

Construction Hoists

Understanding Exposures & Controls

By Sathy Rajendran and Brian Clarke

Construction hoists, also known as man-lifts, personnel hoists and construction elevators, are commonly used when constructing high-rise buildings to transport personnel, tools, equipment and materials between floors (Photo 1). Incidents involving construction hoists caused 93 deaths among construction workers between 1992 and 2003 (ASSE, 2010). Table 1 presents deaths from hoist-related injuries by major construction occupation. Despite the number of fatalities associated with hoist operations and the similarity of hoists to tower cranes in terms of tall mast sections, building tie-ins and public exposure, construction hoist installation and operation have received little attention.

Over the past few decades, hoists and tower cranes have made construction material handling easier and safer. However, the hoist itself introduces several hazards and exposures that must be mitigated during its life cycle on a project (Figure 1, p. 30). A hoist is erected on site from several components, usually with the help of an on-site tower crane. If a jobsite has no tower crane or if tower crane operations are limited, a mobile crane (an assist crane) is used.

A hoist is typically rented by a general contractor from a lessor (rental or manufacturer), although some large contractors own hoists as part of their equipment fleet. In either case, as the controlling contractor, a general contractor that uses a construction hoist on its site is responsible for its

safe operation; therefore, the controlling contractor should implement a comprehensive construction hoist safety program. Subcontractors should address hoist operations in their safety planning when their work is performed near a hoist.

Failure to follow proper safety procedures during a hoist's life cycle could result in severe personal injury, death or property damage. This article provides information to help contractors and SH&E professionals develop proactive construction hoist safety programs.

Hoists have either one or two cars that travel vertically along stacked mast tower sections. The base of the mast is connected to a structural concrete foundation. Mast sections are tied-in to the building at regular intervals determined by the hoist manufacturer. The manufacturer typically provides the different forces generated by the hoist on the building. Based on these data, the structural engineer (with a P.E. license) designs or verifies the tie-in connection point to the building to withstand the load imposed on the building.

Construction Hoists: Existing Practices

The authors conducted an extensive search of the existing literature to locate articles, reports, regulatory standards and other documents that address best practices related to construction hoists. Minimal guidance was found. This section summarizes current industry best practices pertaining to construction hoists.

OSHA Subpart N, Cranes, Derricks, Hoists, Elevators and Conveyors, §1926.552 titled "Material hoists, personnel hoists and elevators" covers the regulatory requirements for construction hoists. It directs employers to "manufacturer specifications" and provides limited guidance on hoist operation safe practices. According to this regulation:

[T]he employer shall comply with the manufacturer's specifications and limitations applicable to the operation of all hoists and elevators. Where manufacturer's specifications are not available, the limitations assigned to the equipment shall be based on the determinations of a professional engineer competent in the field. (OSHA, 2006b)

IN BRIEF

- Construction contractors who use construction hoists on their sites should implement a proactive comprehensive hoist safety program.
- Failure to follow proper safety procedures during a hoist's life cycle on a project could result in severe personal injury, death or property damage.

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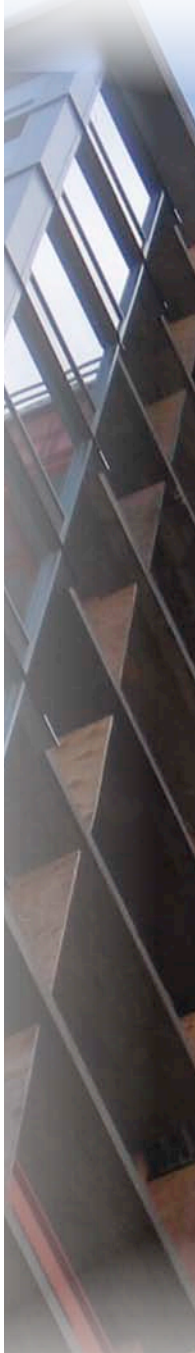




Photo 1. A two-car construction hoist in operation on a residential high-rise.

