



## INTRODUCING MMA

Founded in 1933, **The Monorail Manufacturers Association, Inc. (MMA)** is an independent incorporated trade association affiliated with the Material Handling Industry. The membership of MMA is made up of companies which produce the preponderance of patented and enclosed track underhung cranes and monorail systems.

MMA operates through committees with programs and policies reviewed and adopted by the membership with representation from each member company. Its many activities include an active engineering committee. MMA is represented on a number of standards developing committees and actively supports the development and certification of safety standards by the ANSI consensus method.

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### **Our Members**

MMA member companies are the recognized leaders in the marketplace and the subject matter expert's. The members are concerned, conscientious manufacturers affiliated in an industry association to provide voluntary standards for the mechanical, structural and electrical design of patented and enclosed track underhung cranes and monorail systems and to formulate guidelines for the proper use, operation and maintenance of these equipment and systems.

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### **Our Association**

MMA is a member driven organization. To qualify for Membership, you must manufacture industrial monorail equipment or as a partial manufacturer of industrial monorail equipment for at least three (3) years. Member companies of MMA meet regularly to review, discuss and revise the standards for design, performance and proper operation. MMA member companies have committed to the development, maintenance and publishing of industry standard specifications.

Additionally, MMA has prepared, published and distributes Training, Inspection and Maintenance recommendations that are available to all users.

The MMA sponsored the Specifications for Patented Track Underhung Cranes and Monorail Systems (MH27.1) and the Specifications for Enclosed Track Underhung Cranes and Monorail Systems (MH27.2) in the interest of improved uniformity of patented track and enclosed track underhung crane and monorail performance and enhanced public safety.

The Occupational Safety and Health Administration (OSHA) recently announced an alliance with the Monorail Manufacturers Association (MMA), the Crane Manufacturers Association of America (CMAA) and the Hoist Manufacturers Institute (HMI). The purpose of this alliance is to provide monorail systems, crane and hoists owners and operators with information, guidance, and access to education and training resources that will advance their workplace safety and health.

Member companies participate in a requisite number of regularly scheduled meetings which among other things further the ongoing process of revising and updating today's standards to meet the ever-changing demands of technology and the modern industrial environment.

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MH27.2 – 2003



# Specifications for Enclosed Track Underhung Cranes and Monorail Systems



An Affiliated Trade Association of  
Material Handling Industry of America  
A Division of Material Handling Industry  
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Charlotte, NC 28217-3992

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**ANSI MH27.2 – 2003**

**American National Standard**

# **Specifications for Enclosed Track Underhung Cranes and Monorail Systems**

**Monorail Manufacturers Association, Inc. (MMA)**

An Affiliated Trade Association of Material Handling Industry of America,  
A Division of Material Handling Industry

**Approved September 10, 2003**

American National Standards Institute, Inc.

## **Disclaimer**

This standard, which was developed under the ANSI Canvass method and approved by ANSI on September 10, 2003, represents suggested design practices and performance testing criteria for crane and monorail equipment. It was developed with the sole intent of offering information to parties engaged in the manufacture, marketing, purchase, or use of crane and monorail equipment. This standard is advisory only and acceptance is voluntary and the standard should be regarded as a guide that the user may or may not choose to adopt, modify, or reject. The information does not constitute a comprehensive safety program and should not be relied upon as such. Such a program should be developed and an independent safety adviser consulted to do so.

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## **Foreword** (This foreword is not part of American National Standard MH27.2-2003)

This standard was sponsored by the Monorail Manufacturers Association, Inc. in the interest of improved uniformity of patented track underhung crane and monorail performance and enhanced public safety. Since the intention of this standard is to encourage better communication between the manufacturer and the user, it should be regarded as a guide rather than a rigid specification.

This standard has been subjected to the American National Standards Institute's Canvass Review and approved as an ANSI Standard September 10, 2003 as MH27.2-2003.

The following organizations recognized as having an interest in the standardization of enclosed track underhung crane and monorail systems were contacted prior to approval of this standard. Inclusion in this list does not necessarily imply that the organization concurred with the submittal of the proposed standard to ANSI.

American Fabricators & Engineers  
Baroid Drilling Fluids  
Cincinnati Incorporated  
Columbus McKinnon Corporation  
Dupont Engineering  
Fluor Federal Svcs. M/S E6-15  
G.S. Safety Consultants  
Mannesman Dematic Corp.  
Meridian Engineering & Technology, Inc.  
MHAM  
TC/American Monorail, Inc.  
Underwriters Laboratories, Inc.  
Unified Industries, Inc.  
United Water  
U.S. Air Force  
Van Dorn Demag Corporation

At the date of approval of this standard, the Monorail Manufacturers Association, Inc. consisted of the following member companies:

Acco Chain & Lifting Products  
Assembly Technology & Test, Inc.  
Columbus McKinnon Corporation (CM)  
Demag Cranes & Components Corporation  
Gorbel, Inc.  
Ingersoll-Rand Co.  
Siemens Dematic Material Handling Automation Division  
Spanco, Inc.  
TC/American Monorail Inc.  
Trambeam Corporation  
Unified Industries  
United States Monorail, Division of American Crane and Hoist Corp.

Suggestions for improvement, and questions regarding interpretation of this standard will be welcome. They should be sent to: MH 27.2 Committee (MMA), Material Handling Industry of America, 8720 Red Oak Blvd., Suite 201, Charlotte, NC, 28217-3992 or [standards@mhia.org](mailto:standards@mhia.org).



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## SPECIFICATIONS FOR ENCLOSED TRACK UNDERHUNG CRANES AND MONORAIL SYSTEMS

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## SPECIFICATIONS FOR ENCLOSED TRACK UNDERHUNG CRANES AND MONORAIL SYSTEMS

### SECTION 1 – Scope

- 1.1 These specifications apply to underhung cranes whose end trucks operate on the internal flange of a runway using enclosed track section; and to trolleys (carriers) operating on single-track monorail systems, including all curves, switches, transfer devices, lift and drop sections, and associated equipment. Systems used for transporting personnel require special considerations and are not included in these specifications.
- 1.2 Hoist(s) and/or trolley(s) may be supplied by the crane or monorail manufacturer or by the purchaser. In either case, the hoist(s) and trolley(s) shall comply with the applicable sections of ASME B30.16, Safety Standard for Overhead Hoists (Underhung); ASME 30.11, Safety Standard for Monorails and Underhung Cranes, and appropriate ASME HST Performance Standards. If the hoist(s) and/or trolley(s) are supplied by the purchaser, the crane builder shall be provided with dimensional drawings with all required data including wiring diagrams, carrier collector locations and weights.
- 1.3 This specification includes consideration for cranes and monorail equipment only. It does not include consideration for the design of the building, the design of supporting structure, electrical power supply, or erection. All references to loads and dimensions are based on English units unless otherwise noted.
- 1.4 Sections 1 through 14 are for use in normal ambient temperatures and atmospheric conditions; any other conditions require special consideration.

