PDHonline Course M245 (4 PDH)

Electric Overhead Traveling (EOT) Cranes and Hoists

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Electric Overhead Traveling (EOT) Cranes and Hoists

Course Content

PART – 1 GENERAL INTRODUCTION

In this section we discuss the following:

- General Overview
- Type of Overhead Cranes
- Basic Components
- Specifying an Overhead Crane
- Basic Crane Terminology

GENERAL OVERVIEW

Cranes are industrial machines that are mainly used for materials movements in construction sites, production halls, assembly lines, storage areas, power stations and similar places. Their design features vary widely according to their major operational specifications such as: type of motion of the crane structure, weight and type of the load, location of the crane, geometric features, operating regimes and environmental conditions.

When selecting an electric overhead traveling crane, there are a number of requirements to be taken into account.

1) What specifications, codes or local regulations are applicable?
2) What crane capacity is required?
3) What is the required span?
4) What is the lift required by the hoist?
5) What will be the duty cycle (usage) of the crane?
6) What is the hoist weight? Do you need the use of a second hoist on the bridge crane?
7) What is the hook approach required?
8) What length of runway system is desired?
9) What factors need to be considered in the design of runway and building structure?
10) What will the operating environment be (dust, paint fumes, outdoor, etc)?
11) What are the necessary crane and trolley speeds?
12) What is the supply voltage/phases/amperage?
13) What control system is desired?
14) Is there existing cranes on the runway?

15) What safety considerations are to be followed?

16) Consider maintenance aspects of the crane.

17) Consider other accessories such as lights, warning horns, weigh scales, limit switches, etc.

We will address these aspects one by one. But before we discuss further, let's have a general clarity of the terminology used in the overhead crane industry. We shall be discussing here only the Electric Overhead Traveling (EOT) Cranes.

TYPES OF ELECTRIC OVERHEAD CRANES

There are various types of overhead cranes with many being highly specialized, but the great majority of installations fall into one of three categories: a) Top running single girder bridge cranes, b) Top running double girder bridge cranes and c) Under-running single girder bridge cranes. Electric Overhead Traveling (EOT) Cranes come in various types:

1) Single girder cranes - The crane consists of a single bridge girder supported on two end trucks. It has a trolley hoist mechanism that runs on the bottom flange of the bridge girder.

2) Double Girder Bridge Cranes - The crane consists of two bridge girders supported on two end trucks. The trolley runs on rails on the top of the bridge girders.

3) Gantry Cranes - These cranes are essentially the same as the regular overhead cranes except that the bridge for carrying the trolley or trolleys is rigidly supported on two or more legs running on fixed rails or other runway. These "legs" eliminate the supporting runway and column system and connect to end trucks which run on a rail either embedded in, or laid on top of, the floor.

4) Monorail - For some applications such as production assembly line or service line, only a trolley hoist is required. The hoisting mechanism is similar to a single girder crane with a difference that the crane doesn't have a movable bridge and the hoisting trolley runs on a fixed girder. Monorail beams are usually I-beams (tapered beam flanges).

Which Crane should you choose – Single Girder or Double Girder

A common misconception is that double girder cranes are more durable! Per the industry standards (CMMA/DIN/FEM), both single and double girder cranes are equally rigid, strong and durable. This is because single girder cranes use much stronger girders than double girder cranes. The difference between single and double girder cranes is the effective lifting height. Generally, double girder cranes provide better lifting height. Single girder cranes cost less in many ways, only one cross girder is required, trolley is simpler, installation is quicker and runway beams cost less due to the lighter crane dead weight. The building costs are also lower.

However, not every crane can be a single girder crane. Generally, if the crane is more than 15 ton or the span is more than 30m, a double girder crane is a better solution.

The advantages and limitations of Single / double girder cranes are as follows:

Single Girder Cranes

- Single girder bridge cranes generally have a maximum span between 20 and 50 feet with a maximum lift of 15-50 feet.

- They can handle 1-15 tonnes with bridge speeds approaching a maximum of 200 feet per minute (fpm), trolley speeds of approximately 100 fpm, and hoist speeds ranging from 10-60 fpm.

- They are candidates for light to moderate service and are cost effective for use as a standby (infrequently used) crane.
- Single girder cranes reduce the total crane cost on crane components, runway structure and building.

Double Girder Cranes

- Double girder cranes are faster, with maximum bridge speeds, trolley speeds and hoist speeds approaching 350 fpm, 150 fpm, and 60 fpm, respectively.
- They are useful cranes for a variety of usage levels ranging from infrequent, intermittent use to continuous severe service. They can lift up to 100 tons.
- These can be utilized at any capacity where extremely high hook lift is required because the hook can be pulled up between the girders.
- They are also highly suitable where the crane needs to be fitted with walkways, crane lights, cabs, magnet cable reels or other special equipment.

EOT CRANE CONFIGURATION

1) Under Running (U/R)

2) Top Running (T/R)

Under running cranes

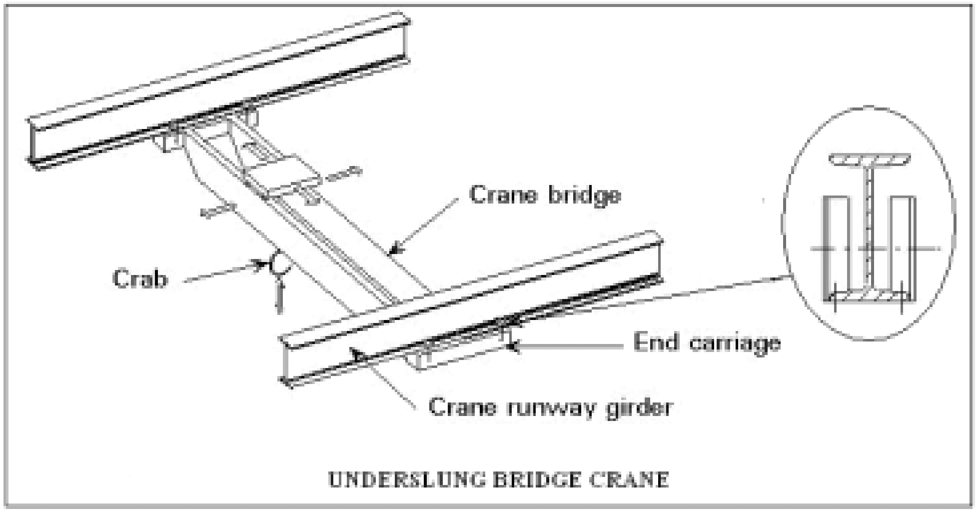
Under Running or under slung cranes are distinguished by the fact that they are supported from the roof structure and run on the bottom flange of runway girders. Under running cranes are typically available in standard capacities up to 10 tons (special configurations up to 25 tons and over 90 ft spans). Under hung cranes offer excellent side approaches, close headroom and can be supported on runways hung from existing building members if adequate.

The Under Running Crane offers the following advantages:

- Very small trolley approach dimensions meaning maximum utilization of the building's width and height.
- The possibility of using the existing ceiling girder for securing the crane track.

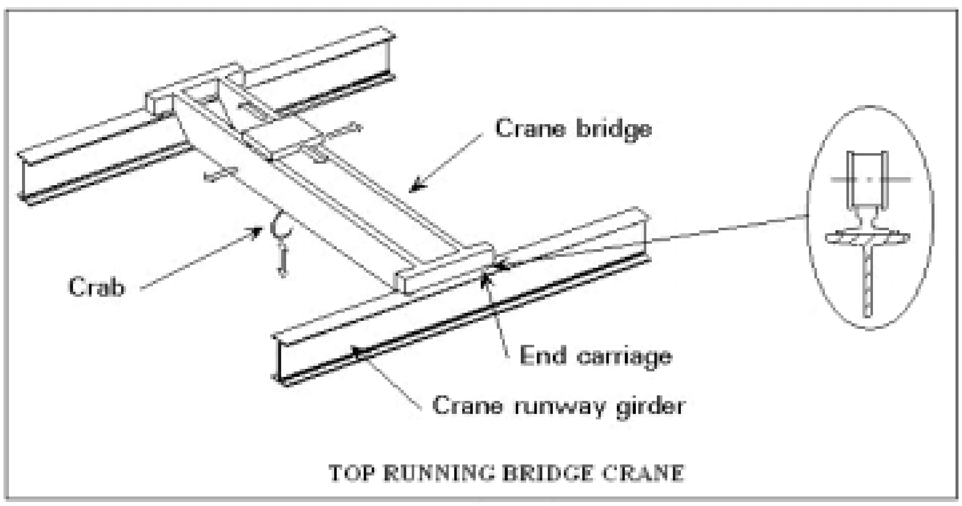
Following are some limitations to Under Running Cranes -

- Hook Height - Due to Location of the runway beams, Hook Height is reduced
- Roof Load - The load being applied to the roof is greater than that of a top running crane
- Lower Flange Loading of runway beams require careful sizing otherwise, you can "peel" the flanges off the beam



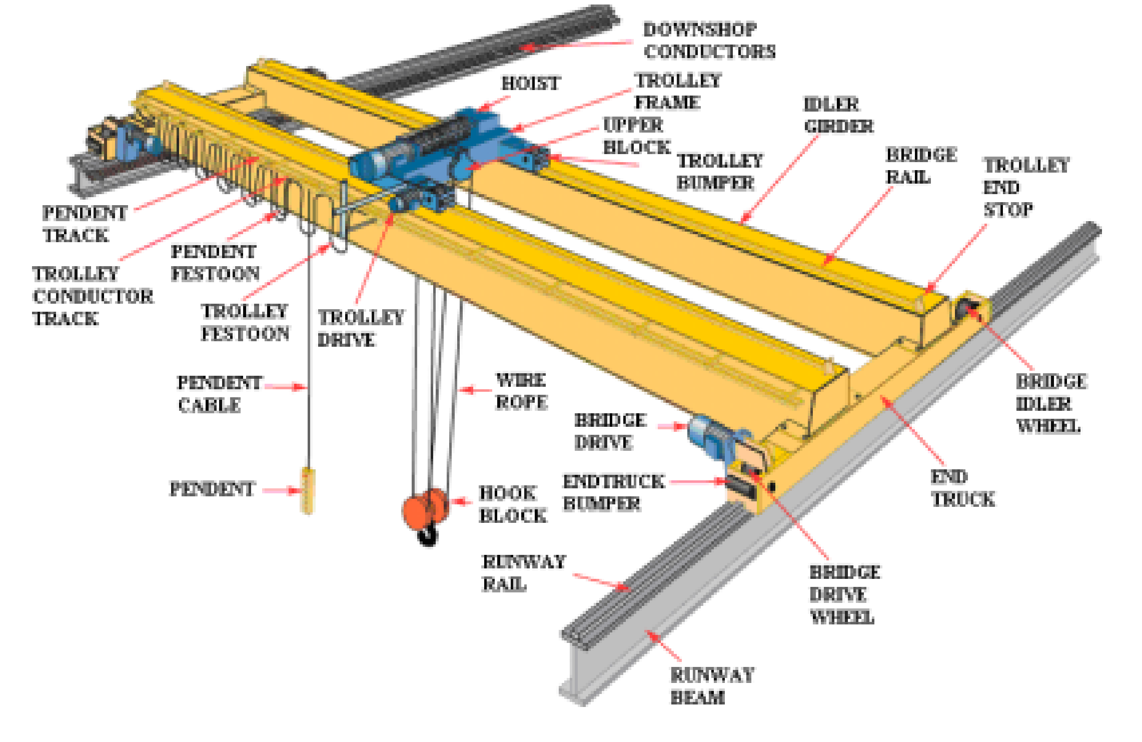
Top Running Cranes

The crane bridge travels on top of rails mounted on a runway beam supported by either the building columns or columns specifically engineered for the crane. Top Running Cranes are the most common form of crane design where the crane loads are transmitted to the building columns or free standing structure. These cranes have an advantage of minimum headroom / maximum height of lift.



BASIC CRANE COMPONENTS

To help the reader better understand names and expressions used throughout this course, find below is a diagram of basic crane components.



TOP RUNNING DOUBLE GIRDER CRANE

1) Bridge - The main traveling structure of the crane which spans the width of the bay and travels in a direction parallel to the runway. The bridge consists of two end trucks and one or two bridge girders depending on the equipment type. The bridge also supports the trolley and hoisting mechanism for up and down lifting of load.

2) End trucks - Located on either side of the bridge, the end trucks house the wheels on which the entire crane travels. It is an assembly consisting of structural members, wheels, bearings, axles, etc., which supports the bridge girder(s) or the trolley cross member(s).

3) Bridge Girder(s) - The principal horizontal beam of the crane bridge which supports the trolley and is supported by the end trucks.

4) Runway - The rails, beams, brackets and framework on which the crane operates.

5) Runway Rail - The rail supported by the runway beams on which the crane travels.

6) Hoist - The hoist mechanism is a unit consisting of a motor drive, coupling, brakes, gearing, drum, ropes, and load block designed to raise, hold and lower the maximum rated load. Hoist mechanism is mounted to the trolley.

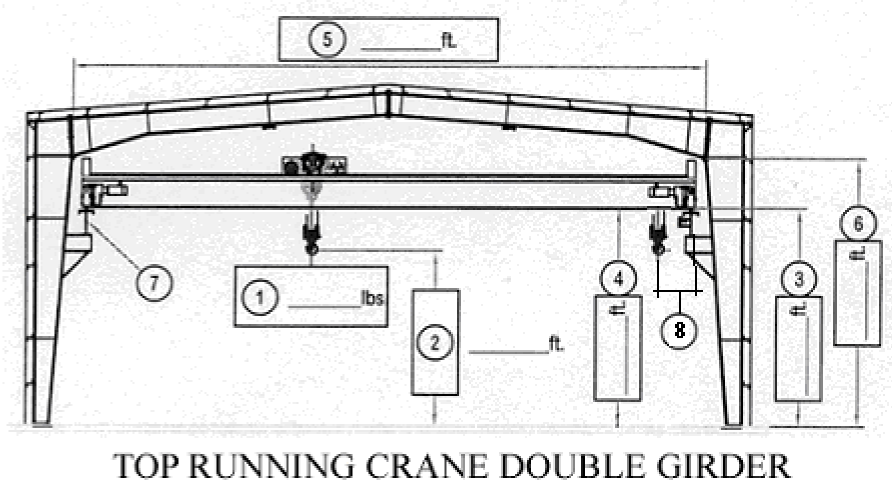
7) Trolley - The unit carrying the hoisting mechanism which travels on the bridge rails in a direction at right angles to the crane runway. Trolley frame is the basic structure of the trolley on which are mounted the hoisting and traversing mechanisms.

8) Bumper (Buffer) - An energy absorbing device for reducing impact when a moving crane or trolley reaches the end of its permitted travel, or when two moving cranes or trolleys come into contact. This device may be attached to the bridge, trolley or runway stop.

Refer to Annexure -A for definition of technical terms.

SPECIFYING AN OVERHEAD CRANE

PARAMETERS NEEDED FOR SPECIFYING AN OVERHEAD CRANE



1 Crane capacity (tons) 2 Required lifting height (in.) 3 Runway height (ft. & in.) 4 Clearance Required (ft. & in.) 5 Building Width, Clear Span (ft. & in.) 6 Building Height (ft. & in.) 7 Runway Size & Length (in. & ft) 8 Hook Approach & End Approach (ft. & in.)	Other Desired Information ✓ Hoist Speed (ft per minute) ✓ Bridge Travel Speed (ft per min) ✓ Trolley Travel Speed (ft per min) ✓ Electrical Requirements (Festoon or Conductor Bar) ✓ Control Requirements

ESSENTIAL PARAMETERS FOR SPECIFING EOT CRANES

To select correct crane envelope that will fit in the building foot print, the user must identify and pass on the following key information to the supplier:

1) Crane Capacity * - The rated load, the crane will be required to lift. Rated load shall mean the maximum load for which a crane or individual hoist is designed and built by the manufacturer and shown on the equipment identification plate.

2) Lift Height - The rated lift means the distance between the upper and lower elevations of travel of the load block and arithmetically it is usually the distance between the beam and the floor, minus the height of the hoist. This dimension is critical in most applications as it determines the height of the runway from the floor and is dependent on the clear inside height of the building. Do not forget to include any slings or below the hook devices that would influence this value.

3) Runway Height – The distance between the grade level and the top of the rail.

4) Clearance- The vertical distance between the grade level and the bottom of the crane girder.

5) Clear Span- Distance between columns across the width of the building. Building width is defined as the distance from outside of eave strut of one sidewall to outside of eave strut of the opposite sidewall. Crane Span is the horizontal center distance between the rails of the runway on which the crane is to travel. Typically distance is approximate to 500mm less than the width of the building. How much span a crane requires depends on the crane coverage width dictated by the application. (According to the span and the maximum load handling capacity, the crane steel structure is selected to be either a single or double girder crane construction).

6) Building Height- Building height is the eave height which usually is the distance from the bottom of the main frame column base plate to the top outer point of the eave strut. Eave height is the distance from the finished floor to the top outer point of the eave strut. There must be a safety distance between the top edge of the crane runway rail and the first obstacle edge in the building (for example roof beams, lights and pipes).

7) Runway Length- The longitudinal run of the runway rail parallel to the length of the building.

8) Hook approaches - Maximum hook approach is the distance from the wall to the nearest possible position of the hook. *The smaller the distance is, the better can the floor area be utilized.* Always check which crane gives optimum hook approaches and when combined with the true lift of the hoist you can utilize most of the available floor space. This is also termed as side hook approach.

   End Approach – This term describes the minimum horizontal distance, parallel to the runway, between the outermost extremities of the crane and the centerline of the hook.

9) Bridge, Trolley and Lift Speeds - The rate at which the bridge or trolley travels or at which the hoist lifts is usually specified in feet per minute or FPM. The crane operating speeds are selected to allow safe operation whilst using the pendant. Dual operating speeds, normally a fast and slow speed with a ratio of 4:1 are commonly used but for optimum control a variable speed control system is strongly recommended.

10) Electrical Requirements - Specify the circuit voltage shall not exceed 600 volts for AC or DC current. Ideally 480 volt, 3 phase, 60 hertz for US requirements. The runway power is usually by conductor bar and hoisting trolley by festoon cable. (refer section 6 for details)

11) Control Requirements - The control circuit voltage at pendant pushbuttons shall not exceed 150 volts for AC and 300 volts for DC. Other control options including radio control, free-floating pendant (festooned) or hoist-mounted pendant requirements must be stated.

Other than addressing the above parameters, some specific conditions applicable to your application must be mentioned.

1) Do you need the use of a second hoist on the bridge crane? (This hoist may be used as an auxiliary hoist or be required in a process such as tilting/tipping. In case you are handling long materials, like steel tubes and plates, the best solution are to have a crane with two hoists (and hooks) for better stability of the load ensuring safe lifting).

2) What will the operating environment be (dust, paint fumes, outdoor, etc.)?

3) Is there existing cranes on the runway? Then, consider the use of a collision avoidance or collision warning system.

4) Do you require a catwalk on the crane for maintenance access?

5) What other accessories are required such as lights, warning horns, weigh scales, limit switches, etc.

* Note that the rated capacity of crane is the live load that can be lifted by the crane system. The rated load is defined as the maximum working load suspended under the load hook. Load block and ropes are not included in the rated load.

The design load for the crane system is based on the rated capacity plus 15% for the weight of the hoist and trolley (capacity x 1.15) and an additional 25% for impact (capacity x 1.25) for a total design capacity x 1.4. (Note 25% impact factor is good for hoists speeds up to 50 fpm).

The capacity of crane is the maximum rated load (in tons) which a crane is designed to carry. The net load includes the weight of possible load attachment. For example , a 1000 lb crane allow you to pick up a 1000lb load, provided the hoist weighs 150lbs or less and the hoist speed is less than 50 feet per minute. Under no conditions should the crane be loaded beyond its rated capacity.

Note that the Crane test loads are typically specified at 125% of rated capacity by both OSHA and ASME.

PART-2 **CLASSIFICATION OF CRANES**

In this section we will discuss

- Crane Duty Groups
- General Comparison between different Standards

CRANE DUTY GROUPS

Crane duty groups are set of classifications for defining the use of crane. There are several different standards where these groups are named differently. One may have heard names CMAA, FEM, ISO or HMI. They all have their own classification of duty groups but are still based on the same calculations and facts. Following is a short description of what a duty group means and what it is for.

A crane duty group tells which kind of duty the crane is for; the range is from light duty up to very heavy duty. It is vital to define the needs and estimate the use because of safety reasons and for to ensure a long working life for the crane. You can't put for example a crane designed for light duty into continuous heavy-duty work.

CMAA CRANE CLASSIFICATION

As to the types of cranes covered under CMAA Specification No. 70 (Top Running Bridge and Gantry Type Multiple Girder Electric Overhead Traveling Cranes); there are six (6) different classifications of cranes, each dependent on duty cycle. Within the CMAA Specification is a numerical method for determining exact crane class based on the expected load spectrum. Aside from this method, the different crane classifications, as generally described by CMAA, are as follows:

CMAA Class	Description	Details
A	Standby or Infrequent service	This service class covers cranes where precise handling of equipment at slow speeds with long idle periods between lifts. Capacity loads may be handled for initial installation of equipment and for infrequent maintenance. Typical examples are cranes used in powerhouses, public utilities, turbine rooms, motor rooms, and transformer stations. This is the lightest crane as far as duty cycle is concerned.
B	Light Service	This service class covers cranes where service requirements are light and the speed is slow. Loads vary from none to occasional full capacity. Lifts per hour would range from 2 to 5, and average 10 feet per lift. Typical examples are cranes in repair shops, light assembly operations, service buildings, light warehousing, etc.

CMAA Class	Description	Details
C	Moderate Service	This service covers cranes whose service requirements are deemed moderate, handling loads which average 50 percent of the rated capacity with 5 to 10 lifts per hour, averaging 15 feet, with not over 50 percent of the lifts at rated capacity. In terms of numbers, most cranes are built to meet Class C service requirements. This service covers cranes that may be used in machine shops or paper mill machine rooms.
D	Heavy Service	In this type of service, loads approaching 50 percent of the rated capacity will be handled constantly during the work period. High speeds are desirable for this type of service with 10 to 20 lifts per hour averaging 15 feet, with not over 65 percent of the lifts at rated capacity. Typical examples are cranes used in heavy machine shops, foundries, fabricating plants, steel warehouses, container yards, lumber mills, etc., and standard duty bucket and magnet operations where heavy duty production is required.
E	Severe Service	This type of service requires a crane capable of handling loads approaching the rated capacity throughout its life with 20 or more lifts per hour at or near the rated capacity. Typical examples are magnet, bucket, magnet/bucket combination cranes for scrap yards, cement mills, lumber mills, fertilizer plants, container handling, etc.
F	Continuous Severe Service	In this type of service, the crane must be capable of handling loads approaching rated capacity continuously under severe service conditions throughout its life. Typical examples are custom designed specialty cranes essential to performing the critical work tasks affecting the total production facility, providing the highest reliability with special attention to ease of maintenance features.

