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Standard Guide for Specifying Harmonized Standard Grade Compositions for Wrought Carbon, Low-Alloy, and Alloy Steels[1]

This standard is issued under the fixed designation A1040; 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.

~~ε^1 NOTE—Units statement was inserted in 1.8 editorially in September 2015.~~

1. Scope*

1.1 This guide covers ASTM Subcommittees A01.02, A01.03, A01.06, A01.09, A01.11, A01.15, A01.19, A01.22, and A01.28 for specifying chemical composition limits of wrought carbon, low-alloy, and alloy steels. It is intended that these recommended grade composition limits be suitable for adoption by other standardization bodies that prepare standards for carbon, low-alloy, and alloy steel products, including discontinued steels.

1.2 Included in this guide are the recommendations for determining the number of significant figures for specifying chemical composition.

1.3 The carbon and alloy steel grades in all standards overseen by the aforementioned ASTM subcommittees have been included, except those grades applicable to restricted special end uses.

1.4 Not addressed are minor composition modifications that a specific ASTM 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 where established by ASTM subcommittees) is a complete rationalization of all limits, especially where such would conflict with long-standing practices and is not justified by special technical effect.

1.6 This guide does not address discontinued or formerly standard steel grades. A listing of such steel grades can be found in SAE J1249. Also excluded from this guide are cast materials and welding filler metals.

1.7 In 1995, the AISI made the decision to transfer the responsibility of maintaining its numbering system to the Society of Automotive Engineers (SAE) for carbon and alloy steels (SAE J403 and SAE J404) and to ASTM International for stainless steels (Guide A959 and others). To inform users of this important event, historical information is included in the appendix of this standard.

1.8 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.9 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]
A276/A276M Specification for Stainless Steel Bars and Shapes
A941 Terminology Relating to Steel, Stainless Steel, Related Alloys, and Ferroalloys
A959 Guide for Specifying Harmonized Standard Grade Compositions for Wrought Stainless Steels
2.2 *SAE Standards:*[3]
SAE J403 Chemical Compositions of SAE Carbon Steels
SAE J404 Chemical Compositions of SAE Alloy Steels

[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 A01.15 on Bars.

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

[3] Available from SAE International (SAE), 400 Commonwealth Dr., Warrendale, PA 15096, http://www.sae.org.

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

SAE J1013 Measurement of Whole Body Vibration of the Seated Operator of Off-Highway Work Machines
SAE J1249 Former SAE Standard and Former SAE EX-Steels

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *long product, n*—generic term describing wrought bars, rod, wire, rail, tubing (welded and seamless), plate, and pipe.

3.1.1.1 *Discussion*—

Product forms such as "C" shapes, "HP" shapes, "L" shapes, "M" shapes, "MC" shapes, "S" shapes, "W" shapes, and sheet piling are considered long products. Such product forms are produced to mechanical properties and are not normally produced to the chemical compositions listed in this guide.

3.1.2 *flat product, n*—generic term describing wrought sheet and strip.

3.2 Refer to Terminology A941 for additional definitions of terms used in this guide.

4. Significance and Use

4.1 It is anticipated that the ASTM Subcommittees A01.02, A01.03, A01.06, A01.09, A01.11, A01.15, A01.19, A01.22, and A01.28 will use the standard composition limits listed in this guide for the grades identified in their product specifications unless there is a specific technical justification for doing otherwise.

4.2 The composition limits given in this guide 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 ASTM 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 upon these guidelines.

5. General Guidelines Used for Determining Composition Limits

5.1 Table 1 gives typical chemical composition limits for respective elements.

6. Harmonized Standard Grade Wrought Carbon, Low-Alloy, and Alloy Steel Compositions

6.1 The harmonized composition limits are given in Tables 2-17, grouped by metallurgical classification. Within all tables, grades are listed in numerical order.

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

6.3 Criteria for the addition of grades to the grade lists in this guide are as follows: *(1)* New grades will be considered based upon the grade meeting a standard grade designation and chemistry; *(2)* New grades shall have an annual production or consumption of 250 tons (225 Mg); *(3)* New grades shall have the sponsorship of at least two individual users or producers.

