Designation: A 576 – 90b (Reapproved 2006)

Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality[1]

This standard is issued under the fixed designation A 576; 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.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This specification covers hot-wrought special quality carbon steel bars. Special quality bar applications include forging, heat treating, cold drawing, machining, and many structural uses. A guide for the selection of steel bars is contained in Practice A 400.

1.2 The bars shall be furnished in the grades specified in Table 1. Sections and sizes of bar steel available are covered in Specification A 29/A 29M. Hot-wrought special quality carbon steel bars are produced in cut lengths and coils; the manufacturer should be consulted regarding sections and sizes available in coils, produced to a chemical composition.

1.3 Merchant quality hot-wrought carbon steel bars are covered in Specification A 575.

1.4 Some end uses may require superior surface quality, or special chemical restrictions, metallurgical characteristics, heat treatment, or surface finishes which the purchaser may obtain by designating one or more of the available Supplementary Requirements.

1.5 The values stated in inch-pound units are to be regarded as standard.

2. Referenced Documents

2.1 *ASTM Standards:* [2]

A 29/A 29M Specification for Steel Bars, Carbon and Alloy, Hot-Wrought, General Requirements for

A 400 Practice for Steel Bars, Selection Guide, Composition, and Mechanical Properties

A 575 Specification for Steel Bars, Carbon, Merchant Quality, M-Grades

E 45 Test Methods for Determining the Inclusion Content of Steel

E 527 Practice for Numbering Metals and Alloys (UNS)

2.2 *SAE Standard:*

SAE J 1086 Recommended Practice for Numbering Metals and Alloys (UNS)[3]

3. Ordering Information

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

3.1.1 Quantity (weight or number of bars),

3.1.2 Name of material (hot-wrought carbon steel bars),

3.1.3 Dimensions,

3.1.4 ASTM specification number and date of issue,

3.1.5 Deoxidation practice (see 4.2.1),

3.1.6 Grade designation or chemical composition limits (see 5.1 and Table 1),

3.1.7 Coarse or fine grain steel (4.2.2),

3.1.8 Test reports, if required (Section 7),

3.1.9 Additions to the specification and Supplementary Requirements, if required, and

3.1.10 End use.

NOTE 1—A typical ordering description is as follows: 10 000 lb, carbon steel bars, hot rolled 1 000 in. diameter by 10 ft, ASTM A 576 dated ___, killed steel, Grade 1018, test reports required, coarse grain Supplementary Requirement S10, welded industrial fan hubs and shafts.

4. Materials and Manufacture

4.1 *Melting Practice*—The steel shall be made by one or more of the following primary processes: open-hearth, basic-oxygen, or electric-furnace. The primary melting may incorporate separate degassing or refining and may be followed by secondary melting using electroslag remelting or vacuum arc remelting. Where secondary melting is employed, the heat shall be defined as all of the ingots remelted from a single primary heat.

4.2 *Deoxidation*:

4.2.1 Unless otherwise specified, the steel shall be rimmed, capped, semi-killed, or killed at the manufacturer's option.

4.2.2 If killed steel is specified, the purchaser may designate that the steel be made to coarse or fine austenitic grain size (see S10 or S11).

NOTE 2—Assured coarse grain size is not always possible since certain

[1] This specification is under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel and Related Alloys and is the direct responsibility of Subcommittee A01.15 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 Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096.

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elements or combination of elements or certain quantities of elements such as manganese, sulfur, and lead tend to produce grain refinement.

4.3 *Quality*—The bars shall be special quality.

4.4 *Hot Forming*—The bars shall be hot wrought, as wrought.

TABLE 1 Grade Designations and Chemical Requirements of Hot-Wrought Carbon Steel Bars

NOTE—Grade designations and compositions correspond to the respective AISI designations and compositions.