HMI/ASME HOIST DUTY RATINGS

The following table provides an idea of the relative significance of the duty cycle ratings for the various electric hoists. Note that the duty cycle determination for a particular application involves obtaining a significant amount of additional information and expertly applying it to the intended use.

HMI Class	Operating Based on 65% of Capacity				Details
	Uniform Usage		Infrequent Usage		
	Max On Time (min/hour)	Max Starts/Hr	Max On Time From Cold Start	Max Starts	
H1	7.5 minutes (12.5%)	75	15	100	Powerhouse and Utilities, infrequent handling, Hoists used primarily to install and service heavy equipment, loads frequently approach capacity and hoist idle for long periods between use.
H2	7.5 (12.5%)	75	15	100	Light machine shop fabricating, service and maintenance; loads and utilization randomly distributed; rated loads infrequently handled. Total running time not over 12.5% of the work period.
H3	15 (25%)	150	30	200	General machine shop fabricating, assembly, storage, and warehousing; loads and utilization randomly distributed. Total running time not over 25% of work period.
H4	30 (50%)	300	30	300	High volume handling of heavy loads, frequently near rated load in steel warehousing, machine and fabricating shops, mills, and foundries, with total running time not over 50% of the work period. Manual or automatic cycling operations of lighter loads with rated loads infrequently handled such as in heat treating or plating operations, with total running time frequently 50% of the work period
H5	60 (100%)	600	Not Applicable [Note (1)]	Not Applicable [Note (1)]	Bulk handling of material in combination with buckets, magnets, or other heavy attachments. Equipment often cab operated. Duty cycles approaching continuous operation are frequently necessary. User must specify exact details of operation, including weight of attachments.

NOTE (1): Not applicable since there are no infrequent work periods in Class H5 service.

AISE SERVICE CLASS

AISE also provides for different service classes for cranes covered under AISE Technical Report No. 6, "Specifications for Electric Overhead Traveling Cranes for Steel Mill Service". Like CMAA, AISE also provides a numerical method for determining crane class based on the expected load spectrum. Without

getting into the specifics of this method, AISE does generally describe the different service classes (load cycles) as follows:

1. Service Class 1 (N1): Less than 100,000 cycles
2. Service Class 2 (N2): 100,000 to 500,000 cycles
3. Service Class 3 (N3): 500,000 to 2,000,000 cycles
4. Service Class 4 (N4): Over 2,000,000 cycles

Further AISE describe the different Load Classes as

1. L1= Cranes which hoist the rated load exceptionally, and normally hoist very light loads
2. L2= Cranes which rarely hoist the rated load, and normally hoist loads about 1/3 the rated capacity
3. L3= Cranes which hoist the rated load fairly frequently, and normally hoist loads between 1/2 and 2/3 or the rated capacity
4. L4= Cranes which are regularly loaded close to the rated capacity

Based on the load classes and load cycles, the CMMA chart below helps determine the class of the crane.

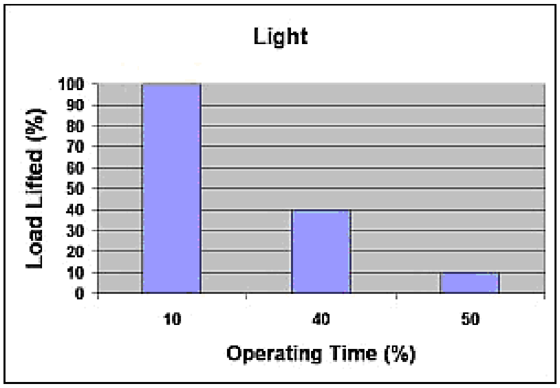
Load Classes	**Load Cycles**			
	N1	**N2**	**N3**	**N4**
L1	A	B	C	D
L2	B	C	D	E
L3	C	D	E	F
L4	D	E	F	F

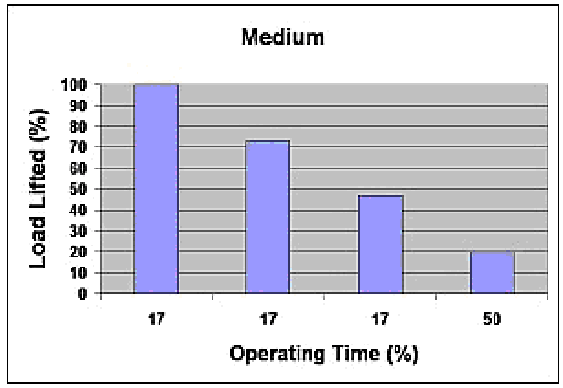
FEM SERVICE CLASS

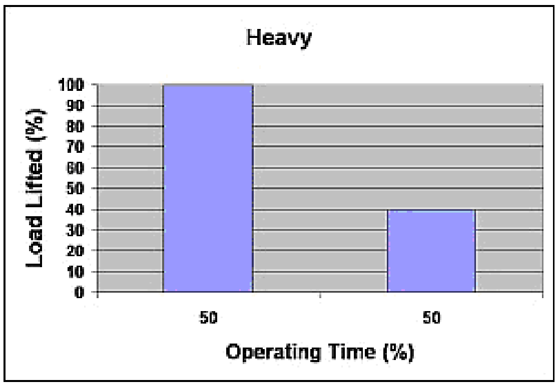
To determine your crane duty group (according to FEM, Fédération Européene de la Manutention) you need following factors:

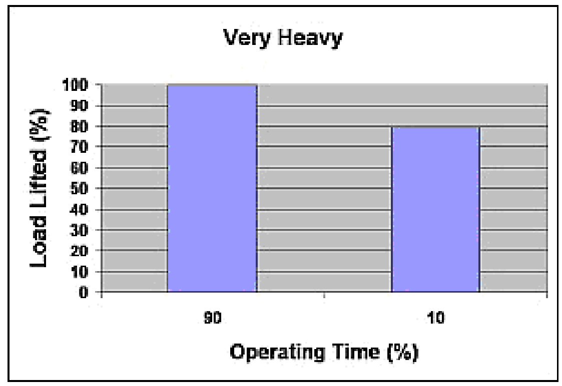
1) Load spectrum (Indicates the frequency of maximum and smaller loadings during examined time period).
2) Class of utilization (This is determined according to number of hoisting cycles during lifetime of crane)
3) Combining these factors is how a duty group is selected.

Example of different load spectrums:









Calculate the Average Daily Operating Time

t = (2 x H x N x T) / (V x 60)

Where:

- H = average hoisting height (m or feet)
- N = number of work cycles per hour (cycle/hour)
- T = daily working time (h)
- V = hoisting speed (m/min or feet/min)

Determine the Operating Group of the Hoist

Load Spectrum	**Average Daily Operating Time (hours / day)**					
	<= 0.5	<= 1	<= 2	<=4	<= 8	<= 16
Light			M3 1Bm	M4 1Am	M5 2m	M6 3m

Medium		M3 1Bm	M4 1Am	M5 2m	M6 3m	M7 4m
Heavy	M3 1Bm	M4 1Am	M5 2m	M6 3m	M7 4m	
Very Heavy	M4 1Am	M5 2m	M6 3m	M7 4m		

GENERAL COMPARISON

CMAA	A	B	C	D	E	F	
FEM	1	2	3	4	5	6	
FEM*	1Bm	1Am	2m	3m	4m	5m	Based on 63% mean effective load
ISO	M3	M4	M5	M6	M7	M8	
HMI*	H2	H3	H4	H5			* Based on 65% mean effective load

(* Machinery Class)

Summarizing

To select correct crane duty, crane structure and mechanical components, the user must identify and pass on the following information to the supplier:

1) Average lifts and trolley and bridge movements made in an hour.

2) Average length of each movement.

3) Estimate the load lifted each time.

4) Total operating hour per day.

PART-3 **HOISTS**

In this section we will discuss the following:

- Hoists Types
- Hoists Lifting Media – Chains or Ropes
- Hoists Lifting Considerations
- Hoist Selection Considerations
- Hoisting Equipment
- Hoist Standards

HOISTS

A hoist is a device used for lifting or lowering a load by means of a drum or lift-wheel around which rope or chain wraps. Cranes and Hoists are somewhat interchangeable terminology since the actual lifting mechanism of a crane is commonly referred to as a hoist. Hoists may be integral to a crane or mounted in affixed position, permanently or temporarily. *When a hoist is mounted to a trolley on a fixed monorail, two directions of load motion are available: forward or reverse, up or down. When the hoist is mounted on a crane, three directions of load motion are available: right or left, forward or reverse, up or down.* Figure below shows a rope hoist for double girder crane application.

Fig- Double Girder Crane Hoist

The majority of hoists used in the United States are classified as Standard or "packaged hoists", typically defined as largely self contained units, prepared to be installed on existing structures.

Hoist Lifting Media

There are two basic hoist lifting media - Wire Rope Hoist which is very durable and will provide long term, reliable usage and the other type of hoist is the Chain Hoist.

For a given rated load, wire rope is of lighter weight per running foot but is limited to drum diameters far large than the lift wheel over which chain may function. Therefore a high-performance chain hoist may be of significantly smaller physical size than a wire rope hoist rated at the same working load. High speed lifting (60 ft/min +) requires wire rope over a drum because chain over a pocket wheel generates fatigue inducing resonance for long lifts.

Which hoist is better – Chain hoist or Wire Rope hoist

Chain Hoist

Chain hoists are used for lower capacity, lighter duty applications and for projects in which cost is a primary deciding factor. Chain hoists are mainly used for maintenance tasks. The main reasons for choosing a chain hoist are the following:

1) Possible to change height of lift by changing the chain (versatile)

2) Compact design (no drum, which saves space)

3) Portable and can tolerate greater levels of abuse

4) Usually more economical than a wire rope hoist

5) Provide true vertical lift at no extra cost

6) Capacity up to 5 tons (up to 20 tons for some makes)

Chain hoists do, however, have certain inherent inconveniences, such as

1) Limited lifting speed

2) Noisier operation than a wire rope hoist

3) May be problematic at a height of lift of over 20ft (6 meters)

4) Space taken by the chain or chain container

Wire Rope

The wire rope is a piece of equipment that is used mainly for production tasks. The main reasons for choosing a wire rope hoist are the following:

1) Very fast lifting speeds than a chain hoist

2) Quieter than a chain hoist

3) No room taken up by chain or chain receptacle

4) Recommended for considerable long lifting height

5) Very smooth lifting operation such as handle glass panel

6) Heavy Safe Working Load up to 25 tons

Both wire rope and chain hoists available in market today are rugged and durable products. A good load chain can lasts up to 30 times longer than standard wire rope, it greatly reduces the down time and

operational costs. Duty ratings stated in various standards (HMI/DIN / FEM) are a better indicator of the durability of hoist type (chain or wire rope). Therefore, when purchasing a crane, focus on lifting speeds, headroom and features, less on the type of hoist.

Overhead Hoist Power Application

Three methods of applying power for overhead hoists:

1) Manual – By hand Chain

2) Electric - The most common power source application

3) Pneumatic - Often required in applications of high speed, higher duty cycle involving rapid, repetitive tasks or hazardous areas where electric power is inadvisable.

HOIST TYPES

There are various types of hoists that perform a wide range of basic lifting functions. These can be categorized as packaged hoists or specially engineered hoists. The packaged hoists include hand chain, ratchet lever; electric chain and electric wire rope hoists. Choosing the right hoist type and model generally depends on the number of lifts per day and the average weight.

1) Ratchet Lever - Small, hand powered hoist capable of lifts between 3/4 ton to 6 tons with standard lifts between 5 feet and 15 feet. Capable of lifting, pulling and stretching loads vertically and horizontally; light, portable - often carried site-to-site.

   - Common Applications: Rigging, installing or repairing machinery in industrial and construction applications.

   - Selection Considerations: Steel construction; corrosion resistant; double-pawl enclosed load brake; long life anti-friction bearings.

2) Hand Chain - Hand powered chain hoist capable of lifts between 1/2 ton and 25 tons with standard lifts between 8 feet and 20 feet. Normally hook mounted to a fixed point or trolley; provides true vertical lift; lifts are slow and require high work effort; precise load spotting.

   - Common Applications: General production or maintenance in light industry requiring few lifts per day; preferred in certain corrosive or abrasive environments.

   - Selection Considerations: Steel construction; heavy-duty housing; mechanical load brake for positive load holding; long-life anti-friction bearings; spark proof; headroom.

3) Electric Chain: Capable of lifts between 1/2 ton and 3 tons with standard lifts between 10 feet and 20 feet (1/2 and one ton) and 10 and 15 feet (one to 3 tons). Extended lifts are possible after factory modifications. Operated by pushbutton control; powered by electric motor; controlled by an electric motor brake; equipped with upper and lower travel limit stop.

   - Common Applications: Light duty; general machine shop work; high duty; bulk handling in a steel warehouse.

   - Selection Considerations: Motor insulation rated for longer motor life; geared limit switches; anti-friction bearings; oversized chain; chain container; dual braking system.

4) Electric Wire Rope - Capable of lifts between 1/8 ton and 5 tons with standard lifts between 15 feet and 30 feet. Operated by pushbutton control; designed for heavy-duty, high-performance lifting.

5) Engineered Wire Rope - With specially designed components, electric wire rope and monorail hoists frequently handle capacity loads in harsh or demanding environments. Capable of lifts between 1 ton and 60 tons with standard lifts between 15 feet and 234 feet. High performance, high duty cycle; normally for 2 or more speeds with excellent load spotting capabilities; sophisticated componentry.

- Common Applications: Heavy machine shop, airline maintenance, steel manufacturer or warehouse.
- Selection Considerations: Heavy duty motor and bearings; high-strength cable; thermal motor detectors; limit switches; disc motor brake; motorized trolley.

6) Special Applications - Specially designed hoists are often as unique as the lifting operations they perform. Examples include hot metal carriers, twin hook hoists used to move hard to balance loads, power sling hoists for rotating suspended cumbersome loads and lock and dam machinery. Lift capacities and ranges are dependent on application.

- Common Applications: Hot metal carrier: foundries, engine manufacturers; powersling hoist: automobile manufacturing, airline maintenance; twin hook hoist: paper plant, textile plant, or lumber yard.
- Selection Considerations: Highly dependent on application; consult engineer for equipment selection.

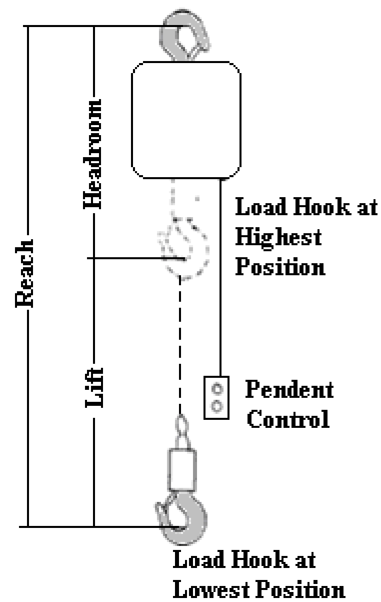
7) Trolley Hoists - An electric hoist and top running motorized trolley combined in one unit provides accurate load positioning in a variety of applications. Wheels, drives and control packages are normally designed specifically for the application. Available for use on class A thru D cranes having capacities from 5 tons to 30 tons with standard lifts of 100 feet or more.

- Common Applications: Moderate service including heavy machine shops, metal fabricating plants and steel warehousing.
- Selection Considerations: Durable, welded steel frame; geared limit switches; variable hoist and trolley speeds and controls; heat treated wheels; heavy-duty crane rated motors; double reeving for true vertical lift; heavy-duty, long-life bearings.

HOIST SELECTION FACTORS

To select the proper hoist, consider:

1) The weight of the load to be lifted including below-the-hook lifting, load supporting, and positioning devices.
2) Physical size of the load.
   - Holding and orienting devices.
   - Design for center of gravity (control & stability).
   - Lift – the vertical distance the load can be moved.
3) Clearance Considerations
   - Headroom
   - Obstacles to be cleared during the load transfer.
   - Design for vertical lift required including holding device height.
4) Lifting Speed Considerations
   - Distance the load is to be raised and lowered
   - Frequency of usage
   - Required positioning accuracy
   - Nature of the load being lifted
5) Hoist duty Cycle Considerations based on:
   - Number of lifts per hour
   - Total number of lifts per shift
   - Maximum number of starts and stops per hour
   - Number of shifts per day
   - Average distance load is raised and lowered
   - Average weight to be lifted
   - Maximum weight to be lifted
   - Frequency of lifts with maximum weight.



(Refer to HMI/ASME Hoist duty ratings table in section-2 of this course, which gives an idea of the relative significance of the duty cycle ratings for the various electric hoists.)

OTHER CRITICAL FACTORS

Number of critical issues should be addressed, beginning with an assessment of the load. This will include a determination of its weight (mass) and the position of its centre of gravity in relation to the lifting (pick-up) points. Other questions include whether the load is in one piece. Will it fall apart when lifted? Does it have built-in lifting points? Is special equipment needed to lift it? Care should obviously be taken not to exceed the safe working load of the equipment involved, particularly in multi-point lifting operations. Note the following desired characteristics-

1) The number of starts and stops per hour directly affects all electro-mechanical devices such as motors, contactors, brakes, and solenoids due to high inrush amperage at startup being approximately 3 times the normal running amps. Operator training and proper equipment selection can minimize this frequent source of equipment damage. Two speed motors and inverters can solve many of the spotting problems that result in the improper, "staccato", use of the push button by the operator.

2) The type of use will help determine the equipment 's class of service:

- Maintenance and production application must use Class H4 minimum (200 to 300 starts/stops an hour) and Safety factor 5:1 ultimate stress.

- For molten metal service, use safety factor 10:1 for ultimate stress for hook, cable and bottom block.

3) The hoist shall have at least two independent means of braking; a holding brake which shall be applied automatically on power removal and controlled braking to prevent speeding when lowering the load.

4) When making hoist selection with regard to maximum capacity load to be lifted consider that ball bearing life for the equipment normally varies inversely according to the cube of the load. For example, a two ton hoist operated at a mean effective load of one ton will have a ball bearing life eight times that of the same hoist used steadily at its rated load. This can amount to huge savings in repairs and downtime for critical use hoists.

5) The hoist may use various types of lifting attachments ranging from simple hook, lifting beam or automatic grab. Lifting attachments should be equipped with a safety latch to prevent the disengagement of the lifting wire, chain or rope to which the load is attached. Numerous factors will influence the choice of lifting equipment and sling (or other load lifting attachment). Not least of these should be the ability to position the lifting machine's hook over the load's centre of gravity.

6) The hoist's suspension is the means of attaching it to a lifting lug or a trolley. When ordering a hoist with trolley, preferably request lug mounting by stationary retaining bracket. This type of mounting provides a more compact, rigid and sturdy package. However, if you want the hoist to disconnect easily from the trolley, choose hook mounting.

7) Power supply and control cords, cord reels, hoses, electrification systems, and flexible festooning systems provide means for supplying power to hoists. Such systems must be properly sized and meet all prevailing codes or regulations.

8) Hoists are generally designed to operate at temperature between -10°F (-23°C) and 130°F (55°C). For temperatures beyond this range, consult the manufacturer.

9) Electric hoists shall be provided with an approved limit stop to prevent the hoist block from traveling too far in case the operating handle is not released in time. A limit switch on a hoist is one of the most important safety features available for electric chain hoists. These devices shut off the hoist when the hook rises to highest position and normally also when it reaches its low point. There are generally three levels of limit switches recommended for in electric chain hoists:

   - The hoist drive shall have a rotary limit switch driven from the hoist drum shaft that operates in the hoist control circuit. This limit switch shall act as an upper limit switch and shall also prevent lowering the hook below a predetermined lower position by interrupting the hoist motor control.

   - A back-up over hoist limit switch that is operated by the hook block which prevents over travel in the hoisting direction by cutting off the motor power shall be provided.

   - A back-up slack rope limit switch (lower limit) shall prevent accidental unwinding of the hoist wire rope. For hoists having a capacity of 5 tonnes or more, a stack rope detector shall also be installed that detects ropes crossing over on the drum.

Note that all limit switches are meant to be a safety cut off in case the hoist reaches the maximum travel. They are not meant to be used for a method of stopping the hoist a predetermined points. Hoists shall also be provided with an overload switch that stops the hoisting operation when the lifted load exceeds the rated working load limit of the hoist.

HOISTING EQUIPMENT

Sheaves

A "Sheave" is a grooved wheel or pulley used with a rope or chain to change direction and point of application of a pulling force. Key Points:

1) Sheaves shall be fitted on ball or roller bearings and arranged to swivel, if necessary to maintain rope alignment.

2) Sheave grooves shall be smooth and free from surface defects which could cause rope damage.

3) The Sheave pitch diameters measured at the base of the groove shall not be less than 25 times the diameter of the rope.

4) The sheaves in the bottom block shall be equipped with close-fitting guards that will prevent ropes from becoming fouled when the block is lying on the ground with ropes loose.

5) Pockets and flanges of sheaves used with hoist chains shall be of such dimensions that the chain does not catch or bind during operation.

6) All running sheaves shall be equipped with means for lubrication. Permanently lubricated, sealed and/or shielded bearings meet this requirement.

7) Wire-rope sheaves shall be machine-grooved, hardened steel or cast iron with chilled groove surfaces.

Load Block

Load Block is an assembly of hook, swivel, bearings, sheaves, pins and frame suspended from the hoisting ropes. In a "short type" block, the hook and the sheaves are mounted on the same member, called the swivel. In a "long type" block, the hook and the sheaves are mounted on separate members. *The supporting member for the sheaves is called the sheave pin and the supporting member for the hook is called the trunnion.*

Hook Assembly -

1) Load blocks and hook assembly shall be non-sparking, non-corroding type, fabricated of AISI Type 304, 18-8 chrome-nickel, corrosion-resistant steel or a bronze alloy of suitable strength and section for the rated capacity load. Hook material can be forged steel for non-hazardous areas.

2) Hook assembly for electric hoists shall be carried on antifriction bearings to permit free swivel under rated-capacity load without twisting load chain or wire.

3) Each hook assembly shall include a machined and threaded shaft and swivel locknut with an effective locking device to prevent nut from backing off.

4) Each hook shall have a spring-loaded safety latch.