7. Keywords

7.1 alloy steels; carbon steels; harmonized carbon, low-alloy, and alloy steel compositions; low-alloy steels

TABLE 1 Expression of Chemical Composition Limits

Chemical Element	Chemical Composition Limit
C, Cr, Cu, Mn, Mo, Ni, Pb, Si	Two decimal places (0.xx %) or (1.xx %)
Al, Ca, N, Nb (Cb),[A] P, S, Sn, Ti, V	Three decimal places (0.xxx %)
B	Four decimal places (0.xxxx %)

[A] Columbium (Cb) and Niobium (Nb) are alternate names for element 41 in the Periodic Table of the Elements.

TABLE 2 Chemical Composition for Nonresulfurized Carbon Steels

Grade	Composition,[AA, B, C,B,C] %					
	C	Mn	P max	S max	P max	S max
			Long Product		Flat Product	
1001	0.01 max	0.35 max	...	...	0.030	0.035
1002	0.02 max	0.35 max	...	...	0.030	0.035
1003	0.04 max	0.35 max	...	...	0.030	0.035
1004	0.02/0.06	0.35 max	...	...	0.030	0.035
1005	0.06 max	0.35 max	0.040	0.050	0.030	0.035
1006[B]	0.02/0.08	0.45 max	...	...	0.030	0.035
1006[D]	0.08 max	0.25-0.45	0.040	0.050	...	...
1006[E]	0.08 max	0.45 max	...	...	0.030	0.035
1007	0.02/0.10	0.50 max	...	...	0.030	0.035
1008[D]	0.10 max	0.30-0.50	0.040	0.050	...	...
1008[E]	0.10 max	0.50 max	...	...	0.030	0.035
1009	0.15 max	0.60 max	...	...	0.030	0.035
1010	0.08-0.13	0.30-0.60	0.040	0.050	0.030	0.035
1011	0.08-0.13	0.60-0.90	0.040	0.050	...	...
1012	0.10-0.15	0.30-0.60	0.040	0.050	0.030	0.035
1013[D, F]	0.11-0.16	0.50-0.80	0.040	0.050	...	...
1013[E]	0.11-0.16	0.30-0.60	...	...	0.030	0.035
1015	0.13-0.18	0.30-0.60	0.040	0.050	0.030	0.035
1016	0.13-0.18	0.60-0.90	0.040	0.050	0.030	0.035
1017	0.15-0.20	0.30-0.60	0.040	0.050	0.030	0.035
1018	0.15-0.20	0.60-0.90	0.040	0.050	0.030	0.035
1019	0.15-0.20	0.70-1.00	0.040	0.050	0.030	0.035
1020	0.18-0.23	0.30-0.60	0.040	0.050	0.030	0.035
1021	0.18-0.23	0.60-0.90	0.040	0.050	0.030	0.035
1022	0.18-0.23	0.70-1.00	0.040	0.050	0.030	0.035
1023	0.20-0.25	0.30-0.60	0.040	0.050	0.030	0.035
1024	0.18-0.25	1.30-1.65	0.035	0.035	...	...
1025	0.22-0.28	0.30-0.60	0.040	0.050	0.030	0.035
1026	0.22-0.28	0.60-0.90	0.040	0.050	0.030	0.035
1027	0.22-0.29	1.20-1.55	0.035	0.035	...	...
1029	0.25-0.31	0.60-0.90	0.040	0.050	...	...
1030	0.28-0.34	0.60-0.90	0.040	0.050	0.030	0.035
1033	0.30-0.36	0.70-1.00	0.040	0.050	0.030	0.035
1034	0.32-0.38	0.50-0.80	0.040	0.050	...	...
1035	0.32-0.38	0.60-0.90	0.040	0.050	0.030	0.035
1037	0.32-0.38	0.70-1.00	0.040	0.050	0.030	0.035
1038	0.35-0.42	0.60-0.90	0.040	0.050	0.030	0.035
1039	0.37-0.44	0.70-1.00	0.040	0.050	0.030	0.035
1040	0.37-0.44	0.60-0.90	0.040	0.050	0.030	0.035
1042	0.40-0.47	0.60-0.90	0.040	0.050	0.030	0.035
1043	0.40-0.47	0.70-1.00	0.040	0.050	0.030	0.035
1044	0.43-0.50	0.30-0.60	0.040	0.050	...	...
1045	0.43-0.50	0.60-0.90	0.040	0.050	0.030	0.035
1046	0.43-0.50	0.70-1.00	0.040	0.050	0.030	0.035
1049	0.46-0.53	0.60-0.90	0.040	0.050	0.030	0.035
1050	0.48-0.55	0.60-0.90	0.040	0.050	0.030	0.035
1053	0.48-0.55	0.70-1.00	0.040	0.050	...	...
1055	0.50-0.60	0.60-0.90	0.040	0.050	0.030	0.035
1059	0.55-0.65	0.50-0.80	0.040	0.050	...	...
1060	0.55-0.65	0.60-0.90	0.040	0.050	0.030	0.035
1064	0.60-0.70	0.50-0.80	0.040	0.050	0.030	0.035
1065	0.60-0.70	0.60-0.90	0.040	0.050	0.030	0.035
1069	0.65-0.75	0.40-0.70	0.040	0.050	...	...
1070	0.65-0.75	0.60-0.90	0.040	0.050	0.030	0.035
1070m[G]	0.65-0.75	0.80-1.10	0.025	0.025	...	...
1071	0.65-0.70	0.75-1.05	0.040	0.050	...	...
1074	0.70-0.80	0.50-0.80	0.040	0.050	0.030	0.035
1075	0.70-0.80	0.40-0.70	0.040	0.050	...	...
1078	0.72-0.85	0.30-0.60	0.040	0.050	0.030	0.035
1080	0.75-0.88	0.60-0.90	0.040	0.050	0.030	0.035
1084	0.80-0.93	0.60-0.90	0.040	0.050	0.030	0.035
1085	0.80-0.93	0.70-1.00	0.040	0.050	0.030	0.035
1086	0.80-0.93	0.30-0.50	0.040	0.050	0.030	0.035

