ASME HST-5–2020
(Revision of ASME HST-5–2014)

Performance Standard for Air Chain Hoists

AN AMERICAN NATIONAL STANDARD

The American Society of Mechanical Engineers

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The American Society of Mechanical Engineers
Two Park Avenue • New York, NY • 10016 USA

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The American Society of Mechanical Engineers
Two Park Avenue, New York, NY 10016-5990

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FOREWORD

This Standard is one in a series that provides performance requirements for hoists; it was originally issued in 1985. It was developed by The American Society of Mechanical Engineers (ASME) HST Standards Committee, Hoists — Overhead. It is intended to serve as a guide to manufacturers of the equipment and to the purchasers and users of the equipment.

Standards in this series are

Designator	Title
HST-1	Performance Standard for Electric Chain Hoists
HST-2	Performance Standard for Hand Chain Manually Operated Chain Hoists
HST-3	Performance Standard for Lever Hoists
HST-4	Performance Standard for Overhead Electric Wire Rope Hoists
HST-5	Performance Standard for Air Chain Hoists
HST-6	Performance Standard for Air Wire Rope Hoists

This edition contains various updates to the definitions and references in Sections 5-0.2 and 5-0.3 and para. A-2.2. A new paragraph has been added to provide guidance on air supply characteristics and considerations. The scope has been revised to reflect the Standard's applicability to the U.S. Department of Defense (DOD) applications. When Nonmandatory Appendix A is invoked, this Standard becomes applicable to hoists used for DOD applications.

This Standard has been formatted in accordance with the 2019 ASME Codes and Standards Writing Guide and Editorial Style Guide.

This Standard was approved as an American National Standard on April 2, 2020.

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Hoists — Overhead

(The following is the roster of the Committee at the time of approval of this Standard.)

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General. ASME Standards are developed and maintained with the intent to represent the consensus of concerned interests. As such, users of this Standard may interact with the Committee by requesting interpretations, proposing revisions or a case, and attending Committee meetings. Correspondence should be addressed to:

Secretary, HST Standards Committee
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Proposing Revisions. Revisions are made periodically to the Standard to incorporate changes that appear necessary or desirable, as demonstrated by the experience gained from the application of the Standard. Approved revisions will be published periodically.

This Standard is always open for comment, and the Committee welcomes proposals for revisions. Such proposals should be as specific as possible, citing the paragraph number(s), the proposed wording, and a detailed description of the reasons for the proposal, including any pertinent documentation.

Proposing a Case. Cases may be issued to provide alternative rules when justified, to permit early implementation of an approved revision when the need is urgent, or to provide rules not covered by existing provisions. Cases are effective immediately upon ASME approval and shall be posted on the ASME Committee web page.

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Interpretations. Upon request, the HST Standards Committee will render an interpretation of any requirement of the Standard. Interpretations can only be rendered in response to a written request sent to the Secretary of the HST Standards Committee.

Requests for interpretation should preferably be submitted through the online Interpretation Submittal Form. The form is accessible at http://go.asme.org/InterpretationRequest. Upon submittal of the form, the Inquirer will receive an automatic e-mail confirming receipt.

If the Inquirer is unable to use the online form, he/she may mail the request to the Secretary of the HST Standards Committee at the above address. The request for an interpretation should be clear and unambiguous. It is further recommended that the Inquirer submit his/her request in the following format:

Subject:	Cite the applicable paragraph number(s) and the topic of the inquiry in one or two words.
Edition:	Cite the applicable edition of the Standard for which the interpretation is being requested.
Question:	Phrase the question as a request for an interpretation of a specific requirement suitable for general understanding and use, not as a request for an approval of a proprietary design or situation. Please provide a condensed and precise question, composed in such a way that a "yes" or "no" reply is acceptable.
Proposed Reply(ies):	Provide a proposed reply(ies) in the form of "Yes" or "No," with explanation as needed. If entering replies to more than one question, please number the questions and replies.
Background Information:	Provide the Committee with any background information that will assist the Committee in understanding the inquiry. The Inquirer may also include any plans or drawings that are necessary to explain the question; however, they should not contain proprietary names or information.

Requests that are not in the format described above may be rewritten in the appropriate format by the Committee prior to being answered, which may inadvertently change the intent of the original request.

Moreover, ASME does not act as a consultant for specific engineering problems or for the general application or understanding of the Standard requirements. If, based on the inquiry information submitted, it is the opinion of the Committee that the Inquirer should seek assistance, the inquiry will be returned with the recommendation that such assistance be obtained.

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Chapter 5-0
Scope, Definitions, References, and Appendices

SECTION 5-0.1: SCOPE

(a) This Standard establishes performance requirements for air-powered chain hoists for vertical lifting service involving material handling of freely suspended (unguided) loads using load chain of the roller or welded link types with one of the following types of suspension:

(1) lug
(2) hook or clevis
(3) trolley

(b) This Standard is applicable to hoists manufactured after the date on which this Standard is issued. It is not applicable to

(1) damaged or malfunctioning hoists
(2) hoists that have been misused or abused
(3) hoists that have been altered without authorization of the manufacturer or a qualified person
(4) hoists used for lifting or supporting people, or
(5) hoists used for the purpose of drawing both the load and the hoist up or down the hoist's own load chain(s)

The requirements of this Standard shall be applied together with the requirements of ASME B30.16. Please also refer to ASME B30.16 for requirements pertaining to marking, construction, and installation; inspection, testing, and maintenance; and operation.