Gear Assembly -

1) Gear shafts shall be manufactured from high-carbon steel or alloy steel, machined and ground for accurate fit and splined for fitting to the mating gear.

2) Gear-train assembly shall be carried on antifriction bearings and enclosed in the hoist frame casting. Assembly shall operate in a sealed oil bath.

3) Frame casting shall be provided with lubrication fittings and inspection ports.

Rope Drum -

1) Rope drum shall be hardened steel or special-grade cast iron.

2) Drum shall have accurate, machine-cut grooves, cut to full depth of wire-rope radius, with rounded corners of dimension as required for the indicated lift. Groove diameter and pitch centers shall be not less than 1/32 inch (0.79mm) greater than diameter of rope.

3) Drum shall be flanged at each end and shall have enclosed tops and sides to preclude cable binding and jamming.

4) Drum shall be proportioned to store not more than one layer of rope with the load hook at the upper operating limit and shall have not less than two full turns remaining on the drum in the lowest elevation of the lift. Drum and sheave pitch diameters (in rope diameter units) shall be not less than the following:

CRANE DUTY CLASS	DRUMS	RUNNING SHEAVES	EQUALIZER SHEAVES
A	20	16	12
B	20	18	12
C	24	20	12

Ropes-

In using hoisting ropes, the crane manufacturer's recommendation shall be followed. The rated load divided by the number of parts of rope shall not exceed 20 percent of the nominal breaking strength of the rope.

1) Wire rope for standard applications shall be extra flexible, preformed, and improved, plow steel, 6 by 37, fiber-core wire conforming to FS RR-W-410, Type I, Class 3.

2) Wire rope for single-line application shall be preformed, improved plow steel, 18 by 7, fiber-core, non-rotating wire conforming to FS RR-W-410, Type IV, and Class 2.

3) Wire rope for non-corroding, non-sparking hoist application shall be preformed, AISI Type 304, 18-8 corrosion-resistant steel, 6 by 19, bright finish, conforming to FS RR-W-410, Type I, Class 2.

4) Wire rope shall have a safety factor of not less than 5, based on the minimum ultimate strength of the material used, for Class A and B cranes, and a safety factor of 6 for Class C cranes.

5) No less than three wraps of rope shall remain on the drum when the hook is in its extreme low position and ensure that one additional rope turn can be accommodated when the hook is at its upper limit of hoisting (i.e. the rope shall not overlap when the hook is at its highest point).

6) Rope end shall be anchored by a clamp securely attached to the drum, or by a socket arrangement in an approved manner such that the tension of the rope comes on the anchor points as near tangentially as possible. Anchoring shall be of captive type, easily detached for changing and repair.

7) Rope clips attached with U-bolts shall have the U-bolts on the dead or short end of the rope. Clips shall be drop-forged steel in all sizes manufactured commercially. When a newly installed rope has been in operation for an hour, all nuts on the clip bolts shall be retightened.

8) Rope ends must be tapered and fused.

9) Wherever exposed to temperatures, at which fiber cores would be damaged, rope having an independent wire-rope or wire-strand core or other temperature-damage resistant core shall be used.

Operational Considerations

Hoist operators should be trained in the proper use of all hoisting equipment. Many accidents occur because operators simply do not know that they are doing something dangerous. Refer to the manufacturer's parts, maintenance and operating documents.

The route the load will take must be checked. Does the load need to be moved, turned over or re-orientated? Who will potentially be put at risk by the operation? Is the landing site itself clear and suitable for the load?

Obviously, unless absolutely unavoidable, loads should not be lifted above people. The area in question should be cleared and a system of communication must be agreed between personnel involved in the lifting operation.

Unless exceptional circumstances demand otherwise, just one person should be responsible for giving instructions to the operator of the lifting machine.

To Avoid Injury:

- Do not exceed Working load limit, load rating, or capacity.
- Do not use product to lift people or loads over people.
- Read all manuals and safety precautions before using products.

ASME B30.16 deals with equipment and the workplace safety issues, which apply to all overhead hoists that lift freely suspended unguided loads.

Hoist Standards

There are many standards produced by many different standards-writing bodies. Generally, for hoist installations in the US the standards published by the American Society of Mechanical Engineers apply. Three are safety standards and six are performance standards. All carry the American National Standards Institute (ANSI) designator for a consensus American National Standard (ANS):

1) ASME-HST-1 Performance Standard for Electric Chain Hoists

2) ASME-HST-2 Performance Standard for Hand Chain Manually Operated Chain Hoists

3) ASME-HST-3 Performance Standard for Manually Lever Operated Chain Hoists

4) ASME-HST-4 Performance Standard for Overhead Electric Wire Rope Hoists

5) ASME-HST-5 Performance Standard for Air Chain Hoists

6) ASME-HST-6 Performance Standard for Air Wire Rope Hoists

7) ASME-B30.7 Safety Standard for Base Mounted Drum Hoists

8) ASME-B30.16 Safety Standard for Overhead Hoists (Under hung)

9) ASME-B30.21 Safety Standard Manually Lever-Operated Hoists

10) OSHA (Parts 1910 and 1926) adopts or invokes the American Society of Mechanical Engineers (ASME) HST Performance and B30 Safety Standards for hoists and related equipment.

PART-4 STRUCTURAL DESIGN CONSIDERATIONS

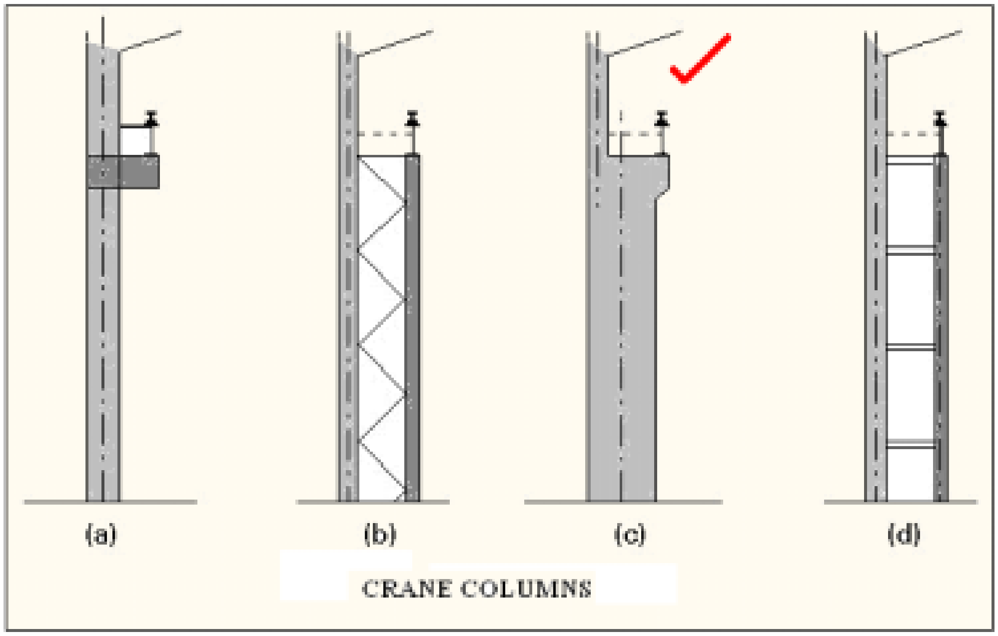
In this section we will discuss the following:

- Crane Runway
- Crane Loads for designing Building Structure
- Type of loads on Crane Runway Girder
- Selection Options for Crane Runway Girders
- Loads Specific to Crane Supporting Structure
- Design of Crane Runway Girder

CRANE RUNWAY

Crane runway is composed of rails, beams, stiffeners and columns on which the crane operates. The rail, on which the end trucks run, is fastened to the runway beam. This beam is then supported on columns, which can either be completely “free standing” or ‘tied back” to the existing building structure.

In designing cranes, rails, runway girders and the supporting structure, the most important parameters are the maximum and most frequently occurring weights to be lifted, the speed and acceleration and the free height below the crane. The maximum wheel loads are determined by the net capacity of the crane together with the dead weight of the crane and dynamic effects. The support method of the crane runway girder depends on the magnitude of the reactions being transmitted, in relation to the strength of the structural framing of the building. Some typical arrangements for supporting top-running cranes ranging from the lightest to the heaviest are shown in Figure below (a to d).



<u>Fig 1 (a) - Crane runway girders supported on brackets secured to the columns</u>

The maximum capacity of cranes supported in this manner is about 100kN. Above this capacity, it is better to provide a separate leg or to increase the depth of the column below the crane runway girder to give adequate support.

<u>Fig 1 (b) & (d) - A separate crane column</u>

When an overhead traveling crane is introduced into a building, special care must be taken to ensure that the building is adequately braced in both directions. This arrangement is attractive to heavy cranes as it permits the effect of the crane to be considered isolated. However there lies a danger, since the displacement of the building column could induce overstress in the connection between the two columns.

<u>Fig 1(c) - Analyze the columns as one</u>

Where heavy cranes are involved, the crane runway girders may be subjected to severe fatigue conditions. This arrangement is a correct and more realistic approach to provide stability.

CRANE LOADS FOR DESIGNING BUILDING STRUCTURES

The forces imposed on the runway girders by the crane are in part caused by the behavior of the crane itself, especially in regard to the vertical and lateral stiffness of the girder. A crane structure is subjected to following types of loads (forces):

1) Dead Loads – A load that is applied steadily and remain in a fixed position relative to the structure. Note that the dead load is a steady state and does not contribute to the stress range.

2) Live Load - A load which fluctuates, with slow or fast changes in magnitude relative to the structure under consideration.

3) Shock Load – A load that is applied suddenly or a load due to impact in some form.

All these loads induce various types of stresses on the building structure. The stresses can be generally classified in one of six categories:

- Residual stresses – These are due to the manufacturing processes that leaves stresses in a material, for example welding leaves residual stresses in the metals welded.

- Structural stresses- These are stresses produced in structural members because of the weights they support. These are found in building foundations and frameworks due to dead weight of the crane.

- Thermal stresses – These exist whenever temperature gradients are present in a material.

- Fatigue stresses – These occur due to cyclic application of a stress. These stresses could be due to vibration or thermal cycling.

Of all these stresses, the fatigue stresses demand the maximum attention. Crane runway girders are subjected to repetitive stressing and un-stressing due to number of crane passages per hour (or per day). Since it is not easy to estimate the number of crane passages, for design purposes it is assumed that the number of stress fluctuations corresponds to the class of the crane as specified in the codes.

When designing building structures supporting crane, the main loads and forces to be considered are:

1) Vertical Loads – The predominant loading on the crane supporting structure is vertical loads and is usually supplied by manufactures by way of maximum wheel loads. These loads may differ from wheel to wheel depending on the relative positions of the crane components and the lifted load. On cranes without a cab or platform, the maximum wheel load (MWL) occurs when trolley and rated capacity load are positioned at the *extreme* end of the bridge.

2) Side Thrust Lateral Loads - Crane side thrust is a horizontal force of short duration applied transversely by the crane wheels to the rails. Side thrust arises from one or more of:

   - Acceleration and deceleration of the crane bridge and the crab

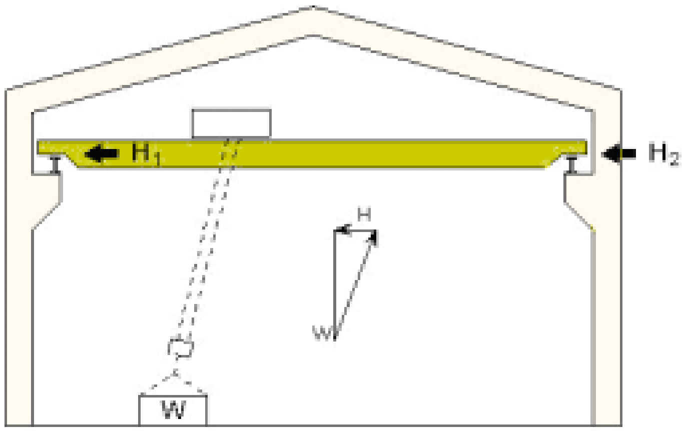
   - Impact loads due to end stops placed on the crane runway girder

   - Off-vertical lifting at the start of hoisting

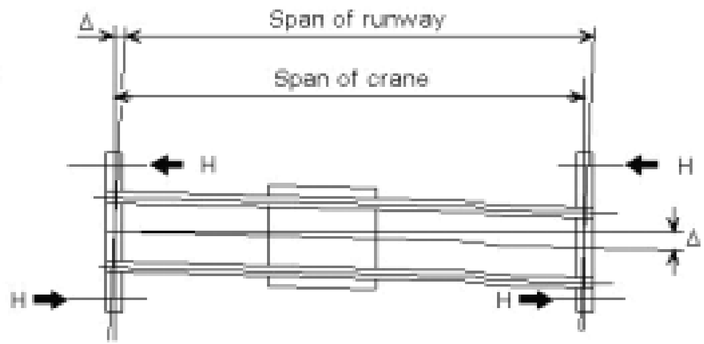
   - Tendency of the crane to travel obliquely

   - Skewing or crabbing of the crane caused by the bridge girders not running perpendicular to the runways. Some normal skewing occurs in all bridges.

   - Misaligned crane rails or bridge end trucks



OFF - VERTICAL LIFTING



OBLIQUE TRAVEL

Oblique traveling of the crane can also induce lateral loads, as shown in figure above. The forces on the rail are acting in opposite directions on each wheel of the end carriage and depend on the ratio of crane span to wheel base.

3) Traction Load - Longitudinal crane tractive force is of short duration, caused by crane bridge acceleration or braking. If the number of driven wheels is unknown, take the tractive force as 10% of the total wheel loads.

4) Bumper Impact - This is longitudinal force exerted on the crane runway by a moving crane bridge striking the end stop. Impact allowance of the rated capacity load is typically taken as half of one percent of the load per foot per minute of hoisting speed, but not less than 15% or more than 50%, except for bucket and magnet cranes for which the impact allowance shall be taken as 50% of the rated capacity load.

SELECTION OPTIONS FOR THE CRANE RUNWAY GIRDER

During the conceptual stage of the design of the crane runway girder the fundamental questions are:

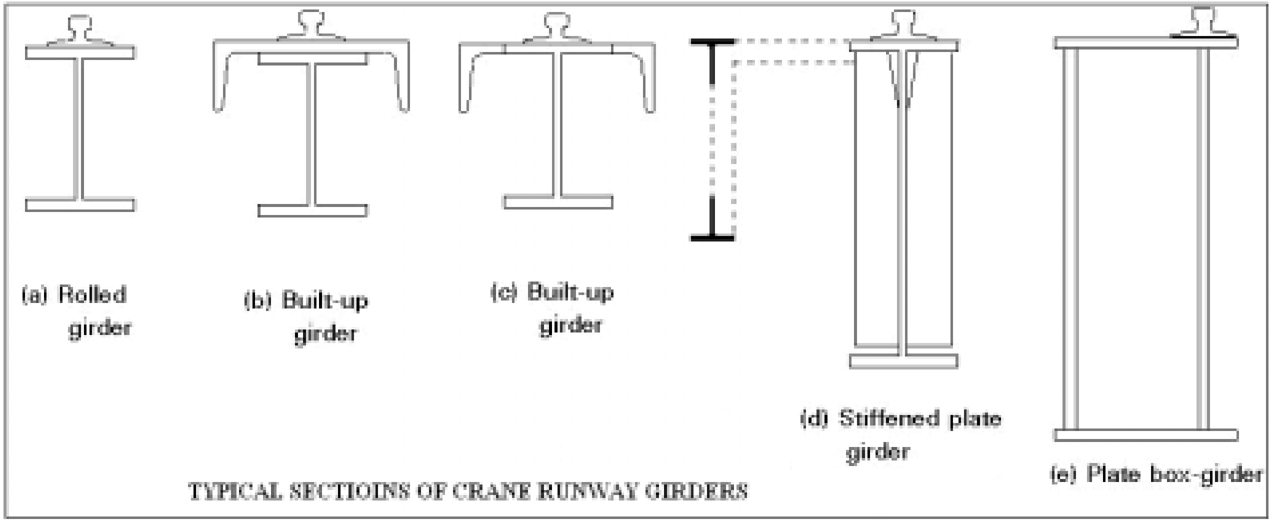
1) Should a simply-supported or a continuous girder be used?

2) Should a solid web girder or a latticed girder be used?

3) Should a single or double web construction be used?

4) Should high strength steel be used?

Figures below shows some cross-sections used for crane runway girders.



1) For small spans and light-to-medium crane loads, it is normally possible to use rolled-beam sections (figure- a).

2) In some cases reinforcement may be necessary to give resistance to lateral forces… sea figure (b-c).

3) Single web plate girders are suitable for the majority of heavier cranes. Their insufficient resistance to lateral forces is normally solved by introducing web stiffener, as shown in Figure (d).

4) Plate box girders are popular for the crane itself but are seldom used for the crane girder. The rail must be situated directly over the inner web of the box girder, so that transverse flexural stresses in the top flange plate are avoided, as shown in Figure (e).

High strength steel is seldom used in crane runway girders because fatigue considerations limit the permissible stresses quite severely and thus reduce the economical advantages (the fatigue strengths of mild and high strength steel for welded structures are the same). Additionally, deflection and lateral-torsional buckling considerations also prevent the designer from gaining advantage from using high strength steel.

DESIGN OF THE CRANE RUNWAY GIRDER

The transfer of the crane wheel reactions to the crane runway girder induces a complex pattern of stresses in the upper part of the girder and leads to early service failures. Crane runway girder are usually I-beams (tapered beam flanges) though H-beams (flat flanges) or other patented track/enclosed track can also be used. I- beam is a built-up beam section, forming an 'I' shape that consists of 2 flanges and 1 web. It is of utmost importance to judiciously select the height, width and type of beam used. As a rough guideline, the usual range of girder depth-to-span ratios is between 8 and 14. The deflection limitation may dictate a larger depth, especially where spans are long.

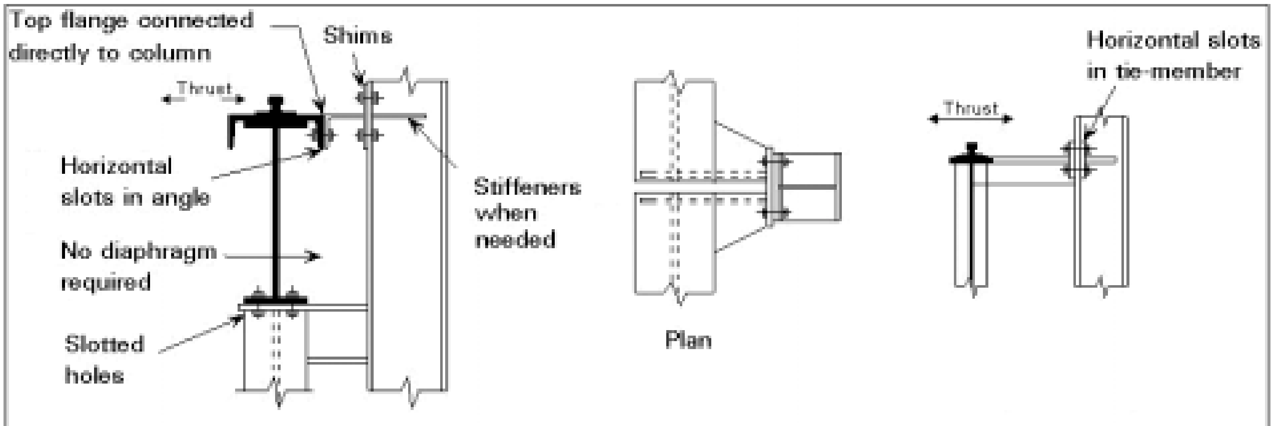
One of the most important decisions in connection with the design is to determine how far to go in minimizing the mass of steel. Good design must take into consideration all costs during the design life of the crane installation. A very light design may promise a low first cost, but could give rise to large maintenance costs resulting from a need for frequent repairs. The design of crane runway girders has some special aspects listed below:

1) Crane Runway Girder-to-Column Details

The loads transmitted to the rail produce a triaxial stress state in the flange and the upper part of the web. The predominant loading is vertical and the next principal loading is transverse. Careful consideration should be given to the transfer of the horizontal forces from the top flange of the girder to the column.

1) The best way to reduce stresses from the crane runway girder to the column or bracket below is by means of welded brackets (refer figure below). The top flange acts as a horizontal beam delivering its reaction to the column.

2) Another important aspect is the need for adjustment. It is impossible to erect building frames to the tolerance required by the crane manufacturer and it is therefore essential that the whole crane runway girder can be adjusted up to 10mm with respect to the building columns. Therefore, slotted holes and shims shall be provided as shown in figure below.



TOP FLANGE CONNECTIONS TO COLUMN

2) Rigidity Requirements

The following maximum values for the deflection of the crane girder must normally not be exceeded in order to avoid undesirable dynamic effects and to secure the function of the crane:

1) Vertical deflection is defined as the maximum permissible deflection ratio allowed for a lifting device. For bridge crane this value is usually L/700 (few specs require L/900), where L is the span of a bridge crane.

2) Horizontal deflection is a maximum deflection ratio allowed for a bridge crane or runway. This value is L/600, where L is the span of a bridge crane.

In the absence of more detailed calculations, it is acceptable to assume that the top flange resists the whole horizontal force. The rigidity requirement for horizontal deflection is essential to prevent oblique traveling of the crane. The vertical deflection is normally limited to a value not greater than 25 mm to prevent excessive vibrations caused by the crane operation and crane travel.

3) Fatigue Considerations

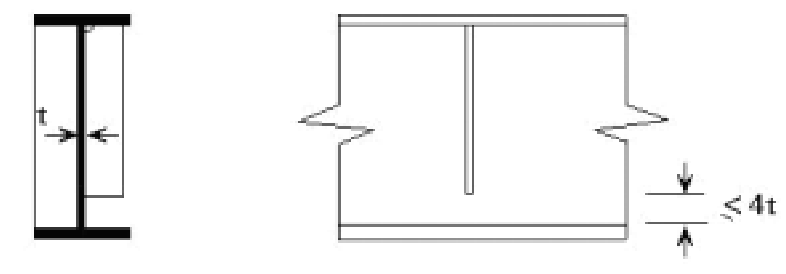
The critical details in fatigue design are the stiffener-to-flange, the stiffener-to-web, and the flange-to-web connections where severe concentrations of stresses exist. The following recommendations are made:

1) Welds attaching the stiffeners to the girder web should be terminated at a distance from the flanges to reduce the stress concentration.

2) Welds connecting the web to the top flange should be full penetration butt welds, although fillet welds are sometimes used for light, primarily static cranes.

