CMAA HMI MMA

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An OSHA Cooperative Program

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OVERHEAD LIFTING BEST PRACTICES GUIDE

PREPARED & PUBLISHED BY THE CRANE HOIST AND MONORAIL (CHM) ALLIANCE OSHA COOPERATIVE PROGRAM

CONTRIBUTIONS FROM CRANE MANUFACTURERS ASSOCIATION OF AMERICA (CMAA), HOIST MANUFACTURERS INSTITUTE (HMI), MONORAIL MANUFACTURERS ASSOCIATION (MMA). VISIT OVERHEADALLICANCE.ORG FOR MORE INFORMATION.

CHM-OSHA Alliance
Best Practices

Overview

The overhead lifting product groups of MHI (Crane (CMAA), Hoist (HMI) and Monorail (MMA) (collectively "CHM Partners") and the U.S. Department of Labor's Occupational Safety and Health Administration (OSHA) entered a collaborative relationship to foster safer and more healthful American workplaces in 2005. In this Alliance, the three product groups committed to provide information, guidance and training resources that could help protect the health and safety of worker and to help employers understand their responsibilities under the Occupational Safety and Health Act. The Alliance between OSHA and the CHM Partners has been recently renewed as Ambassador status. Documents that have been developed by the CHM Alliance can be found at https://www.osha.gov/alliances/cmaa-hmi-mma/cmaa-hmi-mma.

Background

Many current OSHA regulations were developed in a relatively short period of time after the Occupational Safety and Health Act was signed into law in late 1970. To expedite drafting those regs, OSHA worked with organizations (like CMAA) that had widely recognized standards (i.e., CMAA Spec 70 and 74) to create the new OSHA standards. Following the period of early drafting, OSHA instituted a more rigorous process to change its regulations.

Current Specifications

Many resources refer to specifications from different years. With the increasing rate of change in today's world, the CHM Partners deem it necessary that these Best Practices are in line with current versions of standards. Throughout this document, the most current versions of specifications that are available to the public are referenced.

OSHA DISCLAIMER

Through the Alliance between OSHA and the CHM Partners (CMAA, HMI and MMA), the CHM Partners developed the following Best Practices for informational purposes only. They do not necessarily reflect the official views of OSHA or the U.S. Department of Labor.

EMPLOYER RESPONSIBILITIES AND WORKER RIGHTS

Under the Occupational Safety and Health Act, employers are responsible (www.osha.gov/as/opa/worker/employer-responsibility.html) for providing a safe and healthy workplace and workers have rights (www.osha.gov/workers/index.html). OSHA can help answer questions or concerns from employers and workers. OSHA's On-Site Consultation Program (www.osha.gov/consultation) offers free and confidential advice to small and medium-sized businesses, with priority given to high-hazard worksites. For more information, contact your regional or area OSHA office (www.osha.gov/html/RAmap.html), call 1-800-321-OSHA (6742), or visit www.osha.gov.

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Qualifications of an Overhead Crane/Hoist Operator

Definition

Qualification: a quality or accomplishment that makes a person suitable for a particular job or opportunity.

Operator: a person that operates equipment or a machine in this case a hoist or crane.

Requirements

1910.179 (b)(8)– Only designated personnel shall be permitted to operate a crane
ASME B30.20

- Shall[1] demonstrate proficiency to read and write in English.
- Shall demonstrate proficient oral and written communication skills.
- Shall be subject to other safety, drug, or other specific requirements as mandated by the Seller or Purchaser(s) from time to time.
- Shall adhere to Seller and/or Purchaser's health and safety guidelines.
- Shall be able to distinguish colors, regardless of position of colors, if color differentiation is required for the task.
- Receive classroom and practical training on basic operating principles and methods, i.e., rigging; hand signals; starting, stopping, and controlling loads; dos and don'ts for safe operation, etc.
- Not have evidence of physical restrictions; be subject to seizures or loss of physical control, or emotional instability that could render a hazard to the operator or others. Evidence of such conditions may be cause for disqualification. In such cases, specialized clinical or medical judgments and tests may be required.
- Crane operators should be familiar with the parts of a crane and have a thorough knowledge of crane control functions and movements.

Best Practices

- Understand the particular equipment operating, familiarize themselves with the OEM procedures.
- Be familiar with standard rigging practices.
- Daily inspections shall be performed by the operator or other designated person at the start of each shift, or at the time the crane is first used during each shift. The crane operator should not perform frequent or periodic inspections unless designated to perform such inspections by the employer or supervisor.
- Crane operators, crane-rigging personnel, crane signal persons, and crane maintenance personnel should be required to know the location, function, and proper operation of the main runway conductor disconnect switch for all cranes in the area.
- Special crane operations may require the use of additional hand signals or modifications of the standard hand signals. When special signals are required, they shall be documented by the crane owner/user and agreed upon, and understood by, the signal person and crane operator. Special signals shall not conflict with standard signals.

[1] Throughout this document, the following definitions will apply:
Shall: indicates a requirement; Should: indicates a recommendation; Qualified Person: is a person who holds an academic degree or a certificate of professional standing or who has extensive knowledge, training and experience in a pertinent field and has demonstrated the ability to solve problems relating to the pertinent subject matter.

Fall Protection

Question: Can fall protection lifelines be integrated into the crane structure?