SECTION 5-0.2: DEFINITIONS

abnormal operating conditions: environmental conditions that are unfavorable, harmful, or detrimental to the operation of a hoist, such as excessively high or low temperatures, exposure to weather, corrosive fumes, dust-laden or moisture-laden atmospheres, and hazardous locations.

ambient temperature: the temperature of the atmosphere surrounding the hoist.

beam: an overhead standard structural or specially fabricated shape on which the trolley operates.

brake: a device, other than a motor, used for retarding or stopping motion by means of friction or power.

brake, holding: a friction brake for a hoist that is automatically applied and prevents motion when the air supply is interrupted.

brake, mechanical load: an automatic type of friction brake used for controlling loads in a lowering direction. This unidirectional device requires torque from the motor to lower a load but does not impose additional load on the motor when lifting a load. This may also be used as a holding brake if designed as such by the manufacturer.

braking, control: a method of controlling speed by removing energy from the moving body or by imparting energy in the opposite direction.

braking, dynamic: a method of controlling speed by using the motor as a compressor.

chain, hand: the chain provided to control movement of a hand chain-operated trolley.

chain, load: the load-bearing chain in the hoist.

chain, roller: a series of alternately assembled roller links and pin links in which pins articulate inside the bushings and the rollers are free to turn on the bushings. Pins and bushings are press-fit in their respective link plates.

chain, welded link: a chain consisting of a series of interwoven links formed and welded.

NOTE: Load chain properties do not conform to those shown in ASME B30.9.

control: a device or group of devices that serves to govern in some predetermined manner the power delivered to the apparatus to which it is connected.

control, pendant: a valve system, connected to the hoist or trolley by hoses, that either directly controls flow of air to the motor or controls a pilot-operated valve system at the motor inlet.

control, pull: cords or chains suspended from the hoist, by means of which a valve system on the hoist can be operated.

control, rod: a rigid rod suspended from the hoist, with which a valve system on the hoist can be operated.

hazardous (classified) locations: locations where fire or explosion hazards may exist. Locations are classified depending on the properties of the flammable vapors, liquids, or gases, or combustible dusts or fibers that may be present, and the likelihood that a flammable or combustible concentration or quantity is present. Refer to ANSI/NFPA 70.

headroom: headroom is measured with the load hook at its upper limit of travel and is the distance from the saddle of the load hook to the following locations (see Figure 5-0.2-1):

(a) saddle of the top hook on hook-suspended hoists
(b) centerline of the suspension holes on lug-suspended hoists
(c) wheel treadline on trolley-suspended hoists

hoist: a machinery unit that is used for lifting or lowering a freely suspended (unguided) load.

hoist speed: the rate of motion that the load hook obtains while lifting rated load.

hook suspended: suspension of the hoist from a trolley or rigid structure by means of a hook at top of hoist.

idler sprocket: a freely rotating device that changes the direction of the load chain. This device is sometimes called idler wheel, idler sheave, pocket wheel, or chain wheel (see Figure 5-0.2-2).

lift: the maximum vertical distance through which the load hook can travel and is the total hook movement between its upper limit of travel and its position when at the lower limit of travel (see Figure 5-0.2-1).

lifting devices, below-the-hook: devices that are not normally reeved onto the hoist chains such as hook-on-buckets, magnets, grabs, and other supplemental devices used for handling certain types of loads. The weight of these devices is to be considered part of the load to be lifted.

limit device: a device that limits equipment motion or takes control of particular functions without action of the operator when a limiting condition is reached.

load, rated: the maximum load for which a hoist or trolley is designated by the manufacturer or qualified person.

load, working: the external load applied to the hoist, including the weight of load-attaching equipment such as shackles and slings.

load block: the assembly of hook or shackle, swivel bearing, pins, sprocket, and frame suspended by the load chain. This shall include all appurtenances reeved in the load chain.

load chain container: a device used to collect the slack load chain.

load hook: the hook used to connect the load to the hoist.

load sprocket: a hoist component that transmits motion to the load chain. This component is sometimes called load wheel, load sheave, pocket wheel, chain wheel, or lift wheel (see Figure 5-0.2-2).

load suspension parts: the means of suspension (hook or lug); the structure or housing that supports the load sprocket, load chain, sprockets, and load block or hook.

lug suspended: suspension of the hoist from a trolley or permanent structure by means of a bolt(s) or pin(s) through a rigid-type or swivel-type lug.

minimum radius: the smallest radius of the beam, measured to the center line of the web of the beam, on which the trolley will operate.

normal operating conditions: conditions during which a hoist is performing functions within the scope of the original design.

overload: any load greater than the rated load.

parts (lines): number of lines of chain supporting the load block or hook.

power transmission parts: the machinery components, including the gears, shafts, clutches, couplings, bearings, motors, and brakes.

qualified person: a person who, by possession of a recognized degree in an applicable field or certificate of professional standing, or who, by extensive knowledge, training, and experience, has successfully demonstrated the ability to solve or resolve problems relating to the subject matter and work.

rated air pressure: the air pressure, at the hoist inlet, at which the hoist is designed to lift rated load at rated speed.

reach: the distance from the saddle of the load hook at its lower limit of lift to the upper point of the headroom measurement. Reach is equal to lift plus headroom (see Figure 5-0.2-1).

reeving: a system in which a chain travels around sprockets (see Figure 5-0.2-2).

shall: a word indicating a requirement.

should: a word indicating a recommendation.

trolley: a wheeled mechanism from which a hoist is suspended to provide horizontal motion of the hoist along a beam.

trolley speed: the rate of motion that a motor-operated trolley (and hoist) attains while traveling along a beam.

trolley suspended: suspension of a hoist from a trolley. The hoist can be connected to the trolley by hook, clevis, or lug suspension, or the hoist can be integral with the trolley.

valve: a device for starting, stopping, or changing the flow in a pneumatic circuit.

SECTION 5-0.3: REFERENCES

The following is a list of publications referenced in this Standard. The latest edition shall apply.

ANSI/NFPA 70, National Electrical Code
Publisher: National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02169-7471 (www.nfpa.org)

ASME B30.9, Slings
ASME B30.16, Overhead Underhung and Stationary Hoists
Publisher: The American Society of Mechanical Engineers (ASME), Two Park Avenue, New York, NY 10016-5990 (www.asme.org)

SECTION 5-0.4: APPENDICES

Nonmandatory Appendix A applies to the performance requirements for hoists used in marine and other applications. The requirements stated in Nonmandatory Appendix A are in addition to the requirements of ASME HST-5 and shall be specifically invoked.