TABLE 2 *Continued*

Grade	Composition,[A, B, C,B,C] %					
	C	Mn	P max	S max	P max	S max
			Long Product		Flat Product	
1090	0.85-0.98	0.60-0.90	0.040	0.050	0.030	0.035
1095	0.90-1.03	0.30-0.50	0.040	0.050	0.030	0.035

[A] Where silicon is required, the following ranges and limits are commonly specified: 0.10 % maximum, 0.10 % to 0.20 %, 0.15 % to 0.35 %, 0.15 % to 0.40 %, 0.20 % to 0.40 %, or 0.30 % to 0.60 %.
[B] If required, copper can be specified as 0.20 % minimum.
[C] Where boron treatment for killed steel is specified for enhanced hardenability, titanium is generally added to shield the boron from oxidation. Boron levels between 0.0005 % and 0.0030 % can be expected for this practice. If the usual titanium addition is not permitted, the steel may contain up to 0.0050 % boron for enhanced hardenability.
[D] Long product.
[E] Flat product.
[F] SAE J1013 has chemical limits for manganese of 0.30-0.60 %.
[G] 1070m has chemical limits for silicon, 0.15-0.35 %; chromium, 0.20 % maximum; nickel, 0.25 % maximum; and molybdenum, 0.10 % maximum.

TABLE 3 Chemical Composition for Resulfurized Steels

Grade	Composition,[A, B,B] %			
	C	Mn	P max	S max
1108	0.08-0.13	0.60-0.80	0.040	0.08-0.13
1109	0.08-0.13	0.60-0.90	0.040	0.08-0.13
1110	0.08-0.13	0.30-0.60	0.040	0.08-0.13
1115	0.13-0.20	0.60-0.90	0.040	0.08-0.13
1116	0.14-0.20	1.10-1.40	0.040	0.16-0.23
1117	0.14-0.20	1.00-1.30	0.040	0.08-0.13
1118	0.14-0.20	1.30-1.60	0.040	0.08-0.13
1119	0.14-0.20	1.00-1.30	0.040	0.24-0.33
1132	0.27-0.32	1.35-1.65	0.040	0.08-0.13
1137	0.32-0.39	1.35-1.65	0.040	0.08-0.13
1139	0.35-0.43	1.35-1.65	0.040	0.13-0.20
1140	0.37-0.44	0.70-1.00	0.040	0.08-0.13
1141	0.37-0.45	1.35-1.65	0.040	0.08-0.13
1144	0.40-0.48	1.35-1.65	0.040	0.24-0.33
1145	0.42-0.49	0.70-1.00	0.040	0.04-0.07
1146	0.42-0.49	0.70-1.00	0.040	0.08-0.13
1151	0.48-0.55	0.70-1.00	0.040	0.08-0.13

[A] It is not common practice to produce these steels to specified limits for silicon because of its adverse effect on machinability.
[B] Where silicon is required, the following ranges and limits are commonly specified: 0.10 % maximum, 0.10 % to 0.20 %, 0.15 % to 0.35 %, 0.20 % to 0.40 %, or 0.30 % to 0.60 %.