ANSI/ASSE A10.4-2007 is a national consensus standard titled Safety Requirements for Personnel Hoists and Employee Elevators: American National Standard for Construction and Demolition Operations (ANSI/ASSE, 2007). It applies to the design, construction, installation, operation, inspection, testing, maintenance, alterations and repair of hoists and elevators that 1) are not an integral part of buildings; 2) are installed inside or outside buildings or structures during construction, alteration, demolition or operations; and 3) are used to raise and lower workers and other personnel connected with or related to the structure. These personnel hoists and employee elevators also may be used for transporting materials under specific circumstances defined in the standard, which establishes minimum requirements intended to provide for the safety of those engaged in occupations requiring

Table 1

Deaths Resulted From Hoist-Related Injuries

Occupations	Deaths
Elevator installers and repairers	6
Carpenters	6
Roofers	6
Structural metal workers	8
Construction laborers	20
Others	47
Total	93

Note. Deaths resulted from hoist-related injuries by major occupation in construction, 1992-2003. Adapted from Bureau of Labor Statistics Census of Fatal Occupational Injuries, as cited by ASSE website, 2010.

the use of personnel hoists or employee elevators. It is a great reference to construction contractors seeking to establish a hoist safety program.

Further guidance is available from the U.K.-based Construction Hoist Interest Group (CHIG), a specialty group that is part of the Construction Plant-Hire Association (CPA). CHIG has developed several best practice guides including:

- Best Practice Guide: Construction Hoist Maintenance, Inspection and Thorough Examination. This document provides guidance on daily preuse checks, inspections, thorough examination and maintenance of hoists (CPA, 2004).

- Best Practice Guide: Working at Height on Construction Hoists. This document provides guidance on work at height during the erection, safe use, maintenance, dismantling and thorough examination of construction hoists (CPA, 2009).

Hoist Safety Program

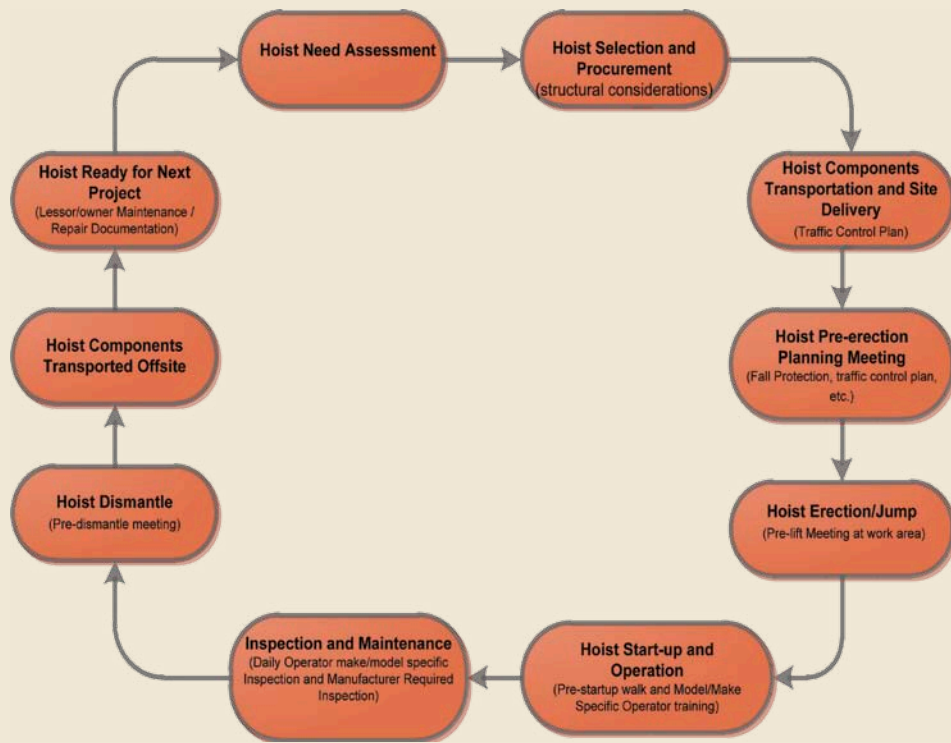
At this time, ANSI/ASSE A10.4 is not referenced in OSHA standards. However, contractors should recognize a key caveat to the compliance component. It is in contractors' best interest to have a written construction hoist safety program that at a minimum complies with ANSI A10.4.