Figure 5-0.2-1 Headroom, Lift, and Reach

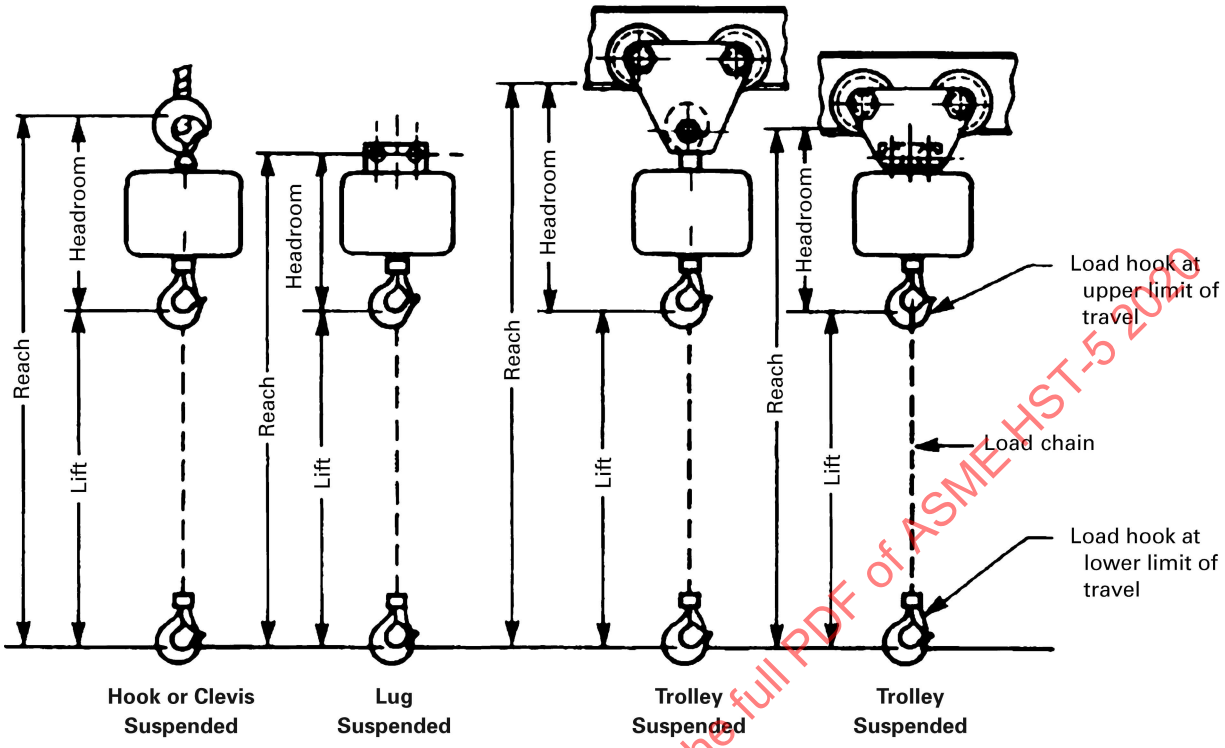
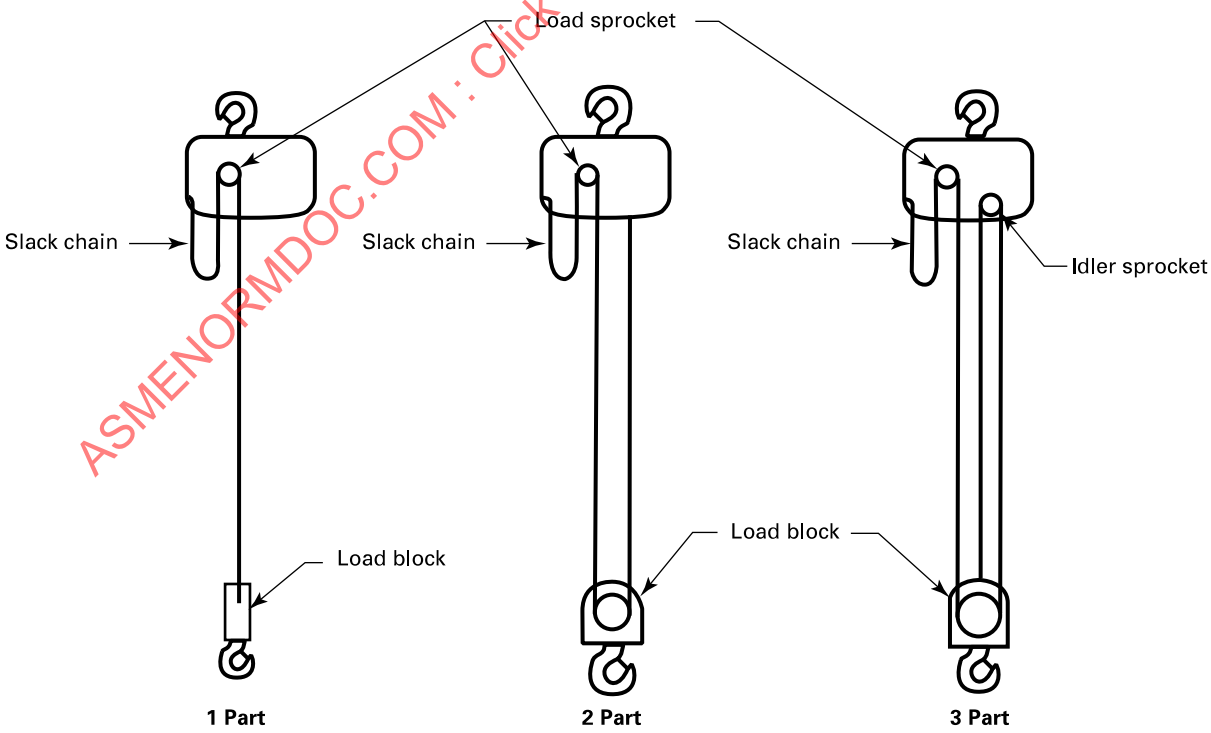


Figure 5-0.2-2 Reeving



Chapter 5-1
Performance

SECTION 5-1.1: GENERAL

All equipment selected in accordance with this Standard is designed to perform satisfactorily when used in accordance with ASME B30.16, Chapters 16-2 through 16-4, and within the rated load and hoist duty service classification. All equipment shall provide speeds, lifts, and headroom in accordance with the manufacturer's specifications or to specifications agreed upon by the manufacturer and user.

