NJ FACE

INVESTIGATION REPORT

Fatality Assessment & Control Evaluation Project

FACE 05-NJ-099 **April 6, 2009**

Crane Failure Kills Worker at Scrap Metal Recycling Yard

A crane boom at a scrap metal recycling yard collapsed onto a 41-year-old male worker as a result of a structural failure within the crane, resulting in the worker's death. Three other workers were injured during this incident, which occurred at approximately 4:30 am on November 24, 2005. The exact age of the crane was unknown, but it was at least 20 years old. The crane was used to extricate large metal pieces that jammed the hammer mill, a machine that shreds vehicles (e.g., cars, buses, trucks, vans), appliances, and other large metal objects received for scrap recycling. These metal pieces have variable shapes and weights. The weight of these pieces is not easily estimated, and therefore makes a determination of the load lifted by the crane difficult to assess. Additionally, the practice of "jogging" the crane during attempts to free jammed materials in the mill resulted in indeterminate loads being exerted on the crane boom. Difficulty in assessing the load possibly resulted in weights that exceeded the recommended maximum load capacity for the crane and, over time, resulted in small structural stress fractures in the crane pole assembly. This may have contributed to the eventual fracturing of the boom assembly that resulted in the crane failure and collapse. NJ FACE investigators recommend following these safety guidelines to prevent similar incidents:

- **Develop and adhere to a site-specific crane safety program based on Occupational Safety and Health Administration (OSHA) regulations and National Institute for Occupational Safety and Health (NIOSH) guidelines.**

- **Develop a critical lift plan and have it reviewed by a professional engineer who specializes in hoisting operations.**

Jon S. Corzine
Governor

Public Health Services Branch
Division of Epidemiology, Environmental and Occupational Health
Occupational Health Service
Occupational Health Surveillance Program
(609) 984-1863
www.nj.gov/health/surv/index.shtml

NEW JERSEY DEPARTMENT of HEALTH and SENIOR SERVICES

Heather Howard
Commissioner

- **Ensure that crane operators are trained to follow all OSHA regulations and NIOSH guidelines regarding the safe use of cranes.**

- **Ensure that all crane operators have received model-specific training on the cranes they operate, and that they demonstrate proficiency in the operation of the crane.**

- **Routinely inspect cranes for operational safety and structural integrity. Maintain a preventative maintenance log. Follow all manufacturer's instructions and recommendations for inspection and maintenance.**

- **Use modern safety devices, such as load-moment indicators (LMIs) on all cranes, and retrofit old cranes with such devices to prevent exceeding the maximum critical load.**

- **Develop a change-out schedule for cranes and/or their structural components to ensure their continued integrity and safety.**

- **Ensure that load charts are placed at the location of the crane operator and that these charts are understood and followed by the crane operator.**

- **Crane operators should be cognizant of co-workers at all times when operating cranes.**

- **Ensure that all crane operators follow boom loading specifications and be cognizant of boom dynamics at all times when operating cranes. Side loading and shock loading should be avoided.**

INTRODUCTION

The incident occurred at a scrap metal recycling and shipping facility located in a major city in New Jersey. The parent company employed 1,800 workers; 65 employees worked at the New Jersey site. This company was a scrap metal recycler that shredded vehicles (e.g., cars, buses, trucks, vans), appliances, and other large metal objects. They also removed copper wiring from electrical generators for copper recovery. Employees at the location of the incident were represented by a labor union.

Material to be shredded was brought in to the recycling facility through a dedicated entry point, where the material was weighed and scanned for radioactivity. The bulk metal products were then added to a conveyor that feeds a 4,000 horsepower hammer mill equipped with approximately thirty 300-pound hardened magnesium-alloy hammers that spin at approximately 100 miles per hour to completely shred the material into small pieces. The outdoor hammer mill processed approximately 100-150 tons of material per hour and operated 24 hours per day on two shifts, 6 days of the week. Scrap metal that was being shredded occasionally jammed in the hammer mill, approximately one to two times per 8-hour shift, requiring that a crane be used to extricate these jammed pieces of material from the mill.

After shredding, the material was sorted into piles of ferrous metal, non-ferrous metal, and non-metal material (e.g., foam from car seats, plastic, etc). The shredded material was scanned again for radioactivity before being packaged for shipment. The shredded ferrous and non-ferrous metals were then packaged into cargo shipping containers and/or onto boats for delivery to secondary smelters throughout the world. These smelters then melted the shredded metal pieces in electric arc furnaces, added various ingredients necessary for the alloys they are produced, and then shipped the reformed metal to various users throughout the world.