Definition

Fall Protection is a means to prevent the accidental fall of workers and their tools while working at height. In case of an accident, fall protection equipment will stop the fall before it causes catastrophic injury.

Requirements

OSHA 1910.28 requires employers to provide protection for each employee exposed to fall or falling objects.

OSHA 1910.29 requires that companies determine what work employees might perform that necessitates fall protection. Once this is determined, the company must confirm each fall protection system provides the necessary protection to the employee and is installed and operational prior to the employee completing that work.

OSHA 1910.30 requires the employer must provide training for each employee who uses personal fall protection systems or who is required to be trained before any employee is exposed to a fall hazard.

Best Practices

- Ensure that fall protection harnesses are regularly inspected and certified.
- Ensure that fall protection equipment is properly design for the application.
- Lifelines on top of the crane for maintenance on the crane are acceptable.
- Lifelines attached to the bottom of the girder for below the crane fall protection are NOT recommended.
- Consult equipment manufacturer is attempting to combine both hoisting and fall protection in an enclosed track system.

Capacity Markings

Definition

Capacity Markings are signage used to notify the operator of the maximum load designed by the manufacturer or qualified person, for which the crane or monorail system is designed and built.

Requirements

- **OSHA 1910.179(b)(5)**: *Rated load marking*. The rated load of the crane shall be plainly marked on each side of the crane, and if the crane has more than one hoisting unit, each hoist shall have its rated load marked on it or its load block and this marking shall be clearly legible from the ground or floor.
- **ASME B30.17-1.1.1 Cranes**: (a) The rated load shall be marked on each side of the crane, and if the crane has more than one hoisting unit, each hoist shall have its rated load marked on the hoist and its load block so that the rated load marking shall be legible from the ground or floor.
- **ASME B30.17-1.1.2 Monorails**: The rated load of the monorail should be marked on the monorail and, if marked shall be legible from the ground or floor.
- **ASME B30.16-1.1.1 Hoists**: The rated load of a hoist shall be marked on the hoist or its load block and shall be legible from the ground or floor.

Best Practices

- Recommend the rated load capacity markings be on the hoist and its load block, however if either the hoist or its load block is marked, it's highly recommended to be the load block.
- Crane capacity markings should use simple, clear language with bold lettering large enough to be visible from a distance from either direction of the crane.
- Recommend monorails have the rated load plainly marked on each side of the monorail.

Safety Signs

Definitions

Safety sign: A visual alerting device in the form of a decal, label, placard, cord tag, or other marking such as an embossing, stamping, etching, or other process which advises the observer of the nature and degree of the hazard(s). It may also describe safety precautions or evasive actions to take or provide other directions to eliminate or reduce the hazard.

Signal word: The word that calls attention to the safety sign and designated a degree or level of hazard seriousness. The signal words for product safety signs are "DANGER", "WARNING", "CAUTION" and "NOTICE".

Requirements

- **B30.2-2005; Section 2-1.1.5: Warnings.** Floor-operated and remote operated cranes. A safety label or labels SHALL be affixed to the pendant station, portable operating station, or load block. The label or labels shall be in compliance of ANSI Z535.4. Labels shall include but are not limited to cautionary language against exceeding rated load, hoisting off-centered loads, lifting people, lifting loads over people and operating damaged or malfunctioning crane. Cab-operated and pulpit operated cranes. A safety label or labels SHALL be affixed to the cab or pulpit. The label or labels shall be in compliance of ANSI Z535.4. Labels shall include but are not limited to cautionary language against exceeding rated load, hoisting off-centered loads, lifting people, lifting loads over people and operating damaged or malfunctioning crane. Electrical control enclosures. A safety label shall be affixed and shall be in compliance with ANSI Z535.4.
- **ANSI Z535.4:** DANGER – Indicates a hazardous situation which, if not avoided, will result in death or serious injury. This signal word is to be limited to the most extreme situations. The word DANGER shall be in safety white letters on a safety red background. WARNING – Indicates a hazardous situation which, if not avoided, could result in death or serious injury. The word WARNING shall be in safety black letters on a safety orange background. CAUTION – Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury. It may also be used without the safety alert symbol as an alternative to "NOTICE". The word CAUTION shall be in safety black letters on a safety yellow background. NOTICE – "NOTICE" is the preferred signal word to address practices not related to personal injury. The safety alert symbol shall not be used with this signal word. As an alternative to "NOTICE", the work "CAUTION" without the safety alert symbol may be used to indicate a message not related to personal injury. The word NOTICE shall be in white letters on a safety blue background.

Best Practices

- Signs shall be placed to alert and inform viewer of hazard from a safe distance.
- Signs shall be placed so they are legible, non-distracting and not hazardous to employees.
- Signs shall not be in areas where the motion of the hazardous device may remove them.
- Wording should be concise and easily understood.
- Signs with multiple messages should have sufficient space between them to prevent visually blending.
- When detailed instructions are required referring to an instruction manual is recommended.

Audible and Visual Warning Alarm Requirements

Definition

Audible Alarm: Warning device that provides sound signals to indicate to operator and others in crane operation path that specific events/conditions have occurred.

Visual Alarm: Warning light device that provides visible signal to indicate to operator and others in crane operation path that specific events/conditions have occurred.

Floor-Operated Crane: Crane which is pendant or nonconductive rope controlled by an operator on the floor or an independent platform.