SECTION 5-1.2: HOIST DUTY SERVICE CLASSIFICATION

5-1.2.1 General Considerations

Service conditions have an important influence on the performance of wearing parts of a hoist such as gears, bearings, load chain, sprockets, brake linings, load and lift limit devices, wheels, and pneumatic components. Careful consideration of the hoist duty service classifications described in this Section will enable the user to evaluate the application and to obtain a hoist designed for optimum performance and minimum maintenance. If doubt exists regarding hoist selection, the hoist supplier should be consulted. Many factors enter into the selection of the proper hoist to perform a given function. Hoisting equipment consists of both mechanical and pneumatic components and both must be considered when analyzing the service the hoist must perform. The factors that influence the performance of any hoist include

(a) Load Distribution. The actual distribution or proportion of full and partial loads to be handled by the equipment, including lifting devices, has an important effect on the life of power transmission components. For example, ball bearing life varies according to the cube of the load. A 2-ton (1814.4-kg) hoist operated at a mean effective load of 1 ton (907.2 kg) will have a ball bearing life of eight times that of the same hoist used steadily at its rated load.

(b) Operational Time. Operational time is the total running time of the hoist per hour or per work period.

(c) Repetitive Long Lowering Operations. Such operations generate heat in mechanical load brake.

(d) Environmental Conditions. Examples are high or low ambient temperatures, dust, moisture, corrosive fumes, etc.

5-1.2.2 Hazardous Locations

When hoists are used in hazardous locations as defined by ANSI/NFPA 70 or other special codes, modifications or additional precautions not covered by this Standard may be required. In these locations, only hoists designed in a manner suitable for the conditions encountered shall be used.

5-1.2.3 Duty Classification

While all the factors listed in para. 5-1.2.1 must be considered in selecting the proper class of hoist, most industrial applications can be generalized according to the percentage of rated load normally handled and the running time. Listed in Table 5-1.2.3-1 are the two duty classes that have been established for air-powered chain hoists. The majority of hoist applications will fall into the A4 category.

Table 5-1.2.3-1 Air Chain Hoist Duty Service Classification

Hoist Duty Class	Description
A4	Loads normally less than 50% of rated load with running time up to continuous, or Loads normally above 50% of rated load with running time up to 50% of work period
A5	Loads normally above 50% of rated load with running time above 50% of work period

Table 5-1.4-1 Typical Hoist and Motorized Trolley Speeds

Rated Load		Hoist Speed, ft/min (m/min) [Note (3)]	Motorized Trolley Speed, ft/min (m/min) [Note (3)]
Tons (kg) [Note (1)]	Tonnes (kg) [Note (2)]		
⅛ (114)	⅛ (125)	16 to 100 (5 to 30)	30 to 100 (9 to 30)
¼ (227)	¼ (250)	7 to 100 (2 to 30)	30 to 100 (9 to 30)
½ (454)	½ (500)	7 to 100 (2 to 30)	30 to 100 (9 to 30)
1 (909)	1 (1 000)	7 to 100 (2 to 30)	30 to 100 (9 to 30)
1½ (1 364)	1½ (1 500)	4 to 40 (1 to 12)	30 to 100 (9 to 30)
2 (1 818)	2 (2 000)	4 to 40 (1 to 12)	30 to 100 (9 to 30)
3 (2 727)	3 (3 000)	4 to 40 (1 to 12)	30 to 100 (9 to 30)
4 (3 636)	4 (4 000)	4 to 24 (2 to 7)	30 to 100 (9 to 30)
5 (4 545) and over	5 (5 000) and over	4 to 24 (2 to 7)	30 to 100 (9 to 30)

GENERAL NOTE: This Table is to be used as a guide only and is not intended to restrict either the manufacturer or buyer from offering or specifying speeds outside the ranges shown, nor should it be inferred that speeds above or below the ranges shown are not compatible with the required class of hoist.

NOTES:
(1) Tons of 2,000 lb.
(2) Tonnes of 1 000 kg.
(3) Lifting and lowering speeds will vary depending on the percent of rated load. Lowering speeds are inherently greater than lifting speeds. Refer to manufacturer's catalog.

SECTION 5-1.3: SPECIFICATIONS OF LIFT, HEADROOM, AND REACH

5-1.3.1 Lift

Most air chain hoists are manufactured with standard lifts of 10 ft (3.1 m), 15 ft (4.6 m), and 20 ft (6.1 m). One of these standard lifts will normally be adequate for the particular requirement. It is recommended that the purchaser specify the required lift on his inquiry or bid request.

5-1.3.2 Headroom

Headroom should be specified if important to the application.

5-1.3.3 Reach

Reach should be specified if important to the application.

SECTION 5-1.4: SPEEDS — HOIST AND TROLLEY

Hoisting equipment is available over a wide range of hoist and trolley speeds. Listed in Table 5-1.4-1 are typical speed ranges commonly available.

NOTE: Table 5-1.4-1 is to be used as a guide only and is not intended to restrict either the manufacturer or buyer from offering or specifying speeds outside the ranges shown, nor should it be inferred that speeds above or below the range shown are not compatible with the required class of hoist.

SECTION 5-1.5: TROLLEYS

Hoist trolleys are available in plain, hand chain-operated, and motor-driven types. Selection of each type depends upon the application.