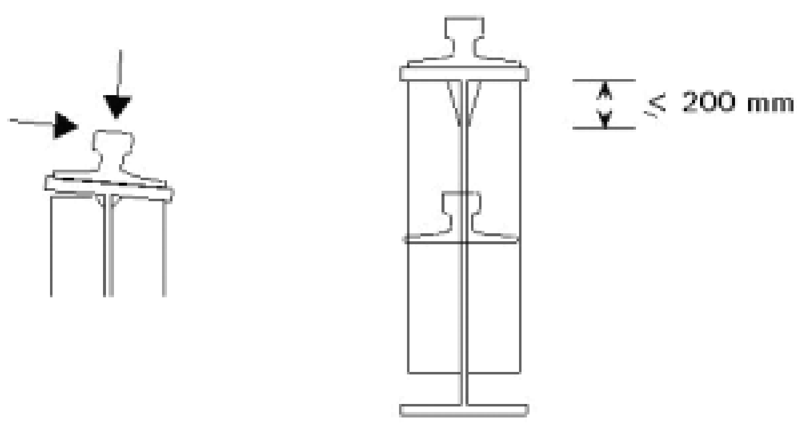
4) Web Stiffeners

The stiffening is carried out using welding the vertical plate(s) connecting the upper and lower flanges or cover plates of a girder. The method of attaching the stiffeners to the web and the flanges must be detailed carefully to prevent fatigue failure. The distance between the stiffeners must not be so large that twisting of the top flange becomes too large at the mid-point. Fatigue in the tensile flange can be averted by providing a gap of 4t between the end of the stiffener and the bottom flange, as shown in Figure below.



WEB STIFFENERS WITH GAP AT THE TENSILE FLANGE

The method adds resistance to the web but it still has a possibility of causing fatigue at the termination of the stiffener. To overcome this problem another method is shown below is considered to be a better solution. Here, the stiffener is welded to the compression flange so that relative movement of the flange in relation to the web is totally prevented. The stiffener should be coped a maximum of 200 mm.



WEB STIFFENERS WELDED TO THE COMPRESSION FLANGE

5) Lateral Forces and Lateral-Torsional Buckling

As a rough guideline, the usual range of girder depth-to-span ratios is between 8 and 14. The deflection limitation may dictate a larger depth, especially where spans are long. When the girder is relatively deep and the lateral forces are high.

Lateral forces due to off-vertical lifting, inertial effects and oblique traveling can only be estimated approximately. Values obtained from relevant codes together with the use of duty factors given in the codes is the only means at the designer's disposal. Torsion in the section is caused by:

1) Lateral force acting at the rail head level

2) Eccentricity of the vertical force due to tolerances dependent on the fabrication of the rail to the girder

The geometry of the top flange should be chosen from those alternatives that offer the best torsional resistance and the best lateral stiffness.

RUNWAY GIRDER SIZING

The procedure below outlines the steps and calculations involved in selecting a runway beam for a 4-wheel top running crane having 2 wheels per end truck.

1) Maximum Wheel Load (MWL)

MWL means the load on any wheel with the trolley and rated capacity load positioned on the bridge to give the maximum loading condition on that wheel. *MWL will occur when trolley and rated capacity load are positioned at the extreme end of the bridge and on cranes without a cab or platform* is calculated as follows:

MWL = K * P/2 + H/2 + C/4

Where

- P = Rated capacity loads in pounds (1metric ton = 1000kg = 2205 lbs; and 1imperial ton = 2000lbs)
- H = Weight of hoist and trolley in pounds
- C = Weight of crane in pounds
- K = Impact allowance factor (Impact allowance of the rated capacity load shall be taken as ½ % of the load per foot per minute of hoisting speed, but not less than 15% or more than 50%, except for bucket and magnet cranes for which the impact allowance shall be taken as 50% of the rated capacity load.) Therefore: K = 1 + (.005) * (S), where S is hoist hook speed in feet per minute. If a fixed bridge cab or platform is used, ½ of the weight of the cab or platform and mounted equipment shall be added to MWL.

2) Equivalent Center Load (ECL)

ECL is the load that, when applied in a concentrated loading condition at the center of the runway span length between supports specified, causes a bending stress in the beam equivalent to the bending stress that occurs in the beam when a 2-wheel top running end truck of a specified wheel base operates on it.

ECL is calculated by multiplying MWL by multiplication factor K1 or ECL = K1 * MWL

(Refer item 4 for estimating K1)

3) Maximum Support Load (MSL)

Loading at the runway span supports will vary as the two equal moving loads change position during operation on the runway. The maximum loading condition must be known for design of the support and is called MSL caused by the moving crane loads.

MSL is calculated by multiplying MWL by multiplication factor K2 or MSL = K2 * MWL

(Refer item 4 for estimating K2)

Note: The above calculated MSL is based on loading caused by the crane only and the total load on the support to use in the support design must also include the runway beam weight, lateral and longitudinal loads caused by crane trolley and bridge movement, and weight of any attachments and equipment mounted on the runway.

4) Determining K1 and K2

The following information for calculating ECL and MSL is based on the standard AISC equations for a simple beam having two equal concentrated moving loads.

- Step 1 – Calculate Ratio A/L

The figure below represents a runway beam span length between supports on which is operating two equal moving loads separated by a distance equal to a crane and truck wheel base. Each moving load is equal to MWL and can be calculated by procedures outlined above.

Calculate the ratio A/L, where A = truck wheel base, and L = runway span length between supports. Values of A and L must be in the same units, both in feet or inches.

- Step 2 - Select Multiplication Factors (K1 & K2)

From the following table, select the multiplication factors K1 and K2 based on the calculated A/L ratio. When the calculated value of A/L falls between the A/L values shown in the table, use the next lower tabulated A/L value.

A/L	> 0.05	0.05	0.1	0.15	0.20	0.25	0.30
K1	2.000	1.902	1.805	1.712	1.620	1.532	1.445
K2	2.000	1.950	1.900	1.850	1.800	1.750	1.700
A/L	0.35	0.40	0.45	0.50	0.55	0.60	0.65
K1	1.362	1.280	1.202	1.125	1.052	1.000	1.000
K2	1.650	1.600	1.550	1.500	1.450	1.400	1.350

A/L	0.70	0.75	0.80	0.85	0.90	0.95	1.00 or greater
K1	1.000	1.000	1.000	1.000	1.000	1.000	1.000
K2	1.300	1.250	1.200	1.150	1.100	1.050	1.000

5) Select Runway Beam Size

Maximum center loads (MCL) for various beams and composite beams for American Standard Shapes (I-Beam) are available in steel design handbooks. Any beam or composite beam having MCL greater than ECL for the span length under consideration may be used as the runway beam size.

Example

A crane having a rated capacity of 7.5 tonnes has a top running trolley hoist weighing 2975lbs. The crane operates on a runway span of 25 feet with a hook speed of 27 feet per minute and weighs 5935 lbs. The end truck has a wheel base of 7ft - 8inches. Calculate the MWL, ECL and the beam size.

Calculate MWL

MWL = K * P/2 + H/2 + C/4

K = 1 + (0.005) (S)

K = 1 + (0.005) (27)

K = 1.135 (.... use 1.15)

P = 7.5 x 2000 = 15000 lbs

H = 2975 lbs

C = 5935 lbs

MWL = 1.15 * 15000 / 2 + 2975/2 + 5935/4

MWL = 11597 lbs

Calculating A/L ratio

A = 7.67 ft

L = 20 ft

A/L = 7.67/20 = 0.383

Table does not have and A/L value of 0.385, therefore, use the next lower value, A/L = 0.35

K1 = 1.362

ECL = K1 x MWL

ECL = 1.362 * 11597

ECL = 15795 lbs

Referring to MCL tabulation for American Standard Shapes (I-beam) a beam must be selected that has a MCL greater than 15795 lbs when the span length is 20'. S20 x 66 has a MCL of 17330 lbs and therefore can be used.

CRANE RAILS

The crane rail and its interaction with the top flange of the girder have a very strong influence on the performance of the crane. It is important to know what type of crane is going to be applied when designing the crane rail and runway girder. Loading characteristics should be adopted which are in accordance with the crane and can be obtained from manufacturers manuals. In practice it is sometimes impossible to prepare the design of the crane and the crane runway girder at the same time because the crane is ordered much later than the building structure. The result may be a poor design leading to problems such as excessive wear of the crane rail and crane wheel flanges or fatigue cracking in the upper web of the girder.

The crane rail must meet the requirements for protecting the top flange from wear and for distributing the wheel loads evenly over the greatest possible length of contact. The crane rail must therefore have:

1) An adequate wear resistance

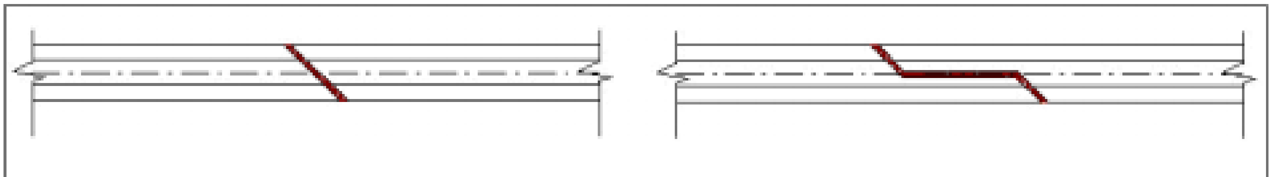
2) A high flexural rigidity

3) Rail Splices; there are two types of splice:

- Splices which join individual lengths
- Expansion splices

Longer rail lengths can be obtained rather by welding than by bolting. Welded splices are normally superior to bolted splices because the welded joint avoids a gap and gives a step-free running surface. Special care is required in the welding operation if there are high carbon and manganese contents in the steel.

Expansion joints in rails must be provided on long runways when rails are fixed to the girders. They should coincide with joints in the main girder. A gradual transfer of wheel load from one rail to another is ensured if the ends of the rail are beveled as shown in Figure below.

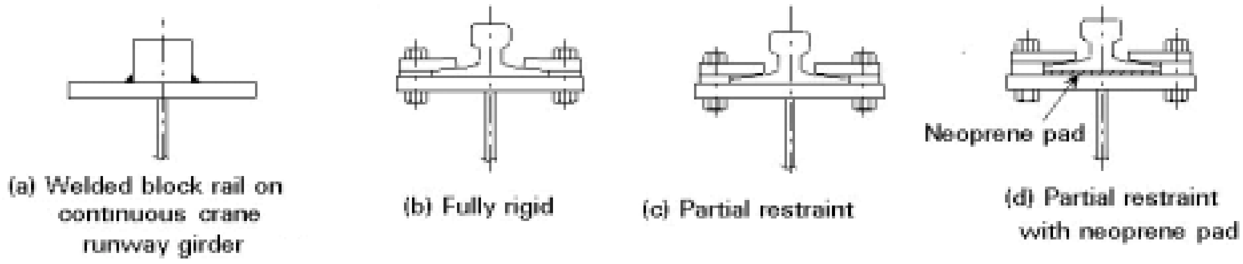


RAIL BEVELLING

Rail Fastenings

Various types of rail fastenings techniques are available. The traditional approach is to provide a fastening which restrains the rail in all directions. *The fastening of block rails is always by shop welding.*

The fastening of specially rolled rail sections is normally obtained by a fully rigid clamp or by welding the rail to the flange of the crane runway girder.



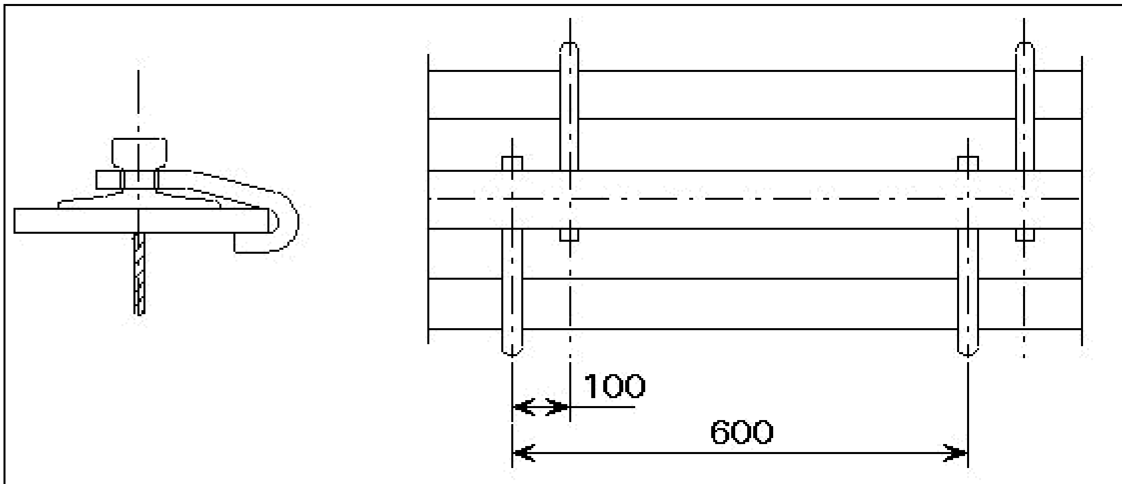
RAIL FASTENINGS

Welding has the advantage that the rail can be accurately located on the girder centerline due to the fact that lateral adjustment is possible. However the use of welding gives problems in some cases, for example:

1) Renewal may be difficult - In simply-supported joints crane runway girders occur at each support if shop welded. This problem is solved if site welding is located at positions where the bending moments are minimal, in which case the stress situation in the welds is less critical.

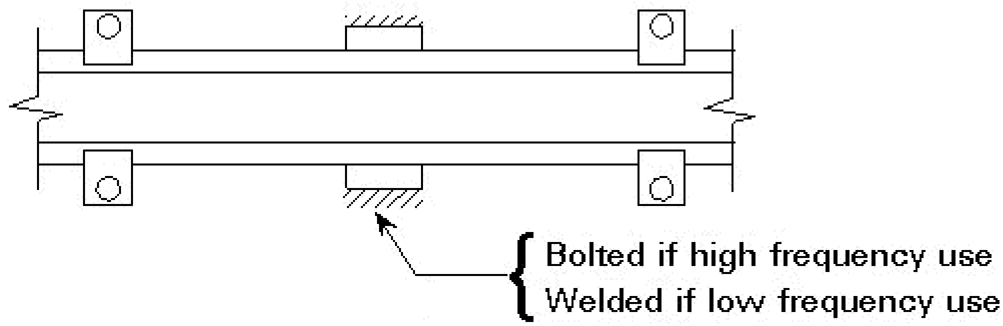
2) The welds can induce fatigue cracks - When higher strength steel has been specified, the welding operation is more difficult. Modern practice tends towards a fastening which gives partial restraint, as shown in Figure (c) above. The rail is restrained in the vertical and lateral direction, but the clamps allow the rail to move in the longitudinal direction.

Figure below shows the rail fastening using hook bolts



RAIL FASTENINGS USING HOOK BOLTS

Figure below shows another very economical method, for heavy duty applications of obtaining lateral restraint by site welding 'steering' plates between the clamps instead of using high strength bolts in the clamps to eliminate the possibility of movement. This type of fixing has to be checked for its influence on the fatigue of the crane runway girder.



RAIL FASTENING USING STEERING PLATES

Summarizing

Crane runway girders require a special care in design and detailing. The uncertainties, especially regarding the transverse loads and the transfer of forces to the girders, have to be clearly recognized.

1) Crane runway girder are usually I-beams (tapered beam flanges) though H-beams (flat flanges) or other patented track/enclosed track can also be used. It is of utmost importance to judiciously select the height, width and type of beam used. As a rough guideline, the usual range of girder depth-to-span ratios is between 8 and 14. The deflection limitation may dictate a larger depth, especially where spans are long.

2) Simplified calculations are adequate for light load cranes, but more rigorous analyses are required for heavy load cranes. The depth of structural investigations can be decided from the class of the crane.

3) Although minimum weight design may provide an economical solution to many design problems, this is not the case in the design of crane runway girders where the overall costs must include the maintenance costs.

4) Welded fabrication should be given a more rigorous inspection than the rest of the building structure. No further welding attachments should be allowed during the lifetime of an intensively used crane girder.

5) To make a realistic assessment of the stresses, the following design hints could be given:

- Wheel load should be distributed over a length equal to twice the rail depth.

- The stresses in the web should be calculated with an assumption for the eccentricity of the wheel with respect to the centre of the web, which might occur at the supports or when the crane and/or the rail have seriously suffered wear. Eccentricity of the rail to the runway girder usually has to be prevented by connecting them together with very small tolerances (preferably shop welding).

- Welds connecting the flange to the web should be checked for a combination of vertical stresses and bending stresses due to eccentricity (of the wheel load) in addition to shear.

- To avoid the necessity to move the rail from its location above the web, alignment of the whole crane runway girder should be possible. Therefore, slotted holes and shims should be applied.

- If welded crane runway girders are used, a full penetration butt weld should be used for the top flange to web joint to give resistance to fatigue.

PART-5 CRANE ELECTRIFICATION & POWER SUPPLY

In this section we will discuss the following:

- Methods of Crane Electrification
- Bridge and Runway Electrification Systems
- Bridge Span Electrification
- Motors and Controllers
- Enclosures – NEMA Standards
- Crane Controls

There are two circuits in most hoist electrification systems, power and control.

1) Power Circuit - The power circuit provides the energy to lift loads, and run other motors that perform work. Since bridges, trolleys, and hoists move during operation there must be powered by appropriate means.

2) Control Circuit – Another secondary low voltage electrical circuit supply power to the control functions. The crane or hoist is normally operated by some type of pushbutton arrangement held in an operator's hand. The benefit of reducing shock hazard by reducing the voltage and current are obvious.

Methods of Crane Electrification

1) Cable Reel – Round cable stored in a spring winder. The advantage of these systems is that it takes up less space and advantageous in curves. Not recommended for manual trolleys.

2) Coiled Cable – Round cable coiled in a spiral (like telephone cord). It is inexpensive compared to other types but becomes tangled after a time.

3) Insulated power bars – This method uses insulated bars with sliding shoe collector system, which removed the most of the exposed conductor safety hazard and provides an option of very high amperage compared to other power systems. Although this is an improvement over other methods, the shoes wore out quickly.

4) Festoon – Flat cable on a trolley traveling on a C rail provides direct contact, which is extremely wear resistant. This system provides advantage of superior reliability. However this method is not recommended for curves.

At the present time insulated power bar is the preferred choice for crane runway electrification while festooning is the choice for bridge cross conductors and floating pushbuttons. Routing festoon systems becomes somewhat of a problem when more than one separately moving system must operate on the same runway or bridge. When you consider that two or more bridges often operate on one runway system, use of the insulated bar for runways makes sense.

ELECTRICAL STANDARDS

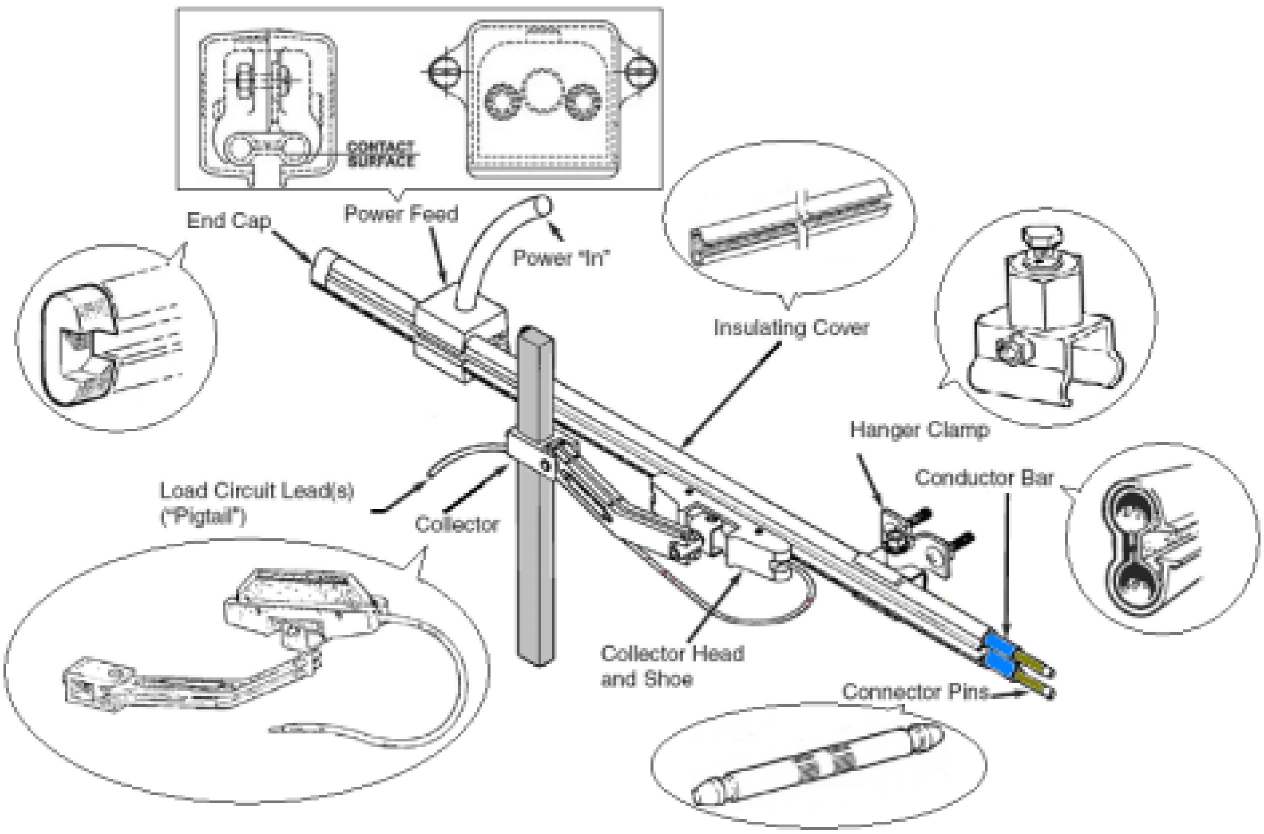
Crane, bridge-trolley, runway and hoist wiring, contact conductors, controls, over-current protection, and grounding shall conform to NFPA 70. All electrical equipment shall be in accordance with NEMA Publication No. ICS 8 and National Electric Code Article 610 (Cranes and Hoists).

The control circuit voltage shall not exceed 600 volts for AC or DC current. Ideally 480 volt, 3 phase, 60 hertz for US requirements

The voltage at pendant pushbuttons shall not exceed 150 volts for AC and 300 volts for DC.

