# DRAFT

BSR E1.6-2 – 20xx

Entertainment Technology—
Design, Inspection, and Maintenance of Electric Chain Hoists for the Entertainment Industry

Approved by the ANSI Board of Standards Review on _____

Rig/2019-2027r0

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**Published by:**

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**Observer (non-voting) members:**
Insert current Observer roster here.

**Interest category codes:**
CP = custom-market producer
DE = designer
DR = dealer rental company
G = general interest
MP = mass-market producer
U = user

## Table of Contents

## 1 Scope*

This standard covers the design, inspection, and maintenance of serially manufactured electric link chain hoists used in the entertainment industry. This standard does not cover attachment to the load or to the overhead structure. Controls used for multiple hoist operation are excluded from the scope of this standard.

(NB: Clauses marked with an asterisk * have an explanatory Annex note.)

## 2 Definitions

**2.1 chain dead end:** The attachment point at the hoist for the load bearing static end of the load chain on multiple-reeved hoists.

**2.2 competent person**: A person capable of identifying existing and predictable hazards in the surroundings or working conditions that are hazardous or dangerous to employees, and who is authorized to take prompt corrective measures to eliminate the hazards.

**2.3 dynamic load test:** A test of the hoist wherein a test load is applied to the hoist and, at a minimum, lifted the distance required to completely test the power transmission system.

**2.4 hook block assembly:** A mechanical device that attaches the hook to the load chain.

**2.5 hook throat opening:** The distance from the inside of the hook body to the inside tip of the hook at its narrowest point.

**2.6 lift wheel:** A powered sprocket device that produces movement of the load chain.

**2.7 link chain:** A chain consisting of a series of interwoven links formed and welded.

**2.8 load block:** The hook or shackle assembly, bearing, swivel, sprockets, sheaves, frame, and pins, suspended by the load chain.

**2.9 operational test:** Testing of the hoist in a no-load condition to check function of the operating mechanisms.

**2.10 power transmission system:** Machinery components of the hoisting machine that transfer load, including the gears, shafts, clutches, couplings, bearings, motors, and if applicable brakes.

**2.11 qualified person:** A person who by possession of a recognized degree 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.

**2.12 serially manufactured:** Indicating a specific manufacturing process in which the same facilities and procedures are used to produce a series of identical products for general use, each containing unique, permanently applied sequential alphanumeric identification marks, all of which are permanently recorded by the manufacturer for traceability, and for which the manufacturer's established operational design criteria and quality assurance procedures for any single unit are equally applicable to all other units of the series.

**2.13 service:** Usage.

## 3 Minimum Design Criteria

### 3.1 General

**3.1.1** Hoists shall be designed so that they may be configured for use in either a hoist up or hoist down orientation.

**3.1.2** Applicable design and performance standards should be considered in the hoist design.

**3.1.3** Any modifications to modernize, upgrade, or rerate the hoist shall be authorized by the original hoist manufacturer or by a qualified person.

**3.1.4** Any replacement parts or additions shall be approved by the manufacturer or by a qualified person. Cosmetic changes to the hoist's non-load bearing parts are permitted under this standard.

**3.2 Mechanical Design**

**3.2.1** The hoist shall be designed to withstand all stresses associated with normal operating conditions and rated loads, including the self-weight of the hoist.

**3.2.2** The hoist shall be designed such that, under full rated load, no component is stressed more than 20% of the minimum ultimate strength as determined by empirical testing, or 15% of the minimum ultimate strength as calculated.

**3.2.3** Load suspension parts shall not exceed 20% of the average ultimate material strength for the calculated static stress of the rated load.

**3.2.4** The manufacturer shall establish fatigue requirements such that fatigue failure shall not occur and shall ensure that the system is designed so that the fatigue requirements are not exceeded.

**3.2.5** Gears shall be designed based on the highest loading generated by the load path.

**3.2.6** The design of power transmission parts shall be such that the dynamic stresses calculated for the hoist's rated load shall not exceed the manufacturer's established fatigue and endurance limits.