TABLE 4 Chemical Composition for Rephosphorized and Resulfurized Carbon Steels

Grade	Composition,[A, B,B] %			
	C	Mn	P	S
1211	0.13 max	0.60-0.90	0.07-0.12	0.10-0.15
1212	0.13 max	0.70-1.00	0.07-0.12	0.16-0.23
1213	0.13 max	0.70-1.00	0.07-0.12	0.24-0.33
1215	0.09 max	0.75-1.05	0.04-0.09	0.26-0.35

[A] It is not common practice to produce these steels to specified limits for silicon because of its adverse effect on machinability.
[B] Where silicon is required, the following ranges and limits are commonly specified: 0.10 % maximum, 0.10 % to 0.20 %, 0.15 % to 0.35 %, 0.20 % to 0.40 %, or 0.30 % to 0.60 %.

TABLE 5 Chemical Composition for High-Manganese Carbon Steels

Grade	Composition,[A, B, C] %					
	C	Mn	P max	S max	P max	S max
			Long Product		Flat Product	
1513	0.10-0.16	1.10-1.40	0.040	0.050	...	...
1518	0.15-0.21	1.10-1.40	0.040	0.050	...	...
1522	0.18-0.24	1.10-1.40	0.040	0.050	...	...
1524	0.19-0.25	1.35-1.65	0.040	0.050	0.030	0.035
1525	0.23-0.29	0.80-1.10	0.040	0.050	...	...
1526	0.22-0.29	1.10-1.40	0.040	0.050	...	...
1527	0.22-0.29	1.20-1.50	0.040	0.050	0.030	0.035
1536	0.30-0.37	1.20-1.50	0.040	0.050	0.030	0.035
1541	0.36-0.44	1.35-1.65	0.040	0.050	0.030	0.035
1547	0.43-0.51	1.35-1.65	0.040	0.050	...	...
1548	0.44-0.52	1.10-1.40	0.040	0.050	0.030	0.035
1551	0.45-0.56	0.85-1.15	0.040	0.050	...	...
1552	0.47-0.55	1.20-1.50	0.040	0.050	0.030	0.035
1561	0.55-0.65	0.75-1.05	0.040	0.050	...	...
1566	0.60-0.71	0.85-1.15	0.040	0.050	...	...
1572	0.65-0.76	1.00-1.30	0.040	0.050	...	...

[A] Where silicon is required, the following ranges and limits are commonly specified: 0.10 % maximum, 0.10 % to 0.20 %, 0.15 % to 0.35 %, 0.20 % to 0.40 %, or 0.30 % to 0.60 %.
[B] If required, copper can be specified as 0.20 % minimum.
[C] If lead is required as an added element to a standard steel, a range of 0.15 % to 0.35 % inclusive is specified. Such a steel is identified by inserting the letter "L" between the second and third numerals of the grade designation, for example, 15L25. A heat analysis is not determinable where lead is added to the ladle stream.

TABLE 6 Chemical Composition for Carbon Steels with Hardenability Requirements

Grade	Composition, %				
	C	Mn	P max	S max	Si
1038H	0.34-0.43	0.50-1.00	0.040	0.050	0.15-0.30
1045H	0.42-0.51	0.50-1.00	0.040	0.050	0.15-0.30
1522H	0.17-0.25	1.00-1.50	0.040	0.050	0.15-0.30
1524H	0.18-0.26	1.25-1.75	0.040	0.050	0.15-0.30
1526H	0.21-0.30	1.00-1.50	0.040	0.050	0.15-0.30
1541H	0.35-0.45	1.25-1.75	0.040	0.050	0.15-0.30
1552H	0.47-0.55	1.00-1.50	0.040	0.050	0.15-0.30

TABLE 7 Chemical Composition for Standard High-Manganese Boron Carbon Steels with Hardenability Requirements

Grade	Composition,[A] %				
	C	Mn	P	S	Si
15B21H	0.17-0.24	0.70-1.20	0.040	0.050	0.15-0.30
15B35H	0.31-0.39	0.70-1.20	0.040	0.050	0.15-0.30
15B37H	0.30-0.39	1.00-1.50	0.040	0.050	0.15-0.30
15B41H	0.35-0.45	1.25-1.75	0.040	0.050	0.15-0.30
15B48H	0.43-0.53	1.00-1.50	0.040	0.050	0.15-0.30
15B62H	0.54-0.67	1.00-1.50	0.040	0.050	0.15-0.30

[A] Where boron treatment for killed steel is specified for enhanced hardenability, titanium is generally added to shield the boron from oxidation. Boron levels between 0.0005 % and 0.0030 % can be expected for this practice. If the usual titanium addition is not permitted, the steel may contain up to 0.0050 % boron for enhanced hardenability.