### SECTION 2 – Referenced Specifications and Standards

Within the text, reference is made to the following publications, copies of which may be obtained from the publishers as indicated.

*Manual for Steel Construction, 9<sup>th</sup> Edition, 1989*

*Publisher:*

American Institute of Steel Construction, Inc.  
1 East Wacker Drive, Suite 3100  
Chicago, IL 60601

*Specifications for Aluminum Structures (1986)*

*Publisher:*

The Aluminum Association, Inc.  
818 Connecticut Avenue, N.W.  
Washington, DC 20006

ANSI Z244.1-1982, *Personnel Protection – Lockout/Tagout of Energy Sources – Minimum Safety Standards*

*Publisher:*

American National Standards Institute, Inc.  
11 West 42<sup>nd</sup> Street, 13<sup>th</sup> Floor  
New York, NY 10036

ANSI/ASCE 7-88-1990, *American Society of Civil Engineers Minimum Design Loads for Buildings and Other Structures*

*Publisher:*

American Society of Civil Engineers  
345 East 47<sup>th</sup> Street  
New York, NY 10017

ASME B15.1 – 1992, *Safety Standard for Mechanical Power Transmission Apparatus*

ASME B30.9 – 1990, *Slings*

ASME B30.10 – 1993, *Hooks*

ASME B30.11 – 1993, *Monorails and Underhung Cranes*

ASME B30.16 – 1993, *Overhead Hoists (Underhung)*

ASME B30.20 – 1993, *Below-the-Hook Lifting Devices*

ASME HST-1M – 1989, *Performance Standard for Electric Chain Hoists*

ASME HST-2M – 1989, *Performance Standard for Hand Chain Manually Operated Chain Hoists*

ASME HST-4M – 1991, *Performance Standard for Electric Wire Rope Hoists*

ASME HST-5M – 1991, *Performance Standard for Air Chain Hoists*

ASME HST-6M – 1986, *Performance Standard for Air Wire Rope Hoists*

*Publisher:*

The American Society of Mechanical Engineers  
United Engineering Center  
345 East 47<sup>th</sup> Street  
New York, NY 10017

ASME Order Department  
22 Law Drive  
Box 2300  
Fairfield, NJ 07007-2300

ANSI/AWS D1.1-96, *Structural Welding Code – Steel*

ANSI/AWS D1.2-90, *Welding Code – Aluminum*

ANSI/AWS D14.1-85, *Specification for Welding Industrial and Mill Cranes and Other Materials Handling Equipment*

*Publisher:*  
American Welding Society  
550 N.W. LeJeune Road  
Miami, FL 33126

ANSI/NFPA 70-1996, *National Electric Code 1996*

*Publisher:*  
National Fire Protection Association  
Batterymarch Park  
Quincy, MA 02269

NEMA Standards Publication No. ECS6 – 1993, *Industrial Control and Systems: Enclosures*

ANSI Z535.1 – 1991, *Safety Color Code*

ANSI Z535.3 – 1991, *Criteria for Safety Symbols*

ANSI Z535.4 – 1991, *Product Safety Signs and Labels*

*Publisher:*  
National Electric Manufacturers Association  
1300 N. 17<sup>th</sup> Street, Suite 1847  
Rosslyn, VA 22209

ANSI Z241.2 – 1989, *Safety Requirements for Melting and Pouring of Metals in the Metal Casting Industry*

*Publisher:*  
American Foundrymen's Society  
505 State Street  
Des Plaines, IL 60016

## **SECTION 3 – Duty Service Classification**

- 3.1** Duty service classifications have been established to enable the buyer to specify the most economical trolley (carrier) or crane for a particular installation. To determine proper service classification or equipment, it should be noted that there are three possible basic modes of operation to be considered. These modes are crane (bridge) travel, trolley (carrier) travel, and hoist travel. Trolleys (carriers) or cranes are affected by operating conditions. Such conditions are high ambient temperatures, dust, moisture, corrosive fumes, etc. Unless otherwise specified, trolleys (carriers) and crane shall be designed to operate in ambient temperatures between 0° and 104°F (-18° and 40°C) and in atmospheres reasonably free from dust, moisture, and corrosive fumes.

Unless otherwise specified, trolleys (carriers) and cranes shall be designed for "Duty Service" as defined in Table 1.

**3.2** Service conditions have an important influence on the performance of wearing parts such as bearings, wheels, etc.

Careful consideration of the duty service classifications described in the Section will enable the user to evaluate the application and to obtain a trolley (carrier) or crane designed for optimum performance and minimum maintenance. If doubt exists regarding selection, the manufacturer should be consulted. Many factors enter into the selection of the proper equipment to perform a given function. Trolley (carrier) and crane equipment consists of both mechanical and electrical components and both must be considered when analyzing the service the equipment must perform.

<b>TABLE 1 DUTY SERVICE CLASSIFICATION</b>	
<b>DUTY SERVICE</b>	<b>DESCRIPTION</b>
Infrequent Usage (Light Service)	This service covers equipment or systems which are used infrequently and operational time does not exceed 20% of the work period.
Frequent Usage (Heavy Service)	This service shall be one of two situations: A. System or equipment where operational time is up to 100% of work period and lifted load is 50% or below of rated capacity. B. System or equipment is used where operation time is less than 50% of work period and lifted load is greater than 50% of rated capacity.
Severe Usage (Continuous Service)	This service covers systems or equipment where the operational time is consistently greater than 50% of the work period and lifted load is consistently greater than 50% of the rated capacity. Note: Applications involving vacuums, magnets, or other high impact lifting devices fall within this classification category.

The factors that influence the mechanical and electrical performance include:

**3.2.1 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 all components. For example, ball bearing life generally varies inversely according to the cube of the load.

**3.2.2 Operation Time**

Operational time is the total running time per hour.

**3.2.3 Work Distribution**

This is predetermined by whether the operation time is uniformly distributed over the work period or concentrated in a short time span. Work distribution generally does not appreciably affect mechanical wear, but may materially affect other system components.

**3.2.4 Hazardous Locations**

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

**3.2.5 Mean Effective Load**

Mean effective load denotes a theoretical single load value which has the same effect on the equipment as various loads actually applied to the equipment over a period of time.

K is the mean effective load factor and is expressed as:

$$K = \sqrt[3]{W_1^3 P_1 + W_2^3 P_2 + W_3^3 P_3 + W_n^3 P_n}$$

Where:

K = mean effective load factor. Mean effective load factor is the ratio of the mean effective load to the rated load.