**3.3 Lift Wheel**

**3.3.1** The lift wheel shall be constructed with chain pockets or teeth to engage the load chain.

**3.3.2** The lift wheel shall have a guard.

**3.3.3** Hoist shall be constructed to prevent binding of the load chain inside the hoist while operating under normal conditions.

**3.4 Chain Design**

**3.4.1** Chain shall be designed based on the highest stress generated anywhere along the load path.

**3.4.2** Chain pitch shall be designed to prevent binding when chain passes over lift wheels and sheaves.

**3.4.3*** Chain manufacturer shall proof test welded link type load chain using a load of at least 1 ½ times the hoist's rated load divided by the number of chain parts supporting the load.

**3.4.4** When more than one part of the load chain is supporting a load, the tension on all parts shall be equal.

3.4.5 Chain must be permanently labeled for identification as being fit for use per the hoist manufacturer's requirement.

**3.5 Chain End Fitting**

**3.5.1** The end fitting attached to the load chain shall swivel to prevent twisting of the load chain.

**3.5.2** Load blocks shall be enclosed, and shall be designed in such a manner as to prevent chain jams within the block under normal operating conditions.

### 3.6 Hook Design

**3.6.1** The hook shall be designed to deform, elongate, or otherwise yield in a clearly visible manner prior to its ultimate failure.

**3.6.2** The hook shank and all restraining components shall be designed to yield at values higher than the hook yield point.

**3.6.3** The hook shall be provided with latches unless the use of a latch poses a hazard in normal usage.

**3.6.4** Hooks of the swivel type shall be able to rotate freely.

### 3.7 Overload Protection Device

The hoist shall have an overload protection device that prevents the hoist from lifting a load greater than the hoist manufacturer's recommended overload capacity.

### 3.8* Overtravel Protection

Design and construction of the hoist shall ensure that the upper limit of travel will not be exceeded by a load hook, whether it is empty or loaded.

Design and construction of the hoist shall ensure that travel will be limited such that no unsafe condition shall occur.

### 3.9 Brake Design

**3.9.1** The brake shall not exert a force in the load path that exceeds the established fatigue requirements.

**3.9.2** The brake shall stop and hold the load when the application of power is terminated by either the control system or by complete loss of power to the system.

**3.9.3** The brake shall be capable of adjustment to compensate for wear and to maintain the manufacturer's specified gap.

### 3.10 Lubrication

Hoist lubrication points shall be accessible.

### 3.11 Power Failure Protection

Interruption of power to the hoist during operation shall not result in the loss of support of the load.

### 3.12 Electrical Design

**3.12.1** The electrical design and construction of the hoist shall be compliant with NFPA 70, Article 610 - Cranes and Hoists-2017.

**3.12.2** Electrical design shall be such that live components are protected against accidental contact under normal operating conditions.

**3.12.3** If resistor enclosures are used, they shall have a thermal dissipation capacity that meets or exceeds the hoist's thermal load. Resistor enclosures shall be designed to prevent buildup of combustible material, and shall prevent broken or molten resistor parts from falling on personnel or on combustible material.

**3.12.4** If contactors are used, they shall be mechanically held normally open, and electrically closed.

Electrically closed contacts shall return to a normally open state when power is removed. To prevent line-to-line faults, contactors shall be mechanically or electrically interlocked.

**3.12.5** Electrical controls integral to the serially manufactured hoist design shall permit electrical current flow and hoist operation only in accordance with the manufacturer's operational design criteria.

## 4 Inspections and Testing

The requirements set forth in this section establish minimum criteria for inspection and testing. Manufacturer requirements shall be followed in addition to those listed here.

### 4.1 Service Classifications

All operations shall be performed within the duty cycle of the hoist as determined by the manufacturer. One day's use equals at least one lifting operation per day.