In a March 27, 2006, interpretation letter, Russell Swanson, director of OSHA's Directorate of Construction, notes:

[T]he ANSI A10.4-2004 industry consensus standard has not been incorporated by reference into any OSHA construction standard. However, Section 5(a)(1) of the Occupational Safety and Health Act (the "General Duty Clause") requires an employer to furnish to its employees: "employment and a place of employment which are free from recognized hazards that are causing or are likely to cause

Figure 1

Construction Hoist Project Life Cycle



ing) and dismantling procedures; pertinent regulatory requirements; make-/model-specific inspection and maintenance procedures; make-/model-specific operator/user training; and emergency procedures. Beyond regulatory compliance, the two most important elements of a hoist safety program are the erection, alteration (jumping) and dismantling procedures, and operator training.

Hoist Erection, Alteration & Dismantle

A hoist must be erected, jumped, dismantled and operated in accordance with manufacturer's specifications and procedures. Ensuring the safety of construction workers and public during these processes is critical.

A preerection meeting should be held with all major stakeholders, including

hoist lessor/owner representative, hoist foundation contractor, erection company representative, crane operator or company representative, trucking company representative, project superintendent, site construction engineer, SH&E professional, electrical subcontractor and flagging company representative (if needed). Hoist selection and sizing must be preplanned and determined before this meeting and must be part of the project safety plan.

During the meeting, all stakeholders involved should identify tasks in sequential order, hazards associated with each task and controls. Just one stakeholder being proactive and safety conscious does not help the hoist to be erected, jumped or dismantled in a safe manner. All stakeholders should have a detailed written safety plan identifying critical elements of the task. Each stakeholder has critical elements to consider. Figure 2 presents a sample page of an actual checklist used during a preerection meeting.

All Stakeholders

- Confirm that the hoist meets project needs (e.g., building height, capacity).
- Obtain emergency contacts for all stakeholders.
- Ensure that all workers involved attend the site-specific orientation and have all required training associated with hoist erection/dismantle (e.g., fall protection, flagger certification, welding).
- Review the site plan to ensure that no underground or overhead services interfere with the work area.
- Hold a pretask meeting at the work area, with the entire erection/dismantle crew, before work commences.
- Review the emergency medical and rescue plan

The hoist itself introduces several hazards and exposures that must be mitigated during its life cycle on a project.

death or serious physical harm to his employees." Under the General Duty Clause, employers are responsible for taking feasible steps to prevent/correct a recognized serious hazard. ANSI or other industry consensus standards can be evidence that the industry recognizes a serious hazard associated with a particular area or work procedure and that there are feasible means of preventing/correcting it.

To the extent that ANSI A10.4-2004 addresses hazards that are not addressed in the regulatory text of Part 1926 Subpart N or in ANSI A10.4-1963, it would be evidence that the industry now recognizes such additional hazards and that there are feasible means of preventing/correcting them. If that were the case, it would indicate that the employer would have an obligation under the General Duty Clause to protect its employees from such hazards.

Hence, the contractor (employer) who rents or owns personnel hoists for use in construction activities would be required to comply with all applicable OSHA requirements, including those in 29 CFR Part 1926 Subpart N that pertain to personnel hoists and potentially the ANSI A10.4-2004 from a General Duty Clause standpoint. (OSHA, 2006a)

Construction contractors should have a written hoist safety program that exceeds regulatory requirements as part of their overall company safety manuals. This program should identify the program's objective; roles and responsibilities of different stakeholders; erection, alteration (jump-

during the meeting. Know what will be done if something goes wrong.