Requirements

- **OSHA 1910.179(i)** Except for floor-operated cranes, a gong or other effective warning signal shall be provided for each crane equipped with a power travelling mechanism.
- **OSHA 1910.179(b)(4)** Outdoor storage bridges shall be provided with automatic rail clamps. A wind-indicating device shall be provided which will give a visible or audible alarm to the bridge operator at a predetermined wind velocity.
- **ASME B30.2** a warning device shall be provided for cab and remote operated cranes. Pendant operated cranes should be provided for installations where the ability of the operator to warn persons in the path of the load is impaired. The operator shall activate the warning device before starting the bridge or trolley motion of a crane.

Best Practices

- A warning device should be used that best accommodates the customer's working conditions, i.e., in a noisy facility a visual warning device would have the greatest impact. In a bright facility or one with a large amount of air contaminants, an audible device would be best.
- Audible warning devices should at a minimum be 100 db. However, it should be clarified with customer's site requirements of how far from the equipment a noise should be heard, and what the ambient noise levels are, to make sure the audible device is heard on the proper range from the device.
- Visual warning device colors should be applied best for the application. Each location should determine what colors are most visible, properly represent safety/warning, and do not match any existing warning devices.
- Visual warning devices should be mounted so that the light from the device is visible to the operator and other people in the operating area.
- Devices should be mounted so that they provide warning to people in the personnel operating areas that interface with the cranes.
- Crane manufacturers and owners should also be aware of any state/local codes that require audible/visual warning devices for overhead cranes.

Load Tests Requirements

Questions: When are load tests required? How often should they be completed? How long should they take to complete? What weight should be used? Are pre/post inspections required?

Definitions

Load Test: verifies the crane and hoist will perform all of the design functions (lift, lower, traverse length of bridge, traverse length of runway) while supporting a test load at least equal to the rated capacity of the equipment.

Periodic Inspection: is a detailed visual and operational inspection whereby individual components are examined to determine their condition, performed by a qualified person.

Load Test Requirements

- **OSHA 1910.179(k)(2)**: Modified or rerated cranes shall be load tested. Test loads shall not be more than 125% of the rated load unless otherwise recommended by the manufacturer. The test reports shall be placed on file where readily available to appointed personnel.
- **ASME B30.2, ASME B30.16 and ASME B30.17**: New, reinstalled, altered, repaired and modified cranes and hoists should be load tested prior to initial use with a test load equal to 100% to 125% of rated load and to include all design functions (lift, lower, traverse length of bridge, traverse length of runway).
- **CMAA 78 –** Section 4.7 Load Test: Cites the load test requirements of **OSHA 1910.179** and states a load test should be performed at a minimum of once every 4 years at 100% load with a pre-test and post-test inspection per periodic inspection guidelines, and there must be a written report of the load test and inspection results.

Best Practices

- A load test should be completed on newly installed, altered, repaired or modified hoists prior to being placed into service. All cranes should be load tested at a minimum of once every 4 years.
- Test loads shall be no less than 100% or more than 125% of rated capacity.
- Load tests should be dynamic and include all design functions (lift, lower, traverse length of bridge, traverse length of runway).
- Load test weights should be certified.
- All equipment is recommended to have a pre-inspection performed prior to any load testing to identify any deficiencies that may impact safety, or the load test results.
- A periodic inspection of the equipment should be completed post load test.
- Load test reports should be placed on file for the entirety of the life of the equipment.
- Any Load test that may exceed 125% should follow the engineered lift guidelines as specified in **ASME B30.2**.

Conductor Bar Systems:
Bare Uninsulated Conductors & 4th Bar

Definition

Bare Uninsulated Conductors: Copper Wire stretched between two points along the length of a runway system to supply power to overhead material handling equipment.

Grounding Conductor: Conductor provided exclusively for grounding of the overhead equipment. It does not supply power to any of the equipment. It must also be distinguishable from the other conductor bars on the system, i.e., a separate color, etc.

Requirements

- **OSHA 1910.179(a) 28**: Conductors, runway (main) are the electrical conductors located along a crane runway to provide power to the crane.
- **NEC 610.13 B**, contact conductors: Contact conductors along runways, crane bridges, and monorails shall be permitted to be bare and shall be copper, aluminum, steel, or other alloys or combinations thereof in the form of hard-drawn wire, tees, angles, tee-rails, or other stiff shapes."
- **NEC 610.61** Grounding: "The trolley frame and bridge frame shall not be considered as electrically grounded through the bridge and trolley wheels and its respective tracks. A separate bonding conductor shall be provided.

Best Practices

- A 4th ground bar providing a continuous ground shall always be used.
- When replacing an existing 3-bar conductor bar system, a 4th ground bar shall be provided.
- If environment dictates and the customer cannot assure a continuous ground through the crane wheels, unimpeded by things such as bearings and lubricants, then a 4th ground bar shall be added to an existing system.
- When sizing conductor bar, the system length, power feed location(s), and equipment power draw must be taken into consideration. This includes the number of pieces of equipment, the amp draw of specific items which should be sized for full draw at all times, and all below the hook lifting devices that require a power feed. Reference NEC 610 for proper ampacity sizing.
- Festoon cable should be used in place of conductor bar when:
    - The environment of the application does not allow for open electrical contacts.
    - Complex control applications dictate that conductor bar is not a feasible option.
- As long as the system meets the above stipulations, hard drawn copper wire is acceptable for conductor systems.
- 4th ground bar should be in an easily accessible location in relation to the existing 3 conductors and meet all other requirements for conductors.

