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Hoist & Crane Safety from within: How to Prevent a Potentially Disastrous Incident

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Introduction

Crane-related injuries are often severe and pose a serious hazard for employees and operators – Crane-related fatal occupational injuries in the United States from 1997 to 2006 averaged 81.6 fatalities per year (BLS 2008). Despite the fact that there are a considerable number of regulations and standards as a reference to establish controls, Cummins, Inc. required an internal hoist & crane (H&C) safety strategy with specific selection of standards based on internal needs.

The general situation, in this case study, reflected operations where incidents started to occur at a frequency more than expected. Fortunately, incidents were associated mainly with near hits (no human injury) and a minority of incidents with minor injuries – e.g., collapse, overturning, or failure of lifting equipment. The monitoring of this proactive indicator laid the path to prevent catastrophic incidents with cranes, including fatalities.

The company ventured to develop a customized internal strategy, aimed at preventing hoist and crane related incidents sustained on the following elements: a) pre-defined training levels; b) custom-built inspection types; c) H&C design parameters and design of fundamental components; d) safe operation elements, and e) an internal rigging plan. This arrangement of in-house-designed hazard-control elements based on past crane-related incidents in the corporation (including near hits) translated into a robust strategy. Key experienced individuals were selected to participate and contribute in the development of the strategy.

How Training Impacts Prevention

The prevention of crane incidents is influenced by adequate and effective training. An analysis of crane incidents from OSHA public records concluded that in 70% of incidents, proper training could have prevented the consequence (Lang 2011). Internal incident analysis in the company concluded that concurrent root causes were associated with "safe operation" elements. As a result, four core levels of training were defined:

1. *Awareness level* training aimed at all employees who may be affected by the operation of hoist and cranes. Customized training content compiled with fundamental crane hazards awareness and basic hazard mitigation controls as key components.

2. *Management level* training focused on managers, supervisors and leaders at the site that influence decision-making processes on any crane aspect and/or the site safety program. Also, customized training with basic and technical content necessary to make informed decisions (i.e. crane types, uses and associated hazards).

3. *Operator level* training as designed in conventional programs (e.g., crane components, controls, operation, rigging and inspection) and mainly concentrated in overhead and/or floor cranes per the nature of the company manufacturing environment. Certification and a license-issuing operator program were also defined and implemented internally.

4. *Specialty level* training focused on special pre-defined circumstances associated with singular hazards and content delivered by a qualified contractor. The identified circumstances included: a) remote-operated cranes, b) cab-operated cranes, c) mobile cranes above 15000 pound capacity and 25ft boom length, d) tower cranes, e) day-to-day rigging decision-makers, and f) “critical” lifts as identified by the site (e.g., cranes subject to 80-100% of their capacity, hazardous chemicals, explosive/flammable material, windy environments, unusual load dimensions, etc.)

This training approach provided the framework to maintain employees engaged, leaders informed, operators qualified and special circumstances covered. Theoretical and practical training was a key component – the printed-license operator program demonstrated to be a robust system.

Custom-Built Inspections

The majority of regulations in different countries are prescriptive in the hoist and crane inspection elements. However, unique internal issues may not be inspected at the right level of detail to ensure incident prevention, and such aspects were added to regulation requirements.

The company experienced crane incidents related to rope, hook and sling failure. Inspection criteria was strengthened around these three components. As a result, the company re-designed the common inspection types:

- *Daily Inspection*. A visual and operational inspection by the operator of the hoist & crane at the beginning of the shift or when it is first operated each day.

- *Initial Inspection*. Detailed examination, by a qualified contractor, for new, altered and/or modified cranes before initial utilization. Predefined criteria were established with added elements, and it was also focused on internal incident trends.

- *Frequent Inspection*. Visual examination by an internal qualified party with frequency based on service classification (i.e., normal use - monthly, heavy use – monthly and severe use - weekly).

- *Periodic Inspection*. Detailed examination by a qualified contractor in which period is defined by service classification (i.e. normal and heavy service – yearly; severe service – quarterly).

The addition of internal inspection elements to regulatory requirements resulted in a more comprehensive inspection process. A key input for the identification of additional inspections elements (e.g. hooks, ropes and synthetic slings) was an effective crane incident management and analysis that unveiled trends on root causes – ASME B30.10 and ASME B30.26 were important references.

Guidance on Crane Selection and Design Parameters

Selection of the appropriate crane for the lifting need is important for an effective operator-crane interaction and the prevention of incidents. Only some regulations and standards worldwide offer information on this regard (e.g., ISO 23813). Essential points to evaluate before crane selection were defined in Table 1. In addition, guidance was provided for the “design safety factor” (ratio between nominal or minimum breaking strength and rated load capacity of the component) by establishing minimum values – or complying with local regulations if more stringent parameters apply.

Crane Selection Elements	Design Safety Factor
1. Masses, dimensions and characteristics of loads 2. Operational speeds, radius, heights of lifts and areas of movement 3. Number, frequency and types of lifting operations 4. Length of time for which the crane will be required or anticipated life expectancy for a permanently installed crane; 5. Site, ground and environmental conditions or restrictions arising from the use of existing buildings 6. Clearances to overhead electrical power lines 7. Space available for crane access, erection, travelling, operation and dismantling 8. Any special operational requirements or limitations imposed. 9. Physical condition of the crane.	Wire rope – 5 Steel chain – 4 Synthetic slings – 5 Load block – 4 Rigging hardware – 5

Table 1. Crane selection elements and Design Safety Factors (ISO 2007)

Safe Operation

As previously stated, effective training plays a key role in the prevention of incidents by performing an adequate operation of the crane and identifying potentially hazardous conditions—errors—while operating, which is the main root cause for company crane incidents. The principle "cranes should be operated with the expectation that the load (or components) could fall at anytime" was communicated as an operating guideline. This fact not only increased awareness but also facilitated the identification of general safe-operating rules, which have been related to incidents in general industry. Some rules defined were referenced to incidents which had occurred in the company.

