1.00	19.0–21.5	5.5–7.5	. . .	0.15–0.40	. . .	. . .
S21904	XM-11[D]	0.04	8.0–10.0	0.045	0.030	1.00	19.0–21.5	5.5–7.5	. . .	0.15–0.40	. . .	. . .
S24000	XM-29[D]	0.08	11.5–14.5	0.060	0.030	1.00	17.0–19.0	2.3–3.7	. . .	0.20–0.40	. . .	. . .
S24100	XM-28[D]	0.15	11.0–14.0	0.045	0.030	1.00	16.5–19.0	0.50–2.50	. . .	0.20–0.45	. . .	. . .
S28200	. . .	0.15	17.0–19.0	0.045	0.030	1.00	17.0–19.0	. . .	0.75–1.25	0.40–0.60	. . .	Cu 0.75–1.25
S30100	301	0.15	2.00	0.045	0.030	1.00	16.0–18.0	6.0–8.0	. . .	0.10	. . .	. . .
S30103	301L[C]	0.030	2.00	0.045	0.030	1.00	16.0–18.0	5.0–8.0	. . .	0.20	. . .	. . .
S30153	301LN[C]	0.030	2.00	0.045	0.030	1.00	16.0–18.0	5.0–8.0	. . .	0.07–0.20	. . .	. . .
S30200	302	0.15	2.00	0.045	0.030	1.00	17.0–19.0	8.0–10.0	. . .	0.10	. . .	. . .
S30215	302B	0.15	2.00	0.045	0.030	2.00–3.00	17.0–19.0	8.0–10.0	. . .	0.10	. . .	. . .
S30300	303	0.15	2.00	0.20	0.15 min	1.00	17.0–19.0	8.0–10.0	. . .	. . .	. . .	. . .
S30310	XM-15[D]	0.15	2.5–4.5	0.20	0.25 min	1.00	17.0–19.0	7.0–9.0	. . .	. . .	. . .	. . .
S30323	303Se	0.15	2.00	0.20	0.06	1.00	17.0–19.0	8.0–10.0	. . .	. . .	. . .	Se 0.15 min
S30345	XM-2[D]	0.15	2.00	0.05	0.11–0.16	1.00	17.0–19.0	8.0–10.0	0.40–0.60	. . .	. . .	Al 0.60–1.00
S30400	304	0.08	2.00	0.045	0.030	1.00	18.0–20.0	8.0–11.0	. . .	. . .	. . .	. . .
S30403	304L	0.030	2.00	0.045	0.030	1.00	18.0–20.0	8.0–12.0	. . .	. . .	. . .	. . .
S30409	304H	0.04–0.10	2.00	0.045	0.030	1.00	18.0–20.0	8.0–11.0	. . .	. . .	. . .	. . .
S30415	. . .	0.04–0.06	0.80	0.045	0.030	1.00–2.00	18.0–19.0	9.0–10.0	. . .	0.12–0.18	. . .	Ce 0.03–0.08
S30430	. . .	0.03	2.00	0.045	0.030	1.00	17.0–19.0	8.0–10.0	. . .	. . .	. . .	Cu 3.0–4.0
S30432	. . .	0.07–0.13	0.50	0.045	0.030	0.30	17.0–19.0	7.5–10.5	. . .	0.05–0.12	2.5–3.5	Cb 0.20–0.60, Al 0.003–0.030, B 0.001–0.010
S30451	304N	0.08	2.00	0.045	0.030	1.00	18.0–20.0	8.0–11.0	. . .	0.10–0.16	. . .	. . .
S30452	XM-21[D]	0.08	2.00	0.045	0.030	1.00	18.0–20.0	8.0–10.0	. . .	0.16–0.30	. . .	. . .
S30453	304LN	0.030	2.00	0.045	0.030	1.00	18.0–20.0	8.0–11.0	. . .	0.10–0.16	. . .	. . .