TABLE 8 Chemical Composition for Standard High-Manganese Boron Carbon Steels with Restricted Hardenability Requirements

Grade	Composition,[A] %				
	C	Mn	P	S	Si
15B21 RH	0.17-0.22	0.80-1.10	0.035	0.040	0.15-0.35
15B35 RH	0.33-0.38	0.80-1.10	0.035	0.040	0.15-0.35

[A] Where boron treatment for killed steel is specified for enhanced hardenability, titanium is generally added to shield the boron from oxidation. Boron levels between 0.0005 % and 0.0030 % can be expected for this practice. If the usual titanium addition is not permitted, the steel may contain up to 0.0050 % boron for enhanced hardenability.

TABLE 9 Chemical Composition for Microalloyed Carbon Steels

Grade	Composition,[A,B] %				
	C	Mn	P max	S	V
10V40	0.37-0.44	0.60-0.90	0.040	0.050 max	0.02-0.20
10V45	0.43-0.50	0.60-0.90	0.040	0.050 max	0.02-0.20
11V37	0.32-0.39	1.35-1.65	0.040	0.08-0.13	0.02-0.20
11V41	0.37-0.45	1.35-1.65	0.040	0.08-0.13	0.02-0.20
15V24	0.19-0.25	1.35-1.65	0.040	0.050 max	0.02-0.20
15V41	0.36-0.44	1.35-1.65	0.040	0.050 max	0.02-0.20

[A] Where silicon is required, the following ranges and limits are commonly specified: 0.10 % maximum, 0.10 % to 0.20 %, 0.15 % to 0.35 %, 0.20 % to 0.40 %, or 0.30 % to 0.60 %.
[B] Microalloyed carbon steels are standardized grades containing vanadium as the microalloying element.

TABLE 10 Chemical Composition for Leaded Carbon Steels

Grade	Composition,[A,B] %				
	C	Mn	P	S	Pb
11L18	0.14-0.20	1.30-1.60	0.040 max	0.08-0.13	0.15-0.35
12L13	0.13 max	0.70-1.00	0.07-0.12	0.24-0.33	0.15-0.35
12L14	0.15 max	0.85-1.15	0.04-0.09	0.26-0.35	0.15-0.35
12L15	0.09 max	0.75-1.05	0.04-0.09	0.26-0.35	0.15-0.35

[A] If lead is required as an added element to a standard steel, a range of 0.15 % to 0.35 % inclusive is specified. Such a steel is identified by inserting the letter "L" between the second and third numerals of the grade designation, for example, 12L15. A heat analysis is not determinable if lead is added to the ladle stream.
[B] The elements bismuth, calcium, selenium, and tellurium may be added as agreed upon between purchaser and supplier.

TABLE 11 Chemical Composition for Merchant Quality M Series Carbon Steels

Grade	Composition, %			
	C	Mn[A]	P max	S max
M1008	0.10 max	0.25-0.60	0.040	0.050
M1010	0.07-0.14	0.25-0.60	0.040	0.050
M1012	0.09-0.16	0.25-0.60	0.040	0.050
M1015	0.12-0.19	0.25-0.60	0.040	0.050
M1017	0.14-0.21	0.25-0.60	0.040	0.050
M1020	0.17-0.24	0.25-0.60	0.040	0.050
M1023	0.19-0.27	0.25-0.60	0.040	0.050
M1025	0.20-0.30	0.25-0.60	0.040	0.050
M1031	0.26-0.36	0.25-0.60	0.040	0.050
M1044	0.40-0.50	0.25-0.60	0.040	0.050

[A] Unless prohibited by the purchaser, the manganese content may exceed 0.60 % on heat analysis to a maximum of 0.75 %, provided that the carbon range on heat analysis has the minimum and maximum reduced by 0.01 percentage point for each 0.05 percentage point manganese over 0.60 %.