Hoist Erector

- The hoist erector/dismantler representative should submit a detailed lift plan for the contractor to review and approve before the preerection meeting.
- Review the erection/dismantle sequence during the meeting.
- Discuss the protection of the erection zone, with “danger tape and sign” to prevent the entry of unauthorized personnel (workers and public) into the work area.
- Establish a fall protection plan, and have the contractor and registered engineer identify and approve all tie-off points (Photo 2, p. 32).
- Implement fire prevention measures in case of hot work such as welding.
- Discuss how the public will be protected from welding exposure.
- Obtain FAA authorization if the work is close to airports or heliports for assist cranes.
- Ensure that the erection crew has been trained for make-/model-specific erection specifications.

Truck Representative/Flagging Company

Most high-rise buildings are near busy city streets. Therefore, temporary traffic control systems play a vital role in transporting components on and off a jobsite (Photo 3, p. 32). The goal is to positively and safely control vehicular traffic and minimize traffic disruptions. Vehicular traffic poses a great risk to construction employees working near streets.

The general contractor’s detailed traffic control plan should be reviewed by the trucking company and the erection/dismantle company, then submitted to the SH&E professional for approval. Several items should be addressed:

- Confirm whether a city-approved traffic control plan is required.
- The lessor/truck representative should ensure that all hoist components arrive at the jobsite in a safe manner.
- Address any potential traffic restrictions (e.g., time of day, local activities such as holidays). Determine whether any scheduled public activities around the erection/dismantle date will affect traffic control.
- Review the trucking route several days before the erection/dismantle to check for elements such as sharp corners, public interruptions and staging.
- Identify who owns and who will maintain temporary traffic control devices.
- Ensure that all flaggers have current flagger certification and are working under the supervision of a traffic control supervisor.

Crane Representative

The crane representative/operator plays a critical role throughout the process. The site tower crane is typically used to erect/dismantle a hoist. However, as noted, based on tower crane limitations, a mobile crane can be erected on site to install the hoist.

The crane representative/operator should consider several factors:

- Ensure that the ground is safe for the assist crane setup [underground (e.g., water lines) and overhead conditions (e.g., power lines)].
- Check weight of each load against load charts. Inform the crane operator of all load weights of mast sections, cars, etc.
- Check the outrigger footing on the mobile crane and plate adequately.
- Discuss the mobile crane assembly area. The discussion should cover crane certifications and inspection records; operator, riggers, signal personnel certifications; overhead or underground utilities (e.g., overhead power lines); ground conditions (e.g., soft soil); coordination with other trades working in the area; crane positioning with respect to the erection area; outrigger placement; pinch points with counterweights; access to trucks to unload crane components; and area congestion.

Figure 2 Sample Hoist Preerection Checklist

Sample Actual Meeting checklist.

CONSTRUCTION HOIST PRE-ERECTION SAFETY MEETING CHECKLIST

The individuals listed below should attend this meeting and be responsible for items discussed hereafter.

<input checked="" type="checkbox"/> Trucking Company Rep	<input checked="" type="checkbox"/> Hoist Erector Rep	<input type="checkbox"/> Crane Operator
<input checked="" type="checkbox"/> Project Superintendent	<input checked="" type="checkbox"/> Site Engineer	<input checked="" type="checkbox"/> Labor Foreman
<input checked="" type="checkbox"/> Safety Manager	<input checked="" type="checkbox"/> Traffic Control Rep	<input type="checkbox"/> Electrical Rep
<input checked="" type="checkbox"/> Lessor Rep	<input checked="" type="checkbox"/> Others <i>Crane Rep</i>	<input checked="" type="checkbox"/> Others <i>Site Superintendent</i>

All Parties

- Obtain emergency contacts for all parties, who do we contact in case of an accident
- Ensure that all employees attend the site orientation and have the required training (i.e. fall protection, flagger certification, etc.) *(Document submitted)*
- Discourage the use of cell phones when critical tasks are being performed.
- Consider if after hour security is needed for laydown area to protect against theft *No*
- Review site plan to be sure no underground services interfere with the area selected to position erection crane. *Reviewed, none.*
- Hold a brief Safety Meeting at the area the hoist is to be erected and share all information with the erection crew. Review your emergency plan during this meeting. *Yes. All parties to attend.*