UNS Designation[A]	Grade	Heat Chemical Ranges and Limits, %			
		Carbon	Manganese	Phosphorus, max	Sulfur, max[B]
		Nonresulfurized Carbon Steels[C,D,E,F,G] Low Manganese 1.00 % max or less			
G10080	1008	0.10 max	0.30–0.50	0.040	0.050
G10100	1010	0.08–0.13	0.30–0.60	0.040	0.050
G10120	1012	0.10–0.15	0.30–0.60	0.040	0.050
G10150	1015	0.13–0.18	0.30–0.60	0.040	0.050
G10160	1016	0.13–0.18	0.60–0.90	0.040	0.050
G10170	1017	0.15–0.20	0.30–0.60	0.040	0.050
G10180	1018	0.15–0.20	0.60–0.90	0.040	0.050
G10190	1019	0.15–0.20	0.70–1.00	0.040	0.050
G10200	1020	0.18–0.23	0.30–0.60	0.040	0.050
G10210	1021	0.18–0.23	0.60–0.90	0.040	0.050
G10220	1022	0.18–0.23	0.70–1.00	0.040	0.050
G10230	1023	0.20–0.25	0.30–0.60	0.040	0.050
G10250	1025	0.22–0.28	0.30–0.60	0.040	0.050
G10260	1026	0.22–0.28	0.60–0.90	0.040	0.050
G10290	1029	0.25–0.31	0.60–0.90	0.040	0.050
G10300	1030	0.28–0.34	0.60–0.90	0.040	0.050
G10350	1035	0.32–0.38	0.60–0.90	0.040	0.050
G10370	1037	0.32–0.38	0.70–1.00	0.040	0.050
G10380	1038	0.35–0.42	0.60–0.90	0.040	0.050
G10390	1039	0.37–0.44	0.70–1.00	0.040	0.050
G10400	1040	0.37–0.44	0.60–0.90	0.040	0.050
G10420	1042	0.40–0.47	0.60–0.90	0.040	0.050
G10430	1043	0.40–0.47	0.70–1.00	0.040	0.050
G10440	1044	0.43–0.50	0.30–0.60	0.040	0.050
G10450	1045	0.43–0.50	0.60–0.90	0.040	0.050
G10460	1046	0.43–0.50	0.70–1.00	0.040	0.050
G10490	1049	0.46–0.53	0.60–0.90	0.040	0.050
G10500	1050	0.48–0.55	0.60–0.90	0.040	0.050
G10530	1053	0.48–0.55	0.70–1.00	0.040	0.050
G10550	1055	0.50–0.60	0.60–0.90	0.040	0.050
G10600	1060	0.55–0.65	0.60–0.90	0.040	0.050
G10700	1070	0.65–0.75	0.60–0.90	0.040	0.050
G10780	1078	0.72–0.85	0.30–0.60	0.040	0.050
G10800	1080	0.75–0.88	0.60–0.90	0.040	0.050
G10840	1084	0.80–0.93	0.60–0.90	0.040	0.050
G10900	1090	0.85–0.98	0.60–0.90	0.040	0.050
G10950	1095	0.90–1.03	0.30–0.50	0.040	0.050
G15130	1513	0.10–0.16	1.10–1.40	0.040	0.050
G15180	1518	0.15–0.21	1.10–1.40	0.040	0.050
G15220	1522	0.18–0.24	1.10–1.40	0.040	0.050
G15240	1524	0.19–0.25	1.35–1.65	0.040	0.050
G15250	1525	0.23–0.29	0.80–1.10	0.040	0.050
G15260	1526	0.22–0.29	1.10–1.40	0.040	0.050
G15270	1527	0.22–0.29	1.20–1.50	0.040	0.050
G15360	1536	0.30–0.37	1.20–1.50	0.040	0.050
G15410	1541	0.36–0.44	1.35–1.65	0.040	0.050
G15470	1547	0.43–0.51	1.35–1.65	0.040	0.050
G15480	1548	0.44–0.52	1.10–1.40	0.040	0.050
G15510	1551	0.45–0.56	0.85–1.15	0.040	0.050
G15520	1552	0.47–0.55	1.20–1.50	0.040	0.050
G15610	1561	0.55–0.65	0.75–1.05	0.040	0.050
G15660	1566	0.60–0.71	0.85–1.15	0.040	0.050
G15720	1572	0.65–0.76	1.00–1.30	0.040	0.050
		Resulfurized Carbon Steels[C,E,G]			
G11090	1109	0.08–0.13	0.60–0.90	0.040	0.08–0.13
G11100	1110	0.08–0.13	0.30–0.60	0.040	0.08–0.13
G11160	1116	0.14–0.20	1.10–1.40	0.040	0.16–0.23
G11170	1117	0.14–0.20	1.00–1.30	0.040	0.08–0.13
G11180	1118	0.14–0.20	1.30–1.60	0.040	0.08–0.13
G11190	1119	0.14–0.20	1.00–1.30	0.040	0.24–0.33
G11320	1132	0.27–0.34	1.35–1.65	0.040	0.08–0.13

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TABLE 1 *Continued*

UNS Designation[A]	Grade	Heat Chemical Ranges and Limits, %			
		Carbon	Manganese	Phosphorus, max	Sulfur, max[B]
G11370	1137	0.32–0.39	1.35–1.65	0.040	0.08–0.13
G11390	1139	0.35–0.43	1.35–1.65	0.040	0.13–0.20
G11400	1140	0.37–0.44	0.70–1.00	0.040	0.08–0.13
G11410	1141	0.37–0.45	1.35–1.65	0.040	0.08–0.13
G11440	1144	0.40–0.48	1.35–1.65	0.040	0.24–0.33
G11450	1145	0.42–0.49	0.70–1.00	0.040	0.04–0.07
G11460	1146	0.42–0.49	0.70–1.00	0.040	0.08–0.13
G11510	1151	0.48–0.55	0.70–1.00	0.040	0.08–0.13