CRANE BRIDGE & RUNWAY ELECTRIFICATION

The figure below shows a basic insulated power bar arrangement for the crane runway:



Conductor Power Bar Components & Specifications

Power supply to the runway electrification shall be by means of bridge conductors and collector system as shown above. The typical components and specifications are as follows:

1) Conductor Bar – Track electrification shall be accomplished by UL approved conductor continuous bar. Conductor bars shall be one piece, copper conductor complete with thermoplastic insulating covers and end covers. The insulated bar are also called 8-bar system because the bar inside the insulation when viewed from the end looks like a figure 8. Conductors shall be accurately aligned to ensure positive electrical contact between the collector and the conductor. Separate conductors shall be provided for each phase. More than one conductor in a single enclosure will not be permitted.

   - Maximum voltage drop from the building power takeoff point for the track electrification system to the hoist motor shall not exceed 4 percent, and the equivalent conductance shall not be less than

No. 4 American Wire Gage (AWG) copper wire. Size of bridge conductors shall be proportioned to limit the total voltage drop in the conductors to a maximum of 3 percent of the supply voltage when the current on the individual motors is full load.

- Short-circuit current rating of conductors shall be not less than 10,000 amperes.
- Continuous-current, thermal rating of conductors shall not exceed 140ºF (60ºC) based on an ambient temperature of 86ºF (30ºC).

2) Power feed – This is an attachment for incoming power and is a fully insulated simple clamp type is easily installed anywhere on the system for in coming power to the conductor rails. The power supply to the runway conductors shall be controlled by a switch or circuit breaker located on a fixed structure, accessible from the floor, and arranged to be locked in the open position.

   - A fused, manual disconnect switch with a lockable handle mounted through the panel door shall be provided and wired into the incoming power circuit.
   - All power for crane shall be supplied through one main visible blade fuse switch located on the crane bridge in an easily accessible position.

3) Collectors - Current collector assembly consists of a spring loaded sliding contact type shoe of hard copper alloy or sintered copper graphite. Shoe shall be mounted in an insulating case of phenolic or urea compound of suitable temperature and insulation quality. Exposed parts of current collectors shall be grounded and of corrosion-resistant material.

   - Current collector assembly shall be designed to operate through gaps, splices, and switches and shall be self-centering. System shall include expansion sections for every 150 feet (45720 mm) for systems using galvanized steel conductors and every 100 feet (30480 mm) for systems using copper conductors.

4) Hangers- Supports the conductor bar, may also be used as an anchor to direct movement due to expansion and contraction

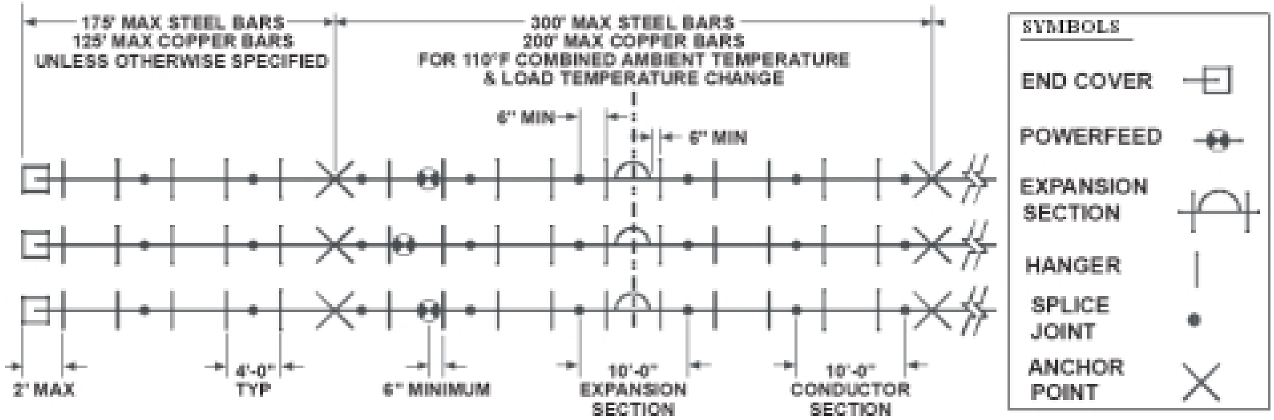
5) End Cover- Used to close the end of the conductors to cover exposed conductor and avoid accidental contact.

6) Insulating cover –Insulation cover shall be rigid PVC, self extinguishing, with a heat distortion point of 160ºF at 260psi.

7) Connector pins - Used to join the conductor bar sections together.

System shall be complete with unit length conductors, insulating conductor covers, insulators, splices and splice covers, end caps, support brackets and fasteners, current collectors, expansion, isolation and power-interrupting sections, disconnect switch, and conduit and wiring to power takeoff point.

Typical Installation Guidelines



The expansion section shall be considered at 350 ft length for steel conductor and 250 ft length for copper. Expansion sections are required to compensate for thermal expansion.

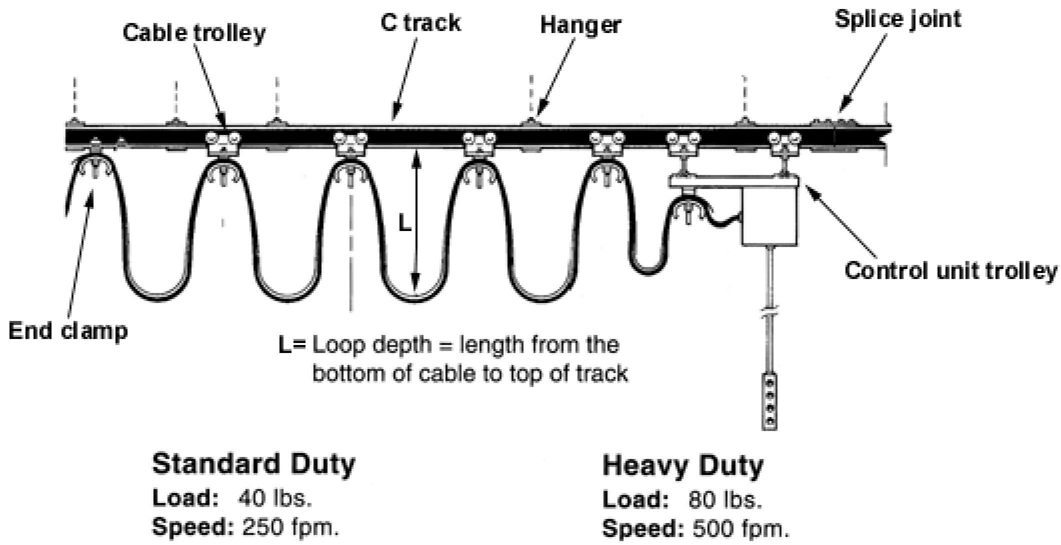
Standard hanger spacing: every 4 feet for straight runs, every 3 feet for curves.

HOISTING TROLLEY ELECTRIFICATION

Power supply to the hoisting trolley shall be by means of a multi-stranded flat cable suspended from catenary system on I-beam tracks for top running crane. Such a system is called Festooning. The typical specifications for festooned bridge conductor system are as follows:

Festooned bridge conductor system shall consist of extra-flexible stranded copper conductors, cross-linked 90°C polyethylene insulation rated 1000V with high temperature outer jacket. Conductor sizes shall be as recommended by the hoist and trolley manufacturer.

Cables to the trolley shall be suspended from a rail type cable support system called “messenger track” that shall be mounted above one of the main bridge platforms, to provided safe access to the cables and catenary system. The festooned wires may be used to transmit current from the bridge to the trolley or from the bridge to a pendant control unit.



MOTORS AND CONTROLS

Depending on the application, the EOT cranes require motors at three areas:

a) Bridge and end truck motors

b) Trolley motors

c) Hoist motors

Motor Specifications

1) Motors shall be fixed, dual or variable speed drive and shall be suitable for quick reversing crane duty. The motors shall be high-starting-torque, high-slip, squirrel-cage AC motor or alternatively where specified shall be a variable-speed, low-slip, wound-rotor AC motor.

2) Drives shall be rated to carry the full load current of the hoist motors continuously for 10 minutes. Drives shall be rated to carry the full load current of the long and cross travel motors continuously for 5 minutes.

3) If using variable speed drives, the adjustable drive shall be vector control and closed loop encoders for control of hoist motors or open loop vector for control of the bridge long travel and cross travel trolley motors.

4) Motors shall be totally enclosed, non-ventilated type, certified for 30-minute time-rated operation at full identification plate power output in an ambient temperature of 104ºF (40ºC), maximum temperature rise 167ºF (75ºC), insulation not less than Class B system. Motors for hazardous environment, where indicated, shall be explosion proof.

5) Motors shall not be built integral with the crane framework and output shafts shall be tapered. The design shall include for automatic application of motor brakes in the event of a failure of the electronic circuitry or of the power supply.

6) Each motor shall be provided with a full magnetic, electrically operated, reversing-type controller with thermal-overload protection, fused disconnects switch, and control-circuit transformer.

7) Enclosure shall be fitted with a UL-approved drain and breather and shall be certified and labeled in accordance with UL 674, Class 1, Groups C and D.

ENCLOSURES

The enclosures house all of the electrical components on the crane and are rated by the National Electrical Manufacturers Association (NEMA) as to the level of protection they provide from the conditions in the surrounding environment. Typically, the most common practice is to specify NEMA 1 level of protection for all electrical equipment and NEMA 12 for all controls panels.

NEMA Standards Summarized

NEMA Type	NEMA Definition*	Application for NEMA Enclosures*
1	Enclosures are intended for indoor use primarily to provide a degree of protection against contact with the enclosed equipment in areas where unusual service conditions do not exist.	Enclosures are suitable for general application indoors, where atmospheric conditions are normal. These enclosures provide limited protection against falling dust, but are not dust tight.
2	Enclosures are intended for indoor use primarily to provide a degree of protection against limited amounts of falling dust and water. NEMA Standard 1-10-1979	Drip tight (indoor) enclosures are similar to Type 1 enclosures, with the addition of drip shields, and are suitable for application where condensation may be severe, such as that encountered in cooling rooms or laundries.
3	Enclosures are intended for outdoor use primarily to provide a degree of protection against windblown dust, rain, sleet and external ice formation. NEMA Standard 1-10-1979	Suitable for applications outdoors on ship docks, canal locks, construction work and for application in tunnels and subways. Use indoors where dripping water is a problem.
3R	Enclosures are intended for outdoor use primarily to provide limited protection against falling rain, sleet and external ice formation. (May be ventilated). NEMA Standard 1-10-1979	Outdoor use to provide a degree of protection against falling rain and sleet; undamaged by the formation of ice on the enclosure.
4	Enclosures are intended for indoor or outdoor use primarily to provide a degree of protection against windblown dust and rain, splashing water, and hose-directed water. NEMA Standard 1-10-1979	Water tight enclosures are suitable for dairies, breweries, etc., where they are subjected to large amounts of water from any angle. (They are not submersible)

NEMA Type	NEMA Definition*	Application for NEMA Enclosures*
4X	Enclosures are for indoor or outdoor use primarily to provide a degree of protection against corrosion, windblown dust and rain, splashing water and hose directed water. NEMA Standard 1-10-1979	Corrosion resistant enclosures satisfy the requirements of Type 4, and are suitable for food processing plants, dairies, refineries and any other industries where corrosion is prominent.
5	Enclosures are intended for indoor use primarily to provide a degree of protection against settling airborne dust, falling dirt and dripping non-corrosive liquids. NEMA Standard 5-25-1988.	
6	Enclosures are for indoor or outdoor use primarily to provide a degree of protection against the entry of water, during occasional, temporary submersion at a limited depth. NEMA Standard 1-10-1979	Submersible enclosures are suitable for application where the equipment may be subject to submersion, such as quarries, mines and manholes. The enclosure design will depend upon the specified conditions of pressure and time.
7	Enclosures are for indoor use in locations that are classified as Class I, Groups A, B, C or D, as defined in the National Electric Code. NEMA Standard 1-10-1979.	Hazardous areas indoor classified as shown.
8	Enclosures are for indoor or outdoor use in locations that are classified as Class I, Groups A, B, C, or D, as defined in the National Electric Code. NEMA Standard 1-10-1979	Hazardous areas indoor or outdoor classified as shown.
9	Enclosures are for indoor use in locations classified as Class II, Groups E, F, or G, as defined in the National Electrical Code. NEMA Standard 5-19-1986	Hazardous areas indoor enclosures classified as Class II, Group E, F, or G.
12	Enclosures are intended for indoor use primarily to provide a degree of protection against dust, falling dirt and dripping non-corrosive liquids. NEMA Standard 1-10-1979.	Indoor uses to protect the equipment against fibers flyings, lint, dust, and light splashing, seepage, dripping, and external condensation of non-corrosive liquids.
13	Enclosures are intended for indoor use primarily to provide a degree of	Indoor enclosures intended primarily to house pilot devices such as limit

NEMA Type	NEMA Definition*	Application for NEMA Enclosures*
	protection against dust, spraying water, oil, and non-corrosive coolant. NEMA Standard 1-10-1979	switches, push buttons, selector switches, pilot lights, etc., and to protect these devices against lint and dust, seepage, external condensation, and spraying of water, oil, and co

CRANE CONTROLS

Controls deserve special consideration, especially in high duty classifications where response is crucial. Unless otherwise specified, all crane functions shall be controllable from the floor with radio remote control and from the crane operator's cab (if provided). A pendent control station shall also be suspended from the crane on an independent track, running approximately the full span of the crane. Cranes shall be able to be switched between remote and pendent control.

1) Single- and two-speed controls have traditionally been the controls of choice for light to moderate duty crane applications (class B), since precise load positioning isn't as critical factor in most class B applications.

2) Multi-speed control relies on three to five specific speed points, which are produced by changing the resistance of a wound rotor induction motor through the use of magnetic contactors and resistor banks.

3) AC static step-less control is suited for higher duty applications (D-F), where high temperatures, or high dust or corrosive gas conditions exist. It is called "step-less" because it changes the inductance of a wound rotor without the use of speed step magnetic contactors to achieve infinitely variable speeds. This control also uses an eddy current load brake on hoists, and reduces maintenance by replacing contactors and relays with potted, non-wearing solid state devices.

4) Adjustable frequency is the state-of-the-art control system in solid-state technology and now the mainstay of Class D, E, and F cranes. A micro-computer allows acceleration and deceleration rates to be adjusted digitally and independently for smooth stops and starts and unequalled inching capability. And because of its solid-state construction, is has no moving parts. It uses reliable, low-maintenance squirrel cage motors and does not require eddy current load brakes on hoists.

Note: A 'deadman' function shall be supplied at all locations that shall only permit control of the crane when activated.

Control Equipment

1) Pendent Pushbutton Control Stations - Pushbuttons stations for crane control shall be heavy-duty; oil tight, momentary contact devices with the number of buttons and the marking of identification plates in accordance with NEMA ICS 1. Unit shall have a pendant-mounted conductor cable with a permanently attached strain-reliever chain or cable integral with the pendant conductor cable. Pushbutton station shall be grounded to the hoist and crane bridge. Strain-reliever chain or cable shall not be used as a grounding circuit. Pushbuttons shall be designed to transmit a distinct notch or step feeling to the operator for each pressure or release action on hand-controlled speed points. Pendant pushbuttons shall be legibly and permanently marked and shall be vertically arranged in the following top to bottom grouped order:

   - TROLLEY FORWARD

- TROLLEY REVERSE
- BRIDGE FORWARD
- BRIDGE REVERSE; UP, DOWN; and
- RESET, STOP

Stop control shall be red, plastic-covered, mushroom-head button. A pilot light to indicate that power is available shall be furnished integral with the pushbutton cases. An emergency stop pushbutton and a reset button shall be provided to operate the main line contactor.

Bottom of the control station shall be approximately 48 inches (1220mm) above the operating floor level. A limit switch shall be provided to prevent power being applied to the crane travel motor when the crane track beam is interlocked to a fixed track beam. Operation of the interlock shall be controlled by means of nylon ropes or chains with suspended, unbreakable, insulated handles having appropriate reach and location. Handles shall be approximately 54 inches (1370 millimeter) above the operating floor level.

The pendant may be suspended from the Trolley Hoist, requiring the operator to walk with and beside the load, or on a separate sliding track system allowing the operator to move independently of the load.

2) Variable Frequency Drive (VFD) - A pendant can also be used in conjunction with a Variable Frequency Drive. A VFD is used to vary the frequency of the motors controlling the motions allowing for smooth acceleration and deceleration. The buttons on the pendant operate a VFD unit operated in much the same way as ‘Two Speed control’. The first step is held to maintain the current speed while the second step is used for acceleration. Deceleration shall be achieved by releasing the button entirely. Pressing the button back to the first step will maintain the new slower speed. It should be noted that the deceleration shall not be achieved through uncontrolled coasting but through a programmable dynamic braking system. The control provided by a VFD allows for a high level of customization.

3) Radio Control - The radio control performs exactly like the pendant but operates using a radio frequency. The radio control incorporates numerous safety features and allows the operator a greater range of operator motion than a pendant. Radio control shall be from a portable console and shall preferably utilize ‘Ethernet’ communications for the link. As a backup to radio control all crane functions shall also be controllable from the pushbutton station.

4) Limit Switches - Adjustable upper limit switch shall be provided to prevent overtravel of the hook or load block in the hoisting direction. Limit switches shall be arranged to stop the hoist motor and apply the motor brake before reaching the uppermost safe limit of travel. In case of hook overtravel, the motor shall be automatically and momentarily reversed. Adjustable lower limit switch to stop the hoist motor shall be provided. Motor brake shall be applied when the load hook reaches a predetermined lower limit. According to OSHA, the hoist limit switch must be operationally checked under no load at the beginning of each shift. The purpose of this check is two-fold. It not only verifies the operation of the switch, it also "exercises" the make/break mechanism, thus reducing the chances of it "freezing-up".

PART-6 DESIGN SPECIFICATIONS FOR EOT CRANES

In this section we will discuss the following:

- Specifications and Codes
- Structural Requirements
- Mechanical Requirements
- Electrical & Control Requirements
- Drawings Submittal

General Specification and Codes

1) Top running cranes and their appurtenances shall conform to the requirements of CMAA 70 (latest edition) – Specifications for Top Running Bridge & Gantry Type Multiple Girder Electric Overhead Traveling Cranes.

2) Crane components and appurtenances required for safe operation and maintenance shall be in accordance with OSHA regulations Par. 1910.179 Overhead and Gantry Cranes and ASME B30.2-2001.

3) Crane hoist and trolley shall be in accordance with Hoist Manufacturers Institute HMI 100-74, Specification for Electric Wire Rope Hoist.

4) Crane hooks shall be in accordance with ASME B30.10-Hooks and shall be of the single fishhook design with spring type safety latch.

5) Runway rails and bridge girder shall be fabricated from structural steel conforming to ASTM Designation: A 36 and shall have a maximum deflection of 1/600 of the span length under maximum loading conditions. The runway rails and bridge girders shall be provided with travel stops.

6) In general, electric overhead traveling cranes shall conform in design, materials, construction, and performance with the current issue of the following specifications, codes and standards.

1) CMAA 70 Specification for Top Running Bridge & Gantry Type Multiple Girder Electric Overhead Traveling Cranes

2) AGMA American Gear Manufacturer's Association

3) ASME HST-4 Performance Standard for Overhead Electric Wire Rope Hoists

4) ASME Y 14.1 Decimal Inch Drawing Sheet Size and Format

5) ASME B18.2.2 Square and Hex Nuts

6) ASME B30.2 Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist)

7) ASME B30.10 Hooks

8)	AWS D14.1 Cranes	American Welding Society – Specification for Welding of Industrial and Mill
9)	HMI 100-74	Hoist Manufacturer's Institute - Specification for Electric Wire Rope Hoists
10)	NEC 610-14	Determining Amperage Requirements for Cranes and Hoists
11)	NEMA ICS 8	Industrial Control and Systems - Crane and Hoist Controllers
12)	NFPA70	National Electrical Code
13)	OSHA	Occupational Safety & Health Administration
14)	IBC	International Building Code (This will eventually replace UBC)
15)	UBC	Uniform Building Code

The available literature on crane indicates that the procedural design of cranes is highly standardized. Consideration of the available technology and components is mainly based on the accumulated previous experience on various design projects and the time spent on crane selection is mostly for interpretation and implementation of the available design standards. However correct interpretation is important for better performance, higher safety and more reliable designs.

Many international and/or national standards and rules are available to guide the crane designers for that purpose; e.g. BS 357 , AISE Standard No.6, CMAA No.70 and 74, JIS B8801, DIN 44 and "FEM Rules" . All of these standards offer design methods and empirical approaches and formulae that are based on previous design experiences and widely accepted design procedures.

(Refer to other international codes in Annexure -C)

COMPONENTS – KEY CHARACTERISTICS

Crane Bridge and end truck assembly, trolley rails, and beam runways shall be designed and fabricated in accordance with AISC 317 and CMAA 70, Section 70-2, "Crane Classifications." Salient features of few key components are described below:

Steel-

1) Steel for crane bridges, end truck frames, auxiliary girders, trusses, and reinforcing shall be hot-rolled structural steel I-beam, wide flange beams, channels, and angles and plates not less than ASTM A-36 or equivalent.

2) Girders and track beams shall be true, straight, and free of twists with standard mill tolerances for crane use. Runway track beams that carry rails shall conform to CMAA 70.

Structural Connections-

The main structural connections on overhead traveling cranes shall be high strength bolts, usually either ASTM A-325 or A-490 designation. It is equally important that high strength bolts must be used with nuts and washers that are compatible with the bolt material.

For A-325 bolts (Types 1 and 2, plain, uncoated), this usually means using a nut conforming to ASTM A563 (Grade C, C3, D, DH or D3, plain), or ASTM A194 (Grade 2 or 2H, plain).

For A-490 bolts (Types 1 and 2, plain), nuts conforming to ASTM A563 (Grade DH or DH3, plain) or ASTM A194 (Grade 2H, plain) are usually used. In either case, hardened flat washers conforming to ASTM F436 must be used under the turned part (spring type lock washers are not recommended for high strength bolted connections as they have a tendency to spread apart during installation).

Note that

a) AISE Technical Report No. 6, prohibits the use of low carbon bolts (ASTM A-307) for structural connections.

b) As for maintenance, reuse of A490 bolts and galvanized A325 bolts is prohibited (retightening previously tightened bolts which have become loose by the tightening of adjacent bolts is not considered "reuse").

Bridge Girders-

1) Crane bridges shall consist of welded sections with sufficient reinforcement constructed of rolled steel plates with minimum plate thickness of 6mm.