5-1.5.1 Plain Type

This type is recommended where trolley motion is infrequent or relatively short. Due to the required force to manually operate this type of trolley, it is also recommended that the use of plain trolleys be limited to a maximum load of 3 tons (3 000 kg) with the elevation of the beam not more than 20 ft (6 m) above the operator's floor level.

5-1.5.2 Hand Chain-Operated Trolleys

Motion is obtained by pulling on the hand chain that is connected to trolley wheels through gears or sprockets. This type is recommended where trolley motion is relatively infrequent or short and for those loads and beam heights where a plain-type trolley would be impractical.

The hand chain-operated trolley provides good load spotting ability.

The hand chain shall be guarded to prevent hand chain disengagement from the hand chain wheel.

The hand chain shall withstand, without permanent deformation, a force of three times the pull required to traverse the trolley with rated load.

5-1.5.3 Motor-Operated Trolleys

This type is recommended where the operating frequency, distance of travel, or the type of load being handled would cause unsatisfactory operation if the trolley were the plain or of the hand chain-operated type. Design of motor-operated trolleys shall be based on intermittent operation on a straight beam, unless otherwise specified. Where trolley travel involves a curved beam, beam switches, exceptionally long runs, or near continuous operation, a special design may be required, and full particulars should be provided with the inquiry.

Brakes, when specified, may be actuated by mechanical or pneumatic means, and shall have the following characteristics:

(a) sufficient capacity to stop the trolley within a distance in feet (meters) equal to 10% of the rated speed in feet per minute (meters per minute) when travelling at rated speed with rated load

(b) heat dissipation capability for the specified frequency of operation

(c) provisions for adjustment where necessary to compensate for wear

5-1.5.4 Trolley Wheels

When a trolley is required for use with a hoist, the type and size of support beam must be specified to ensure the trolley wheel contour is suitable for the contour of the beam.

5-1.5.5 Overload Limiting Device

An overload limiting device, when furnished, shall be designed to permit operation of the hoist within its rated load and to limit the amount of overload that can be lifted by a properly maintained hoist under normal operating conditions.

The overload limiting device may allow the lifting of an overload, but shall be designed to prevent the lifting of an overload that could cause damage to a hoist. That does not imply that any overload is to be intentionally applied to the hoist.

The overload limiting device is an emergency device and shall not be used to measure the maximum load to be lifted and shall not be used to sense the overload imposed by a constrained load.

5-1.5.6 Air Supply Characteristics

Air supply characteristics should be as specified by the hoist manufacturer. Refer to the technical manual provided with the hoist, or contact the hoist manufacturer for detailed information.

SECTION 5-1.6: CONTROL

Hoists and trolleys shall have pendant, pull, or rod control. Control actuators shall automatically return to the off position.

5-1.6.1 Pendant Control

The pendant control station shall be supported to protect the pneumatic hose and connections against strain. The pendant control station shall be clearly marked to indicate the function of each actuator. Unless otherwise specified, the standard pendant control shall have a length that will locate the pendant approximately 3 ft to 5 ft (0.9 m to 1.5 m) above the lower limit of lift.

5-1.6.2 Pull Control

Pull control shall consist of two pull chains or cords with suitable handle(s) clearly marked for direction. Unless otherwise specified, the standard pull control shall have a length that will locate the control handles approximately 3 ft to 5 ft (0.9 m to 1.5 m) above the lower limit of the lift.

5-1.6.3 Rod Control

Rod control shall permit control of hoist or trolley motion by linear or rotary movement of the rod handle, or a combination of both. The rod handle shall be clearly marked for direction of motion. Unless otherwise specified, the rod handle shall be located 3 ft to 5 ft (0.9 m to 1.5 m) above the lower limit of lift.

SECTION 5-1.7: TYPICAL AIR CHAIN HOIST AND TROLLEY INQUIRY DATA

See Form 5-1.7-1.

Form 5-1.7-1 Typical Air Chain Hoist and Trolley Inquiry Data Form

HOIST

Quantity required _____

Rated capacity _____ ton (_____ kg)

Lift [Note (1)] _____ ft (_____ m) Reach _____ ft (_____ m)

Headroom _____ in. (_____ mm)

Distance from operating floor to underside of beam or to support point:

_____ ft _____ in. (_____ m)

Hoisting speed _____ ft/min (_____ m/min)

Type of control:

☐ Pendant ☐ Pull ☐ Rod

☐ Other _____

Air supply pressure at hoist under normal operating conditions _____ psig

Performance Requirements (see Section 2):

Average lift _____ ft (_____ m)

Number of lifts/hr _____

Number of starts/hr _____

Shift hr/day _____

Hoist service classification A- _____

Furnish complete information regarding any abnormal operating conditions: _____

_____

_____

Type of Suspension:

☐ Lug ☐ Hook ☐ Clevis

☐ Plain trolley ☐ Hand chain operated trolley

☐ Motor operated trolley ☐ Other _____

TROLLEY (see para. 5-1.5)

Travel speed _____ ft/min (_____ m/min)

☐ Trolley brake required

Type of control:

☐ Pendant ☐ Pull ☐ Rod

☐ Other _____

Type and size of beam _____

Width of running flange _____ in. (_____ mm)

Minimum radius of beam curves

_____ ft _____ in. (_____ m)

Clearance dimensions of interlocks, switches, or beam splices (if used) _____

_____

_____

Muffler ☐ Yes ☐ No

OPTIONAL EQUIPMENT

_____

_____

_____

_____

_____

NOTE:
(1) Refer to manufacturer's catalog for standard lift that will meet the application requirement.

NONMANDATORY APPENDIX A
PERFORMANCE REQUIREMENTS FOR AIR CHAIN HOISTS USED IN MARINE AND OTHER APPLICATIONS AS REQUIRED BY THE U.S. DEPARTMENT OF DEFENSE (DOD)

A-1 GENERAL

A-1.1 Scope

This Appendix provides performance requirements beyond those cited in ASME HST-5 for air wire rope hoists for use in marine and other applications as required by the U.S. Department of Defense (DOD).

