



Designation: A 973/A 973M – 01

Standard Specification for Grade 100 Alloy Steel Chain¹

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1. Scope*

1.1 This specification covers Grade 100 heat-treated alloy steel chain for such applications as slings, lifting assemblies, and load binding.

NOTE 1—This specification does not cover alloy steel chain for pocket wheel applications.

1.2 This specification is a performance standard for Grade 100 chain used between -20 and 400°F [-29 and 205°C]. The chain manufacturer should be contacted for use at temperatures outside this range.

1.3 The values stated in either SI units or in other units shall be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system must be used independently of the other, without combining values in any way.

2. Referenced Documents

2.1 ASTM Standards:

A 29/A 29M Specification for Steel Bars, Carbon and Alloy, Hot-Wrought and Cold-Finished, General Requirements for²

A 919 Terminology Relating to Heat Treatment of Metals³

E 30 Test Methods for Chemical Analysis of Steel, Cast Iron, Open-Hearth Iron, and Wrought Iron⁴

E 350 Test Methods for Chemical Analysis of Carbon Steel, Low-Alloy Steel, Silicon Electrical Steel, Ingot Iron, and Wrought Iron⁵

E 415 Test Method for Optical Emission Vacuum Spectrometric Analysis of Carbon and Low-Alloy Steel⁵

2.2 SAE Standard:

SAE J422 Microscopic Determination of Inclusions in Steels⁶

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 A01.27 on Steel Chain.

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² Annual Book of ASTM Standards, Vol 01.05.

³ Discontinued. See 1998 Annual Book of ASTM Standards, Vol 01.02.

⁴ Discontinued. See 1995 Annual Book of ASTM Standards, Vol 03.05.

⁵ Annual Book of ASTM Standards, Vol 03.05.

⁶ Available from Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096.

3. Terminology

3.1 Definitions of Terms Specific to This Standard:

3.1.1 *breaking force, minimum*—the minimum force in pounds or newtons at which the chain, during manufacture, has been found by testing to break when a constantly increasing force is applied in direct tension. This test is a manufacturer's attribute acceptance test and shall not be used as criteria for service.

3.1.2 *lot*—for the purpose of acceptance testing, a lot shall consist of 3000 ft [1000 m], or fraction thereof, of the same size chain. If a continuous length of chain exceeds 3000 ft [1000 m], it shall also be considered a lot.

3.1.3 *proof test*—a quality control tensile test applied to chain for the purpose of verifying weld and material quality. It is the minimum force in pounds or newtons which the chain has withstood at the time it left the producer, under a test in which a constantly increasing force has been applied in direct tension to a straight length of chain. Proof test loads are a manufacturing integrity test and shall not be used as criteria for service or design purposes.

3.1.4 *working load limit (WLL)*—the maximum combined static and dynamic load in pounds or kilograms that shall be applied in direct tension to an undamaged straight length of chain.

4. Ordering Information

4.1 It shall be the responsibility of the purchaser to specify all requirements that are necessary for material ordered under this specification. Such requirements include, but are not limited to, the following:

4.1.1 Product to conform to Specification A 973/A 973M and date of issue,

4.1.2 Nominal size of chain (in. or mm),

4.1.3 Quantity of chain (ft or m),

4.1.4 Length of each piece, if required,

4.1.5 Finish, if required,

4.1.6 Certification of test(s), if required,

4.1.7 Acceptance of inspection by purchaser, if required, and

4.1.8 Supplementary requirements, if required.

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



5. Manufacturing

5.1 *Melting Process*—The alloy steel shall be fully killed and have an austenitic grain size of five or finer.

5.2 *Welding Process*—Alloy steel chain may be made by the electric welding or gas welding process.

5.3 *Heat Treatment*—After welding, alloy steel chain shall be heat treated before applying the proof test. Heat treatment shall include quenching and tempering as defined by Terminology A 919.

6. Material Requirements

6.1 *Heat Analysis*—The selection and amounts of the alloying elements in the steel are left to the judgment of the individual chain manufacturer provided the steel meets the following criteria: carbon = 0.35 % max; phosphorous = 0.025 % max; sulfur = 0.025 % max. The following elements must all be present in alloying amounts, nickel (0.40% min), chromium (0.40% min), and molybdenum (0.15% min). The steel shall have oxide and silicate inclusions of 4 or less as determined by SAE J422.