Rephosphorized and Resulfurized Carbon Steel[E,G,H]

Designation	Grade	Carbon	Manganese	Phosphorus	Sulfur	Lead
G12110	1211	0.13 max	0.60–0.90	0.07–0.12	0.10–0.15	...
G12120	1212	0.13 max	0.70–1.00	0.07–0.12	0.16–0.23	...
G12130	1213	0.13 max	0.70–1.00	0.07–0.12	0.24–0.33	...
G12150	1215	0.09 max	0.75–1.05	0.04–0.09	0.26–0.35	...
...	12L14	0.15 max	0.85–1.15	0.04–0.09	0.26–0.35	0.15–0.35

[A] New designations established in accordance with Practice E 527 and SAE J 1086.

[B] Maximum unless otherwise indicated.

[C] When silicon is required, the following ranges and limits are commonly specified: 0.10 %, max, 0.10 to 0.20 %, 0.15 to 0.35 %, or 0.20 to 0.40 %.

[D] Copper can be specified when required as 0.20 % minimum.

[E] When lead is required as an added element to a standard steel, a range of 0.15 to 0.35 % incl is specified. Such a steel is identified by inserting the letter "L" between the second and third numerals of the grade designation, for example, 10 L 45. A cast or heat analysis is not determinable when lead is added to the ladle stream.

[F] When boron treatment is specified for killed steels, the steels can be expected to contain 0.0005 to 0.003 % boron.

[G] The elements bismuth, calcium, selenium, or tellurium may be added as agreed between purchaser and supplier.

[H] It is not common practice to produce these steels to specified limits for silicon because of its adverse effect on machinability.

5. Chemical Composition

5.1 The heat analysis shall conform to the requirements for chemical composition specified in Table 1 for the grade specified, or to such other limits as may be specified using the ranges and limits in Table 2.

6. Workmanship, Finish, and Appearance

6.1 *Descaling*—When descaled bars are required, S15 on Pickling or S16 on Blast Cleaning must be specified.

6.2 The bars shall be free of visible pipe and conditioned as necessary to remove injurious surface imperfections.

7. Certification and Test Reports

7.1 When specified by the purchaser, a manufacturer's certification that the material was manufactured and tested in accordance with this specification together with a report of the heat analysis test results for the specified elements and for copper, chromium, nickel, molybdenum, vanadium, and columbium shall be furnished. When the amount of an element present is less than 0.02 %, the analysis may be reported as <0.02 %. The report shall include the name of the manufacturer, ASTM designation number and year date and revision letter, if any, type and grade, heat number, and size.

7.2 When supplementary requirements are specified, the report shall include a statement of compliance with the requirement or the results of tests when the requirement involves measured test values such as S12 on Restricted Incidental Elements.

8. General Requirements

8.1 Material furnished under this specification shall conform to the applicable requirements of the current edition of Specification A 29/A 29M, unless otherwise provided herein.

9. Keywords

9.1 carbon steel bars; hot-wrought steel bars; steel bars

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TABLE 2 Heat Chemical Ranges and Limits of Hot-Wrought Carbon Steel Bars

Element	Chemical Ranges and Limits, %		
	When Maximum of Specified Element is:	Range	Lowest Maximum
Carbon[A]	...	...	0.06
	to 0.12 incl	...	...
	over 0.12–0.25 incl	0.05	...
	over 0.25–0.40 incl	0.06	...
	over 0.40–0.55 incl	0.07	...
	over 0.55–0.80 incl	0.10	...
	over 0.80	0.13	...
Manganese	...	...	0.35
	to 0.40 incl	0.15	...
	over 0.40–0.50 incl	0.20	...
	over 0.50–1.65 incl	0.30	...
Phosphorus	to 0.040 incl	...	0.040
	over 0.040–0.08 incl	0.03	...
	over 0.08–0.13 incl	0.05	...
Sulfur	to 0.050 incl	. . .	0.050
	over 0.050–0.09 incl	0.03	...
	over 0.09–0.15 incl	0.05	...
	over 0.15–0.23 incl	0.07	...
	over 0.23–0.50 incl	0.09	...
Silicon[B]	...	...	0.10
	to 0.10 incl	...	...
	over 0.10–0.15 incl	0.08	...
	over 0.15–0.20 incl	0.10	...
	over 0.20–0.30 incl	0.15	...
	over 0.30–0.60 incl	0.20	...
Copper	When copper is required 0.20 min is generally specified		
Lead[C,D]	When lead is required, a range of 0.15–0.35 is specified		
Boron		0.0005 min	
Bismuth[E]			
Calcium[E]			
Selenium[E]			
Tellurium[E]			

[A] The carbon ranges shown in the column headed “Range” apply when the specified maximum limit for manganese does not exceed 1.10 %. When the maximum manganese limit exceeds 1.10 %, add 0.01 to the carbon ranges shown above.
[B] It is not common practice to produce a rephosphorized and resulfurized carbon steel to specified limits for silicon because of its adverse effect on machinability.
[C] A heat analysis for lead is not determinable, since lead is added to the ladle stream while each ingot is poured.
[D] It is not common practice to produce these steels to specified limits for silicon because of its adverse effect on machinability.
[E] Element specification range as agreed to between purchaser and supplier.