This Appendix, in conjunction with ASME HST-5, replaces the requirements of MIL-H-2813 and MIL-H-24591 for air chain hoists.

A-1.2 Classification

Air chain hoists shall be of the following classes and types as specified [see para. A-5.1(b)].

A-1.2.1 Classes

Class 1	Conventional weight, for general material handling
Class 2	Light weight, for general material handling

A-1.2.2 Types

Type A	Air chain hoist, hook suspension
Type B	Air chain hoist, plain trolley suspension, hand operated
Type C	Air chain hoist, geared trolley suspension, hand operated
Type D	Air chain hoist, geared trolley suspension, air-motor powered
Type E	Air chain hoist, geared trolley suspension, low headroom, air-motor powered

A-1.3 Definitions

brittle material: material showing less than 10% elongation in gage length for the tensile test specimen.

continuous operation: lifting and lowering through the full hoisting range a rated load at the specified lifting and lowering speeds.

excessive wear: wear that is sufficient to impair safe operation of the hoist. The following conditions define excessive wear:

(a) increase in chain wheel pocket dimension in excess of 10%
(b) increase in clearance tolerance between shaft and bearing in excess of 15%
(c) life-lubricated bearings requiring lubrication
(d) load brake lining reduced in excess of 50% of useful life
(e) reduction of bar diameter of link chain in excess of 10%
(f) reduction of wall thickness for rollers and pins of roller chain in excess of 10%
(g) reduction in gear tooth thickness of reduction gear drive in excess of 10%

mean time to repair: the average time it takes to fix a failed item. It is calculated by dividing the total corrective maintenance time by the total number of corrective maintenance actions during a specified measurement interval.

recovered materials: materials that have been collected or recovered from solid waste and reprocessed to become a source of raw materials, as opposed to virgin raw materials.

A-1.4 References to Other Codes and Standards

Refer to the following publications, copies of which may be obtained from the publisher as indicated. The edition bearing the latest date of issuance shall be used.

AGMA 6010, Standard for Spur, Helical, Herringbone, and Bevel Enclosed Drives
AGMA 6034, Practice for Enclosed Cylindrical Worm Gear Speed Reducers and Gear Motors
Publisher: American Gear Manufacturers Association (AGMA), 1001 North Fairfax Street, Suite 500, Alexandria, VA 22314 (www.agma.org)

ASTM A48, Standard Specification for Gray Iron Castings (DOD adopted)
ASTM A143, Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement (DOD adopted)
ASTM B26, Standard Specification for Aluminum-Alloy Sand Castings (DOD adopted)
ASTM B633, Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel (DOD adopted)
Publisher: American Society for Testing and Materials (ASTM International), 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959 (www.astm.org)

MIL-DTL-917, Detail Specification: Electric Power Equipment, Basic Requirements for
MIL-S-901, Shock Tests, H.I. (High-Impact) Shipboard Machinery, Equipment, and Systems, Requirements for
MIL-STD-167-1, Mechanical Vibrations of Shipboard Equipment (Type I — Environmental and Type II — Internally Excited)
MIL-STD-740-1, Airborne Sound Measurements and Acceptance Criteria of Shipboard Equipment
MIL-STD-889, Detail Specification: Dissimilar Metals
Publisher: Department of Defense, Defense Logistics Agency (DLA), DLA Document Services, Building 4/D, 700 Robbins Avenue, Philadelphia, PA 19111-5094 (http://quicksearch.dla.mil)

A-2 PERFORMANCE REQUIREMENTS

A-2.1 General

Performance requirements shall be in accordance with ASME HST-5, and as specified in this Appendix.

A-2.2 Application

Metals susceptible to corrosion attack in a seawater environment shall be treated, plated, or painted to provide corrosion resistance. Assemblies containing dissimilar metals shall be protected against galvanic corrosion in accordance with MIL-DTL-917 and MIL-STD-889. If a metal is coated or plated, the coating or plating metal rather than the base metal shall be considered in metal-to-metal contact between parts that depend upon coating or plating for corrosion resistance.

When specified [see para. A-5.1(c)], hooks shall be zinc plated. Zinc plating shall be in accordance with ASTM B633, Type II, Class Fe/Zn 12. The hook throat safety device shall be constructed of noncorrosive material or treated for corrosion resistance.

When specified [see para. A-5.1(d)], the load chain shall be protected from corrosion by zinc plating in accordance with ASTM B633, Type II, Class Fe/Zn 12.

The safeguarding against and procedure for detecting embrittlement of zinc coating shall be in accordance with ASTM A143.

A-2.3 Characteristics

A-2.3.1 Type A, Air Chain Hoist, Hook Suspension. Type A hoists shall be in accordance with Table A-2.3.1-1 and the requirements specified herein.

A-2.3.2 Type B, Air Chain Hoist, Plain Trolley Suspension, Hand Operated and Type C, Air Chain Hoist, Geared Trolley Suspension, Hand Operated. Type B and Type C hoists shall be in accordance with Table A-2.3.2-1 and the requirements specified herein. Trolley track size shall be as specified [see para. A-5.1(e)].

Table A-2.3.1-1 Type A, Air Chain Hoist, Hook Suspension

Rated Load, ton [Note (1)]	Minimum Standard Lift, ft	Headroom, in.	Maximum Weight of Chain Hoists		Minimum Lifting Speed, ft/min
			Class 1, lb	Class 2, lb	
¼	8	14.5	68	48	40
½	8	15	68	48	30
1	8	18	100	61	19
1½	8	23.5	155	107	15
2	8	23.5	233	107	10
3	8	32	270	130	10
4	8	37	320	138	8
5	8	45	413	172	8
6	8	45	420	195	8
8	8	49	500	305	6
10	8	54	620	322	4
12	8	54	875	350	4
16	8	60	1,120	600	4
20	8	71	1,300	1,100	4

NOTE: (1) 2,000 lb/ton.

