



SURFACE VEHICLE STANDARD	J403™	FEB2024
	Issued 1911-06 Revised 2014-06 Stabilized 2024-02	
	Superseding J403 JUN2014	
Chemical Compositions of SAE Carbon Steels		

RATIONALE

The technical report covers products and processes which are mature and not likely to change in the foreseeable future.

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1. SCOPE

In 1941, the SAE Iron and Steel Division, in collaboration with the American Iron and Steel Institute (AISI), made a major change in the method of expressing composition ranges for the SAE steels. The plan, as now applied, is based in general on narrower cast or heat analysis ranges plus certain product analysis allowances on individual samples, in place of the fixed ranges and limits without tolerances formerly provided for carbon and other elements in SAE steels.

For years the variety of chemical compositions of steel has been a matter of concern in the steel industry. It was recognized that production of fewer grades of steel could result in improved deliveries and provide a better opportunity to achieve advances in technology, manufacturing practices, and quality, and thus develop more fully the possibilities of application inherent in those grades.

Comprehensive and impartial studies were directed toward determining which of the many grades being specified were the ones in most common demand, and the feasibility of combining compositions having like requirements. From these studies, the most common grades of steel have been selected and kept in the current revision. The cast or heat chemical composition limits or ranges of these grades are given in Tables 1, 2, 3A, and 3B. These cast or heat limits or ranges are subject to standard variations for product analysis as given in SAE J409. Since AISI is no longer issuing steel grade designations, grades listed in this document are SAE grades.

It is recognized that chemical compositions other than those listed in the previously mentioned tables will at times be needed for specialized applications or processing. When such a steel is required, the elements comprising the desired chemical composition are specified in one of three ways: (a) by a minimum limit, (b) by a maximum limit, or (c) by minimum and maximum limits, termed a range.

Standard cast or heat analysis limits and ranges for the various elements of carbon steels are given in Table 4. In this table, range is the arithmetical difference between the minimum and maximum limits (that is, 0.19 to 0.25 is a 0.06 range). These cast or heat limits and ranges are also subject to standard variations for product analysis as given in SAE J409.

ISTC Division 1 has developed a procedure which allows for the maintenance of the grade lists in this document. This will involve conducting an industry-wide survey to solicit input. This survey will be conducted at a frequency deemed necessary by the technical committee.

Criteria have been established for the addition to or the deletion of grades from the grade lists. New grades will be considered based on the grade meeting a SAE grade designation and chemistry, having a minimum production or consumption of 225 tonnes/year (250 tons/year) and has the sponsorship of at least two individual users or producers. New steel compositions will be considered as Potential Standard (PS) steels, based on the guidelines in SAE J1081, until such time as production of the new steel achieves a level of production or usage qualifying it for consideration as a standard steel.

Deletion of grades will be by consensus based on the grade survey. Deleted grades will be archived in SAE J1249.

When the cast or heat analysis is requested to be reported to demonstrate conformance to the chemical limits shown in Tables 1, 2, 3A, or 3B, in addition to the quantities of carbon, manganese, phosphorus, and sulfur, the following elements and their quantities shall also be reported: copper, chromium, nickel, molybdenum, and silicon. When the amount of any one of these last five elements is less than 0.02% that analysis may be reported as "<0.02%."

Based on a survey question in the 2006 Grade Survey, the grade lists have been revised such that chemistries of all product forms are now consolidated into single tables. The chemistry ranges listed will be the narrowest range for the various product forms with the exception of S content. It is acknowledged however that due to differences in the section size of the various product forms, chemical composition demands for the product forms should be different to allow for adequate flexibility of steel application. These differences are reflected in Tables 4 and 5.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

SAE J409	Product Analysis - Permissible Variations from Specified Chemical Analysis of a Heat or Cast of Steel
SAE J411	Carbon and Alloy Steels
SAE J1081	Potential Standard Steels
SAE J1249	Former SAE Standard and Former SAE Ex-Steels
SAE J1268	Hardenability Bands for Carbon and Alloy H Steels
SAE J1868	Restricted Hardenability Bands for Selected Alloy Steels

2.1.2 ISS Publication

Available from ISS, 186 Thorn Hill Rd., Warrendale, PA 15086-7528, Tel: 724-776-6040, www.iss.org.