Hoist Erector

- Review erection sequence.
- Inform Crane operator of all load weights and check for adequate load chart on erection crane. *Info from lessor*
- Provide critical lift plan (> 75% capacity) and reviewed by safety manager *(None)*
- If mobile Cranes are used check Mobile Crane outrigger footing (plate as necessary). *Yes, Steel plates.*
- Erection zone barricaded with “danger tape and sign” to prevent unauthorized personnel entry
- Fall Protection Plan is in place. Identify and approve appropriate tie off points *100' He. off*
- Erectors should make sure that all connection points are tight and that entire machine is in good working order and properly working according to manufacturer's specification *Certification from lessor.*
- All workers must wear hard-hats, reflective vests, and shoes adequate for construction site
- Fire prevention measures should be in place in case of hot work such as welding, cutting etc
- Use approved method to get onto or off of trucks while rigging loads. Use ladder, steps and etc. (Do Not Jump)

Truck Representative

- Drivers must wear hard-hats, reflective vests, and shoes adequate for construction site. *Speed limit 10mph on site unloaded.*
- Move trucks into position for unloading, remove tie downs and stay away from truck until it's unloaded.
- Any potential traffic restrictions (time of day, day of week, local activities such as holidays etc.) *None*
- Review the trucking route (sharp corners, public interruptions, staging, etc.). *Sharp corner @ N. Kerby Ave.*
- All special permits in place *Yes*

Crane Representative

- Ensure the ground is safe for crane setup: underground (e.g. water lines) and overhead conditions (e.g. power lines). Plate outriggers as necessary (mark areas to place outriggers). *Yes marked.*
- Check weight of each lift against load charts. *Yes, attached Crane Swing radius*
- Notify Superintendent of clear area needed to assemble erection crane.

** 55,000v power line on Groublein
* well marked with flags. 20' clearance!*

Page 1 of 2

Note. Used with permission from Hoffman Construction Co. of Oregon safety program. This is only part of the preerection meeting checklist.



- Inform the crane operator and oiler that they are responsible for ensuring that all involved in assembly/disassembly of the erection crane use all PPE and adhere to all safety precautions.
- Discuss the type of rigging that will be used, rigging owner, rigger and signaler qualification, and related topics (Photo 4).

- Inform the crane operator and oiler that they are responsible for ensuring that all safety devices are reinstalled and checked for proper operation.
- Conduct a final preoperation walkthrough with all parties involved to ensure safe operation of the hoist. Look for items such as hoistway protection, gaps between landing area and floors, and related issues.
- Ensure that bolt retorquing is scheduled per manufacturer specifications.
- Provide a make-/model-specific self-inspection checklist.
- Verify make/model operator training, including that for back-up operators (during breaks).

Photo 2 (top, left). Ironworkers installing the hoist mast sections in place with 100% tie-off. Photo 3 (top, right). A city street blocked off during a hoist dismantle operation. Photo 4 (above). Hoist mast dismantle in progress with an assist mobile crane.

Project Superintendent (General Contractor)

During construction hoist erection/dismantle, complacency is a concern. Crews may rush to complete a job, and the repetition of assembling and disassembling an erection crane as well as the hoist can lead to overconfidence and a failure to take necessary precautions. This is dangerous work and all involved must continuously watch for any and all hazards.

The superintendent must address several key elements.

- Discuss pedestrians (“sidewalk superintendents”) who may become curious about the construction activity and enter the work area to ask questions.
- Ensure that the hoist foundation is poured and finished per design, and has attained its required strength before hoist installation.
- Locate a travel path for trucks to give them the best route to/from the work area.
- At the safety meeting the week before work begins, inform workers where and when the assist crane will be assembled. Direct them to find an alternate route to avoid walking through this area.
- Ensure that electrical disconnect and power are available before work commences.
- Verify that the connection points between the hoist and the building are installed per the structural engineer’s approved design.
- When the erection team is finished, make sure all safeguards are working, including all floor in-

Hoist Operator Training Program

The next critical step is the safe operation of the hoist at the construction site. A hoist should be controlled by operators trained on hoist operation (general and make-/model-specific), inspection and maintenance.