W = Load Magnitude. Load magnitude is the ratio of the equipment operating load to the equipment rated load. Operation with no load shall be included along with the weight of any dead load such as lifting attachments or devices.

P = load probability. Load probability is the ratio of the running time under each load magnitude condition to the equipment total running time. The sum total of all load probabilities used in the above equation shall equal 1.0.

**3.2.6 Randomly Distributed Loads**

Randomly distributed implies that loads applied to the equipment are assumed to be evenly distributed within the rated load of the equipment in decreasing steps of 20% of the previous load value. Random loads are, therefore, considered as 100, 80, 64, 51, 41, 33, 26, etc., % of rated load.

Operation with random loads is considered on an equal time basis for the operating time remaining after accounting for the time the equipment is operating at no load and rated load. Randomly distributed loads will result in mean effective load factor of 0.65.

**SECTION 4 – General Specifications****4.1 Design Criteria**

**4.1.1** The following limitations of stress provide a margin of strength to allow for variations in the properties of materials, manufacturing methods, operating conditions, and design assumptions; and under no condition should imply authorization or protection for users loading the crane beyond its rated capacity.

**4.1.2** Castings, forgings, stampings, and other mechanical load-bearing parts, with the exception of structural members shall be designed with an allowable stress not to exceed 20% of the minimum ultimate strength of the material. For Case 3 loadings (see Section 4.2.3) the allowable stress may be raised to 30% of the minimum ultimate strength of the material.

- 4.1.3** For the design stresses of track, runways, bridge girders, and end trucks, refer to Sections 6 and 9.
- 4.1.4** Structural members not specifically covered by this specification, members in compression, bracing members and compression flanges of long span bending members shall be designed in accordance with the AISC Specifications for Structural Steel for Buildings.
- 4.1.5** In the design of bridge girders, runway and monorail tracks, hanger rods and fasteners (bolts of SAE Grade 5 or equal may be used) subject to repeated load, consideration shall be given to the number of stress cycles, the expected stress range and stress category as contained in Appendix K-4, AISC Manual of Steel Construction, (Allowable Stress Design), 9<sup>th</sup> Edition.
- 4.1.6** All welding shall conform to ANSI/AWS D14.1 – Specification for Welding Industrial and Mill Cranes and other Material Handling Equipment or AWS D1.2 Welding Code - Aluminum. Where field welding of equipment is required, welding shall be in accordance with the manufacturer's recommendations. Where field welding to the building is required, it shall be done with the owner's permission and in accordance, as applicable, with ANSI/AWS D1.1 – Structural Welding Code-Steel or AWS D1.2 Welding Code – Aluminum.
- 4.1.7** Where two or more cranes operate on one runway or two or more trolleys (carriers) operate on a crane, monorail or a combination of transfer cranes, the maximum loading conditions on the runway, cranes, and monorail tracks shall be specified by stating the position of the loads. Means should be provided so that loads will not be positioned to exceed the design limitations set.
- 4.1.8** Requirements of ASME B30.11 – Safety Standards for Monorails and Underhung Cranes, shall be incorporated in equipment furnished under these specifications.
- 4.2 Rated Load**
- 4.2.1** The rated load of the trolley (carrier) or crane shall be the maximum load for which the trolley or crane is designed and built by the manufacturer. In determining the rated load, all handling and lifting devices shall be included as part of the load to be handled.
- 4.2.2** The rated load of the crane shall be marked in accordance with ASME B30.11 – Safety Standard for Monorails and Underhung Cranes.
- 4.2.3** The rated load of each hoist on a crane or monorail shall be marked in accordance with ASME B30.16 – Safety Standards for Overhead Hoists (Underhung).
- 4.3 Clearances**
- 4.3.1** Clearance shall be provided between the crane or monorail and any lateral or overhead obstruction. All factors that influence clearances, such as wheel float, truss sag, and bridge or trolley skewing shall be considered.
- 4.3.2** Where two non-interlocking cranes operate on parallel runways with no intervening walls or structures between them, there shall be clearance provided and maintained between the two cranes.

- 4.3.3** Where two cranes on parallel runways are designed for interlocking and transfer of the trolley (carrier), means shall be provided to maintain clearance between the cranes so that the interlocking ends of the crane girders do not strike each other when passing, and so that the interlocking ends of the crane girders do not strike a fixed interlocking crossover or spur track. Clearance between the ends of the crane bridge girders shall be no more than 1/8" (3 mm) for enclosed track.
- 4.3.4** Clearance shall be provided at the curves of a monorail system for swing of the load when negotiating the curve. Clearance shall be determined by giving due consideration to the trolley (carrier) design; size, weight, and speed of travel of the load; and the curve radius.
- 4.3.5** Clearances should take into account the length of load, hoists, and trolley (carrier).
- 4.4 Markings**
- 4.4.1** Rated load markings for cranes shall be in accordance with ASME B30.11.
- 4.4.2** Rated load markings for monorails shall be in accordance with ASME B30.11.
- 4.4.3** Rated load marking for hoists used on cranes and monorails shall be in accordance with ASME B30.16.
- 4.4.4** Warnings and other markings for cranes and monorails shall be in accordance with ASME B30.11/ANSI Z5.35.
- 4.4.5** Warnings and other markings for hoists used on cranes and monorails shall be in accordance with ASME B30.16/ANSI Z5.35.