S30454	304LHN[C]	0.03	2.00	0.045	0.030	1.00	18.0–20.0	8.0–11.0	. . .	0.16–0.30	. . .	. . .
S30500	305	0.12	2.00	0.045	0.030	1.00	17.0–19.0	11.0–13.0	. . .	. . .	. . .	. . .
S30600	. . .	0.018	2.00	0.020	0.020	3.7–4.3	17.0–18.5	14.0–15.5	0.20	. . .	. . .	Cu 0.50
S30601	. . .	0.015	0.50–0.80	0.030	0.013	5.0–5.6	17.0–18.0	17.0–18.0	0.20	0.05	. . .	Cu 0.35
S30615	. . .	0.16–0.24	2.00	0.030	0.030	3.2–4.0	17.0–19.5	13.5–16.0	. . .	. . .	. . .	Al 0.80–1.50
S30800	308	0.08	2.00	0.045	0.030	1.00	19.0–21.0	10.0–12.0	. . .	. . .	. . .	. . .
S30815	. . .	0.05–0.10	0.80	0.040	0.030	1.40–2.00	20.0–22.0	10.0–12.0	. . .	0.14–0.20	. . .	Ce 0.03–0.08
S30900	309	0.20	2.00	0.045	0.030	1.00	22.0–24.0	12.0–15.0	. . .	. . .	. . .	. . .
S30908	309S	0.08	2.00	0.045	0.030	1.00	22.0–24.0	12.0–15.0	. . .	. . .	. . .	. . .
S30909	309H[C]	0.04–0.10	2.00	0.045	0.030	1.00	22.0–24.0	12.0–15.0	. . .	. . .	. . .	. . .
S30940	309Cb[C]	0.08	2.00	0.045	0.030	1.00	22.0–24.0	12.0–16.0				Cb 10xC-1.10
S30941	309HCb[C]	0.04–0.10	2.00	0.045	0.030	1.00	22.0–24.0	12.0–16.0	. . .	. . .	. . .	Cb 10xC-1.10
S31000	310[C]	0.25	2.00	0.045	0.030	1.50	24.0–26.0	19.0–22.0	. . .	. . .	. . .	...
S31002	. . .	0.015	2.00	0.020	0.015	0.15	24.0–26.0	19.0–22.0	0.10	0.10	. . .	. . .
S31008	310S	0.08	2.00	0.045	0.030	1.00	24.0–26.0	19.0–22.0	. . .	. . .	. . .	. . .
S31009	310H[C]	0.04–0.10	2.00	0.045	0.030	1.00	24.0–26.0	19.0–22.0	. . .	. . .	. . .	. . .
S31040	310Cb[C]	0.08	2.00	0.045	0.030	1.00	24.0–26.0	19.0–22.0	. . .	. . .	. . .	Cb 10xC-1.10
S31041	310HCb[C]	0.04–0.10	2.00	0.045	0.030	1.00	24.0–26.0	19.0–22.0	. . .	. . .	. . .	Cb 10xC-1.10
S31042	310HCbN[C]	0.04–0.10	2.00	0.045	0.030	1.00	24.0–26.0	19.0–22.0	. . .	0.15–0.35	. . .	Cb 0.20–0.60
S31050	310MoLN[C]	0.030	2.00	0.030	0.015	0.40	24.0–26.0	21.0–23.0	2.00–3.00	0.10–0.16		. . .
S31254	. . .	0.020	1.00	0.030	0.010	0.80	19.5–20.5	17.5–18.5	6.0–6.5	0.18–0.22	. . .	Cu 0.50–1.00
S31266	. . .	0.030	2.0–4.0	0.035	0.020	1.00	23.0–25.0	21.0–24.0	5.2–6.2	0.35–0.60	1.00–2.50	W 1.50–2.50
S31272	. . .	0.08–0.12	1.50–2.00	0.030	0.015	0.30–0.70	14.0–16.0	14.0–16.0	1.00–1.40	. . .	. . .	Ti 0.30–0.60, B 0.004–0.008