Some employers have operators read the hoist operations and maintenance manual, then have them sign a form that states “read and understood the manual.” Although this form may satisfy regulations, these operators are being set up to fail. Most equipment operators will not read the manual and, therefore, will not have the knowledge to operate the hoist safely.

On several sites, to test compliance with “read and understood the operator’s manual,” business cards were inserted deep within manuals for aerial lifts and cranes with the note, “When you get this card call the safety department for a company jacket.” Not a single jacket was given out during this period. This reinforces the fact that simply having operators “read and understand” a manual is not an effective way to provide training.

Rental companies (lessors) and manufacturers were contacted to inquire about hoist operator training. Most did not have a training program, although some lessors had a multiday class at their shops that covered everything about a hoist. However, it often is not practical or economical to send operators to a manufacturer’s site because of factors such as cost, high turnover among operators that requires training several operators during a short period, and availability of training when it is needed (schedule).

The authors’ firm created its own short training



program that covers all major elements associated with hoist operation, inspection and maintenance. With guidance from in-house staff (experienced superintendents, SH&E professionals, operators and maintenance staff), insurance companies and the literature, a 45-minute PowerPoint presentation was developed. The training is based on manufacturers' manuals, OSHA regulations and ANSI/ASSE standards. It helps ensure that operators know the safe procedures to follow during daily operations and what to look for during daily inspections. Such training sets operators up for success. In addition, operators complete make-/model-specific training for each hoist to which they are assigned.

Training should be delivered by a qualified instructor, such as an SH&E professional, manufacturer/rental company representative and/or maintenance staff. The trainer should clearly communicate that safe hoist operation and inspection is the sole responsibility of the operators. In addition to operators, all workers should be briefed about hoist safety during new employee site-specific orientation.

Next, let's discuss critical issues to be addressed during hoist operation, inspection and maintenance. For SH&E professionals or company supervisors who perform site audits of hoist compliance, these items serve as a checklist. The elements highlighted are based on industry literature (CPA, 2004; 2006) and the authors' experience.

Daily Inspection

The operator should conduct a daily inspection using the hoist make-/model-specific checklist. A copy of the checklist should be maintained at the site at all times. If the hoist is older and does not have a model-specific inspection checklist, contact the lessor/manufacturer to see whether one is available.

If not, SH&E professionals and lessors can develop one. This checklist should then be sent to the manufacturer for review (although some manufacturers are no longer in business). Additionally, the project management team must read inspection reports and correct any deficiency noted.

An operator should not be allowed to handle or use the hoist before reading the operator's manual. During audits, ensure that operators are performing their inspections and that the operator's manual is kept in the car at all times.

Emergency

If an operator finds any defect (e.g., faulty interlocks, damaged structural items) during the daily inspection that poses an imminent risk, s/he should shut down and secure the hoist to prevent unauthorized personnel from operating it. The operator should then contact a supervisor or the designated technician to fix the defect prior to operation.

Hoistway Protection

All employees should stay clear of a moving car and counterweight (Photo 5). All activities (e.g., crane work, aerial lifts) performed near the hoist shall be coordinated with the operator.

In one incident, an employee was attempting to install exterior sheathing to the face of a building. At ground level, the employee had maneuvered and parked his scissor lift adjacent to the plywood safety barrier created at the base of the construction hoist. The employee elevated the scissor lift to his desired work height, then extended the platform so he could easily reach the work area in front of him.

The hoist operator, starting his normal operations for the day, looked up and noticed the scissor lift in close proximity to the hoist's mast. He traveled slowly upward and talked to the scissor lift operator, asking, "You in the clear?" (referring to the proximity of the counterweight). The response was "Yes" (this worker recognized the proximity to the hoist car, but apparently not the counterweight above). The hoist operator proceeded toward the top of the building. The hoist's counterweight traveling downward struck the scissor lift basket, causing extensive damage. The 6,000-lb counterweight missed striking the scissor lift operator by a matter of inches.