2) The girders shall be designed with positive pre-camber and the vertical deflection caused by the working load limit and the weight of the trolley in the central position, shall not exceed 1/900 of the span.

End Trucks (or End Carriages)-

1) The end trucks shall be motorized and shall have not less than 4 forged steel wheels with sealed, tapered roller bearings.

2) The end carriages shall be one piece welded construction and designed so that the weight of the crane and its load is equally divided between the wheels. These shall incorporate suitable drop stops to limit the fall of the crane more than 25mm in event of breakage of a track wheel, bogie or axle and designed to engage into the side of the rail in the event of guide roller failure, bringing the crane to a safe stop.

3) Each assembly shall have not less than four wheels. Sufficient wheels shall be provided to distribute the load on the track beams. Static wheel loading in pounds kilogram for cylindrical treads shall not exceed 1,200 DW [544 kg ; 1,200 pound] for crane Duty Classes A and B and 1,000 DW [454 kg;1,000 pound] for Duty Class C. *DW : "D" equals the diameter of the wheel in inches millimeter and "W" equals the nominal width of bearing on the tread.

Cross Travel Trolleys-

1) Trolley shall be fabricated as an integral part of the hoisting mechanism or as an assembly bolted to a unit hoist.

2) Trolley wheels shall be flangeless type, carried on the specified type of antifriction bearings. Tractor frame shall include two guide rollers on each side of the frame, carried on sealed, permanently lubricated antifriction bearings.

3) Buffers shall be provided on the frame to engage the stops in the bridge structure. Where multiple hooks are installed, they are to be in-line and centered between the 2 crane girders.

Wheels-

1) Flangeless wheels shall be used for long travel with side guide roller sets acting on both sides of the rail that is located on the power collector side of the crane. Wheels shall be carried on sealed, self-aligning, and permanently lubricated antifriction bearings designed for axial and thrust loading. Bearings shall be provided with fittings for pressure lubrication.

2) Non-corroding, non-sparking end truck wheels shall be AISI Type 304 corrosion-resistant steel or suitable copper alloy.

3) Wheel base of the end truck assembly for bridges having four pairs of wheels shall be not less than 1/7 of the bridge span; for bridges having eight pairs of wheels, the center-to-center distance of the rocker pins on which the equalizer bar pivots shall be not less than 1/7 of the longest bridge span.

4) Safety lugs shall be provided to limit the drop to not more than 0.5 inch (12.7mm) in case of wheel or axle breakage and to maintain the crane or trolley on the track beam.

5) Wheel Hardness rating shall be above 60 Rockwell C and shall be at least 25-30% harder than its corresponding rail.

6) As applicable to top running bridge cranes, wheels could be manufactured with tapers of 1 in 20, 1 in 25, or 1 in 16 and are generally used on bridge drives on long span cranes to help prevent skewing of the bridge structure. The tapered wheels should almost always be installed with the larger diameter towards the inboard side of the crane.

Rails-

1) All long and cross travel rails shall be in accordance with DIN 536-1(or equivalent) and assembled as per German Standard VDI 3576 (or equivalent).

2) All rail section lengths shall be welded together to give a continuously welded rail between expansion joints; the welded method shall be either by Flashbutt (resistance) or Aluminothermic method.

Cabs -

1) An open operator’s cab, when specified, shall be complete with cushioned seat, joystick, and operating controls and pushbuttons.

2) The general arrangement of the cab and the location of control and protective equipment shall be such that all operating handles are within convenient reach of the operator when facing the area to be served by the load hook, or while facing the direction of travel of the cab. The arrangement shall allow the operator a full view of the load hook in all positions.

3) The clearance of the cab above the working floor or passageway should be not less than seven feet.

Hoists -

1) Hoist assembly shall include hook, load block, wire rope and drum, gearing, brakes, motor drive and controls with integral or attached trolley.

2) The hoist shall have two independent means of braking; a holding brake which shall be applied automatically on power removal and controlled braking to prevent speeding when lowering the load.

3) Electric hoists wiring, contact conductors, controls, overcurrent protection and grounding shall conform to NFPA 70 and to the applicable UL standards and specified requirements. Each unit shall be factory wired and ready for operation.

Bearings -

1) Bearings in the hoist mechanism shall be precision manufactured antifriction bearings, needle-type roller bearings or end and radial thrust ball bearings, operating in an oil bath and conforming to the requirements specified.

2) Exposed bearings and load block bearings shall be pre-lubricated and factory sealed.

3) Hook bearings shall be of the thrust type, designed on the basis of hours of life and load for the applicable hoist duty class at an arbitrary speed of 10 revolutions per minute. Dead load and hook load shall be reduced to percentage with normal impact, shock, and similar loadings omitted.

4) Percentage of dead load and hook load and the applicable L-10 standard ABMA 9, rating life of bearings in hours, as applicable to the crane duty class, shall be as follows:

Crane Duty Class	Hoist Rating		Trolley Rating		Bridge Rating	
	Life*	Load	Life*	Load	Life*	Load
A	7000	75	5000	75	5000	75
B	7000	85	5000	75	7500	75
C	15000	75	10000	85	15000	85

*The L-10, rating life of a group of apparently identical ball bearings is defined as the number of revolutions (or hours at some given constant speed) that 90 percent of a group of bearings will complete or exceed before the first evidence of fatigue develops, ABMA 9.

Brakes -

Automatic brakes shall be provided for all motions. Drum brakes are preferred on hoists and should have taper bores to mate to the gearbox/motor shafts. These shall be applied immediately the current is switched off or fails from any cause. Brakes may be applied by mechanical, electrical, pneumatic, hydraulic, or gravity means.

1) Motor Brakes- Motor brakes shall be provided on electric-motor-operated hoists, trolleys, and bridges. Motor brake shall be an externally adjustable, multiple friction electromagnetic disk brake which shall apply automatically when the power is interrupted.

   Torque rating of the bridge and trolley brakes shall be not more than 50 percent of the full-load torque of the bridge and trolley motors and shall be adjustable to 25 percent for all duty classes.

2) Hoist Load Brake- Each hoisting unit shall be provided with two means of braking. One brake shall be an electric motor brake as specified. The other brake shall be a mechanical load brake, directly applied to the hoist motor shaft or other shaft in the hoist gear reduction.

   Hoist motor brake shall be capable of holding the capacity load of the hoist at any point independent of the load brake and in addition to stopping and safely holding 125 percent of the rated load from any operating speed, shall hold a static load equal to 150 percent of the rated capacity.

Hoists handling molten metal shall be equipped with two holding brakes plus means for control braking. The additional holding brake shall be a direct acting hoist drum brake system that will arrest the hoist motion under full speed and full load.

3) Eddy-Current Load Brake- Eddy-current-type brake shall be provided for hoist control of wound-rotor motors. Eddy-current brakes shall provide an adjustable varying artificial load on four lowering speed points and on not less than two hoisting speed points.

   When eddy current brakes and motors are not determined from root-mean-square computations, the crane torque rating of the eddy-current brakes shall be not less than 1.2 times the torque rating of the motor.

Trolley Stops -

1) Stops shall be provided at the limits of travel of the trolley.

2) Stops shall be fastened to resist forces applied when contacted.

3) A stop engaging the tread of the wheel shall be of a height at least equal to the radius of the wheel.

Bumpers-

1) Bridge Bumpers- The bumpers shall be capable of stopping the crane (not including the lifted load) at an average rate of deceleration not to exceed 3 ft/s/s when traveling in either direction at 20 percent of the rated load speed. The bumpers shall have sufficient energy absorbing capacity to stop the crane when traveling at a speed of at least 40 percent of rated load speed.

2) Trolley Bumper- A trolley shall be provided with bumpers or other automatic means of equivalent effect, for stopping the trolley. The bumpers shall be capable of stopping the trolley (not including the lifted load) at an average rate of deceleration not to exceed 4.7 ft/s/s when traveling in either direction at one-third of the rated load speed.

Walkways-

1) Walkways shall be furnished on all top-running cranes. A full-length walkway shall be provided for access to the bridge drive, crane control mechanism, bridge span conductor system and lube fittings.

2) A short walkway shall also be provided at the opposite side of the bridge girders for access to the festoon cables. All walkways shall include handrails, toe plates, and all required OSHA safety devices.

Lubrication-

1) Means shall be provided for adequate lubrication of moving parts of the crane bridge hoist and trolley, and for filling, draining, and checking the level of the lubricant.

2) Lubricant shall conform to AGMA 250.04, type as recommended by manufacturer.

3) Vertical gear trains shall be provided with positive lubrication to the upper gears and to oil-lubricated bearings. Enclosed reduction gearing and automatic load lowering brakes shall be lubricated in an oil bath.

4) Gear reduction at trolley and bridge wheels for cranes of Duty Classes A and B may be of open design and grease lubricated. Trolley and bridge wheel gears on Duty Class C cranes shall run in oil.

5) Grease-lubricated bearings shall be lubricated through individual pressure lines to each bearing. Each line shall be equipped with a lubrication fitting.

Guards -

1) If hoisting ropes run near enough to other parts to make fouling or chafing possible, guards shall be installed to prevent this condition.

2) Exposed moving parts such as gears, set screws, projecting keys, chains, chain sprockets, and reciprocating components which might constitute a hazard under normal operating conditions shall be guarded.

Clearance from obstruction-

1) Minimum clearance of 3 inches overhead and 2 inches laterally shall be provided and maintained between crane and obstructions in conformity with Specification No. 61 CMAA.

2) Where passageways or walkways are provided obstructions shall not be placed so that safety of personnel will be jeopardized by movements of the crane.

Footwalks & Ladders-

1) If sufficient headroom is available on cab-operated cranes, a footwalk shall be provided on the drive side along the entire length of the bridge of all cranes having the trolley running on the top of the girders.

2) Footwalks should be located to give headroom not less than 78 inches. In no case shall less than 48 inches be provided. If 48 inches of headroom cannot be provided, footwalks should be omitted from the crane and a stationary platform or landing stage built for workers making repairs.

3) Footwalks shall be of rigid construction and designed to sustain a distributed load of at least 50 pounds per square foot.

4) Footwalks shall have a walking surface of antislip type; wood will meet this requirement.

5) Footwalks should be continuous and permanently secured.

6) Footwalks should have a clear passageway at least 18 inches wide except opposite the bridge motor, where they should be not less than 15 inches. The inner edge shall extend at least to the line of the outside edge of the lower cover plate or flange of the girder.

7) All footwalks shall be provided with handrails and toeboards.

Ladders and stairways-

1) Access to the cab and/or bridge walkway shall be by a conveniently placed fixed ladder, stairs, or platform, requiring no step over any gap exceeding 12 inches.

2) Fixed ladders shall be in conformance with the American National Standards Institute, Safety Code for Fixed Ladders, ANSI A14.3-1956.

3) Stairways shall be equipped with rigid and substantial metal handrails. Walking surfaces shall be of an antislip type.

Fire extinguisher-

A carbon dioxide, dry-chemical, or equivalent hand fire extinguisher should be kept in the cab. Carbon tetrachloride extinguishers shall not be used.

Lighting-

Light in the cab and the work area shall be sufficient to enable the operator to see clearly enough to perform the work.

ELECTRICAL & CONTROL

Motor Controller -

1) Motors and controls shall conform to CMAA 70 or CMAA 74. Motor mounting, shaft, and keyway dimensions shall conform to manufacturer's standards.

2) Class I crane controllers are intended for use with all Crane Manufacturers Association of America (CMAA) crane service classes except A and B.

3) Class II crane controllers are intended for use with CMAA crane service classes A and B (infrequent use or light industrial service).

4) Controllers for variable speed motors shall be provided with five speed points, not less than three of which shall be hand-controlled points. When provided with three hand-controlled points, points one, two, and five shall be the hand-controlled points, and points three and four shall be automatic.

5) Accelerating relays, adjustable from at least 1/4 second to 2 seconds, shall be provided for points above the second.

6) Magnetic motor controllers shall be capable of interrupting operating overloads up to and including 10 times their normal motor rating. Continuous current ratings shall be based on temperature rise above an ambient temperature of 104ºF (40ºC). Core and coil assembly, auxiliary contacts, and other control-circuit devices shall be rated at 120 volts.

Resistors –

1) Resistors shall have a thermal capacity of not less than Class No. 150 series and shall be rated for continuous duty. Accelerating resistors shall be rated for Duty Classes A & B cranes, hoists, and trolleys: 15 seconds on and 45 seconds off AND for Duty Class C: 15 seconds on and 30 seconds off.

2) Resistors for variable-speed bridge motors shall provide not more than 25-percent full-load motor torque for the first speed point of bridge travel.

3) Resistors for variable speed hoists and trolley motor shall provide not more than 50-percent full-load motor torque for the first (slow)-speed point hoisting and not more than 25 percent for the first-speed point of trolley travel.

4) Resistors shall be designed for operation within temperature ratings of 707°F (375°C), ambient plus rise when wires are bare, and 572°F (300°C) when embedded. Resistors shall be of the non-breakable, non-corroding, wound type capable of adjustment by taps and shall be thoroughly ventilated. Resistors shall be mounted in substantial end frames and shall be enclosed in louvered enclosures for both indoor and outdoor service.

5) Resistors shall be non-breakable and mounted in ventilated enclosures.

Disconnect Switch, Conduit, and Wiring-

1) Feed-in boxes for the attachment of feeder conductor to runway conductor shall consist of bus tap connections for terminal lugs without over current protection in a protective enclosure.

2) Enclosures shall be formed from cast iron, corrosion-resistant steel, or carbon steel with thickness of metal and box dimensions in accordance with UL 857. Seams and joints shall be closed and reinforced with flanges formed of the same material from which the box is made. Box shall be provided with a screwed-on cover plate. Carbon-steel enclosure shall be zinc coated after fabrication with Type SC3 minimum thickness of coating in accordance with ASTM B 633.

3) Enclosure shall be the same type material and paint finish of NEMA enclosure as specified herein.

4) Disconnect switch shall be a surface-mounted, heavy-duty, single-throw, air-break, enclosed type conforming to NEMA KS 1 as indicated and as follows:

5) Switch box shall be installed with centerline 66 inches 1675 millimeter above the finished floor and at the approximate center of the crane runway length.

6) Conduit between monorail feeder enclosures and disconnect switches and fixed control stations shall be zinc-coated, rigid-steel conduit, couplings, elbows, bends, and nipples conforming to ANSI C80.1. Zinc coating shall be an electrodeposited coating conforming to ASTM B 633.

7) Building wire for use in conduits, raceways, and wire ways in wet or dry locations shall be single-conductor, 600-volt, heat and moisture resistant with a maximum temperature rating of 167º F (75ºC), or cross-linked thermosetting polyethylene insulation with a temperature rating of 194ºF (90ºC).

8) Switchboard wire shall run vertically and horizontally only and in such manner that each wire is accessible and firmly supported. Bus bars shall be made of hard-drawn rectangular copper with silver-plated contact surfaces. Buses shall be rigidly supported and spaced to provide ample room for connecting cables and to prevent arcing.

9) Wiring, except panel wiring, shall be protected by drained or moisture tight, zinc-coated, rigid conduit. Flexible leads, where required, shall be enclosed in moisture proof flexible steel conduit. Crane complex wiring and conduit shall be arranged for a minimum of wiring during assembly and construction on site. Junction boxes shall be provided, where practical.

Switches -

1) On cab-operated cranes a switch or circuit breaker of the enclosed type, with provision for locking in the open position shall be provided in the leads from the runway conductors. A means of opening this switch or circuit breaker shall be located within easy reach of the operator.

2) On floor-operated cranes, a switch or circuit breaker of the enclosed type, with provision for locking in the open position, shall be provided in the leads from the runway conductors. This disconnect shall be mounted on the bridge or footwalk near the runway collectors.

Electrical Safety Provisions –

1) Electrification system for power distribution from the source of supply to mobile tap-off devices on crane runway and Crane Bridge shall be complete with unit length conductors, insulating conductor covers, insulators, splices and splice covers, end caps, support brackets and fasteners, current collectors, expansion, isolation and power-interrupting sections, disconnect switch, and conduit and wiring to power takeoff point.

2) Protective devices shall conform to NEMA ICS 1 and shall include a fused circuit switch for each motor controller, a main-line magnetic contactor incorporating under voltage protection, main overload

protection, and motor overload protection. Two overload relays shall be provided for each 3-phase motor winding.

3) Operation of any protective device (overload, under voltage, control circuit fuse, or stop pushbutton) shall stop motions. Fuses shall be of the nonrenewable cartridge type. Each hoist shall be provided with under voltage and overload protection in accordance with NEMA ICS 1. Overload relays of inverse-time characteristics shall be provided. Under voltage protection shall be provided for cranes of Duty Class C. Overload relays shall be connected in each phase of a 3-phase, ac circuit. Control circuit shall be fused.

4) An emergency stop button and a reset button shall be provided to operate the main-line contactor.

5) Controller component ratings shall conform or be in proportion to the tabulated ratings of NEMA ICS 1. All contactors shall be provided with arc shields or suppressors or the contacts shall be enclosed in an arc box.

6) Over-current protection shall consist of externally operable, manual reset, thermal-overload relays in each pole of the controller. Thermal overload relays shall be melting alloy or bimetallic, nonadjustable type with continuous current ratings and service-limit current ratings in accordance with Section 2, Part 2-321A of NEMA ICS 1.

7) Phase loss protection shall be provided.

8) Conduit and fittings shall be rigid galvanized steel. Liquid tight flexible steel conduit will be acceptable on trolleys and short runs.

9) The cranes shall be electrically grounded through the runway rails and building columns. Separate runway grounding (fourth rail) is not required.

Controls Safety Provisions -

1) Motion warning devices, both audible (siren or horn) and visual (rotating lights) shall be provided and shall operate continuously with either bridge or trolley motion.

2) Cranes shall be designed for stepless remote control using a portable radio transmitter and a pendant push button control. The pendant shall have a fixed reel where the cable can be stored until required.

3) Over-hoisting and over-traveling limit switches shall be provided for all cranes motions.

4) All limit switches shall automatically reset allowing an opposite directional movement to be selected to that which activated the limit switch.

PART-7 OVERHEAD CRANE INSPECTION REQUIREMENTS

In this section we will discuss the following:

- ❖ Key Crane Inspection Areas
- ❖ OSHA Inspection Requirements
- ❖ Testing Requirements
- ❖ Drawings & Layout Submittals

Why Inspections are needed?

It is essential to know precisely how a crane is holding up under its daily workload and whether any special attention is required. An inspection program provides this knowledge. Regular inspection is especially important for Class D, E and F duty-cycle cranes. When performed by a qualified employee or service contractor, regular inspections help:

1) Spot electrical or structural problems.
2) Schedule needed service work at convenient times.
3) Identify trends that can be used to fine-tune maintenance schedules and adjust replacement parts inventory.
4) Detect potential safety problems.
5) Identify opportunities to upgrade components, such as wheels, motors or controls, to extend crane service life or increase productive capacity.

Key Crane Inspection Areas:

- Rails, bumpers, wheels, bearings, shafts
- Bridge or gantry structure
- Bridge or gantry machinery
- Trolleys – rail wear, frames, couplings, axles, reduction gears, etc
- Main and auxiliary hoist machinery
- Bottom blocks, hooks, wire rope
- Upper block assemblies
- Grapples, buckets and other lifting devices
- Trolley and hoist brakes
- Gantry/bridge brake

- Brake rectifiers, line contactors, limit switches, resistors, fuses
- Controls
- Pendants, cable guides and festoons

What Regulations Apply?

The Occupational Safety and Health Association (OSHA) require crane inspections at set intervals based on crane classification. However, more frequent inspections can provide added assurance and improved productivity. Each inspection should end with a written report on the crane's condition, including a list of any needed repairs and a timetable for completion.

OSHA Regulations for Crane Inspections

Crane Service Class	*Definition*	*Minimum OSHA Inspection*	*Typical Preventive Maintenance Schedule*
A	Standby or Infrequent Service	Annually or Semi-Annually	Semi-Annually
B	Light Service	Annually	Quarterly
C	Moderate Service	Annually	Bi-Monthly
D	Heavy Service	Semi-Annually	Monthly
E	Severe Service	Quarterly	Twice a Month
F	Continuous Severe Service	Quarterly	Weekly

Additional inspections may be required due to hours of operation, environment and/or severity of service. The inspection requirements of ANSI (B30.2, B30.11 and B30.17) and the manufacturer must also be followed

TESTING REQUIREMENTS

Crane test loads are typically specified at 125% of rated capacity by both OSHA and ASME. Neither standard, however, specify an acceptable tolerance over or under the 125% figure. The only reference to such a tolerance was given in an interpretation by ASME B30.2. Though not considered a part of the standard, this interpretation suggested a tolerance of +0%/-4% on the weight of the test load. In effect, this suggested a test load weighing between 120% and 125% of the rated crane capacity (i.e.: 125% -

125% x .04 = 120%).
A bridge, gantry or overhead traveling crane installed after January 1, 1999, or such a crane or its runway which has been significantly modified, must be load tested before being put into service as follows:

1) All crane motions must be tested under loads of 100% and 125% of the rated capacity for each hoist on the crane, and the crane must be able to safely handle a load equal to 125% of the rated capacity;

2) All limit-switches, brakes and other protective devices must be tested when the crane is carrying 100% of the rated capacity;

3) Structural deflections must be measured with loads of 100% and 125% of the rated capacity and must not exceed the allowable deflections specified by the applicable design standard;

4) The load must be traveled over the full length of the bridge and trolley runways during the 100% and 125% load tests, and only the parts of runways that have been successfully load tested may be placed into service.

5) A record of all load tests must be included in the equipment record system giving details of the tests and verification of the loads used, and be signed by the person conducting the tests.

6) A replacement crane or hoist to be installed on an existing runway may be load tested in the manufacturer's facility and installed on an existing runway provided that the replacement unit has a rated capacity and gross weight equal to or less than the previously tested rating for the runway, and the runway need not be load tested unless it has been modified since it was previously load tested.

DRAWINGS & LAYOUT SUBMITTALS

For each crane, layout drawings should be prepared showing points at which the crane must pick up or set down material, including loading or unloading of trucks and railroad cars, intermediate or transfer points, maintenance and repair areas, and equipment installation points. These layouts should include points for required lifts and points or areas at which crane lifts may be desirable but not required.

Areas which may be used as storage or warehouse areas should be indicated also. Lifting or handling of heavy items (e.g. a small transformer), which may require moving for which crane service is not planned, should be indicated along with the proposed means of handling.