**4.1.1 Severe Service:** Hoist operates in abnormal operating environments, such as but not limited to excessive heat, weather, and caustic environments or as identified by the manufacturer.

**4.1.2 Normal Service:** Hoist operates more than 25 days a year but not in severe service conditions.

**4.1.3 Standby Service:** Hoist operates 25 or fewer days per year but at least once per year.

**4.1.4 Rental Service:** Hoist is operated on an irregular schedule determined by rental use. A hoist that is offered for rental shall have the items listed in table 4.2.2(frequent inspections) inspected prior to its next use or rental. Additionally, an inspection of the items listed in table 4.2.3 (periodic inspections) shall be performed annually.

**4.1.5 Out of Service:** Hoist does not operate for a period of a year or longer. Out of Service hoists shall be tagged with the hoist serial number and the date removed from service. Prior to reintroduction into service, all the inspection items in table 4.2.3 shall be inspected on the hoist.

### 4.2 Inspection Requirements

#### 4.2.1 General

All inspections shall conform to the manufacturer's recommended procedures. Regular inspection procedures shall be maintained to identify and replace worn or damaged parts, and to ensure continuous, satisfactory operation of the hoist. Each inspection shall include looking at and listening to the general operation and performance of the hoist. Specific inspection method and frequency shall be based on the hoist's service classification.

#### 4.2.2 Frequent inspections

Inspections shall be performed by a competent person following the items listed in Table 4.2.2. Records of such inspections are recommended.

| TABLE 4.2.2 | | | | | |
|---|---|---|---|---|---|
| SERVICE CLASSIFICATIONS | | | | | ITEM |
| Severe | Normal | Stand By | Rental | Out of Service | |
| Weekly to Monthly | Monthly | Every 3 Months | Prior to Next Use or Rental | Prior to Reintroduction into Service | Hoist braking system for proper operation |
| | | | | | Hooks and attachment hardware for correct assembly, damage, cracks, twists, excessive throat openings, latch engagement, and latch operation |
| | | | | | Load chain for adequate lubrication, signs of wear, damaged links, corrosion, or foreign matter |
| | | | | | Load chain for proper reeving and twists |
| | | | | | Limit switches for function, if equipped |
| | | | | | Evidence of lubricant leakage |
| | | | | | Electrical cords, grommets, connectors, cables, and control station enclosure (if applicable) for damage or wear |
| | | | | | Signs of impact damage to housing, cracked covers |

**4.2.3 Periodic inspections**

Inspection shall be performed by a qualified person following the items listed in Table 4.2.3. Records of this inspection shall be recorded and retained for a minimum of 36 months after the hoist is taken out of service.

| TABLE 4.2.3 | | | | | |
|---|---|---|---|---|---|
| SERVICE CLASSIFICATIONS | | | | | ITEM |
| Severe | Normal | Stand By | Rental | Out of Service | |
| Every 3 Months | Yearly | Yearly | Yearly | Prior to Reintroduction in Service | All items listed in Table 4.2.2 for frequent inspections. |
| | | | | | Evidence of loose screws, bolts or nuts. |
| | | | | | Evidence of worn, corroded, cracked or distorted hook block body, suspension screws, gears, bearings, chain dead end and chain pin. |
| | | | | | Evidence of damage or excessive wear of the lift wheel and hook block sheave chain pockets. |
| | | | | | Link by link inspection of the chain for evidence of excessive interlink wear and damage. |
| | | | | | Evidence of chain guide wear or damage where the chain enters the hoist. |
| | | | | | Evidence of excessive wear and/or damage of brake parts. Proper brake adjustment. |
| | | | | | If the hoist is equipped with a reversing contactor, inspect contactors for functionality and free operation of the interlock. |
| | | | | | |
| | | | | | Check bearings for excessive wear or damage. |
| | | | | | Suspension components for damage, cracks, wear and correct operation. |
| | | | | | |

### 4.3 Testing

**4.3.1** An operational test of the hoist shall be performed before a load test of that hoist.

**4.3.1.1** Lifting and lowering functions shall be tested under no-load conditions. (Testing through complete rated lift length is not required).