INVESTIGATION

The crane failure that resulted in the death of one employee and injury of three others occurred at approximately 4:30 am on November 24, 2005, while attempting to use a crane to remove jammed material from the hammer mill. The outside temperature was approximately 36°F, wind speeds were approximately 5 miles per hour West South West, and there was light precipitation with a rain and snow mix. The precipitation was 0.03” in the four hours prior to the accident and there was no snow accumulation. However, weather and visibility did not appear to be a factor in this incident.

The employees involved in this incident were following the typical procedure for removing jammed metal and other material from the hammer mill when the accident occurred. This standard procedure was used if attempts to free the jam by "jogging" the crane were unsuccessful. The standard procedure for removing jams from the hammer mill are listed below in the order that they would be performed.

1. The hammer mill is turned off, electric systems are locked out, and the hammer mill is opened to expose the shaft that swings the magnesium hammers.
2. A welder climbs into the hammer mill chamber and uses an oxyacetylene torch to cut away the jammed metal.
3. A crane operator extends the boom of the crane into position with the help of the foreman and spotter (i.e., laborer) who communicate with the welder.
4. The welder attaches the crane hook to the metal pieces that are cut loose and the crane is used to pull the metal pieces out of the hammer mill.
5. The crane is also used to remove and replace, if necessary, any damaged or worn hammers.
6. The welder climbs out of the hammer mill, the crane boom is withdrawn, the hammer mill chamber is closed, and the system is re-energized.

The pole assembly that supports the boom of the crane fractured during this fatal incident and allowed the boom to fall onto the welder who was inside the hammer mill, pinning him against the wall of the mill chamber and crushing his torso. The victim was still alive at the plant immediately after the accident, but was later pronounced dead at the hospital from traumatic chest injuries. The victim had been working for the company for seven years at the time of the accident. Three other employees were injured during the incident: the foreman fell down the stairs of the platform, the crane operator incurred a shoulder contusion, and a laborer received a concussion when he fell on the platform as the crane collapsed.

The crane that failed was more than 20 years old and was originally designed to be mounted on a truck; the manufacturer is no longer in business. There was no preventative maintenance log for the crane, employees did not recall any previous problems, and company records that were available did not list any previous problems with the crane. At the recycling facility, the crane was permanently mounted to the ground in a stationary position. The crane, which had a 45-foot-long boom, was tether-operated by an operator stationed on a platform adjacent to the hammer mill. The load rating in the crane manual lists a maximum load capacity at full boom extension of 7,000 pounds. There were no obvious signs of a load chart present at the crane location or on the failed crane at the time of the FACE site visit, and interviewed employees were not aware of the critical need to be observant of load weights put on the crane.

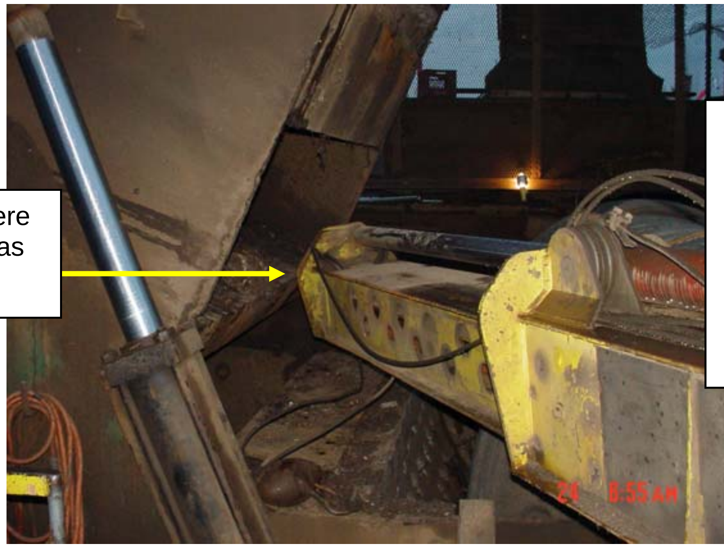

Figure 1 - Crane boom collapsed onto worker within chamber of hammer mill. The fallen crane boom crushed the employee against the hammer mill chamber's interior surface.

The pole assembly of the main crane support fractured with a fairly clean break (Figure 2). This was interpreted by the company safety engineers and OSHA inspectors as suggesting that small stress fractures occurred over time leading to the failure that resulted in the collapse. Routine inspections of the crane might not have identified these stress fractures because the internal support cylinder (referred to as the post assembly in the crane manual) could not be observed without complete disassembly of the crane.