Multi-hoisting (lifting loads with two or more cranes) safety criteria were improved with the following elements:

a. Qualified person shall be in charge of the operation
b. Placement of the hook in relation to the identified center of gravity is critical
c. Each crane load proportion shall be calculated
d. Multiple lifting should comply with ISO 12480-1 standard

Different regulations and standards offer safe operation guidelines (i.e., ASME, OSHA, CMAA, ISO, etc.). Communication, enforcement and adequate understanding by operators are essential for the prevention of potentially catastrophic incidents.

Internal Rigging Plans

Improper arrangement of rigging hardware could cause the load to drop and potentially result in injury and environmental or property damages. The most common root cause of load drops was poor rigging practices (59%) as stated by Lang (2011) in a recent study. Internal incident analysis also showed that the specific rigging hardware required special attention: hooks, wire ropes, and synthetic slings.

As a result, a rigging plan form was designed with general rigging elements but also with customized points that would ensure specific needs were addressed. Adequate rigging processes require the rigger to assess: a) the weight of the load and rigging hardware, b) the capacity of the crane, and c) the working load limit of the rigging hardware. This rigging plan focused on weight-capacity interaction between these three elements.

This form or rigging plan was designed to be completed by a qualified person – with the aid of operators and supervisors – on a periodic basis or sooner if the rigging arrangement required modification. See Table 2.

Rigging Lift Plan

PART A – General Information

Document Number:		**Prepared by:**		**Date:**	

Load(s) description *(insert lines as needed)*

#	Load description	Weight	Material	Symmetrical (Y/N)	Center of gravity identified? (Y/N)	Load share (when center of gravity is side-tilted)	Rigid or flexible (R/F)	Tag line used (Y/N)	Edge Softener /Pads (Y/N)	Observations

Precautions and limitations:-	Ensure that rigging hardware, cranes, hoists, and other lifting equipment are never loaded beyond their rated capacity. It shall not be assumed that a multi-sling hoist will safely lift a load equal to the rated capacity of one sling multiplied by the number of slings. With lifts of more than two slings and a rigid load, two of the slings alone could be bearing the full load while the other slings merely balance it.

Lifting Equipment Information

Lifting Equipment (Crane) ID/ Description:		**Rated Capacity (specify units):**		**Location:**	

Manufacturers' Instructions, scheduled inspections documentation, and Rigging Capacity Card available at the point of use (please circle)	**Yes**	**No**

Lifting Equipment analysis *(insert lines as needed)*

Lifting items	**Description /Type**	**Size**	**Quantity**	**Length (Slings)**	**Horizontal Angle**	**Sling mode (Vertical, Choker or Basket)**	**Rated capacity**	**Calculated sling load/share**	**Design safety factor**	**Observations**
Slings - Wire rope, chain, synthetic OR other										
Hooks										
Shackles										
Turnbuckles, eye bolts, eye nuts, swivel hoist										
Links, rings and swivels										
Rigging Block										
Wire rope clips, wedge sockets.										
Below the hook devices										

Lift Plan Approvals

Lead Crane operator		**Signature**		**Date**	
Foreman/ Supervisor		**Signature**		**Date**	
Qualified Rigging Approver		**Signature**		**Date**	

Lift Plan Review Dates

Released date		**1st Year Review**		**2nd Year Review**	
3rd Year Review		**4th Year Review**		**5th Year Review**	

Table 2. Rigging Lift Plan.

Conclusions

Statistics show that crane accidents are more likely to cause injuries and/or deaths than most other types of equipment (Howell 2007). Hence, the importance of focusing on crane incidents (near hits) before human injury occurs should trigger the strategy to prevent potentially disastrous events.

Each implemented element of this strategy posed advantages at different levels. The augmented training content at the defined levels (awareness, manager, user and specialty) provided the framework for informed employees at all levels in the organization. The re-designed inspection types (i.e., daily, frequent. and initial/periodic) strengthened the verification processes. Moreover, the addition of crane selection criteria and design parameters increased knowledge for a more informed decision-making processes. Finally, an innovative approach in ensuring all rigging hardware met capacity requirements was sustained in an auditable-documented plan that helped fill verification gaps for below-the-hook devices.

All the elements in this strategy are complemented (and exceed in some cases) by local regulations in different countries. In addition, the elements create an environment to prevent H&C hazards that could potentially result in serious incidents. This model is the result of a selected team of subject-matter experts within the company and a comprehensive review of national and international standards.

Main strategy outcomes:

1. Reduced monthly average of crane-related incidents (near hits) at 116 manufacturing and distribution sites worldwide
2. Strengthened the operator and manager training and in general raised H&C safety awareness among general employees
3. Improved and customized inspection processes based on corporation's needs
4. Innovated below-the-hook or rigging evaluation plans aimed at reducing hardware capacity failures and revised/audited in an annual basis.
5. Designed collectively a thoughtful strategy, leveraged on cross-functional teams, based on internal needs and company-based approaches.

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