## **SECTION 5 – Runway and Monorail Track**

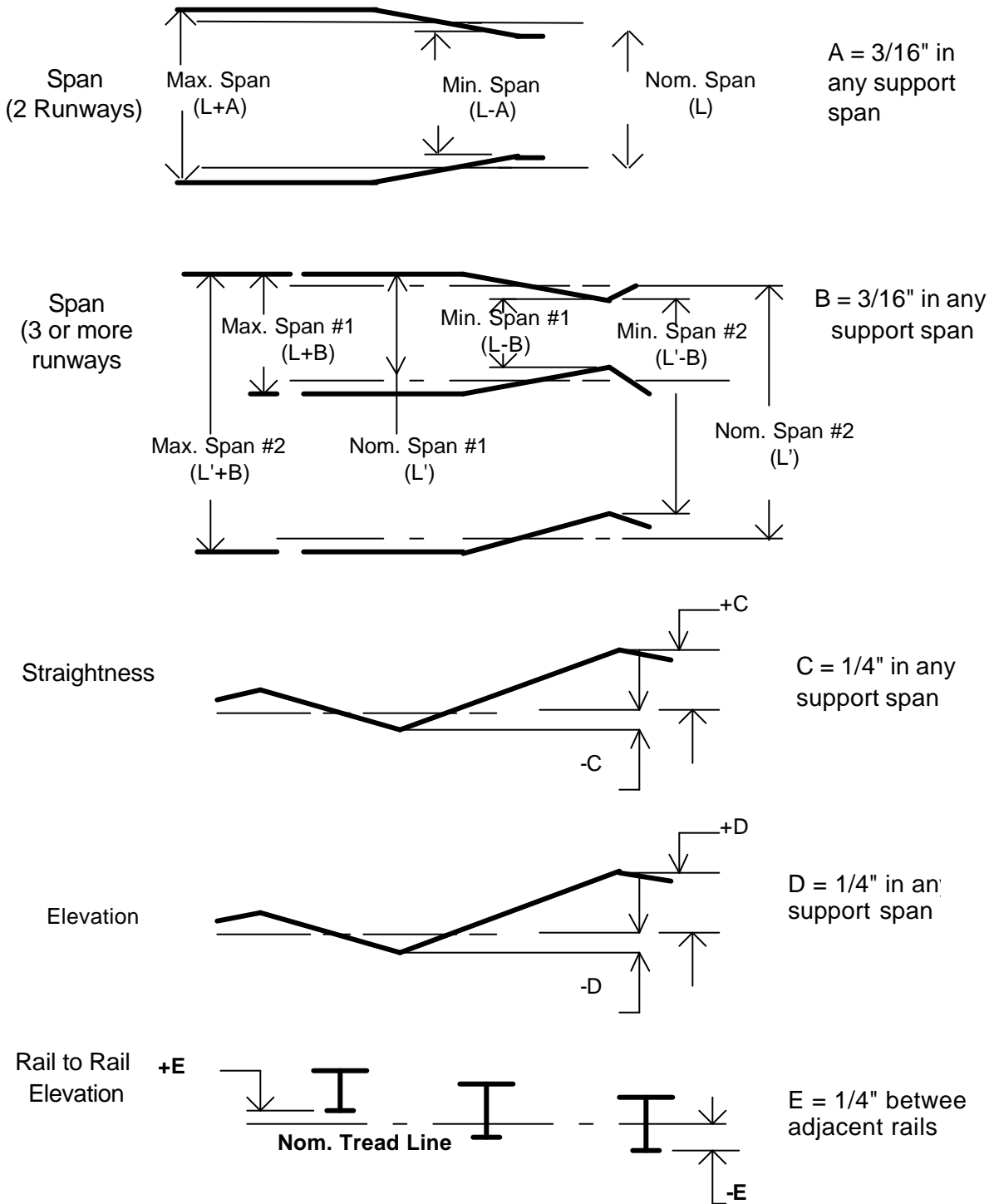
- 5.1** Track shall be specially rolled, extruded, or fabricated section.
- 5.2** The tread of the load carrying flange shall be compatible with the trolley (carrier) wheel.
- 5.3** The maximum vertical deflection of uncambered track produced by the dead load, the weight of hoist, carrier, crane bridge, and the rated load shall not exceed the individual track manufacturer's standard or 1-1/4" (32 mm), whichever is less. Impact shall not be considered in determining deflection.
- 5.4** Suitable splices shall be provided at all track joints. The maximum gap between ends of the load carrying flange shall not exceed 1/16" (1.5 mm).
- 5.5** Stops shall be provided at the ends of the trolley (carrier) and crane travel. Stops or forks shall be provided at open ends of tracks; such as interlocking cranes, track openers and track switches. Stops shall be provided to resist impact forces of a fully loaded trolley (carrier) or crane traveling at a normal walking speed or at 50% of the rated full load speed, if the trolley (carrier) or crane is motor driven.
- 5.6** Monorail curves shall be of such radius as to permit operation of the trolley (carrier) without binding. (Refer to Section 8.3)



- 5.7** Where track systems, directly attached to building structures, cross building expansion joints, provisions shall be made to accommodate for differential expansion of building and track. Expansion compensated for by appropriate hanger-rod swing is one possible provision.
- 5.8** Track straightness, center-to-center distance, and elevation shall be within the tolerance given in Table 2, unless the system is operable with other tolerances as established by the manufacturer. Track running-surface misalignment at joints, following installation and adjustment, shall not exceed 1/32" (1 mm).

## **SECTION 6 – Track Loadings and Design**

- 6.1** Runway and monorail track shall be a specially rolled, fabricated, or extruded section and shall be considered as a simple beam in determining capacity. In determining the capacity of the tracks, the load on the load-carrying flange shall be assumed to be at the point central within the wheel tread. Allowable wheel loads shall take into account the stress imposed on the lower load-carrying flange when a carrier transfers from one track to another. Where track sections are diagonally cut at transfers, the wheel loads shall be limited by the stress imposed on the lower load-carrying flange. When considering horizontal forces on the track, they should be applied through the shear center of the track section, unless track is restrained torsionally.
- 6.1.1** Track is subjected to different loading conditions that vary with the application of the equipment and track. These loading conditions are divided into three different cases. Standard designs shall be based on Case 1. Designs that include considerations of Cases 2 and 3 shall be specified by the purchaser.
- 6.2 Case 1 – Principal Loads**  
Case 1 loadings shall consist of applicable loads as follows:
- a) track dead load,
  - b) carrier dead load,
  - c) crane dead load,
  - d) lifted or live load, and
  - e) lifted or live load impact factor.
- 6.2.1 Track dead load**  
The weight of the track and the weight of any fixed machinery or structure supported by the track.
- 6.2.2 Trolley dead load**  
The weight of the trolley (carrier) unit including the hoist or other components that are part of the trolley (carrier) unit.
- 6.2.3 Crane dead load**  
The weight of the crane unit including all components that are part of the crane unit.
- 6.2.4 Lifted or live load**  
The lifted or live load consists of the rated or working load and the weight of any lifting devices used for handling and holding the working load.



**Figure 1 – Runway Alignment Tolerance**

**6.2.5 Lifted or live load impact factor**

This factor applies to powered hoists only and shall be included in the design of all components of the crane or monorail system.

The impact factor should be 1/2% of the rated or working load for each foot per minute (1.6% of rated or working load for each meter per minute) of hoisting speed with minimum factor value of 15% and a maximum factor value of 50%. For vacuum and magnet applications, a factor value of 50% shall be used.

Designs not in accordance with these standards may be specified.

**6.2.6 Case 2 – Principal plus additional Loads**

Case 2 loading shall include Case 1 loadings plus applicable loadings such as:

- a) operating wind load
- b) operating lateral load

**6.2.7 Operating wind load**

Lateral load due to wind, when applicable or specified, shall be considered as an operating load of 5 pounds per square foot of projected area unless higher wind forces are specified. Where multiple surfaces are exposed to the wind force, such as crane girder and auxiliary girder, and the horizontal distance between surfaces is greater than the depth of the member on the windward side, consideration shall be given to increasing the effective area exposed to the wind.