Conductor Bar Guards

Definition

Conductor bars are the electrical conductors located along the bridge structure of a crane, to provide power to the trolley and along the building runway to supply power to the bridge. Exposed conductor bars are capable of being contacted inadvertently due to hazardous objects not adequately guarded or isolated.

Requirements

- **OSHA 1910.179(e)(5)(i):** If hoisting ropes run near enough to other parts to make fouling or chafing possible, guards shall be installed to prevent this condition.
- **OSHA 1910.179(e)(5)(ii):** A guard shall be provided to prevent contact between bridge conductors and hoisting ropes if they could come into contact.
- **OSHA 1910.179(e)(6)(ii):** Guards shall be securely fastened.
- **OSHA 1910.179(e)(6)(iii):** Each guard shall be capable of supporting without permanent distortion the weight of a 200-pound person unless the guard is located where it is impossible for a person to step on it.
- **OSHA 1910.179(g)(2)(i):** Electrical equipment shall be so located or enclosed that live parts will not be exposed to accidental contact under normal operating conditions.
- **OSHA 1910.179(g)(2)(iii):** Guards for live parts shall be substantial and so located that they cannot be accidently deformed so as to make contact with the live parts.
- **OSHA 1910.179(l)(2)(ii):** After adjustments and repairs have been made the crane shall not be operated until all guards have been reinstalled, safety devices reactivated, and maintenance equipment removed.
- **ASME B30.2**: in generalization of specification, all above conditions also apply to runway conductor systems, and a proper guard shall be provided.

Best Practices

- Exposed bridge and runway conductors that could come into contact with the hoist ropes, block, or load; shall be guarded or isolated.
- Guards shall be securely fastened and substantially constructed; such that they cannot accidentally be deformed by human or other loads; such that contact cannot be made with electrically energized parts.
- Crane shall not be operated unless guards are in place and operational.

Upper Limit Switches
Operational Versus Over Travel Limits

Questions: When is an upper limit device that operates independent of drum rotations on a wire rope hoist required? When is a final/over travel limit required versus an operational limit?

Definitions

OSHA 1910.179 defines a limit switch as a switch which is operated by some part or motion of a power-driven machine or equipment to alter the electric circuit associated with the machine or equipment.

Operational Limit: a geared or similar hoist travel limit that operates off drum rotation or the same to provide operational limits to hook travel.

Final/Over travel Limit: device activated by the actual hook block that stops hoist operation prior to any contact with hoisting structure, preventing death and destruction.

ASME B30.16 defines a limit device as a device that limits equipment motion or takes control of particular functions without action of the operator when a limiting condition is reached.

CMAA 70 and 74 define a limit switch as a device designed to cut off the power automatically at or near the limit of travel for a crane motion (lift-lower, trolley traverse or bridge traverse).

Requirements

- **OSHA Section 1910.179(g)(5)(iv)** states that the hoisting motion of all electric traveling cranes shall be provided with an over travel limit switch in the hoisting (up) direction.
- **OSHA Section 1910.179(n)(4)(ii)** The hoist limit switch which controls the upper limit of travel of the load block shall never be used as an operating control.
- **ASME B30.2 and B30.16** both state that a powered hoist shall be designed and constructed that the load hook, either loaded or empty, shall not exceed the upper limit of travel and on wire rope hoists, if a geared or other limit switch or device that operates in relation to drum turns is used, an additional upper limit switch or device that operates independent of drum turns shall be provided.
- **CMAA 70 and 74** both state that the hoist motion of all cranes shall be equipped with an over travel limit switch in the raising direction to stop hoisting motion and if the limit switch operates off the rotation of the drum, a secondary limit switch that operates independently of drum turns shall be provided.
- **OSHA, ASME and CMAA** all state that the trip setting of hoist limit switches shall be verified by tests with an empty hook traveling at increasing speeds up to the maximum speed and the actuating mechanism of the limit switch shall be located so that it will trip the switch, under all conditions, in sufficient time to prevent contact of the hook or hook block with any part of the trolley.
- **OSHA, ASME and CMAA** also state that the hoist limit switch which controls the upper limit of travel of the load block shall never be used as an operating control.
- **OSHA, ASME and CMAA** also have specific requirements to test an upper limit device on a powered hoist at the beginning of each shift and to inspect and test all limit devices as part of the frequent and periodic inspections performed on the powered crane or hoist.

Best Practices

- Final/Over travel limit devices or switches must be provided on all powered hoists.
- On powered chain hoists both slip clutches and limit switches are acceptable limit devices.
- The hoist upper limit switch is an emergency device only and shall never be used as an operational stop during normal operation.
- The most common types of final/over travel hoist limit switches are commonly block operated limit switches.
- Block operated limit switches commonly have a paddle, weight or some other type of device that activates the switch when contacted/obstructed by the block.
- The crane or hoist operator should:

    a. **ALWAYS** test the operation of the primary upper limit switch of the hoisting motion before each shift.
    b. **ALWAYS** report any faulty limit switches immediately.
    c. **ALWAYS** pay attention to the location of the load block in relation to the hoist.
    d. **ALWAYS** recognize the size and shape of the actual load as it may be possible for some part of the load to come in contact with the hoist or other structure before the load block reaches the limit switch.
    e. **NEVER** use the hoist upper limit switch to stop the hoist under normal operation.
    f. **NEVER** use a hoist with a faulty limit switch.