SUPPLEMENTARY REQUIREMENTS

One or more of the following supplementary requirements shall apply when specified by the purchaser.

S1. Cold-Working Quality

S1.1 This classification encompasses bars subject to severe cold plastic deformation such as, but not limited to, upsetting, heading, forging, forward or backward extrusion.

S1.2 If the type of steel or chemical composition does not have adequate cold working characteristics, appropriate thermal treatments should be specified.

S1.3 When S1 is specified, the bars shall be produced by manufacturing practices and subjected to mill tests and inspection and freedom from injurious surface imperfections to the extent that the bars shall be suitable for the manufacture of identified parts. The quality requirements of individual application vary.

S2. Axle-Shaft Quality

S2.1 Bars shall be suitable for use in the manufacture of power-driven axle shafts of the automotive or truck type.

S3. Scrapless Nut Quality

S3.1 Bars shall be suitable for the production of scrapless nuts from round bars involving cold plastic deformation,

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namely piercing, upsetting, and forming, with consequent expansion in diameter.

S4. Special Surface Quality

S4.1 Special surface steels are produced with exacting control and appropriate inspection and surface preparation to minimize the frequency and degree of seams and other surface imperfections.

S5. Annealing

S5.1 The steel shall be furnished annealed.

S6. Spheroidize Annealing

S6.1 The steel shall be spheroidize annealed.

S7. Special Internal Soundness Requirement

S7.1 The steel shall be produced with special internal soundness, that is, relative freedom from segregation and porosity, as evaluated by means of a macroetch test performed on representative billet samples. The test shall consist of deep etching a cross section in a hot-acid solution and with a visual examination to evaluate soundness. An alternative method consisting of fracturing a billet section and examining the fracture surface to evaluate soundness may be used with purchaser approval.

S8. Nonmetallic Inclusion Requirement (Note S1)

S8.1 A microscopical examination of longitudinal sections to determine the nature and frequency of nonmetallic inclusions shall be made as prescribed in Test Methods E 45. The acceptance limits shall be specified by the purchaser.

NOTE S1—Much of the sulfur in resulfurized steels is present as sulfide inclusions. For this reason, those steels are not generally produced to inclusion rating and S9 may not be specified.

S9. Special Hardenability Requirement

S9.1 Special heat treating (hardenability) is a term used when the purchaser specifies as a requirement, the ability of a steel to heat treat to specified mechanical property values which the purchaser must meet after his heat treatment. Care should be taken so that the desired mechanical property values are compatible with the chemical composition, size, and cross section of the steel.

S10. Grain Size (Coarse)

S10.1 The steel shall conform to the coarse austenitic grain size requirement of Specification A 29/A 29M.

S11. Grain Size (Fine)

S11.1 The steel shall conform to the fine austenitic grain size requirement of Specification A 29/A 29M.

S11.1.1 When aluminum is used as a grain refining element, the fine grain size requirement shall be deemed to be fulfilled if, on heat analysis, the aluminum content is not less than 0.015 % acid soluble aluminum, or alternately, 0.020 % total aluminum. The aluminum content shall be reported. The grain size test specified in S11.1 shall be the referee test.

S11.1.2 When specified on the order, one grain size test per heat shall be made. The test result shall be reported.

S12. Restricted Incidental Elements

S12.1 The steel shall not exceed the limits for copper, nickel, chromium, molybdenum, or other elements as shown on the purchase order.

S13. Stress Relieving

S13.1 The steel shall be stress relieved by heating to a temperature specified by the purchaser or to a temperature selected by the manufacturer.

S14. Special Straightness

S14.1 The bars shall be produced with special straightness (refer to Specification A 29/A 29M for tolerances).

S15. Pickling

S15.1 The surface of the bars shall be descaled by pickling.

S16. Blast Cleaning

S16.1 The surface of the bars shall be descaled by blast cleaning.

S17. Coating

S17.1 The bars shall be oiled, limed, or phosphate-coated as specified by the purchaser. The purchaser shall also specify the method of cleaning (S15 or S16); otherwise the bars shall be descaled by pickling or blasting at the manufacturer's option.

S18. Restricted Heat Chemical Ranges

S18.1 Restricted heat chemical ranges on one or more elements may be specified by the purchaser if the manufacturer agrees to melt to the requested restriction.

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