In this case, the employee, his supervisor and the operator failed to recognize the serious danger that exists near an in-service personnel hoist. Companies should direct all hoist operators to suspend all operations and report to their immediate supervisor whenever they deem people, equipment or materials to be in the hoist's safety zone. Before any work is allowed in the safety zone, the electrical system must be deenergized, locked and tagged out-of-service.

Structural Examination

During every inspection, the operator should examine load-bearing items such as masts, mast bolts,

Photo 5 (left). Construction hoist with hoistway protection on each floor. Photo 6 (right). Operators should maintain clear path during loading operations.

ties, fixing anchors, the load carrying device (load/platform) and the base support. The operator should ensure that no cracking or deformation has occurred and that no connections have become loose or been damaged. In the case of a large building, additional qualified individuals can inspect the connections. This inspection is critical because any structural failure can result in catastrophic incidents.

Material Handling

All loads transported in the hoist (e.g., drywall on carts) should be secured properly. Improperly secured loads can become dislodged easily during travel and pinch against users. Maintain a clear path during loading operations to avoid pinch-point/crush-point hazards (Photo 6, p. 33). Make sure users never exceed the hoist's loading capacity. Users should be required to provide calculated loads for materials and equipment transported in the hoist. Hoist operators must know they have the authority to refuse unsafe loads and that they will be held accountable if they do.

Operator Safety

When workers are loading large loads (tight-fit), the operator should stay clear from the load to avoid pinchpoint hazards between the load and the car. The operator should never help with unloading/loading because it is not part of their job function and they could be injured trying to help. An analogy would be a surveyor trying to help an ironworker lift a piece of I beam. Hoist users should provide enough personnel to safely load and unload their cargo.

Mechanical Inspection

The hoist operator should examine racks and pinions, drive drums, pulleys, gear boxes, transmission motors, brakes, guide rollers, drive shafts and emergency lowering system to detect undue wear or malfunction. When inspecting gears, check oil level and refill as necessary. Leaking seals must be replaced. All repair and maintenance must be performed only by manufacturer-approved representatives.

An operator also should inspect lubrication on racks, safety devices and the trolley system, and check the condition and function of cable guides, guide rollers and roller assemblies. The operator also should perform a detailed examination of wire ropes to identify broken wires, surface wear, excessive stretching, unequal rope tensions, variations in diameter, kinks, localized crushing, "birdcaging" (wire rope strands are forcibly untwisted and become spread outward) due to mispooling, and surface rust and corrosion.

For the counterweight (where applicable), the operator should check the cathead arrangement for possible wear and damage, and confirm that all screw joints are properly tightened.

Safety Devices

The operator must ensure that all emergency stop switches, the final limit switch and electric motor brakes are working. S/he also should check

all electrical interlocks by making test runs. In addition, the operator should check the function of control devices, alarm signal, lighting, automatic stop at landings, emergency light functions, and the condition and operation of the main isolator switch each day.

Housekeeping

All debris should be removed from the base enclosure, cage and roof floor. All landing areas should be free of materials/debris to prevent trip hazards.

Extreme Weather

A hoist must not be used when wind velocities exceed 40 mph. When velocity surpasses 20 mph, do not operate the lift past last tie-in. An operator also must know to not attach any materials to the inside of the car, such as plastic to protect against rain, since such materials increase the possible forces to the structure.

In case of storms, tornadoes, hurricanes or earthquakes, all of a hoist's vital parts must be inspected and tested by an expert or manufacturer-authorized representative before the hoist is used. Where icing can occur, the hoist should be parked at the ground landing upon completion of work. If the mast or power cables are covered with ice, remove ice before using the hoist.

Conclusion

A construction hoist safety program must be an integral component of a construction company's safety program. Failure to follow proper safety procedures during a hoist's life cycle on a project could cause injury, death or property damage. This exposure demands some needed attention. **PS**

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