**6.2.8 Operating lateral load**

Lateral load due to any other forces as specified by the purchaser or determined by the manufacturer shall be considered as an operating load.

**6.2.9 Case 3 – Case 1 or Case 2 plus Extraordinary Loads**

Case 3 loading shall include Case 1 or Case 2 loading plus applicable loadings such as:

- a) stored wind load,
- b) collision load, and
- c) seismic load.

**6.3 Stored wind load**

Lateral load due to the maximum wind that the track and bridge is designed to withstand during an out-of-service condition.

**6.3.1 Collision load**

Load due to the inadvertent collision of two cranes or trolleys (carriers); or crane or trolley (carrier) and end stops or bumpers.

**6.3.2 Seismic load**

Load due to specific seismic conditions. If required, seismic accelerations to the track shall be in accordance with section 6.1 and shall be specified by the owner.

The allowable stress levels under conditions of these loadings shall be applied in accordance with section 6.3.5.

- 6.3.3** The allowable stress in the tack shall be limited by the loading case that is considered. Case 1 and Case 2 loadings are considered operating conditions, while Case 3 loading is considered an extraordinary event. Under Case 3 conditions, the equipment is expected to withstand the loading conditions, however, may not be operational after the event occurs.
- 6.3.4** Allowable stress on the track for Case 1 loading in Enclosed **Steel** Track shall not exceed 60% of the minimum yield strength of the material used. Refer to the AISC Manual of Steel Construction for additional design considerations. The allowable stress in Enclosed **Aluminum** Track shall not exceed 9.5 ksi or 65.5MP<sub>2</sub>. Refer to the Aluminum Association Specification for Aluminum Structures for additional design considerations.
- 6.3.5** Allowable stress on the track for Case 2 loading in Enclosed **Steel** Track shall not exceed 66% of the minimum yield strength of the material used. Refer to the AISC Manual of Steel Construction for additional design considerations. The allowable stress in Enclosed **Aluminum** Track shall not exceed 9.5 ksi or 65.5MP<sub>2</sub>. Refer to the Aluminum Association Specification for Aluminum Structures for additional design considerations.
- 6.3.6** Allowable stress on the track for Case 3 loading in Enclosed **Steel** Track shall not exceed 75% of the minimum yield strength of the material used. Refer to the AISC Manual of Steel Construction for additional design considerations. The allowable stress in Enclosed **Aluminum** Track shall not exceed 9.5 ksi or 65.5MP<sub>2</sub>. Refer to the Aluminum Association Specification for Aluminum Structures for additional design considerations.

## SECTION 7 – Suspension Fittings

All necessary clamps, hanger rods, and other fittings from which a track is suspended shall be considered as part of the track system. Track hangers shall support the load resulting from the maximum loading condition. The allowable cross-sectional area for hanger rods shall be determined from the root area of the rod (minor diameter of threads).

- 7.1** Where the track is suspended from hanger rods, the track shall be braced laterally and longitudinally according to the manufacturer's standards to prevent damaging lateral loads.
- 7.2** Where the track is suspended from hanger rods, means shall be provided to prevent the hanger-rod nuts from backing off the rods.
- 7.3** Where multiple rods are used at a suspension point, consideration shall be given to the unequal load induced in the rods.
- 7.4** In the design of hanger rods, the allowable stress shall be in accordance with AISC Manual of Steel Construction.
- 7.5** The vertical tolerance for hanger rods shall depend on the manufacturer's standards.

## SECTION 8 – Carriers or Trolleys

- 8.1** Standard trolleys (carriers) for Enclosed Track shall be of the double axle type, and shall provide for uniform loading of the track flange.

- 8.1.1 Non-metallic wheels shall have a minimum durometer of D74.
- 8.1.2 Steel wheels shall not be used for load carrying devices in Enclosed **Aluminum** Track.
- 8.1.3 Wheel bearings shall be anti-friction precision type. Bearings shall be prelubricated and sealed or provided with fittings and seals or shields for pressure lubrication.
  - 8.1.3.1 Wheel bearings, applicable to "Duty Service Classification" as defined in Table 1, shall be provided.
  - 8.1.3.2 Bearing life shall be based on 75% of the wheel load (impact need not be included) and the full-rated speed of motor-propelled carriers or an assumed speed of 150 FPM (46 meter per minute) for manually-propelled carriers.
- 8.2 Motor-propelled trolleys (carriers) should be driven by a driving head mounted on the load bar of the load-carrying member with traction dependent on the wheel load of the driving heads, or by a tractor drive which provides traction by pressure of the driving wheel or wheels on the track. The pressure of the driving wheel or wheels on the tractor drive shall be adjustable.
  - 8.2.1 All gearing shall be made from material of adequate strength and durability to meet the requirements for the intended service class.
  - 8.2.2 All gearing shall have adequate lubrication.
- 8.3 The wheelbase of trolleys (carriers) that operate on monorail systems with curves shall be equal to or less than the radius of the smallest curve in the monorail system, not including curved track in switches.

## **SECTION 9 – Cranes, Transfer Cranes, and Interlocking Cranes**

- 9.1 Cranes shall be manually or motor propelled, and operate on two or more runways.
  - 9.1.1 Crane girders shall be designed in accordance with the provisions of Sections 5 and 6.
  - 9.1.2 Standard trolley (carrier) for Enclosed Track shall be of the double axle type, and shall provided for uniform loading of the track flange.
  - 9.1.3 Wheels shall be in accordance with the provisions of Section 8.1.1.
  - 9.1.4 Wheel bearings and bearing life shall be in accordance with the provisions of Sections 8.1.3, 8.1.3.1, and 8.1.3.2.
  - 9.1.5 Lugs shall be provided on end trucks to limit drop of the end truck to 1" (25 mm) or less in the event of wheel or axle failure. Lugs shall be located to provide central loading of the track about the vertical axis if failure occurs.
  - 9.1.6 Ratio of crane span to end-truck wheelbase shall be as follows:
    - 9.1.6.1 Where bridge girder is rigidly attached to the end truck and horizontal guide rollers prevent skewing of the end truck, maximum ratio shall be 26:1.
    - 9.1.6.2 Where bridge girder is pinned to the end truck and the crane is a push pull (manually operated) type, maximum ratio shall be 105:1.