WARNING: On hoists, raising the block too far can cause the load block to strike the hoist or other part of the crane or structure. This is commonly called two-blocking the hoist which can damage the hoist and could result in a load drop.

E-STOP and Safety Disconnect Requirements

Question: What are crane and hoist E-Stops, and safety disconnects and when are they required?

Definitions

OSHA 1910.179(a) (59) defines an "emergency stop switch" as a manually or automatically operated electric switch to cut off electric power independently of the regular operating controls.

ASME B30.2 defines an "emergency stop switch" as a manually actuated switch to disconnect power independently of the regular operating controls.

ASME B30.2 defines a "main switch (crane disconnect)" as a switch on a crane controlling the main power supply from the runway conductors.

ASME B30.2 and B30.17 define a "runway disconnect switch" as a switch usually at floor level, controlling the main power supply to the runway conductors.

Requirements

- **OSHA 1910.179(g)(5)(i), ASME B30.2,ASME B30.17 and the NEC** all specify that the power supply to the runway conductors or other power supply 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.
- **OSHA 1910.179(g)(5)(ii)** specifies that for **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 within easy reach of the operator.
- **OSHA 1910.179(g)(5)(iii)** specifies that for **floor operated** cranes either 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 foot walk near the runway collectors. One of the following types of floor-operated disconnects shall be provided.
- **CMAA 70 and 74** both specify that a crane disconnecting means, either a current rated circuit breaker or a motor rated switch, lockable in the open position, shall be provided in the leads from the runway conductors or other power supply and this disconnecting means shall be located so it is readily accessible to the operator or have a mainline contactor connected after the disconnecting means that is operable from the operator's station.
- **NEC Article 610- Cranes and Hoists** states that for cranes and monorail hoists a disconnecting means shall be provided in the leads from the runway conductors or other power supply and that this disconnecting means must be capable of being locked in the open position. This disconnecting means may be omitted on monorail systems or hand powered bridge cranes where the hoist or crane is operated from the ground and the power disconnecting means is within view of the operator.
- **OSHA 1910.179(g)(3)(ix), ASME B30.2 and ASME B30.17** all specify that remote operated cranes shall function so that if the control signal for any crane motion becomes ineffective the crane motion shall stop.
- **OSHA 1910.179(g)(3)(viii), ASME B30.2 and ASME B30.17** all specify that automatic cranes shall be so designed that all motions shall fail-safe if any malfunction of operation occurs.

Best Practices

- The runway disconnect should be in an easily identifiable, locatable, and accessible area for the crane operator.
- If the operator is not within 1-2 steps of the wall plug, an E-stop should be used on the operator control.
- All remotely operated cranes and hoists must shut down if any part of the control signal is lost or malfunctioning.
- All automatically operated cranes or hoists must shut down if the automatic sequence is malfunctioning in any way.
- Anytime the emergency stop switch is not functioning properly the operator should immediately shut down the crane or hoist and report the problem to management.
- The operator should never circumvent the intendent purpose of the emergency STOP button. The E-Stop when supplied, is intended to be an emergency device, and should not be used to routinely shut down the crane or hoist.

WARNING: Operating a crane or hoist with a mal-functioning or disabled emergency stop switch could result in a serious accident with potential property damage, injury, or death.

Incorporating E-Stops
E-stops – Powered Below the Hook Devices

Question: How should emergency stops operate for below the hook devices that require constant power for operation?

Definitions

Emergency Stop: A manually or automatically operated electric switch to cut off electric power independently of the regular operating controls.

Below the Hook Device (BTH): A device used to attach a load to a hook. The device may contain components such as slings, hooks and rigging hardware and may typically be called a lifter.

Electric Below the Hook Device: A BTH device that is controlled by and depends upon electricity to operate properly. (i.e., Electro-magnets, vacuum lifters, etc.)

Requirements

- **OSHA 1910.179(g)(5)(v):** All cranes using a lifting magnet shall have a magnet circuit switch of the enclosed type with provision for locking in the open position. Means for discharging the inductive load of the magnet shall be provided.
- **ASME B30.2-2016-2-1.13.8 Cranes with Lifting Magnets (a):** A crane for use with a lifting magnet shall have a separate magnet circuit switch of the enclosed type with provision for locking in the open (off) position. The magnet disconnect switch shall be connected to the line side (power supply side) of the crane disconnect switch.
- **ASME B30.20-2018-2.2.3: Vacuum Lifter: (c)** The electrical power supply to the vacuum lifter shall be connected to the line side of the crane disconnect, or to an independent circuit.
- **ASME B30.20-2018-3.2.2: Magnets: (c)** (2) Provisions shall be made for guarding the control switch in the "lift" position to protect it from being inadvertently being turned off, this would result in release of the load.
- **ASME BTH-1-2017-5.6.3: Magnet Disconnect:** Hoisting equipment using an externally powered electro-magnet shall have a separate magnet circuit switch of the enclosed type with provision for locking, flagging, or tagging in the open (off) position. Means for discharging the inductive energy of the lifting magnet shall be provided. The lifting magnet disconnect switch shall be connected on the line side (power supply side) of the hoisting equipment disconnect switch.