**4.3.1.2** Brake(s) operation shall be tested under no-load conditions.

**4.3.2** Dynamic load testing shall be at 125% of the hoist's rated capacity, if approved by the manufacturer. If the operation of an overload protection device prevents lifting a 125% load, then
the load shall be reduced to the rated capacity and the test completed. If the manufacturer prohibits load testing at 125% of the rated capacity, the load testing shall be done with the load specified by the manufacturer.

**4.3.3** Testing of the overload protection device shall be performed according to the manufacturer's recommendations.

**4.3.4** Dynamic load testing shall be required whenever a load bearing component, as identified by the manufacturer is altered, repaired, or replaced.

**4.3.5** Hoists shall be load tested no less than one time per year, with records of the test recorded.

**4.3.6*** The replacement of load chain is specifically excluded from requiring dynamic load testing; however, an operational test shall be made prior to returning the hoist to service.

## 5 Maintenance

**5.1** Maintenance shall be in accordance with the manufacturer's written documentation.

**5.2** Dated records of repairs and maintenance shall be kept on file.

## 6 Labeling and Identification

The manufacturer shall affix the following items to the hoist:

### 6.1 Rated capacity

The rated lifting capacity of the hoist shall be stated.

### 6.2 Serial number

The unique serial number identifying the individual hoist shall be permanently affixed to the main hoist section. The manufacturer shall maintain serial records as part of their permanent files.

### 6.3 Electrical specifications

The electrical specifications, including the operating voltage(s), current draw either in amps or kilowatts, hertz, and phase(s).

### 6.4 Connector information

The connector type and contact configuration of the hoist shall be stated.

### 6.5 Lifting speed

The nominal rate at which the hoist will lift a load when operated on the specified operating voltage(s) at the specified hertz shall be stated.

### 6.6 Standard compliance

The identification label affixed to the hoist shall state compliance with this standard.

**6.7 Contact information**

Contact information shall include the manufacturer or the manufacturer's representative and information sufficient to allow contacting this party.

**7 Documentation**

**7.1** Manufacturer shall provide a maintenance and operation manual. Manuals shall include information on operation, inspection, repair maintenance, lubrication and testing.

**7.2** The hoist owner shall affix documentation to the hoist indicating the date of the last periodic service performed.

**Annex Notes**

**Scope** – This document is a minimum American National Standard. European standards use different parameters for hoists in the entertainment industry.

**E3.4.3** Proof testing of hoist load chain is performed as part of the manufacturing process of the chain. Proof testing of load chain is not used as a method testing the condition of the chain after it has been put into use. Chain proof testing is conducting at the chain manufacturing level.

**E3.8** There are a variety of means to limit the travel of a hoist, including but not limited to the use of electrical contact type limit switches, physical stops on the load chain, position feedback encoders, and slip clutches. It is up to the manufacturer of the hoist to design the method for their product.

**E4.3.2** By the nature of performing a dynamic load test, a load holding test of the brake will be performed in the normal course of the test. During a dynamic load test the operator will lift a load, stop the hoist, and then reverse the hoist to bring the load down. As the dynamic load test will normally be at 125% of the hoist's rated load, the brake will be tested at the same level.

**E4.3.6** Dynamic load testing of hoists is typically done with the chain very close to the upper limit of its travel, with less than 10 feet of chain being in use during the test. A dynamic load test that tested an entire length of chain would require a testing facility with the means to perform the load test with the hoist at its lower travel, in a straight path. The purpose of a dynamic load test is to verify the condition and load bearing capability of the load bearing components. The condition of load chain is best determined through a physical inspection. If the manufacturer identifies the chain end fitting as a load bearing component, then the hoist is subject to the testing requirements of 4.3.4.