- 9.1.7** Stops shall be provided at ends of girders in accordance with the provisions of Section 5.5.
- 9.1.8** Motor-propelled cranes shall be driven by individual driving heads or tractor drives mounted on or attached to end trucks which provide traction by pressure of the driving wheels on the track. Drives shall be in accordance with the provisions of Sections 8.2, 8.2.1, and 8.2.2.
- 9.1.9** On double-girder cranes, means shall be provided to maintain the gauge of the girders.
- 9.1.10** Interlock mechanisms for transfer and interlocking cranes shall maintain alignment of crane girder or girders with spur tracks, fixed transfer sections or crane girders of interlocking cranes operating on adjacent runways to permit the transfer of a carrier from one to the other.
- 9.1.10.1** Interlock mechanisms shall limit load-carrying flange misalignment to a maximum of 1/8" (3 mm).
- 9.1.10.2** Stops or forks shall be an integral part of the interlock mechanisms. When girders and spur tracks or transfer sections are aligned and interlock mechanisms are engaged, stops or forks shall be in the open position and permit transfer of carrier from one to the other. When girders and spur tracks or transfer sections are not aligned and/or interlock mechanisms are disengaged, stops or forks shall be in the closed position and prevent carriers from rolling off the end of spur tracks, transfer sections, or crane girders.
- 9.1.10.3** Transfer and interlocking cranes, spur tracks, and fixed transfer sections shall have a maximum gap of 1/8" (3 mm) between adjacent ends of the load-carrying flange.

## **SECTION 10 – Track Switches**

- 10.1** Track switches shall be of the tongue, rotary, or sliding type. They shall maintain alignment of the incoming tracks and switch tracks, with a maximum gap of 1/16" (1.5 mm) between adjacent ends of the load-carrying flanges. Misalignment shall not exceed 1/16" (1.5 mm). Switches may be operated by mechanical-, electric-, pneumatic- or hydraulic-operated devices.
- 10.2** Stops shall be provided as an integral part of the switch to protect the end of an incoming track when the switch track is not aligned with the incoming track, and shall resist the impact forces of a fully loaded trolley traveling at a normal walking speed or at 50% of the full-load speed, if the trolley is motor propelled. Guards shall also be provided to prevent a trolley (or carrier) on the movable track from running off the movable track, when it is not aligned with an incoming track.
- 10.3** Means shall be provided to hold the movable frame during passage of trolleys (or carriers) through the track switch.

## **SECTION 11 – Track Openers**

- 11.1** Hand-operated or automatic track openers shall be provided where it is necessary to open a section of track to allow for closing of sliding or curtain-type fire doors. These devices shall open the track and allow the door to close either by hand operation or as a result of the parting of a fuse in the event of a fire. The gap between the adjacent track and track opener shall be no more than 1/8" (3 mm) for enclosed track. Forks or stops designed per paragraph 5.5 shall be provided to prevent a trolley (or carrier) from running off either of the open ends of the track when the movable section is not in alignment with the track.

## **SECTION 12 – Vertical Drop or Lift Sections**

- 12.1** Vertical drop or lift sections shall maintain alignment of the stationary track(s) and the movable tracks(s) with a maximum gap of 1/8" (3 mm) for enclosed track, between adjacent ends of the load-carrying flanges.
- 12.2** When sections are operated by electric, pneumatic or hydraulic power, means shall be provided to limit the vertical travel of alignment of the movable track with the stationary track(s). Misalignment between the movable track and stationary tracks shall not exceed 1/16" (1.5 mm).
- 12.3** Stops shall be an integral part of the movable track and shall prevent a trolley (carrier) from running off either end of the movable track when the movable track is not in alignment with the stationary track(s). For enclosed track, the trolley (carrier) should be held centered in the movable track section prior to operation of this section.
- 12.4** Stops shall be an integral part of the stationary track(s) and shall prevent a trolley (carrier) from running off the open ends of the stationary track(s) when the movable track is not in alignment with the stationary track(s).
- 12.5** Clearance should take into account the length of the load, hoist, and trolley (carrier).

## **SECTION 13 – Cab-Controlled Carriers and Cranes (when provided)**

- 13.1** Enclosed Track is not used in these applications.

## **SECTION 14 – Brakes**

- 14.1** Brakes supplied for carrier or crane travel may be applied by mechanical, electrical, pneumatic, or hydraulic means. Brakes shall be in conformance with ASME B30.11 – Safety Standard for Monorails and Underhung Cranes.
- 14.2** Travel Holding Brakes, when provided, shall have a torque rating of at least 50% of the rated motor torque and be adjustable to a minimum of 25% of the rated motor torque.

## SECTION 15 – Electrical Equipment

- 15.1** Wiring and equipment shall comply with the provisions of Article 610, ANSI/NFPA 70 National Electric Code.
- 15.2** The maximum voltage for the system power supply shall be 600 volts for alternating current or 250 volts for direct current. The maximum control circuit voltage shall be 150 volts or A.C. or 250 volts for D.C.
- 15.3** Unless otherwise specified, all functions on floor-operated equipment shall be from a common pendant pushbutton station. The pushbutton station shall be suspended in a manner that will protect the electrical conductors against strain. Motion controls shall return to the off position when released by the operator.
- 15.4** Motors shall be rated on no less than a 30 minute basis with temperature rise in accordance with the latest NEMA standards for the class of insulation and enclosure. Designs not in accordance with these standards may be specified. Motors shall be of the type suitable for crane and hoist service and shall be provided with anti-friction bearings. Motor duty rating shall be suitable for the service class required.
- 15.5** Control systems may be magnetic, solid state, static, or in combination as specified. Crane and carrier controls shall be plain reversing unless otherwise specified. All reversing contactors shall be mechanically and electrically interlocked. Unless otherwise specified, controls shall be mounted in NEMA type 1 general-purpose enclosures (see section 1.4 for special applications).
- 15.5.1** Magnetic control shall have contactors of sufficient size for crane and hoist duty consistent with the horsepower and voltage of the motor or motors with which they are used.
- 15.5.2** Solid state power components such as thyristors, diodes, etc., shall be rated in accordance with the horsepower, voltage and time ratings of the motor or motors with which they are used.
- 15.5.3** Trolleys (carriers) and cranes with squirrel cage motors and single speed control should be provided with reduced torque starting through the use of solid state devices, autotransformers, resistors, fluid couplings, or electro-mechanical means.
- 15.5.4** Trolleys (carriers) and cranes with squirrel cage motors and multi-speed control should be provided with reduced torque in starting and changing from one speed to the other. Reduced torque may be provided through the use of solid state devices, autotransformers, resistors, fluid couplings, or electro-mechanical means.
- 15.5.5** Trolleys (carriers) and cranes with squirrel cage motors that use variable frequency drives with controlled acceleration and deceleration do not need reduced torque solid state devices, autotransformers, resistors, fluid couplings, or electro-mechanical means specified in sections 15.5.3 and 15.5.4.
- 15.5.6** Where more than one motor is employed on a crane, each motor shall have individual phase overcurrent protection. Where two or more motors operate a single carrier or crane and are controlled as a unit by one controller, the motors with their leads may be protected by a single overcurrent device.