Best Practices

- Any below the hook lifting device that requires constant electric power for operation should be separated electrically from the crane or hoist circuit and the operation of the E-stop function on the radio or push-button control.
- A separate electrical circuit including independent branch circuit fusing between the conductor bar system and the below the hook device power cable should be in place.
- Make sure that proper circuitry is in place on overhead cranes and hoists to ensure uninterrupted power is provided to the BTH device.
- Make sure that below the hook devices are in proper working condition and have been tested for capacity and capability on a regular basis.

WARNING: There is the potential that, when operating an overhead crane or hoist equipped with an electrically controlled below the hook lifting device where the power for the BTH device is provided by the crane or hoist circuit, an operator could, upon hitting the E-stop button, disengage the powered lifting device, resulting in the load falling, which could result in property damage, injury, or death.

Runway Disconnect Switch

Question: What is a runway disconnect switch and when is it required?

Definitions

Runway Disconnect Switch An electrical switch that isolates the building power source to the mainline conductor bar system that feeds power to the crane.

Requirements

NEC Article 610 Section 610.31: A disconnecting means that has a continuous ampere rating not less than that calculated in 610.14(E) and (F) shall be provided between the runway contact conductors and the power supply. The disconnecting means shall comply with Section 430.109. This disconnecting means shall be as follows:

- Readily accessible and operable from the ground or floor level.
- Lockable open in accordance with section 110.25.
- Open all ungrounded conductors simultaneously.
- Placed within view of the runway contact conductors.

Best Practices

- There may be a time when the operator may have to disconnect power to the crane if the e-stop button is defective.
- Maintenance personnel may have to disconnect the mainline to work on the crane or cranes on the same system.
- Maintenance may have to disconnect the mainline when working on the building.
- Train operators and maintenance personnel on the location of the disconnect switch.
- Clearly mark the locations of disconnects so they are visible to all personnel in the bay at any time.
- Train operators on what to do in an emergency.
- In case of equipment failure, the operator may not be able to turn the crane off, make sure to train other floor and maintenance personnel on what to do.
- Make sure the disconnect switch is properly located and easily accessible.
- Train the maintenance department in proper “Lockout /Tagout” procedures (also see 29 CFR 1910.147).

Rail Sweeps

Questions: When are rail sweeps required? When should they be replaced?

Definition

Rail Sweep: Structural component of the bridge and trolley end trucks that is mounted in front of the wheels that will clear the rail of obstructions.

Requirements

- Per **OSHA 1910.179(e)(4)** Bridge Trucks shall be equipped with sweeps which extend below the top of the rail and project in front of the truck wheels.
- Per **ASME B30.2,** (section 2-1.9) Rail Sweeps: the bridge and trolley truck rail sweeps shall be provided in front of the leading wheels on both ends of the bridge and trolley end trucks to clear the rail of objects which could cause damage or derailment.
- Per **CMAA spec 70,** section 3.6.3 Bridge end trucks shall have rail sweeps in front of each outside wheel and shall project below the top of the runway.
- Per **CMAA Spec 70**, section 3.9.2 trolleys should have rail sweeps.

Best Practices

a. Why is this topic important to the user?
    i. Rail sweeps remove objects that could cause damage to crane wheels, axles, and bearings.
    ii. Rail sweeps prevent objects from getting between the rail and the wheels and derailing the wheels.
b. Recommendations:
    i. Keep the crane runway beams and crane girders clear of any foreign objects.
    ii. Inspect the rail sweeps on a yearly basis.
    iii. Replace or repair the rail sweeps when damaged or broken.
c. What can happen if these recommendations are not followed?
    i. Objects on the runway rail or girders could cause damage to the crane wheels, axles, and bearings.
    ii. Objects on the runway or girders could cause the crane wheels to derail off of the runway or girder rail.
d. What does the company need to do?
    i. Inspect the rail sweeps and their connections on a yearly basis.
    ii. Maintain sweeps and replace or repair when damaged or broken.
e. What does the crane user/operator need to do?
    i. Report any damage or misalignment of the sweeps to a supervisor or owner.

Trolley and Bridge Bumpers

Definition

A **bumper** is 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. Bumpers can be rubber, polyurethane, spring, or hydraulic type and should engage directly with the end stops.

Requirements

CMAA Specification 70, (Section 4.14), **OSHA 1910.179** ((e) (2) and (e) (3)) and **ASME B30.2**, (Section 2-1.8) the bridge and trolley shall be provided with bumpers or other means providing equivalent effect. These bumpers, when used, have the following minimum characteristics.

- Have energy absorbing capacity to stop the crane when traveling with power off in either direction at a speed of at least 40% for bridge motion or 50% for trolley motion.
- Bridge motion – Be capable of stopping the crane at a rate of deceleration not to exceed an average of 3 feet per second per second when traveling with power off in either direction at 20% of rated load speed.
- Trolley motion – Be capable of stopping the trolley at a rate of deceleration not to exceed an average of 4.7 feet per second per second when traveling with power off in either direction at 50% of rated load speed.
- Be so mounted that there is no direct shear on bolts upon impact.
- Bumpers shall be designed and installed to minimize parts falling from the crane in case of breakage or loosening of bolted connections.
- When more than one bridge or trolley is located and operated on the same crane or runway, bumpers shall be provided on their adjacent ends to meet the requirements stated above.
- Bumpers shall be designed and installed to minimize parts falling from the crane in case of breakage or loosening of bolted connection.