As a minimum, the drawings showing the following information shall be needed:

1) Plan of the building and runways, giving length of runways, spans of runway girders, location and details of runway bumper stops, building access platforms and gates, mezzanines, obstructions, size and locations of pits to be serviced by the hooks, location of crane cab or pendant control station (horizontally and vertically), location of crane in relation to other cranes, cardinal directions, and if critical, the hook approaches towards the ends of the building.

2) Cross section of the building and runways, showing crane and giving span, runway rail type and size, height of top of rail from floor, maximum hook heights required, lowest drop of the hook required, end approaches of the hooks toward the side of the building, clear distance from center of runway rails to columns or other obstructions, such as conduit or ducts, clear distance, or distances from the top of the runway rails to overhead building construction or other obstructions, such as light fixtures or ducts, required clearances at these points, height and dimensions of access platform on building structure; size and type, location, and spacing of runway conductors; and location of crane cab or pendant control station.

3) Cross section of the runway girder showing member sizes, web stiffeners, runway rail and method of securing it to the runway girders.

4) The wheel loads (without impact) and wheel spacing used to design the runway; bumper heights and sizes of bumping races or existing cranes on the same runway; kind of electric current, its voltage, phase, and frequency; and if other cranes are on the runway, the maximum (or minimum, if applicable) distance between hooks of the new crane and the adjacent existing crane, with existing crane data as necessary for the contractor to design his end trucks, walkways, and cab.

NOTE: Drawings must indicate runways, transfer points, construction details, track layout, clearances, location of power source, and number of hoists to be used with horsepower wattage and full-load rating of each.

Appendix - A

KEY WORDS AND DEFINITIONS

A

1. **ABNORMAL OPERATING CONDITIONS -** Environmental conditions that are unfavorable, harmful or detrimental to or for the operation of a hoist, such as excessively high lover 100°F or low (below 0 deg F) ambient temperatures, corrosive fumes, dust laden or moisture laden atmospheres, and hazardous locations.

2. **ACCESS PLATFORM-** A limited length platform, located on the idler girder to access to the end truck wheels only.

3. **ADJUSTABLE OR VARIABLE VOLTAGE:** A method of control by which the motor supply voltage can be adjusted.

4. **AMBIENT TEMPERATURE -** The temperature of the atmosphere surrounding the hoist.

5. **AUTOMATIC CRANE:** A crane which when activated operates through a preset cycle or cycles.

6. **AUXILIARY HOIST:** A supplemental hoisting unit, usually designed to handle lighter loads at a higher sped than the main host.

7. **AUXILIARY GIRDER (OUTRIGGER):** A girder arranged parallel to the main girder for supporting the platform, motor base, operator's cab, control panels, etc., to reduce the torsional forces such load would otherwise impose on the main girder.

8. **AXLE, FIXED** - A shaft which is fixed in the end truck and about which the wheel revolves.

9. **AXLE, ROTATING** - A shaft which is fixed in the wheel and which rotates on bearings fixed in the end truck.

B

10. **Bearing Life (L-10) -** The L-10 life of an anti-friction bearing is the minimum expected life, hours, of 90 percent of a group of bearings which are operating-at a given speed and loading. The average expected life of the bearings is approximately five times the L-10 life.

11. **BEARING LIFETIME LUBRICATED -** An antifriction bearing which is provided with seals and a high-stability oxidation-resistant grease to permit operation of the bearing without re-lubrication for not less than the specified B-10 life

12. **BASE or DECK MOUNTED (HOIST) -** A type of mounting where the hoist is mounted to the top side of a horizontal supporting surface.

13. **BHN-** Brinell hardness number, measurement of material hardness.

14. **BLOCK, LOAD** - The assembly of hook, swivel, bearings, sheaves, pins and frame suspended from the hoisting ropes. In a "short type" block, the hook and the sheaves are mounted on the same member, called the swivel. In a "long type" block, the hook and the sheaves are mounted on separate members. (The supporting member for the sheaves is called the sheave pin and the supporting member for the hook is called the trunnion).

15. **BLOCK, UPPER** - A fixed assembly of sheaves, bearings, pins and frame, located on the trolley cross members, and which supports the load block and its load by means of the ropes.

16. **BOGIE** - A short end truck attached to the end of one girder (or to a connecting member if more than one bogie is used per girder). This type of end truck is used when more than four wheels are required on a crane due to the design of the runway.

17. **BOGIE, EQUALIZING** - A short end truck which is flexibly connected to one girder (or connecting member) by means of a pin upon which the truck can oscillate to equalize the loading on the two truck wheels. This construction uses a very rigid end tie between the girders.

18. **BOGIE, FIXED** - A short end truck which is rigidly connected to one girder. A flexible end tie is used between the girders to permit equalization of the wheel loads by torsional deflection of the girders and flexing of the end tie.

19. **BOOM (OF GANTRY CRANE) -**An extension of the trolley runway that may be raised or retracted to obtain clearance for gantry travel.

20. **BOOM (OF OVERHEAD CRANE) -** A horizontal member mounted on the trolley to permit hoisting and lowering the load at a point other than directly under the hoist drum or trolley.

21. **BOX SECTION -** The rectangular cross-section of girders, trucks or other members enclosed on four sides.

22. **BRAKE** - A device, other than a motor, used for retarding or stopping motion by friction or power means.

23. **BRAKE, CONTROL -** A method of controlling speed by removing energy from the moving body or by imparting energy in the opposite direction.

24. **BRAKE, COUNTER TORQUE -** A method of control by which the power to the motor is reversed to develop torque in the direction opposite to the rotation of the motor using the motor as a generator, with the energy being dissipated by resistance.

25. **BRAKE, DRAG -** A friction brake that provides a continuous retarding force having no external control.

26. **BRAKE, DYNAMIC -** A method of controlling speed by block, load the assembly of hook or shackle, swivel bearing, sheaves, sprockets pins, and frame suspended by the hoisting rope or load chain. This shall include any appurtenances reeved in the hoisting rope or load chain.

27. **BRAKE, EDDY CURRENT** - A device for controlling load speed in the hoisting or lowering direction by placing a supplementary load on the motor. This load results from the interaction of magnetic fields produced by an adjustable direct current in the stator coils and induced currents in the rotor.

28. **BRAKE, MECHANICAL LOAD** - A friction device, usually using multiple discs, used for controlling load speed in the lowering direction only. The brake prevents the load from overhauling the motor.

29. **BRAKE, HOLDING** - A friction brake for a hoist, that is automatically applied and prevents motion when power is off.

30. **BRAKE, PARKING** - A friction brake for bridge or trolley, automatically applied when power to the crane is interrupted.

31. **BRAKE, REGENERATIVE -** A method of controlling speed in which the electrical energy generated by the motor is fed back into the power system.

32. **BRAKE, SERVICE** - A friction brake for bridge or trolley, automatically or manually applied, used during normal operation to apply a retarding force.

33. **BRANCH CIRCUIT-** The circuit conductors between the final over current device protecting the circuit and the outlet(s).

34. **BRAKEAWAY FORCE -** The external force that is required to separate the vacuum pad or vacuum lifting device from the load when applied perpendicular to the attachment surface.

35. **BRIDGE:** That pant of an overhead crane consisting of girders, trucks, end ties, walkway and drive mechanism which carries the trolley and travels in a direction parallel to the runway.

36. **BRIDGE CRANE –** is the entire assembly as a functioning unit of end trucks, beak, trolley, hoist, electrification, control panel, end stops, bumpers, drives, gear boxes and festooning.

37. **BRIDGE CRANE SPAN –** is the distance from center of rail on one runway to center of rail on the other runway side. For under running cranes, this dimension if measured from the runway beam centers as opposed to rail centers.

38. **BRIDGE CONDUCTORS -** The electrical conductors located along the bridge structure of a crane to provide power to the trolley.

39. **BRIDGE GIRDER -** Crane member on which carriers or trolleys travel, horizontally mounted between and supported by the end trucks.

40. **BRIDGE RAIL-** The rail supported by the bridge girders on which the trolley travels.

41. **BRIDGE STRUCTURE -** The structural members of a building which support the building loads and on which the loads of crane or monorail equipment, and the material to be moved, will be imposed.

42. **BUMPER (BUFFER) -** An energy absorbing device for reducing impact when a moving crane or trolley reaches the end of its permitted travel, or when two moving cranes or trolleys come into contact. This device may be attached to the bridge, trolley or runway stop.

C

43. **CAB** - The operator's compartment on a crane

44. **CAB-OPERATED CRANE -** A crane controlled by an operator in a cab located on the bridge or trolley.

45. **CAMBER** - The slight, upward, vertical curve given to girders to partially compensate for deflection due to rated load and weight of the crane parts. Camber, in and by itself, in no way relates (significantly) to the strength of the girder. Its sole purpose is to control girder deflection relative to the horizontal. Negative camber may be an indication of some failure in the structure, typically (but not exclusively) on the bottom tension flange of the girder.

46. **CAPACITY -** The maximum rated load tin tons) which a crane is designed to handle.

47. **CLEARANCE -** Minimum distance from the extremity of a crane to the nearest obstruction.

48. **CMAA -** Crane Manufacturers Association of America, Inc. (Formerly EOCI-Electric Overhead Crane Institute).

49. **COLLECTORS -** Contacting devices for collecting current from the runway or bridge conductors. The mainline collectors are mounted on the bridge to transmit current from the runway conductors, and the trolley collectors are mounted on the trolley to transmit current from the bridge conductors.

50. **COLLECTORS, (Shoe) -** The portion of a collector which makes contact by sliding on the conductor bar.

51. **COLLECTORS, (Wheel) -** The portion of a collector which makes contact by rolling on the conductor bar.

52. **COLLECTORS, (Current) -** Contacting devices for collecting current from runway or bridge conductors.

53. **COLLECTOR, RUNWAY** - A contacting device for obtaining electrical current from the runway conductors. The runway collectors are mounted from the bridge.

54. **COLLECTOR, TROLLEY** - A contacting device for obtaining electrical current from the bridge conductors. The trolley collectors are mounted from the trolley. (Sometimes incorrectly called bridge collectors)

55. **CONDUCTORS, BRIDGE** - The electrical conductors located along the bridge girder(s) to provide power and control circuits to the trolley. (Sometimes incorrectly called trolley conductors)

56. **CONDUCTORS, RUNWAY** - The electrical conductors located along the runway to provide power to the entire crane.

57. **CONTACTOR, MAGNETIC -** An electro-magnetic device for opening and closing an electric power circuit.

58. **CONTROL BRAKING MEANS** - A method of controlling lowering speed of the load by removing energy from the moving load or by imparting energy in the opposite direction. The various options for braking include

    - **COUNTERTORQUE** - A method of control by which the power to the motor is reversed to develop torque in the opposite direction to the rotation of the motor.
    - **DYNAMIC** - A method of controlling speed by using the motor as a generator, with the energy being dissipated in resistors.
    - **EDDY CURRENT** - A method of controlling or reducing speed by means of an electrical induction load brake.
    - **MECHANICAL** - A method of controlling or reducing speed by friction.
    - **REGENERATIVE** - A method of control in which the electrical energy generated by the motor is fed back into the power system.

59. **CONTROLLER -** A device for regulating in a pre-determined way the power delivered to the motor or other equipment.

60. **CONTROLLER, MANUAL** - A controller having all of its basic functions performed by devices which are operated by hand.

61. **CONTROL PANEL** - An assembly of electrical components (magnetic or static) which governs the flow of power to or from a motor in response to signals from a master switch, pushbutton station, or remote control.

62. **COUNTER-TORQUE -** A method of control by which the motor is reversed to develop power to the opposite direction.

63. **COUPLINGS (Splices) -**Mechanical devices used to join the adjacent ends of track sections.

64. **COVER PLATE -** The top or bottom plate of a box girder.

65. **CRANE** - A machine for lifting and lowering a load and moving it horizontally, with the hoisting mechanism an integral part of the machine.

66. **CRANE, CAB OPERATED** - A crane controlled by an operator in a cab attached to the bridge or trolley.

67. **CRANE, FLOOR OPERATED** - A crane which is controlled by a means suspended from the crane, with the operator on the floor or on an independent platform.

68. **CRANE, GANTRY** - A crane similar to an overhead crane except that the bridge is rigidly supported on two or more legs.

69. **CRANE, HOT MOLTEN MATERIAL HANDLING (LADLE)** - An overhead crane used for transporting or pouring molten material.

70. **CRANE, MANUALLY OPERATED** - A crane whose hoist mechanism is driven by pulling an endless chain, and/or whose travel mechanism is driven in the same manner or by manually moving the load or hook in a horizontal direction.

71. **CRANE, OUTDOOR STORAGE GANTRY -** A special type of gantry crane of long span and with long legs, usually used for the storage of bulk material such as ore, coal, limestone, or sane. This type of crane normally will have one or two cantilevered girder ends with through legs.

72. **CRANE, OVERHEAD** - A crane with a single or multiple girder movable bridge, carrying a movable trolley or fixed hoisting mechanism, and traveling on an overhead fixed runway structure.

73. **CRANE, POLAR** - An overhead or gantry type crane which travels on a circular runway.

74. **CRANE, REMOTE OPERATED -** A crane controlled by an operator located other than on the crane and by any method other than a means suspended from the crane. Radio control is the most common means of remote operation.

75. **CRANE, SEMI-GANTRY** - A gantry crane with one end of the bridge supported on one or more legs and the other end of the bridge supported by an end truck connected to the girders and running on an elevated runway.

76. **CRANE SERVICE, (HEAVY) -** Service that involves operating at 85 to 100% of rated load or in excess of 10 lift cycles/hr as a regular specified procedure.

77. **CRANE SERVICE, (NORMAL) -** Service that involves operating at less than 85% of rated load and not more than 10 lift cycles/hr except for isolated instances.

78. **CRANE, TRAVELING -** Cranes that follow a fixed path

79. **CREEP SPEED** - A very slow, constant, continuous, fixed rate of motion of the hoist, trolley, or bridge: usually established at 1% to 10% of the normal full load speed.

80. **CROSS SHAFT -** The shaft extending across the bridge, used to transmit torque from motor to bridge drive wheels.

81. **CUSHIONED START-** An electrical or mechanical method for reducing the rate of acceleration of a travel motion.

D

82. **DEAD LOADS:** The loads on a structure that remain in a fixed position relative to the structure. On a crane bridge such loads include the girders, foot walk, cross shaft, drive units, panels, etc.

83. **DEFLECTION –** Displacement due to bending or twisting in a vertical or lateral plane, caused by the imposed live and dead loads. For bridge cranes that value is considered for total load conditions (i.e. lifted load + trolley weight + bridge dead load).

84. **DEFLECTION CRITERIA (Vertical)** - is a maximum permissible deflection ratio allowed for a lifting device. For bridge cranes this value is L/700 and for jibs this value is R/300, where L is the span of the bridge crane and R is the reach of a jib crane.

85. **DEFLECTION CRITERIA (Horizontal) –** is a maximum permissible deflection ration allowed for a bridge crane or runway; usually specified limits are L/600 where L is the span of the bridge crane.

86. **DEFLECTION, DEAD LOAD** - The vertical displacement of a bridge girder due to its own weight plus the weight of parts permanently attached thereto, such as footwalk, drive mechanism, motor and control panels. The dead load deflection is fully compensated for in the girder camber.

87. **DEFLECTION, LIVE LOAD -** The vertical displacement of a bridge girder due to the weight of the trolley plus the rated load.

88. **DIAPHRAGM** - A vertical plate (or channel) between the girder webs, which serves to support the top cover plate and bridge rail and to transfer the forces of the trolley wheel loads to the webs.

89. **DRIFT POINT** - A control point on a travel motion which releases the electric brake without energizing the motor.

90. **DRIVE** - The assembly of the motor and gear unit used to propel the bridge or trolley

91. **DRIVE GIRDER -** The girder on which the bridge drive machinery is mounted.

92. **DRUM** - The cylindrical member around which the hoisting ropes are wound for lifting or lowering the load.

93. **DUMMY CAB -** An operator's compartment or platform on a pendant or radio controlled crane, having no permanently mounted electrical controls, in which an operator may ride while controlling the crane.

94. **DUTY CLASS-** is a method of distinguishing the usage of a crane, from a load and/or cycle point of view.

E

95. **EDDY-CURRENT BRAKING -** A method of control by which the motor drives through an electrical induction load brake.

96. **EFFICIENCY OF GEARING AND SHEAVES-** The percentage of force transmitted through these components that are not lost to friction.

97. **ELECTRIC OVERHEAD TRAVELING CRANE -** An electrically operated machine for lifting, lowering, and transporting loads, consisting of a movable bridge carrying a fixed or movable hoisting mechanism and traveling on an overhead runway structure.

98. **ELECTRICAL BRAKING SYSTEM -** A method of controlling crane motor speed when in an overhauling condition, without the use of friction braking.

99. **ENCLOSED CONDUCTOR(S) -** A conductor or group of conductors substantially enclosed to prevent accidental contact.

100. **ENCLOSURE -** A housing to contain electrical components, usually specified by a NEMA classification number.

101. **END APPROACH:** The minimum horizontal distance, parallel to the runway, between the outermost extremities of the crane and the centerline of the hook.

102. **END TIE -** A structural member other than the end truck that connects the ends of the girders to maintain the square-ness of the bridge.

103. **END TRUCK** - An assembly consisting of structural members, wheels, bearings, axles, etc., which supports the bridge girder(s) or the trolley cross member(s).

104. **EQUIVALENT DURABILITY WHEEL LOAD** is used to express the wheel loads that account for duty rating and wheel RPM. This value is generally less the service wheel load.

105. **EQUALIZER** - A sheave or bar which compensates for unequal length or stretch of the hoisting rope(s) or swinging of the load block.

106. **EXPOSED** - Capable of being contacted inadvertently (applies to hazardous objects not adequately guarded or isolated).

F

107. **FAIL-SAFE -** A provision designed to automatically stop or safely control any motion in which a malfunction occurs.

108. **FESTOONING –** is a free floating flat cable that travels on a C-rail and provides direct contact for energizing hoist trolley movement. The contact is extremely wear resistant and provides advantage of superior reliability. This method is however not recommended for curves.

109. **FIELD WIRING -** The wiring required after erection of the crane.

110. **FIXED AXLE -** An axle that is fixed in the truck and on which the wheel revolves.

111. **FLEET ANGLE** - The angle formed by the wire rope and the drum groove or sheave groove in the plane which contains the wire rope and is parallel to the drum or sheave axis.

112. **FLOOR-OPERATED CRANE -** A crane which is pendant controlled by an operator on the floor or an independent platform.

113. **FOOTWALK** - A walkway with handrail and toeboards, attached to the bridge or trolley for access purposes.

G

114. **GANTRY CRANE -** A crane similar to an overhead crane except that the bridge for carrying the trolley or trolleys is rigidly supported on two or more legs running on fixed rails or other runway.

115. **GAUGE** - The horizontal distance center to center of the bridge rails.

116. **GIRDERS-** The principal horizontal beams of the crane bridge which supports the trolley and is supported by the end trucks.

117. **GIRDER, BRIDGE** - The principal horizontal beam(s) of the crane, which supports the trolley, is supported by the end trucks, and is perpendicular to the runway.

118. **GIRDER, DRIVE (GIRDER "A")** - the bridge girder to which the bridge motor and gearcase(s) are attached. For cranes having a drive on each girder, it is the girder to which the control panels and/or the cab are attached.

119. **GIRDER, IDLER (GIRDER "B")** - The bridge girder which does not have the bridge drive attached, but which usually carries the bridge conductors.

120. **GIRDER, RUNWAY** - A horizontal beam attached to the building columns or wall, and supporting a runway rail on which the crane travels.

121. **GIRDER, AUXILIARY (OUTRIGGER)** - An additional girder, either solid or latticed, arranged parallel to the bridge girder(s) for supporting the footwalk, control panels, operator's cab, etc., to reduce the torsional forces such loads might otherwise impose.

122. **GROUND FAULT -** An accidental conducting connection between the electrical circuit or equipment and the earth or some conducting body that serves in place of the earth.

H

123. **HOIST** - A machinery unit that is used for lifting and lowering a load.

124. **HOIST, AUXILIARY** - A supplemental hoisting unit, usually designed to handle lighter loads at a higher speed than the main hoist.

125. **HOIST, MAIN** - The primary hoist mechanism provided for lifting and lowering the rated load of the crane.

126. **HOLDING BRAKE -** A brake that automatically prevents motion when power is off.

127. **HOOK APPROACH, END** - The minimum horizontal distance, parallel to the runway, between the centerline of the hook(s) and the face of the wall (or columns) at the end of the building.

128. **HOOK APPROACH, SIDE** - The minimum horizontal distance, perpendicular to the runway, between the centerline of a hook (main or auxiliary) and the centerline of the runway rail.

129. **HYDRAULIC BRAKE -** A brake that provides retarding or stopping motion by hydraulic means.

I

130. **IDLER GIRDER -** The bridge girder which does not have the bridge drive attached, but which usually carries the bridge conductors.

131. **IDLER SHEAVE -** A sheave used to equalize tension in opposite parts of a rope. Because of its slight movement, it is not termed a running sheave.

132. **INCH (INCHING)** - See "jog". Often used incorrectly to refer to "creep speed" (which see).

133. **INDUSTRIAL DUTY CRANE -** Service classification covered by CMAA Specification No.70, "Specifications for Electric Overhead Traveling Cranes".

134. **INSULATION CLASS -** Motor winding insulation rating which indicates its ability to withstand heat and moisture.

135. **INVERTER (VARIABLE FREQUENCY DRIVE) -** A method of control by which the fixed line voltage and frequency is changed to a three-phase system with infinitely variable voltage and frequency.

J

136. **JOG (INCH)** - To move the hook, trolley, or bridge in a series of short, discontinuous, increments by momentary operation of a controller.

137. **JIB CRANES-** are a type of crane that allows for rotational movement along with horizontal trolley motion and vertical hoisting motion. Jibs are normally mounted to a column or are free standing.

K

138. **KIP -** A unit of force, equivalent to 1000 pounds.

139. **KNEE BRACE -** The diagonal structural member joining the building column and roof truss

140. **KSI -** Kips per square inch, measurement of stress intensity.

L

141. **LATCH, HOOK** - A device used to bridge the throat opening of a hook.

142. **LEFTHAND END** - A reference to parts or dimensions on the viewer's left of the centerline of span, established when facing the drive girder side of the crane.

143. **LIFT (HOOK TRAVEL)** - The maximum vertical distance through which the hook(s) can move, as determined by the length of rope and/or the number of grooves on the drum.

144. **LIFT CYCLE -** Single lifting and lowering motion (with or without load).

145. **LIFTING DEVICES** - Devices which are not reeved on to the hoist ropes, such as hook-on buckets, magnets, grabs, and other supplemental units used for ease of handling certain types of loads. The weight of these devices is to be considered part of the rated load.