Table A-2.3.2-1 Types B and C, Air Chain Hoists, Plain and Geared Trolley Suspension, Hand Operated

Rated Load, ton [Note (1)]	Minimum Standard Lift, ft	Minimum Lifting Speed, ft/min	Standard Size of I-Beam, in.	Maximum Headroom, in.	Maximum Pull to Traverse Hoist, lbf		Minimum Radius of Track Curve, in.	Maximum Hoist Weight Less Track Clamp, lb			
								Type B		Type C	
					Plain Trolley, Type B [Note (2)]	Geared Trolley, Type C [Note (3)]		Class 1	Class 2	Class 1	Class 2
¼	8	40	5	14.5	15	...	21	137	118	275	...
½	8	30	5	15	20	5	21	137	118	275	...
1	8	19	6	18	40	10	21	240	170	284	205
1½	8	15	7	19.5	45	13	36	322	270	335	270
2	8	10	8	19.5	60	15	36	456	328	500	360
3	8	10	10	26.5	65	21	48	560	430	525	480
4	8	8	10	26.5	70	23	66	765	534	900	630
5	8	8	12	32	75	28	66	1,080	730	1,100	800
6	8	8	12	32	100	35	66	1,090	730	1,120	800

NOTES:
(1) 2,000 lb/ton.
(2) Direct pull on trolley (along direction of track when moving on straight level track).
(3) Pull on gear trolley hand chain (when moving on straight level track).

Table A-2.3.3-1 Type D, Air Chain Hoist, Geared Trolley Suspension, Air-Motor Powered

Rated Load, ton [Note (1)]	Maximum Hoist Weight, lb		Standard Lift, ft		Minimum Lifting Speed, ft/min [Note (2)]		Maximum Headroom, in.		Minimum Radius of Track Curve, in.
	Class 1	Class 2	Class 1	Class 2	Class 1	Class 2	Class 1	Class 2	
1	280	225	12	8	40	30	35	20	26
2	475	225	12	8	20	15	40	20	26
3	660	300	12	8	14	10	43	27.5	36
4	860	365	12	8	12	8	46	30	48
5	1,050	550	12	8	10	8	49	32	66
10	2,000	750	12	8	4	4	66	48	66

NOTES:
(1) 2,000 lb/ton.
(2) Minimum lift speed for fully opened control valve.

A-2.3.3 Type D, Air Chain Hoist, Geared Trolley Suspension, Air-Motor Powered. Type D hoists shall be in accordance with Table A-2.3.3-1 and the requirements specified herein. Type D hoists shall be equipped with a traversing air motor and controls for traversing the trolley. Trolley track size shall be as specified [see para. A-5.1(e)].

A-2.3.4 Type E, Air Chain Hoist, Geared Trolley Suspension, Low Headroom, 2,000-lb and 4,000-lb Rated Load, Air-Motor Powered. Type E air chain hoists shall be in accordance with Table A-2.3.4-1 and the requirements specified herein. Hoist projections, excluding chain basket, shall extend not greater than 15 in. below the underside of the track. No part of the hoist shall extend 4 in. above the bottom of the trolley track. Trolley track size shall be as specified [see para. A-5.1(e)].

A-2.3.5 Air Supply Characteristics. The air supply line shall connect to the hoist. The hoist shall be capable of operating with an air supply having the following characteristics:
(a) rated air gauge pressure 90 psi
(b) a maximum moisture content of 0.002 lb of water per pound of dry air at 60°F and 90 psi absolute
(c) solid particle contamination limited to 25 μm
(d) a minimum of one drop of atomized lubrication for every 10 cfm of air

A-2.3.6 Interchangeability. In no case shall parts be physically interchangeable or reversible unless such parts are also interchangeable or reversible with regard to function, performance, and strength. Component parts for the same type of hoists from the same manufacturer shall be interchangeable to the greatest extent possible.

A-2.4 Manual Operation

When specified [see para. A-5.1(f)], means shall be provided for manual lowering and traversing of the hoist at rated load. To provide hand clearance for operator safety, the length and location of a hand crank shall provide for a minimum of 1 in. operational hand clearance measured vertically between the hand crank and the top of the smallest specified I-beam trolley track, track foundation, or hull structure. The force required on a crank to lower rated load shall not exceed 40 lbf. The load shall not lower unless the brakes are intentionally and manually released, or the hand crank is manually cranked.

Table A-2.3.4-1 Type E, Air Chain Hoist Requirements

Minimum Rated Load, ton	Minimum Lifting Speed, ft/min	Minimum Lift Range, ft	Maximum Weight, lb	Maximum Width, in.	Length, in.	Maximum Headroom, in.	Minimum Radius of Track, in.
1	25	8	185 [Note (1)]	12	26	6.5	26
2	16	8	185 [Note (2)]	12	26	6.5	26
3	10	8	225 [Note (1)]	12.5	31	9.5	36

NOTES:
(1) Excluding chain and hook.
(2) Excluding chain and hook. Cumulative weight of hoist, trolley, and hoist tractor units may total not greater than 225 lb with 8 ft of lift chain and hook, if readily disconnected.

Means shall be provided so that powered operation shall not be possible when the hand crank is removed from its stowage position.

A-2.5 Lubrication

Lubricants used shall be readily available and be free of ozone-depleting chemicals (ODC).

A-2.6 Painting

Paints and coatings shall be lead and chromate free.

A-2.7 Workmanship

The hoist shall withstand any operation specified herein without malfunction or component failure caused by faulty workmanship. Edges and surfaces exposed to operating and maintenance personnel shall be smooth and rounded so that a hazardous surface does not exist.

A-2.8 Availability, Reliability, and Maintainability

The minimum acceptable inherent availability (Ai) of the hoist shall be 0.90. This requirement establishes threshold values for reliability, maintainability, and supportability of the hoist.