Best Practices

- Bumpers prevents structural damage to crane, runway and building.
- User needs to understand what would happen if the crane were run into the end stops at full speed.
- Structural damage to the crane, end stops, building, lifted load and possibly the crane operator if bumpers are not maintained and properly sized.
- Damage to the electrical equipment can also occur.
- Maintain bumpers and adjacent end stops and replace when required.
- Operator needs to visually inspect bumpers before each operational shift.
- Report any damage or misalignment of bumpers to a supervisor or owner.
- Operator training to not rely on bumpers to stop the crane or trolley.
- Trolley/bridge travel or slowdown limits maybe required.
- Operations that require consistent use of the bumpers into the stops may require additional equipment to prevent damage (slowdown limits or distance detection systems).

Bridge and Trolley Brakes

Question: When are bridge and trolley brakes required and how should they be sized?

Definitions

Brake: A device used for retarding or stopping motion by friction or power means.
Holding Brake: A brake that automatically prevents motion when power is off.
Control Braking: A method of controlling speed by removing energy from the moving body or imparting energy in the opposite direction.

References

- **OSHA 1910.179** Section 1910.179(f)(4) Brakes for Trolleys and Bridges
- **CMAA 70** Section 4.9.3 Trolley Brakes and Section 4.9.4 Bridge Brakes
- **CMAA 74** Section 4.4 Bridge Brakes
- **ASME B30.2** Sections 2-1.12.3 Trolley Brakes, 2-1.12.4 Bridge Brakes and 2-1.12.5 Trolley and Bridge Brakes Provisions
- **ASME B30.17** Sections 17-1.13.2 Trolley Brakes, 17-1.13.3 Bridge Brakes and 2-1.13.4 Trolley and Bridge Brakes Provisions

Requirements

OSHA, **ASME** and **CMAA** all recommend or require both bridge and trolley brakes for powered cranes and hoists. The requirements of these standards vary slightly but in general require the following:

- The bridge and trolley must stop within a distance equal to 10% of the rated load speed when traveling at rated speed with a rated load. Example: 120 FPM Bridge or trolley must stop within 12 feet.
- When at rest the bridge and trolley brake must resist a horizontal force equal to 1% of the combined weight of the bridge, hoist, trolley, and rated load for the bridge brake or 1% of the combined weight of the hoist, trolley and rated load for the trolley brake or 50% of the rated motor torque for indoor service or 100% of the rated motor torque for outdoor service, whichever is greater.
- Control braking is an applicable means of braking, as long as a holding brake is employed during times of power loss.
- Non-coasting mechanical drives are an acceptable means of braking, except on cab cranes as long as the stopping distance and holding requirements shown above are met.

Best Practices

- Brakes are important to maintaining control of the load for safe operating practices. They save wear and tear on the bridge and trolley and prevent the load from running into and damaging equipment and personnel.
- The equipment owner should ensure the operator is properly trained and has a full understanding of the trolley and bridge braking functions and how they change based on the load on the trolley or bridge.
- The operator should test the function of all brakes before each operational shift–and report any operational deficiencies such as excessive drift to their supervisor.
- Inspect and maintain all brakes according to manufacturer's recommendations and the applicable requirements of OSHA, ASME and CMAA.

WARNING: Failure to properly inspect and maintain trolley and bridge brakes may result in building, runway structure, crane, or load damage as well as personal injury or death.

Guards – Couplings and Line Shafts

Question: What are the guarding requirements for crane and hoist couplings and line shafts?

Definitions from OSHA

Guard: barriers which prevent access to danger areas.
Fixed Guards: a permanent part of equipment not dependent upon moving parts.
Removable Guards: can be disconnected to assist with maintenance, inspection, etc.
Interlocked Guards: are guards that when opened or moved, shut off the power to the equipment.
Self-Adjusting Guard: move in relation to the item to be guarded and the operator.
Coupling: a device for connecting parts of machinery.
Line Shaft: a power-driven rotating shaft for power transmission.

Requirements

- **OSHA 1910.179(e)(6)(i):** 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.
- **1910.179(e)(6)(ii):** Guards shall be securely fastened.
- **1910.179(e)(6)(iii):** Each guard shall be capable of supporting without permanent distortion the weight of a 200-pound person unless the guard is located where it is impossible for a person to step on it.
- **ASME B30.2-2016 and ASME B30.17-2017:** Both crane standards contain requirements for guarding similar to the OSHA 1910.179 regulation but add requirements for maintenance personnel to ensure all guards have been replaced if lost or damaged before returning the crane or hoist to service.

Best Practices

- A fixed guard shall be installed and securely fastened on all moving parts of the crane or hoist which might constitute a hazard under normal operating conditions.
- Hazards should be identified by a qualified person during normal operating conditions rather than during maintenance procedures.
- Special attention should be given to line shafts and couplings that may be in the walking path of a crane operator when entering or exiting the cab. Guard attachments should be inspected regularly to verify that they are secure and that they do not show signs of significant deterioration or corrosion. Guards should be visually identified or marked to properly identify the guarded hazard. Guards that are removed for inspection or service should be reinstalled prior to operation of the crane or hoist. Crane inspectors should document that guards have been installed on all moving parts which might constitute a hazard under normal operating conditions and that the guards are properly secured and marked to identify the guarded hazard. Couplings and line shafts shall be guarded for all cranes and hoists when they present a hazard during normal operations.
- Guards shall be capable of supporting 200 lbs. unless the guard is in an inaccessible area.