ISS Carbon and Alloy Steel Bar and Semi-Finished Products Manual

3. CHEMICAL REPORTING REQUIREMENTS

- 3.1 When the cast or heat analysis is requested to be reported to demonstrate conformance to the chemical limits shown in Tables 1, 2, 3A, and 3B, the elements and their quantities, as shown in Table 6, shall also be reported.

TABLE 1 - NONRESULFURIZED CARBON STEEL COMPOSITIONS APPLICABLE TO SEMIFINISHED PRODUCTS FOR FORGING, TO HOT-ROLLED AND COLD-FINISHED BARS, TO WIRE RODS, PLATES, STRIP, SHEETS, WELDED TUBING, AND TO SEAMLESS TUBING CAST OR HEAT CHEMICAL RANGES AND LIMITS^(2,3)

UNS No.	SAE No.	Chemical Composition Limits, % C	Chemical Composition Limits, % Mn	<u>Flat Rolled Products</u> Chemical Composition Limits, % P, Max ⁽¹⁾	<u>Flat Rolled Products</u> Chemical Composition Limits, % S, Max ⁽¹⁾	<u>Long Products</u> Chemical Composition Limits, % P, Max ⁽¹⁾	<u>Long Products</u> Chemical Composition Limits, % S, Max ⁽¹⁾
G10020 ⁽⁴⁾	1002 ⁽⁴⁾	0.02–0.04	0.35 Max	0.030	0.035	0.040	0.050
G10030 ⁽⁴⁾	1003 ⁽⁴⁾	0.02–0.06	0.35 Max	0.030	0.035	0.040	0.050
G10040 ⁽⁴⁾	1004 ⁽⁴⁾	0.02–0.08	0.35 Max	0.030	0.035	0.040	0.050
G10050 ⁽⁵⁾	1005 ⁽⁵⁾	0.06 Max	0.35 Max	0.030	0.035	0.040	0.050
G10060 ⁽⁵⁾	1006 ⁽⁵⁾	0.08 Max	See Notes 6 & 7	0.030	0.035	0.040	0.050
G10070 ⁽⁴⁾	1007 ⁽⁴⁾	0.02–0.10	0.50 Max	0.030	0.035	0.040	0.050
G10080 ⁽⁵⁾	1008 ⁽⁵⁾	0.10 Max	See Notes 6 & 7	0.030	0.035	0.040	0.050
G10090 ⁽⁵⁾	1009 ⁽⁵⁾	0.15 Max	0.60 Max	0.030	0.035	0.040	0.050
G10100	1010	0.08–0.13	0.30–0.60	0.030	0.035	0.040	0.050
G10120	1012	0.10–0.15	0.30–0.60	0.030	0.035	0.040	0.050
G10130	1013	0.11–0.16	0.30–0.60	0.030	0.035	0.040	0.050
G10150	1015	0.13–0.18	0.30–0.60	0.030	0.035	0.040	0.050
G10160	1016	0.13–0.18	0.60–0.90	0.030	0.035	0.040	0.050
G10170	1017	0.15–0.20	0.30–0.60	0.030	0.035	0.040	0.050
G10180	1018	0.15–0.20	0.60–0.90	0.030	0.035	0.040	0.050
G10190	1019	0.15–0.20	0.70–1.00	0.030	0.035	0.040	0.050
G10200	1020	0.18–0.23	0.30–0.60	0.030	0.035	0.040	0.050
G10210	1021	0.18–0.23	0.60–0.90	0.030	0.035	0.040	0.050
G10220	1022	0.18–0.23	0.70–1.00	0.030	0.035	0.040	0.050
G10230	1023	0.20–0.25	0.30–0.60	0.030	0.035	0.040	0.050
G10250	1025	0.22–0.28	0.30–0.60	0.030	0.035	0.040	0.050
G10260	1026	0.22–0.28	0.60–0.90	0.030	0.035	0.040	0.050
G10290	1029	0.25–0.31	0.60–0.90	0.030	0.035	0.040	0.050
G10300	1030	0.28–0.34	0.60–0.90	0.030	0.035	0.040	0.050
G10330	1033	0.30–0.36	0.70–1.00	0.030	0.035	0.040	0.050
G10350	1035	0.32–0.38	0.60–0.90	0.030	0.035	0.040	0.050
G10370	1037	0.32–0.38	0.70–1.00	0.030	0.035	0.040	0.050
G10380	1038	0.35–0.42	0.60–0.90	0.030	0.035	0.040	0.050