Designation: A 921/A 921M – 93 (Reapproved 2005)

Standard Specification for Steel Bars, Microalloy, Hot-Wrought, Special Quality, for Subsequent Hot Forging[1]

This standard is issued under the fixed designation A 921/A 921M; 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 specification covers hot-wrought, special quality microalloyed carbon steel bars intended for use as hot forging stock. The bars shall be hot-wrought, as-wrought, unless thermal treatment is necessary to ensure cold shearability.

1.2 The bars shall be furnished to chemical composition only. Chemical composition is based on standard carbon steel grades modified to include microalloying elements such as columbium (niobium), vanadium, or molybdenum. Desired mechanical properties are developed in the subsequent hot forging and controlled cooling operations.

1.3 Sections and sizes of bar steel available are covered in Specification A 29/A 29M.

1.4 Supplementary requirements S1 to S6 are provided for use when additional controls or requirements are desired. These shall apply only when specified on the purchase order.

1.5 The values stated in either inch-pound units or SI units are to be regarded separately as standard. Within the text and tables, 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.

1.6 Unless the order specifies the applicable "M" specification designation, the material shall be furnished to the inch-pound units.

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 576 Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality

A 788 Specification for Steel Forgings, General Requirements

E 45 Test Methods for Determining the Inclusion Content of Steel

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *microalloyed steels*—microalloyed steels are carbon steels to which small quantities of certain elements are added in order to enhance mechanical properties. This enhancement of mechanical properties results from control of the temperature and cooling rate during the final hot-working process.

4. Ordering Information

4.1 Orders for material supplied to this specification should include the following, as required, to describe adequately the desired material:

4.1.1 Quantity (weight or number of bars),

4.1.2 Name of material (hot-rolled microalloyed steel bars),

4.1.3 Dimensions,

4.1.4 ASTM specification number and date of issue,

4.1.5 Grade designation or chemical composition limits (see 8.1-8.5),

4.1.6 Type (see 7.1) to designate grain refiner,

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

4.1.8 End use.

5. General Requirements

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

6. Materials and Manufacture

6.1 *Melting Practice*—The steel shall be produced in accordance with the applicable methods for primary and secondary melting outlined in Specification A 788.

6.2 The steel shall be killed. Supplementary Requirements S1 through S6 may be invoked upon agreement between producer and purchaser.

6.3 The bars shall be special quality.

6.4 The bars shall be hot-wrought, as wrought.

[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.

Current edition approved March 1, 2005. Published March 2005. Originally approved in 1993. Last previous edition approved in 1999 as A 921/A 921M - 93(1999).

[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.

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TABLE 1 Typical Chemical Compositions of Microalloyed Carbon Steels

NOTE 1—These compositions are identical to those in Specification A 576, with the exception of the addition of vanadium.

Grade Designation	Chemical Composition Limits, %				
	C	MN	P	S	V
10V40	0.37–0.44	0.60–0.90	0.040 max	0.050 max	0.02–0.20
10V45	0.43–0.50	0.60–0.90	0.040 max	0.050 max	0.02–0.20
11V37	0.32–0.39	1.35–1.65	0.040 max	0.08–0.13	0.02–0.20
11V41	0.37–0.45	1.35–1.65	0.040 max	0.08–0.13	0.02–0.20
15V24	0.19–0.25	1.35–1.65	0.040 max	0.050 max	0.02–0.20
15V41	0.36–0.44	1.35–1.65	0.040 max	0.050 max	0.02–0.20

7. Metallurgical Requirements

7.1 *Grain Size*—The steel shall conform to the fine grain size requirement of Specification A 29/A 29M. The grain refining element may be specified according to one of the following types:

7.1.1 *Type A—Aluminum*—The total aluminum analysis shall be 0.020 % or greater, and shall be reported.

7.1.2 *Type B*—The grain refining element shall be specified in accordance with 5.1.2.3 of Specification A 29/A 29M.

8. Chemical Composition

8.1 Typical examples of chemical compositions are shown in Table 1. Other compositions may be specified using one of the following methods:

8.1.1 Base compositions selected from Table 1 of Specification A 576, with the addition of microalloying elements as provided in 8.3-8.5, or

8.1.2 Base compositions using the ranges and limits shown in Specification A 576, with the addition of microalloying elements as provided in 8.3-8.5

NOTE 1—For improved machinability, alternative sulfur ranges may be specified by agreement between the purchaser and the producer. Additional machinability-enhancing elements such as lead, bismuth, selenium, or tellurium may also be specified by agreement.

8.2 Silicon analysis shall be 0.15/0.35 %. Silicon content up to 0.80 % maximum may be furnished by agreement between purchaser and producer.

8.3 Vanadium, columbium (niobium), or molybdenum may be specified singly or in combination, subject to the limits shown in Table 2. The elements and ranges specified shall be by agreement between the purchaser and the producer.

8.4 Titanium may be added for refinement of the austenitic and the as-forged ferritic grain size, or as a precipitation strengthener. When titanium is specified, the titanium limits shall be as agreed upon between producer and purchaser. The titanium analysis shall be reported.

TABLE 2 Chemical Requirements—(Microalloy Elements)

Element	Chemical Ranges and Limits, %	
	Heat Analysis	Product Analysis
Vanadium	0.02–0.20	0.01–0.21
Columbium (Niobium)	0.005–0.07	0.004–0.08
Molybdenum	0.01–0.30	0.31 max

8.5 Nitrogen may be specified as a supplement to vanadium, columbium, or titanium. When nitrogen is specified to supplement vanadium, the minimum ratio of vanadium to nitrogen shall be 4 to 1. The nitrogen content shall not exceed 0.03 % and shall be reported.

8.6 Sampling for heat and product analysis shall be in accordance with the requirements of Specification A 29/A 29M.

9. Workmanship and Appearance

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

10. Certification and Test Reports

10.1 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 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 heat analysis may be reported as <0.02 %, except for titanium, aluminum, and nitrogen. When specified, these elements shall be reported to three decimal places.

11. Keywords

11.1 carbon steel bars; microalloyed steel; steel bars

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SUPPLEMENTARY REQUIREMENTS

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

S1. Restricted Chemical Composition

S1.1 Restricted heat analysis limits or ranges or restricted product analysis tolerances on one or more elements may be specified by the purchaser if the manufacturer agrees to meet the requested restriction.

S2. Restricted Incidental Elements

S2.1 The steel shall not exceed the limits for copper, nickel, chromium, molybdenum, or other elements as shown on the purchase order.

S3. Nonmetallic Inclusion Requirement

S3.1 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—In resulfurized steels, much of the sulfur is present as sulfide inclusions. For this reason, maximum sulfide inclusion level should not be specified.

S4. Calcium Treatment

S4.1 The steel shall be calcium treated.

S5. Thermal Treatment to Insure Cold Shearability

S5.1 The bars shall be thermal treated to ensure cold shearability. The type of treatment shall be as agreed upon between the purchaser and producer.

S6. Cleaning

S6.1 The surface of the bars shall be descaled by pickling or shotblasting, or other suitable means.

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