End Stops

Questions: When and where are end stops required? How do you size end stops?

Definition

1910.179(a)(57) A **stop** is a device to limit travel of a trolley or crane bridge. This device normally is attached to a fixed structure and normally does not have energy absorbing ability.

Requirements

CMAA 70 - 4.15 Runway stops limiting the bridge travel are normally designed and provided by the owner or specifier. Stops are located at the limits of the trolley and bridge travel and shall engage the full surface of the bumper. Stops engaging the tread of the wheel are not recommended.

Best Practices

- This device prevents the trolley or bridge from coming off the running surface. User needs to understand what would happen if they ran the crane into the end stops at full speed.
- Damage can occur if the stops are not sufficient to prevent the bridge or trolley from coming off the rail.
- Owner should ensure that end stops are designed correctly.
- Operators should be trained to not rely on the end stops to stop the bridge or trolley.
- Trolley or bridge limits maybe required. Bumpers should engage with the end stop directly, the wheel should not.
- Operators should not need to operate crane or trolley near the end stops.
- End stops should be bolted or welded in place to a substantial member that will accommodate forces or loadings. The web of structural members is not usually considered a substantial mounting surface.

Chain Containers

Question: Are chain containers required and when should they be used?

Definition

A **chain container** is a device that captures and stores hoist load chain when it is on the no-load side of the hoist's load sheave, it is located below the hoist body.

Requirements

ASME B30.16 Section 16-1.3.3(g) states "Where the slack load chain hanging from the hoist may create a hazard to operations or personnel, a chain container recommended by the hoist manufacturer or a qualified person should be used."

Best Practices

- A Chain Container is an optional device that keeps this excess load chain from interfering with the load, adjacent load chain and the operator during hoisting operations. Chain containers should always be used.
- Chain containers should be designed by a qualified Engineer or the hoists manufacturer to ensure the chain container is suitable for its intended use.
- Chain Containers should be designed to have sufficient volume to contain the entire lift length of the hoists load chain. Considerations should be made regarding the chains stacking mode when it is fed into the container by the hoist's operation.
- Chain containers should be designed so as not to interfere with the hoist's performance or function.
- Chain container design should consider application specific requirements. For instance, clearance from obstruction, materials to be used and environmental considerations should be made.
- Chain containers should be installed correctly, and the no-load chain should be terminated in accordance with the manufacturer's instructions.
- Operators should not make alterations to the Chain Container design without a qualified engineer or the equipment manufacturer's approval.
- Operators should avoid contact between the load/load fixture and the Chain Container.
- Chain Containers should be inspected before use to ensure the container, its suspension and hardware are in good working condition. Chain Containers showing signs of wear or damage should be replaced before use.

WARNING: Poorly maintained load chain can affect the load chain's stacking characteristics and result in the chain spilling from the chain container. Poorly maintained load chain is exposed to adverse kinking or corrosion, leading to a critical failure. Maintain the load chain in accordance with the manufacturer's recommendations.

WARNING: The chain container suspension including brackets, links, fasteners, and other components that support the chain container must be designed with sufficient strength to ensure this suspension does not fail under load and must be inspected frequently to ensure the suspension has not been damaged or worn. Failure to properly design and maintain this suspension could result in the container and load chain falling which could cause serious injury or death.

Chain Container Images

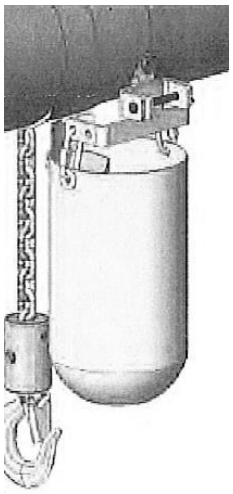

Image 1: Round Style with Suspension

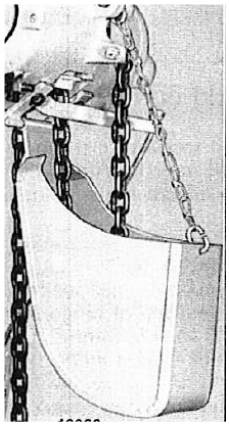

Image 2: Contoured Style with Suspension

Image 3: Poly Molded Style with Suspension

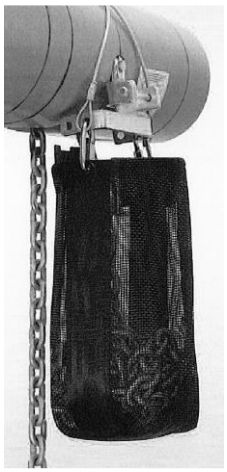

Image 4: Fabric Style with Suspension and Redundant Safety Cable

Image 5: Round Fabric Style with Suspension

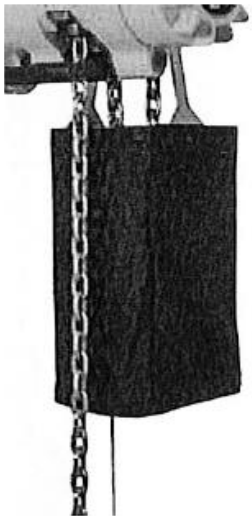

Image 6: Rectangular Fabric Style with Suspension

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