Designation: A 973/A 973M – 07

Standard Specification for Grade 100 Alloy Steel Chain[1]

This standard is issued under the fixed designation A 973/A 973M; 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 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 Grade designation is 1/10 of the minimum breaking strength in newtons divided by two times the nominal cross-sectional area of the chain in square millimetres.

1.4 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:* [2]

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

A 751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products

A 941 Terminology Relating to Steel, Stainless Steel, Related Alloys, and Ferroalloys

2.2 *SAE Standard:*

SAE J422 Microscopic Determination of Inclusions in Steels[3]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *breaking force, minimum*, *n*—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.

3.1.1.1 *Discussion*—This test is a manufacturer's attribute acceptance test and shall not be used as criteria for service.

3.1.2 *date code*, *n*—series of letters, numbers, or both embossed on the chain which enables its manufacturing history to be traced.

3.1.3 *lot*, *n*—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.

3.1.4 *proof test*, *n*—quality control tensile test applied to chain for the purpose of verifying weld and material quality.

3.1.4.1 *Discussion*—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.

3.1.5 *traceability code*, *n*—series of letters, numbers, or both embossed on the chain which enables its manufacturing history, including the identity of the steel heat, to be traced.

3.1.6 *working load limit (WLL)*, *n*—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,

[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.

Current edition approved Nov. 1, 2007. Published November 2007. Originally approved in 1997. Last previous edition approved in 2001 as A 973/A 973M – 01.

[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.

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

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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.

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 941.

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, Practices, and Terminology A 751 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.

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

where:

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

$L\{0\}$ = original gage length (sum or 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.

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

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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 diameter listed in Table 1 within the following tolerance: –3 %. Oversized material may be used for all applications.

9. Finish

9.1 The manufacturer may apply a surface treatment or finish of their own choice for identification or corrosion resistance unless the customer specifies otherwise. The surface treatment or finish shall not alter the chain properties in a manner that would cause the chain to not meet the other provisions of this standard.

10. Retests

10.1 If the original test specimen fails to conform to the requirements in 7.2.2, two additional test specimens from the same lot may be tested, each of which shall conform to the requirements in 7.2.2. If both additional tests are satisfactory, the chain will be considered acceptable.

11. Rework and Retreatment

11.1 Materials that fail to conform to the requirements for dimensions and mechanical tests may be resubmitted after being reworked.

12. Inspection

12.1 When requested on the purchase order or contract, the chain shall be free of paint or other coatings which could mask surface discontinuities at the time of inspection.

12.2 The manufacturer shall afford the purchaser's inspector all reasonable facilities necessary to verify that the chain produced is being furnished in accordance with this specification. Inspection by the purchaser shall not interfere unnecessarily with the manufacturer's operations. All tests and inspection shall be made at the place of manufacture, unless otherwise agreed upon.

12.3 The purchaser may make the tests to govern acceptance or rejection of the chain at their own laboratory or elsewhere. Tests and acceptance criteria shall conform to the requirements contained in this specification unless otherwise stated in the purchase order or contract. Tests at the purchaser's laboratory or elsewhere shall be made at the expense of the purchaser.

13. Rejection and Rehearing

13.1 Material that fails to conform to the requirements of this specification may be rejected. Rejection shall be reported to the producer or supplier promptly and in writing.

13.2 In the case of dissatisfaction with the results of the test discussed in 12.3, the producer or supplier may make claim for a rehearing.

14. Certification

14.1 A manufacturer's certification that the chain conforms to the ordered specification (including year or issue) shall be furnished when requested on the purchase order or contract.

14.2 When requested on the purchase order or contract, the manufacturer shall furnish a certificate of proof test to the purchaser or his representative.

15. Product Marking

15.1 Body chain links shall not be marked with indented characters.

15.2 Body chain links shall be marked for identification purposes at intervals no greater than 3 ft [0.9 m].

15.3 The marking shall consist of at least the grade indicator, the manufacturer's mark or symbol, and the traceability code or date code.

15.4 The grade indicator marking for Grade 100 shall include 10, 100, or 1000.

16. Keywords

16.1 chain; steel chain

SUPPLEMENTARY REQUIREMENTS

The following Supplementary Requirements shall apply only when specified in the purchasing order or contract.

S1. Weld Bend Test

S1.1 When specified by the purchaser in the order or contract, each chain lot shall be subjected to the weld bend test.

S2. Test Requirements

S2.1 *Test Equipment*—The bend test equipment shall comply with the requirements shown in Fig. S1.1, where the V-Block angle shall be 90° and the diameter of the anvil shall be approximately twice the diameter of the chain being tested.

S2.2 *Test Procedure*—A shock-free force is applied to the center of the link by the anvil and each single link shall be deformed a distance of 0.8 times the diameter of the chain link.

S2.3 *Selection of Samples*—Samples shall be tested from each lot and shall be in the final heat treated condition. One sample per welding head shall be tested for all sizes.

S2.4 *Acceptance Criteria*—The link shall be examined after testing and shall be free of any visible defects such as cracks in the area at and around the weld.

S2.5 *Retests*—If both original samples for ⅝ in. [16 mm] or smaller chain fail the weld bend test, the lot is considered rejected. If only one sample for the ⅝ in. [16 mm] and smaller chain fails, or the original sample for ¾ in. [20 mm] or larger chain fails, two additional test samples from the same lot may be tested. If both retests conform to the acceptance criteria in S2.4, the chain will be considered acceptable.

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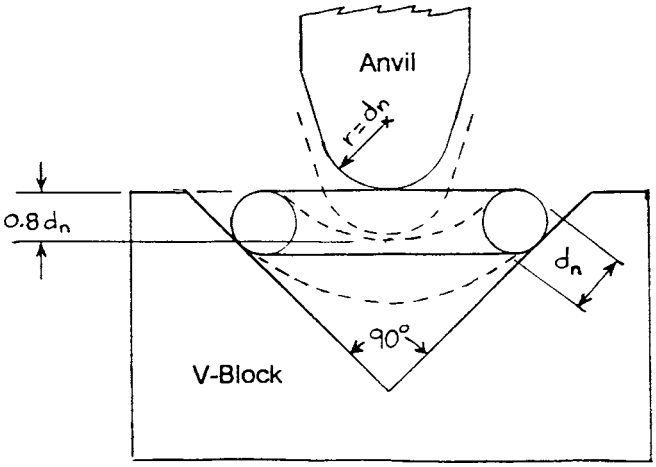

FIG. S1.1 Test Equipment

SUMMARY OF CHANGES

Committee A01 has identified the location of selected changes to this standard since the last issue (A 973/A 973M – 01) that may impact the use of this standard. (Approved Nov. 1, 2007.)

(*1*) Added 1.3.
(*2*) Revised Section 2.
(*3*) Added new terms to Section 3.
(*4*) Added new referenced document citations to 5.3 and 6.3.
(*5*) Revised Section 9.
(*6*) Revised 13.1 and 13.2.
(*7*) Revised 15.3 and 15.4.

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