6.2 *Product Analysis*—The steel used may be analyzed by the purchaser and shall conform to the requirements of 6.1 subject to the product analysis tolerances specified in Specification A 29/A 29M. Test samples may be taken from rods, bars, or finished chain. Samples for analysis shall be so taken as to represent the full cross section of the specimen.

6.3 Test Methods E 30, E 350, or E 415 shall be used for referee purposes.

7. Mechanical Requirements

7.1 *Proof Test*—All chain shall be tested to at least the proof load prescribed in Table 1 for the appropriate size chain. When so tested it shall withstand these loads without loss of chain integrity. Links or chain segments not withstanding the proof test load shall be removed from the chain.

7.2 *Breaking Force*—The breaking force test specimen shall consist of a length from the lot containing at least the number of links in Table 2. All chain shall be in the quenched and tempered condition before the breaking force is measured.

7.2.1 Fixtures for securing chain in a testing machine shall be properly designed to support securely the shoulder of the link (see Note 2). The opening in the fixture shall not be more than 125 % of the stock diameter being tested. Links engaged in the testing fixture shall not be considered part of the test specimen.

TABLE 2 Mechanical Test Sample Length Requirements

Size of Chain	Minimum Number of Links in Test Specimen
7/32 in. [5.5 mm]	9
Larger than 7/32 in. [5.5 mm] but less than 3/4 in. [20.0 mm]	7
3/4 in. [20.0 mm] and larger	3

NOTE 2—“U” bolts of the same or larger diameter and the same or greater strength may be used to secure the chain to the jaws of the testing machine.

7.2.2 Test results shall meet or exceed the minimum breaking force values given in Table 1 for the appropriate size chain.

7.3 Elongation:

7.3.1 All chain must be in the quenched and tempered condition before the elongation is measured.

7.3.2 The elongation test specimen shall consist of a length from the lot containing at least the number of links in Table 2.

7.3.3 A positive load not exceeding 10 % of the proof test shall be applied for determining the original gage length ($L\{0\}$).

7.3.4 The elongation shall be based on the total extension at fracture. This is expressed as a percentage of the change in length (ΔL) divided by the original gage length ($L\{0\}$). The elongation may be determined by the equation below or by autographic recorder or side scale.

$$\text{Elongation (\%)} = \left\{ \Delta L / L\{0\} \right\} \times 100$$

where:

ΔL = test specimen final length at fracture – test specimen original gage length ($L\{0\}$), and

$L\{0\}$ = original gage length (sum of the inside lengths of the test chain links, not counting the fixture links, or as determined in 7.3.3).

7.3.5 The elongation shall be a minimum of 20 %.

7.4 One test for breaking strength and elongation shall be made from each lot. The elongation and breaking force tests may be performed at the same time on the same test specimen.

8. Dimensional Requirements

8.1 The chain shall conform to the dimensional requirements specified in Table 1 for the appropriate size chain.

8.2 *Diameter*—The diameter of the material from which the chain is manufactured shall not be smaller than the material

TABLE 1 Grade 100 Alloy Chain Mechanical and Dimensional Requirements

Nominal Chain Size		Material Diameter		Working Load Limit (max)		Proof Test (min)		Minimum Breaking Force		Inside Length (max)		Inside Width Range	
in.	mm	in.	mm	lb	kg	lb	kN	lb	kN	in.	mm	in.	mm
7/32	5.5	0.217	5.5	2700	1220	5400	23.8	10 800	47.6	0.69	17.6	0.281 to 0.325	7.14 to 8.25
9/32	7	0.276	7.0	4300	1950	8600	38.5	17 200	77	0.90	22.9	0.375 to 0.430	9.53 to 10.92
5/16	8	0.315	8.0	5700	2600	11 400	51	22 800	102	1.04	26.4	0.430 to 0.500	10.92 to 12.70
3/8	10	0.394	10.0	8800	4000	17 600	79	35 200	158	1.26	32.0	0.512 to 0.600	13.00 to 15.20
1/2	13	0.512	13.0	15 000	6800	30 000	134	60 000	268	1.64	41.6	0.688 to 0.768	17.48 to 19.50
5/8	16	0.630	16.0	22 600	10 300	45 200	201	90 400	402	2.02	51.2	0.812 to 0.945	20.63 to 24.00
3/4	20	0.787	20.0	35 300	16 000	70 600	315	141 200	630	2.52	64.0	0.984 to 1.18	25.0 to 30.0
7/8	22	0.866	22.0	42 700	19 400	85 400	381	170 800	762	2.77	70.4	1.08 to 1.30	27.5 to 33.0