- 15.6** A motor-circuit switch or circuit breaker shall be provided in the leads from the runway contact conductors on all electrically-powered cranes. Where this disconnecting means is not readily accessible from the crane operating station, means shall be provided at the crane operating station to open the power circuit to the crane motors, except as specified in Article 610 of ANSI/NFPA 70 National Electric Code. The continuous ampacity of the motor-circuit switch or circuit breaker shall be no less than 50% of the combined short-time ampacities of the motors, nor less than 75% of the sum of the short-time ampacities of the motors required for any single crane motion.

## SECTION 16 – Electrification

- 16.1** Where electrical equipment operates on a system, power shall be supplied by means of insulated contact conductors mounted parallel to the track. Conductors shall comply with the provisions of Article 610, ANSI/NFPA 70 National Electrical Code. Flexible cable may be used in lieu of rigid-type contact conductors.
- 16.2** Conductors shall be sized to carry the required current to the crane(s), when operating with rated load.
- 16.3** Collectors shall be of the wheel or shoe type and shall be designed to minimize sparking between the wheel or shoe and the contact conductor.

## SECTION 17 – Glossary

- 17.1 Ambient Temperature** – The temperature of the atmosphere surrounding the equipment.
- 17.2 Ampacity** – The current carrying capacity expressed in amperes.
- 17.3 Automatic Crane** – A crane that when activated operates through a preset cycle or cycles.
- 17.4 Automatic Dispatch Carrier** – A carrier that when activated operates through a preset cycle or cycles.
- 17.5 Balancer** – A suspended machinery unit that is used for lifting, lowering, or balancing a freely suspended (unguided) load.
- 17.6 Bearing Life** – B-10 Bearing Life – The B-10 bearing life of an anti-friction bearing is the minimum expected life, in hours, of 90% of a group of bearings that are operated at a given speed and loading.
- 17.7 Bridge Travel (Crane Travel)** – Crane movement in a direction parallel to the crane runway.
- 17.8 Bridge Girder (Crane Girder)** – Crane member on which carriers (trolleys) travel, horizontally mounted between and supported by the end trucks.
- 17.9 Building Structure** – The structural members of a building that support the building loads and on which the loads of crane or monorail equipment, and the material to be moved, will be imposed.

- 17.10 Brake** – A device other than a motor used for retarding or stopping motion by friction or power means.
- 17.11 Cab** – An operator's compartment attached to a crane or carrier. (Not applicable to Enclosed Track).
- 17.12 Cab-controlled** – Equipment controlled from an operator's cab. (Not applicable to Enclosed Track).
- 17.13 Carrier** – See Trolley.
- 17.14 Circuit Breaker** – A device to open and close a circuit by non-automatic means, and to open the circuit automatically on a predetermined overcurrent, without injury to itself when properly applied within its rating.
- 17.15 Clamp** – A type of suspension fitting used to support tracks from an overhead structure, which is fastened to the structure by mechanical means rather than welding or direct bolting.
- 17.16 Collectors** – Electrical contacting devices providing a path for current flow from stationary conductors to moving equipment.
- 17.17 Collector, Shoe** – The portion of a collector that makes contact by sliding on the conductor bar.
- 17.18 Collector, Wheel** – The portion of a collector that makes contact by rolling on the conductor bar.
- 17.19 Conductors, Insulated** – A bar with a non-conducting cover material to minimize accidental contact with the conductor, used to transmit an electrical current.
- 17.20 Control, Single Speed** – A drive control system providing one-speed operation in either direction.
- 17.21 Control, Multi-Speed** – A drive control system providing more than one-speed operation in either direction using multi-speed squirrel cage motors.
- 17.22 Control, Variable Speed** – A drive control system providing more than one-speed operation in either direction.
- 17.23 Control Voltage** – The voltage impressed on the control devices.
- 17.24 Controller** – A device by means of which the operator controls the speed, acceleration, torque and/or direction of motor-driven equipment.
- 17.25 Crane** – A machine for lifting and lowering a load, and moving it horizontally. Drives may be manual, power, or a combination of both.
- 17.26 Crane Girder** – See Bridge Girder.
- 17.27 Crossover (Fixed Transfer Section)** – A connecting track with an interlock mechanism on both ends, mounted between two interlocking cranes, used to transfer a carrier from one bridge girder to the other.

- 17.28 Curves** – Formed sections of track used to change the horizontal or vertical directions of carrier travel.
- 17.29 Disconnecting Means** – A device, or group of devices, or other means whereby the conductors of a circuit can be disconnected from their source of supply.
- 17.30 Double Girder Crane** – A crane having two bridge girders mounted between and supported from the end trucks.
- 17.31 Driving Head** – A motor-driven carrier head which is supported from and propelled by the load bearing wheels.
- 17.32 Drop Section (Lift Section)** – A mechanism that will permit a section of track(s) to be lifted or lowered out of alignment with the stationary track(s).
- 17.33 Electric Baffles** – Conductors wired to cut off electric power to approaching motor-driven equipment if track switches, drop sections, and other movable devices are not properly set for passage of equipment.
- 17.34 Electrically Interlocked** – An electrical device that prevents a short circuit when opposite controls are operated at the same time.
- 17.35 Electrification** – The track mounted conductor system by which the moving equipment receives its electrical power.
- 17.36 End Stop** – A device located at the end of the track or crane bridge to prevent the carrier from running off the end of the track or crane.
- 17.37 End Truck** – An assembly consisting of the truck frame and wheels that supports the crane girder(s) and allow movements along the runway.
- 17.38 Equipment Supplier** – The supplier of monorail and/or underhung crane systems under contract.
- 17.39 Fixed Cranes** – Cranes that are non-mobile. Jib cranes are classified as fixed cranes.
- 17.40 Fixed Transfer Section** - See Crossover.
- 17.41 Floor Controlled** – Motor propelled units that are controlled by an operator on the floor by means of pushbutton station suspended from the overhead equipment.
- 17.42 Fork** – A pivoting mechanical end stop portion of an interlock.
- 17.43 Gantry Crane** – A traveling crane similar to an overhead crane, except that the bridge for carrying the hoisting mechanism is rigidly supported on two or more legs running on fixed rails or other runway.
- 17.44 Gauge** – The center-to-center distance between the load-carrying flanges of the two crane girders of a double girder crane.
- 17.45 Guard** – A portion of a switch provided to prevent carriers from running off the open ends of the switch tracks in the event the switch is moved with the carrier on the inner frame of the switch.