146. **LIMIT SWITCH -** A device designed to cut off the power automatically at or near the limit of travel for the crane motion.

147. **LINE CONTACTOR -** A contactor to disconnect power from the supply lines.

148. **LOAD, DEAD** - The load(s) on a portion of the crane, which remain(s) in a fixed position relative to the member being considered.

149. **LOAD, LIVE** - A load which moves or varies relative to the member being considered. For the trolley, the live load consists of the rated load plus the weight of the block. For the bridge, the live load consists of the rated load plus the weight of the trolley.

150. **LOAD, RATED** - The maximum static vertical load for which a crane or an individual hoist is designed.

151. **LOAD FLOAT** - A control system which enables stepless operation of a hoist in either the lifting or lowering direction for a range of about 0-5% of full rated speed, as well as permitting the load to be suspended stationary for a very short time with the holding brake(s) released.

152. **LOAD BLOCK -** The assembly of hook, swivel, bearing, sheaves, pins and frame suspended by the hoisting ropes.

153. **LOAD CARRYING PART -** Any part of the crane in which the induced stress is influenced by the load on the hook.

154. **LOAD CYCLE -** One lift cycle with load plus one lift cycle without load.

M

155. **MAGNETIC CONTROL -** A means of controlling direction and speed by using magnetic contactors and relays.

156. **MAIN LINE CONTACTOR -** A magnetic contactor used in the incoming power circuit from the main line collectors.

157. **MAIN LINE DISCONNECT SWITCH -** A manual switch that breaks the power lines leading from the main line collectors.

158. **MANUAL-MAGNETIC DISCONNECT SWITCH -** A power disconnecting means consisting of a magnetic contactor that can be operated by remote pushbutton and can be manually operated by a handle on the switch.

159. **MASTER SWITCH -** A manually operated device that serves to govern the operation of contactors and auxiliary devices of an electric control.

160. **MATCH MARKING -** Identification of non-interchangeable parts for reassembly after shipment.

161. **MECHANICAL LOAD BRAKE -** An automatic type of friction brake used for controlling loads in the 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.

162. **MEAN EFFECTIVE LOAD -** A load used in durability calculations accounting for both maximum and minimum loads.

163. **MESSENGER TRACK** - A horizontal member, mounted along a handrail or girder, supporting movable carriers from which festooned wires are hung. The festooned wires may be used to transmit current from the bridge to the trolley or from the bridge to a pendant control unit.

164. **MILL DUTY CRANE -** Service classification covered by AISE Standard No. 6, “Specification for Electric Overhead Traveling Cranes for Steel Mill Service”.

165. **MULTIPLE GIRDER CRANE -** A crane that has two or more girders for supporting the live load.

N

166. **NORMAL OPERATING CONDITIONS** - Those conditions during which a crane is being operated and is performing functions within the scope of the original design. For a cab operated crane, the operator is at the operating control devices in the cab and no other person is on the crane. For a floor operated crane, the operator is at the operating control devices, which are suspended from the crane but operated with the operator off the crane, and no person is on the crane. For a remote operated crane, the operator is at the operating control devices, which are not attached to any part of the crane, and no person is on the crane.

167. **NON-COASTING MECHANICAL DRIVE -** A drive with coasting characteristics such that it will stop the motion within a distance in feet equal to 10 percent of the rated speed in feet per minute when traveling at rated speed with rated load.

O

168. **OPERATOR'S CAB -** The operator's compartment from which movements of the crane are controlled. To be specified by the manufacturer as open, having only sides or a railing around the operator, or enclosed, complete with roof, windows, etc.

169. **OVERLOAD -** Any load greater than the rated load.

170. **OVERLOAD PROTECTION (OVERCURRENT) -** A device operative on excessive current to cause and maintain the interruption or reduction of current flow to the equipment governed.

P

171. **PENDANT-** Means suspended from the crane operating the controllers from the floor or other level beneath the crane.

172. **PITCH DIAMETER (ROPE) -** Distance through the center of a drum or sheave from center to center of a rope passed about the periphery.

173. **PLAIN REVERSING CONTROL-** A reversing control which has identical characteristics for both directions of motor rotation.

174. **PLUGGING -** A control function that accomplishes braking by reversing the motor line voltage polarity or phase sequence.

175. **PROTECTIVE PANEL-** An assembly containing overload and under voltage protection for all crane motions.

176. **PITCH DIAMETER** - The distance, measured through the center of a drum or sheave, from center to center of a rope passed about the periphery of the drum or sheave.

177. **PLUG** - To operate a controller in such a manner that the motor line voltage polarity or phase sequence is reversed before the motor rotation has stopped, thereby developing a counter torque which acts as a retarding force.

178. **PLUGGING RELAY** - A current relay used on a bridge or trolley control panel which senses current in the motor secondary circuit of an alternating current motor and limits reverse torque of the motor to the first control point until the motor rotation has stopped. In a direct current control panel, the

relay performs the same function by establishing a patented sensing circuit at the motor armature. (Sometimes called an anti-plugging relay.)

Q

179. **QUALIFIED -** A person who, by possession of a recognized degree, 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.

R

180. **RATED LOAD -** The maximum load that the crane is designed to handle safely as designated by the manufacturer.

181. **RAIL, RUNWAY -** The rail supported by the runway beams on which the crane travels.

182. **RAIL, BRIDGE** - The track supported by the bridge girder(s), on which the trolley travels.

183. **RAIL SWEEP** - A mechanical device attached to the end truck of a bridge or trolley, located in front of the leading wheels, to remove foreign objects from the rail.

184. **RATED CAPACITY-** is the maximum allowable load that can be safely lifted by a device without exceeding any design safety factors or fatigue limits.

185. **REGENERATIVE BRAKING -** A method of controlling speed in which electrical energy generated by the motor is fed back into the power system.

186. **REGULATED SPEED -** A function that tends to maintain constant motor speed for any load for a given speed setting of the controller.

187. **REMOTE OPERATED CRANE -** A crane controlled by an operator not in a pulpit or in the cab attached to the crane, by any method other than pendant or rope control.

188. **RESISTOR RATING -** Rating established by NEMA, which classifies resistors according to percent of full load current on first point and duty cycle.

189. **RIGHTHAND END** - A reference to parts or dimensions on the viewer's right of the centerline of span, established when facing the drive girder side of the crane.

190. **ROTATING AXLE -** An axle that rotates with the wheel.

191. **RUNNING SHEAVE -** A sheave that rotates as the hook is raised or lowered.

192. **RUNWAY -** The rails, beams, brackets and framework on which the crane operates.

193. **RUNWAY CONDUCTORS -** The main conductors mounted on or parallel to the runway that supplies current to the crane.

S

194. **SECONDARY VOLTAGE** - The induced open-circuit voltage in the rotor of a wound-rotor (slip-ring) motor at standstill, as measured across the slip rings with rated voltage applied to the primary (stator) winding.

195. **SHAFT, CROSS (SQUARING SHAFT) (DRIVE SHAFT)** - The shaft(s) extending the length of the bridge, used to transmit torque from the motor to a wheel(s) at each end of the bridge.

196. **SHALL** - When used in a Code or Standard, this word indicates that the rule is mandatory and must be followed. (See "should")

197. **SHEAVE -** A grooved wheel or pulley used with a rope or chain to change direction and point of application of a pulling force.

198. **SHOULD** - When used in a Code or Standard, this word indicates that the rule is a recommendation, the advisability of which depends on the facts in each situation. (See "shall")

199. **SIDE PULL** - The portion of the hoist rope pull acting horizontally when the hoist ropes are not operated vertically.

200. **SKEWING FORCES -** Lateral forces on the bridge truck wheels caused by the bridge girders not running perpendicular to the runways. Some normal skewing occurs in all bridges.

201. **SPAN** – Span is the distance from center of rail on one runway to center of rail on the other runway side. For under running cranes, this dimension is measured from the runway beam centers as opposed to rail centers.

202. **SPRING RETURN** - A device used on a manual controller, master switch, or pushbutton to cause the unit to return automatically to the neutral position, when released by the operator.

203. **STATIC CONTROL-** A method of switching electrical circuits without the use of contacts.

204. **STEPLESS CONTROL-** A type of control system with infinite speed control between minimum speed and full speed.

205. **STEPPED CONTROL -** A type of control system with fixed speed points.

206. **STOP:** A device to limit the travel of a trolley or crane bridge. This device normally is attached to a fixed structure and normally does not have energy absorbing ability.

207. **STRENGTH, AVERAGE ULTIMATE-** The average tensile force per unit of cross sectional area required to rupture the material as determined by test.

208. **SWEEP-** Maximum lateral deviation from straightness of a structural member, measured at right angles to the Y-Y axis.

T

209. **TEFC-** Totally enclosed fan cooled.

210. **TENV -** Totally enclosed non-ventilated.

211. **TOP RUNNING-** cranes run on crane rails mounted on runway beams.

212. **TORQUE, LOCKED-ROTOR** - The minimum torque which a squirrel-cage motor will develop at rest, for all angular positions of the rotor, with rated voltage applied at rated frequency. Not applicable to wound-rotor (slip-ring) motors.

213. **TORQUE, MOTOR BREAKDOWN** - The maximum torque which a squirrel-cage or wound-rotor (slip-ring) motor will develop with rated voltage applied at rated frequency, without an abrupt drop in speed.

214. **TORQUE, MOTOR FULL-LOAD** - The torque developed by an electric motor (AC or DC) to produce its rated horsepower at rated full-load speed.

215. **TORQUE, MOTOR PULL-UP** - The minimum torque developed by a squirrel-cage or wound-rotor (slip-ring) motor during the period of acceleration from rest to the speed at which breakdown torque occurs. For squirrel-cage motors with 8% or greater slip, the pull-up torque, the breakdown torque and the starting torque are all equal and occur at zero speed.

216. **TORSIONAL BOX GIRDER -** Girder in which the bridge rail is located over one web.

217. **TORSIONAL FORCES -** Forces which can cause twisting of a member.

218. **TROLLEY -** The unit carrying the hoisting mechanism which travels on the bridge rails.

219. **TROLLEY FRAME -** The basic structure of the trolley on which are mounted the hoisting and traversing mechanisms.

220. **TWO BLOCKING -** Condition under which the load block or load suspended from the hook becomes jammed against the crane structure preventing further winding up of the hoist drum.

U

221. **UNDER RUNNING -** cranes run on the lower flanges of runway beams. Local flange stresses due to runway wheel loads is considered by Mentor when designing runways beams. Mentor supplies these cranes up to 20 Ton capacities and 60 Ft. spans.

222. **UNDERVOLTAGE PROTECTION -** A device operative on the reduction or failure of voltage to cause and maintain the interruption of power in the main circuit.

223. **UPPER BLOCK -** A fixed assembly of sheaves, bearings, pins and frame, located on the trolley cross members, and which supports the load block and its load by means of the ropes

V

224. **VARIABLE FREQUENCY -** A method of control by which the motor supply voltage and frequency can be adjusted.

225. **VOLTAGE DROP -** The loss of voltage in an electric conductor between supply tap and load tap.

W

226. **WEB PLATE** - The vertical plate(s) connecting the upper and lower flanges or cover plates of a girder.

227. **WHEELBASE** - The distance from center to center of the outermost wheels of the bridge or trolley, measured parallel to the rail.

228. **WHEEL LOAD -** The service load for which the end truck wheels will experience when lifting the rated load.

229. **WHEEL LOAD, BRIDGE** - The vertical force (without impact) produced on any bridge wheel by the sum of the rated load, trolley weight and bridge weight, with the trolley so positioned on the bridge as to give maximum loading.

230. **WHEEL LOAD, TROLLEY** - The vertical force (without impact) produced on any trolley wheel by the sum of the rated load and the trolley weight.

Appendix - B

Steel Building Using Crane - Glossary of Terms

1. **Anchor Bolts-** Bolts utilized to secure building components to the foundation. In the case of primary framing, these bolts are embedded in the foundation and secured to the column base plate.

2. **Bay Spacing-** The distance between primary framing members measured parallel to the ridge or eave. Interior bays are measured from center line of frame to center line of frame.

3. **Building Height-** Building height is the eave height which usually is the distance from the bottom of the main frame column base plate to the top outer point of the eave strut. Eave height is the distance from the finished floor to the top outer point of the eave strut.

4. **Building Length-** The distance between the outside flanges of end wall columns in opposite end walls is considered the building length is a combination of several bay lengths.

5. **Building Width-** The building width is defined as the distance from outside of eave strut of one sidewall to outside of eave strut of the opposite sidewall.

6. **Clear Height-** Distance from the finished floor to the bottom of the rafter at the rafter-to-column connection.

7. **Clear Span-** Distance between columns across the width of the building.

8. **Cold Formed Section-** A structural shape that is formed by bending thin gauge (typically 10-16 ga.) material at ambient temperature. This is typically done on a roll former.

9. **Column-** Vertical support member for primary framing system.

10. **Design Loads-** Design loads are the forces the building will be subjected to. Loads are applied in accordance with the latest building codes and standards applicable to pre-engineered buildings.

11. **Haunch-** The area of increased depth of the column or rafter member which is designed to account for the higher bending moments that occur at such places. Typically, this occurs at the rafter-to-column connection.

12. **Metal Building Systems-** Same as Steel Building System. Both terms are used to describe the same product.

13. **Post-and-Beam End frame-** A structural framing system utilized at the end wall which is composed of corner post, end post and rake beams.

14. **Pre-engineered Building-** Terminology previously used to describe Steel Building Systems (Metal Building Systems). This terminology was used when rigid frames were 'pre-engineered' for a desired load. Today, Steel Building Systems are custom engineered to meet the size and design loads to meet the customer’s needs.

15. **Rafter-** A fabricated member that extends from the haunch member to the frame ridge. Any beam, in general, used in a primary frame.

16. **Rod Bracing-** Rods are utilized in conjunction with purlins and girts to form a truss-type bracing system located in both roof and wall planes.

17. **Roof Purlin-** A roof secondary member which is secured to frame rafters and supports the roof covering.

18. **Roof Slope (x: 12) -** This is the angle of the roof with respect to the horizontal. The most common roof slopes are 0.5/10 and 1/10. Any practical roof slope is possible.

19. **Roof System-** The exterior roof surface consisting of panels, closures and attachments.

20. **Sidewall-** An exterior wall which is parallel to the ridge and sidewall of the building.

21. **Three-Plate-** A built-up beam section, forming an 'I' shape that consists of 2 flanges and 1 web. Using three-plate over conventional structural shapes allows for greater strength at a reduced weight. These sections are often tapered to optimize performance.

22. **Wall Girt-** A horizontal wall secondary member which is secured to columns and supports the wall covering.

23. **Wall System-** The exterior wall surface consisting of panels, closures and attachments.

Appendix - C

International Codes, Standards and Regulations

There are many standards produced by many different standards-writing bodies. The list of standards referenced below, represents the standards that are applicable in different regions of the world. Since some of those standards may differ from the country to country, it is important for purchasers, installers, and users to know which ones apply for a particular situation.

USA

In the USA, the American Society of Mechanical Engineers (ASME; website www.asme.org) publishes standards for hoists.

Three are safety standards and six are performance standards. All carry the American National Standards Institute (ANSI) designator for a consensus American National Standard (ANS):

1. ASME-HST-1 Performance Standard for Electric Chain Hoists
2. ASME-HST-2 Performance Standard for Hand Chain Manually Operated Chain Hoists
3. ASME-HST-3 Performance Standard for Manually Lever Operated Chain Hoists
4. ASME-HST-4 Performance Standard for Overhead Electric Wire Rope Hoists
5. ASME-HST-5 Performance Standard for Air Chain Hoists
6. ASME-HST-6 Performance Standard for Air Wire Rope Hoists
7. ASME-B30.7 Safety Standard for Base Mounted Drum Hoists
8. ASME-B30.16 Safety Standard for Overhead Hoists (Underhung)
9. ASME-B30.21 Safety Standard Manually Lever-Operated Hoists
10. OSHA (Parts 1910 and 1926) adopts or invokes the American Society of Mechanical Engineers (ASME) HST Performance and
11. B30 Safety Standards for hoists and related equipment.

Generally, for hoist installations in the US the standards published by the American Society of Mechanical Engineers apply.

INTERNATIONAL

Outside North America, ISO (International Organization for Standardization) is sometimes referenced. For certain areas of the Asian markets the Japanese JIS standards may apply. Following is a selection of ISO and JIS standards applicable to hoists directly or through association with lifting machinery such as cranes:

ISO STANDARDS

The International Organization for Standardization (ISO; website www.iso.ch) publishes many standards for numerous types of lifting machinery, many specifically for application, design, operation and maintenance of cranes. Below is a brief selection applicable to hoists and hoist components:

1. ISO 1837 Lifting Hooks - Nomenclature

2. ISO 2374 Lifting Appliances - Range Of Maximum Capabilities for Basic Models

3. ISO 2408 Steel Wire Rope for General Purposes

JIS STANDARDS

The Japanese Industrial Standards Committee (JIS; website www.jisc.go.jp) publishes standards for hoists. Some of the primary ones are:

1. JIS B 8802 Manually Operated Chain Hoists

2. JIS B 8815 Electric Chain Hoists

3. JIS B 8819 Manually Operated Chain Lever Hoists

4. JIS C 9620 Electric Wire Rope Hoists

EUROPEAN

Traditionally, European countries have maintained national standards in reference to a large number of industrial products, e.g. DIN (Germany), BSI (United Kingdom). In addition the FEM (Federation Europeenne de la Manutention) has published standards specifically for material handling and lifting equipment. With the creation of the European Union, organizations for standardization were established at different levels of regulatory authority covering numerous product areas.

The highest regulatory level is a European Standards Commission. Its regulations are absolute and regulatory, focusing primarily on worker safety and protection from occupational hazards. There are three main regulations:

1. Machinery Regulation (including Lifting and Material Handling Equipment)

2. Low Voltage Electricity Regulation

3. EMV – Electro-magnetic Compatibility Regulation

At the next level are CEN (mechanical) and CENELEC (electrical) Standards. They are more detailed and product oriented than the regulations. Per definition, the publications of CEN and CENELEC are "Standards", non-regulatory guidelines, reflecting state of the art design and construction practices. They are based on the highest level of probability that equipment, designed to these standards will be safe and functional. They do not preclude deviations or "product improvement based on technological progress".

The goal of the CEN & CENELEC Committees is to harmonize the new, European norms with existing country-specific norms. The committees responsible for generating new standards include workgroups and sub-committees, which are comprised of representatives of related industries, academia and engineering research, as well as legal counsel. When a new CEN/CENELEC standard is introduced and "HARMONIZED" (language, legal, etc.) national norms (DIN (Germany), BS (England), AFNOR (France), AENOR (Spain), etc) lose validity.

CEN/CENELEC and ISO maintain communication between their committees working on related subjects.

FEM is an Industry Association of Material Handling Manufacturers, similar in nature and function to MHIA Product Councils (HMI, CMAA, MMA, etc.). FEM specifications are not regulatory, yet they are widely accepted in the international arena, and usually referred to in the absence of national standards.

Following is a listing of European standards and specifications for hoists and related equipment:

BSI STANDARDS

Selection of primary standards published by British Standards (BSI website www.bsi-global.com) for hoists and related material handling equipment (BS EN indicates harmonized standard):

1. BS EN 292 Safety of Machinery

2. BS EN 14492-2 Cranes – Power Driven Hoists

3. BS EN 60034-1 Rotating Electrical Machines: Rating and performance

4. BS EN 60034-5 Types of Enclosures for Rotating Electrical Machines

5. BS EN 60204-32 Safety of Machinery - Electrical Equipment of Machines - Part 32: Requirements for Hoisting Machines

DIN STANDARDS

Selection of primary standards published by the Deutsches Institut für Normung (DIN; website www.din.de) for application, design, maintenance and safety aspects of hoist and related equipment. (DIN EN indicates harmonized standard):

1. DIN EN 14492-2 Cranes – Power Driven Hoists

2. DIN EN 60204-32 Safety of Machinery; Electrical Equipment of Machines; Requirements for Hoisting Machines.

3. DIN 3051-Sections 1–4 Lifting Ropes; Steel Wires

4. DIN 15017 Cranes & Hoists; Principles of Motor and Gear Sizing

5. DIN 15020- Sections 1–2 Hoists; Principles of Rope Reeving

6. DIN 15061- Sections 1–2 Cranes & Hoists; Grooves for Rope Sheaves & Drums

7. DIN 15100 Serial Lifting Equipment; Nomenclature

8. DIN 15400 through DIN 15414 Detailed Aspects of Load Hooks and Bottom Block Construction

FEM STANDARDS

The Federation Europeenne de la Manutention (FEM; website www.fem-eur.com) publishes many standards for hoists and related material handling equipment. Some of the primary ones are:

1. FEM 1.002 Illustrated Terminology of Heavy Lifting Equipment

2. FEM 9.811 Rope and Chain Hoists – General Specifications

3. FEM 9.511 Rules for the Design of Series Lifting Equipment - Classification of Mechanisms

4. FEM 9.661 Rules for the design of Series Lifting Equipment - Dimensions and Design of Rope Reeving Components

5. FEM 9.683 Selection of Hoist and Travel Motors

6. FEM 9.852 Power Driven Series Hoist Mechanisms, Standardized Test Procedure for Verification of the Classification

7. FEM 9.755 Measures for Achieving Safe Working Periods for Motorized Serial Hoist Units (S.W.P.)

8. FEM 9.751 Power Driven Series Hoist Mechanisms, Safety

9. FEM 9.901 Rules for the Design of Series Lifting Equipment and Cranes Equipped with Series Lifting Equipment

CEN STANDARDS

Selection of primary standards published by the European Committee for Standardization (CEN; website www.cenorm.be) for hoists and related material handling equipment:

1. EN 341 Cranes – Bridge and Gantry Cranes

2. EN 13135-1 Cranes – Equipment – Part 1: Electrical Equipment

3. EN 13135-2 Cranes – Equipment – Part 2:Non-electrical Equipment

4. EN 13157 Cranes – Safety – Hand Powered Cranes

5. EN 13155 Cranes – Safety – Non-fixed Load Lifting Attachments

6. EN 13557 Cranes – Controls and Control Stations

7. EN 14492-1 Cranes – Power Driven Winches and Hoists – Part 1: Power Driven Winches

8. EN 14492-2 Cranes – Cranes – Power Driven Winches and Hoists – Part 2: Power Driven Hoists

9. EN 60204-32 Safety of Machinery; Electrical Equipment of Machines; Requirements for Hoisting Machines