A-2.8.1 Reliability. The hoist shall operate for an average period of 3,000 continuous cycles without failure [this value of 3,000 mean cycles between failure (MCBF) is equivalent to 90 days of normal ship's operation without hoist failure].

A-2.8.2 Maintainability. Routine corrective maintenance at the organizational level shall be accomplished by replacing complete assemblies and subassemblies. Mean time to repair (MTTR) for the hoist shall be 4 hr. At least 95% of all corrective maintenance actions shall require no more than 10 hr to complete.

A-3 MECHANICAL REQUIREMENTS

A-3.1 Design Stress

Hoist mechanical components shall use the loading factors specified in para. A-3.1.1. The maximum combined stresses of mechanical components of the hoist, hoist tractor, and trolley shall not exceed 35% of the yield strength of the material used, when operating with rated load under 10-deg incline condition (see para. A-3.2). The maximum combined stress in structural and mechanical components under 15-deg incline condition (see para. A-3.2) shall not exceed 70% of the yield strength of the material used when the hoist or hoist tractor is subjected to maximum torque or braking conditions.

A-3.1.1 Loading Factor. Hoist components shall incorporate the following loading factors:
(a) dynamic loading based on inertial forces — 1.5 times rated load
(b) static loading based on inertial forces — 2.0 times rated load

A-3.2 Incline Consideration

Hoisting and traversing brakes shall be provided that shall hold the rated load on an incline of ±15 deg with the horizontal in any direction. The hoist shall operate on a ±10-deg incline with the horizontal in any direction, with rated load, at reduced speed, through the full lift range.

A-3.3 Frame or Housing

The frame or housing shall contain the hoist mechanisms including gears, sprockets, load chain stowage, spring reel for chain drum, hoist and trolley brakes, protection of air controls and piping, air motors, and other operating components. Hoist or frame side tilt shall be kept to a minimum when operating on the trolley rail. In case of any inclination of rail or effects of ship motion, no part of the hoist shall project above the top flange of the trolley rail. Means shall be provided to afford protection from damage due to bumping of two or more hoists on the same track. This protection may be provided through use of bumpers or inherent frame or housing features.

A-3.4 Hoist Drives

Hoist lift and Types D and E powered trolley drives shall be powered by a reversible air motor of enclosed construction that shall operate with air gauge pressures between 80 psi and 100 psi. The air motor shall have adequate power and starting torque and shall operate without perceptible vibration at any of the hoist loads or speeds within the rated load and speed capacity.

A-3.4.1 Hoist Lift. The hoist lift drive motor shall be coupled through a speed reducer or drive gear to the load chain sprocket.

A-3.4.2 Hoist Trolley. The hoist trolley air drive motor shall be coupled through drive gears to the trolley drive wheels, friction wheel, or positive drive sprocket wheel. For positive drive unit, the motor shall be coupled through a speed reducer to a chain sprocket for use on a 1-in. pitch single strand No. 80-1 RC-A standard roller chain welded to the bottom of the trolley track.

A-3.5 Hoist Load Lifting Medium

The hoist load lifting medium shall be a link chain or roller chain, as specified [see para. A-5.1(g)].

A-3.5.1 Link Chain. Link chain shall provide a safety factor not less than five for the hoist rated load based on the ultimate strength of the material.

A-3.5.2 Roller Chain. Roller chain shall be manufactured from an alloy steel. Each roller chain link shall be of uniform size and shape and shall seat properly in the hoist chain sprocket. The roller chain shall provide a safety factor of at least five for the rated load based on the ultimate strength of the material. The chain shall be securely attached to the hoist and easily removed.

A-3.5.3 Load Chain Stowage. Hoist construction shall include the means for stowing the full length of load chain in chain reels, bags, or baskets when the hook is in the "UP" position. Chain reels shall be provided for stowage of chain for 8 ft of lift. Bags or baskets shall be used for stowage of chain for lifts greater than 8 ft. The chain reel shall maintain a relatively constant tension force to prevent chain slack between the load sprocket and the chain stowage. Construction of load sprocket and load chain stowage shall provide a constant chain feed without binding or jamming in the chain guide, stowage, or hoist frame.

A-3.6 Load Hooks

Hook throat openings shall be in accordance with the dimensions shown in Table A-3.6-1. The hook shall be clearly marked with manufacturer identification and allowable hook load or allowable hook load designator. Positive means shall be provided to prevent the load hook from loosening due to rotation of the load.

A-3.6.1 Range of Load Hook. The hoist shall lift rated loads from any point within a 19-in. radius from an imaginary perpendicular under the chain sprockets to a horizontal plane 7 ft below the trolley track. The hoist shall lift rated loads at this offset range without binding or jamming of the load chain in the sprocket guide.

A-3.7 Construction

Rotating shafts shall be supported in antifriction bearings or bushings, or both, and shall be enclosed against entry of foreign matter. Rotating and sliding surfaces shall be lubricated. Hoists shall operate through a temperature range of −40°F to 140°F for a minimum of 3,000 cycles without a failure. Gears shall be totally enclosed in a readily accessible casing that will permit examination, servicing, and cleaning. Positive means shall be provided to prevent any component from working loose. Hoist parts shall be readily accessible for servicing and replacement as required. Airborne noise level shall be kept to a minimum (maximum MIL-STD-740-1, Grade D).

A-3.7.1 Controls. The speed of the motor shall be regulated. The controls shall vertically position a load within ±0.250 in.

A-3.7.2 Hoist Brake. The hoist brake shall be spring loaded, of the automatic operating type that shall stop hoist motion when the air pressure is reduced below the safe motor operating pressure. The hoist brake shall be self-adjusting or readily accessible for easy adjustment to compensate for wear of the brake lining. The hoist brake shall hold the test loads required from a stopped position and shall stop and hold rated loads without slipping. The brake shall be equipped with a manual release for use in the event of a loss of air pressure. Manual release mechanisms shall be arranged so that they can be operated without endangering the operator.