- 17.46 Hanger Rod** – Steel rods that, together with other fittings, are used to suspend the track from the supporting structure.
- 17.47 Hoist** – A suspended machinery unit that is used for lifting or lowering a freely suspended (unguided) load.
- 17.48 Holding Brake** – A brake that automatically prevents motion when power is off.
- 17.49 Impact Allowance** – Additional hook load assumed to result from the dynamic effect of the live load.
- 17.50 Interlock Mechanism** – A mechanical device to lock together the adjacent ends of two cranes or a crane to a crossover or spur track to permit the transfer of carriers from one crane or track to the other.
- 17.51 Interlocking Crane** – A crane with an interlock mechanism on one or both ends enabling it to be mechanically locked to another crane, crossover, or spur track for the purpose of transferring a carrier from one to another.
- 17.52 Lift Section** – See Drop Section.
- 17.53 Load** – The total weight superimposed on the loadblock, hook, or trolley.
- 17.54 Load Bar** – A load-carrying member between trolleys or trolley heads.
- 17.55 Load Block** – The assembly of hook or shackle, swivel, bearing, sheaves, pins, and frame suspended by the hoist rope or load chain. This shall include any appurtenances reeved in the hoisting rope or load chain.
- 17.56 Load-Carrying Flange** – The lower flange of the track on which the load-bearing wheels roll.
- 17.57 Lug** – A mechanical device that is part of the truck/carrier frame, which will prevent the crane end truck or trolley from falling on the event of a wheel or axle failure.
- 17.58 Magnet** – An electromagnetic device carried on a hoist hook, used to pick up and carry loads magnetically.
- 17.59 Master Switch** – A device that controls the operation of contactors and auxiliary devices of an electric circuit.
- 17.60 Mechanically Interlocked** – A mechanical device that prevents operation of opposite controls at the same time.
- 17.61 Monorail** – A single run of overhead track on which trolleys (carriers) travel.
- 17.62 Motor Circuit Switch** – A switch, rated in horsepower, capable of interrupting the maximum operating overload current of a motor of the same horsepower rating as the switch at the rated voltage.
- 17.63 Normal Walking Speed** – A walking speed assumed to be 150 FPM (46 meters per minute).
- 17.64 Overhead Traveling Crane** – A crane that follows a fixed path on elevated runways.

- 17.65 Pulpit Controlled** – A unit operated from a fixed operator station not attached to the crane.
- 17.66 Pushbutton Station** – An electrical control device consisting of pushbutton-operated contacts in an enclosure used by the operator for control of the powered motions of the crane, carrier, hoist, and other auxiliary equipment.
- 17.67 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.
- 17.68 Radio Controlled** – A unit operated from a radio transmitter located at a point not mechanically attached to the device being controlled.
- 17.69 Rated Load** – The maximum load designated by the manufacturer or qualified person for which the crane or monorail system is designed and built.
- 17.70 Remote Controlled** – A unit operated from a control station located at a point not mechanically attached to the device being controlled.
- 17.71 Residual Magnetism** – The magnetic field remaining in a magnet after power has been removed.
- 17.72 Rotary Switch** – A track switch with a movable inner frame containing straight and/or curve sections of track. The inner frame can be rotated around a vertical axis to align these tracks with other tracks for routing carriers from one track to another.
- 17.73 Runway** – The track and support system upon which the crane travels.
- 17.74 Semi-Gantry Crane** – A traveling crane with one end of the bridge supported on one or more legs running on fixed rails or other runway and the other end of the bridge supported by a track running on an elevated fixed rail or runway.
- 17.75 Shall** – Indicates that the rule is mandatory and must be followed to comply with this standard.
- 17.76 Should** – Indicates that the rule is a recommendation, the advisability of which depends on the facts in each situation.
- 17.77 Simple Beam** – A structural member supported and unrestrained at each end and subjected to loads acting transversely to its longitudinal axis.
- 17.78 Sliding Switch (Glide Switch)** – A track switch with a movable inner frame containing straight and/or curved sections of track. The inner frame can be moved to align these sections of track with other tracks for routing carriers from one track to another.
- 17.79 Span** – The horizontal distance, center-to-center, of runway tracks.
- 17.80 Splices** – Mechanical devices used to join the adjacent end of track sections.
- 17.81 Spur Track** – A fixed track arranged to interlock with an adjacent crane girder to permit passage of carriers between the spur track and the crane.

- 17.82 Squaring Shaft** – A driven shaft that transmits torque to drive wheels operating on two or more tracks.
- 17.83 Stationary Track** – A fixed track attached to the building or supporting structure.
- 17.84 Stop** – A device to limit travel of a carrier (trolley) or crane.
- 17.85 Structural Supports** – Structural members provided for the support of runways or monorail track and switches.
- 17.86 Supporting Structure** – The structure used for the support of a monorail or crane system.
- 17.87 Suspension Fittings** – Fittings used to attach the track to the supporting structure.
- 17.88 Tagline** – An electrical conductor system employing flexible cables.
- 17.89 Tongue Switch** – A switch that contains one straight section of track, pivoted at one end, which can be rotated to various positions to align with other tracks for routing trolleys (carriers) from one track to another.
- 17.90 Track** – The structural member upon which the carrier or crane wheels operate.
- 17.91 Track, Enclosed** – A generic term referring to track used as crane girders, crane runways, and monorails; whose related equipment operates on the internal lower operating or running flange of such track. The track section is either a rolled and/or fabricated steel shape; or a rolled or extruded and/or fabricated aluminum shape. All enclosed track incorporates a lower operating or running flange shape, in relation to track size, having proprietary shape dimensions dependent upon the individual enclosed track manufacturer.
- 17.92 Track, Patented** – A generic term referring to track used as crane girders, crane runways, and monorails; whose related equipment operates on the external lower operating or running flange of such track. The track section is either a high-carbon, high-manganese rolled steel shape; or a composite fabricated steel section having a high-carbon, high-manganese rolled steel tee-section lower operating or running flange. All patented track, regardless of size or depth, incorporates a lower operating or running flange shape, having proprietary shape dimensions dependent upon the individual patented track manufacturer.
- 17.93 Track Joint** – The point at which two sections of track are joined together.
- 17.94 Track Opener** – A section of track arranged to lift or swing out of the line of the track to make an opening through which a door may pass.
- 17.95 Tractor Drive** – A motor-driven unit supported from wheels and propelled by drive wheel or wheels bearing on the underside of the track.
- 17.96 Trolley** – A unit that travels on the running flange of a monorail track or bridge girder used to support and transport a load.
- 17.97 Turntable** – A track device with a movable inner frame containing a straight section of track that can be rotated about its center with a loaded carrier on it to align the section of track with other tracks for routing of carriers from one track to another.

- 17.98 Underhung Crane** – A traveling crane with a movable bridge running on the lower flanges of an overhead fixed runway structure and carrying a movable or fixed hoisting mechanism.
- 17.99 Wall Crane** – A traveling crane having a jib with a movable or fixed hoisting mechanism and operating on a runway attached to the side walls or columns of a building.



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