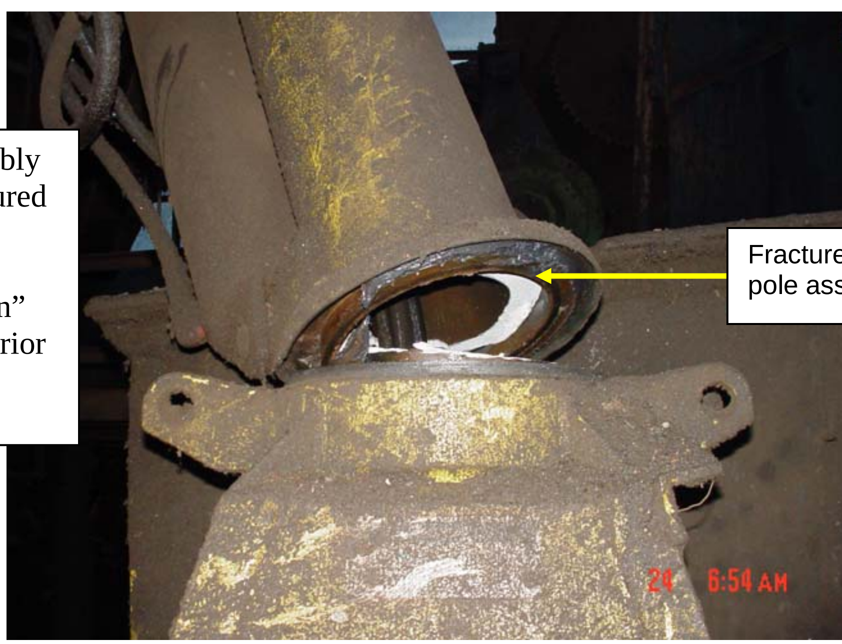

Figure 2 - Pole assembly of crane support fractured and resulted in the collapse of the crane boom. Note the "clean" break and that the interior of the break was not corroded by rust.

A lack of understanding and control of the crane's load limits was probably a significant contributing factor to the crane failure. The procedure followed to remove jams from the hammer mill did not allow for a means to determine the force and load exerted on the crane, potentially giving rise to situations where the rated maximum load capacity of the crane was exceeded. Over time, the structural integrity of the crane deteriorated, resulting in its eventual failure.

RECOMMENDATIONS/DISCUSSIONS

Recommendation #1: A site-specific crane safety program should be developed and adhered to, which is based on Occupational Safety and Health Administration (OSHA) regulations and National Institute for Occupational Safety and Health (NIOSH) guidelines.

Discussion: A crane safety program is a critical element of any operation that uses a crane because it encourages a systematic evaluation of hazards associated with crane use. Both regulations and official government recommendations should be incorporated into the formal crane safety program. OSHA standards that apply to cranes and derricks can be found in 29 CFR 1910 Subpart N and Subpart S, and 29 CFR 1919 (See Appendix). The OSHA standards are legally enforceable by OSHA and non-compliance could result in citations and fines. In addition, useful guidelines that should be incorporated into the crane safety program can be found in the NIOSH Alert: *Preventing Worker Injuries and Deaths from Mobile Crane Tip-Over, Boom Collapse, and Uncontrolled Hoisted Loads* (See Appendix).

Recommendation #2: A critical lift plan should be developed and reviewed by a professional engineer who specializes in hoisting operations.

Discussion: NIOSH defines a "critical lift" as any hoisting operation where the risk of injury is elevated due to unique characteristics about the hoisting operation or the work site. NIOSH guidelines, which are cited above and included in the appendix, recommend considering any situation where a worker is under or near a crane load as a critical lift. Critical lifts are of particular concern because of the catastrophic consequences that can result from a failure, as was the case in this incident. Critical lifts should be avoided when possible. When it is not possible to avoid performing a critical lift, NIOSH recommends taking extra precautions. In addition, OSHA has specific requirements for critical lifts, including the implementation of a critical lift plan that is reviewed by a professional engineer who specializes in hoisting operations. OSHA regulations and NIOSH recommendations that are cited in this report should be carefully reviewed when planning for critical lifts.

Recommendation #3: Crane operators should be trained to follow all OSHA regulations and NIOSH guidelines regarding the safe use of cranes.

Discussion: Training and motivating workers to use safe practices that comply with OSHA regulations and NIOSH recommendations is important. Workers need solutions that are practical and they must also understand how to implement safe practices. Understanding the potential consequences of accidents will provide motivation for employees to use safe practices. Training should include case studies of actual accidents, their consequences, and how they could have been prevented.

Recommendation #4: Crane operators should receive model-specific training on the cranes they operate.

Discussion: Crane operators should be trained on the safe operation of the specific crane being used. Model-specific training for the crane should be incorporated into worker safety training, and should include a discussion on the load limitations of the crane and methods to minimize stresses on the crane components.

Recommendation #5: Cranes should be routinely inspected for operational safety and structural integrity. A preventative maintenance log should be maintained. All manufacturer's instructions and recommendations for inspection and maintenance should be followed.

Discussion: A routine inspection and maintenance schedule is necessary to identify and correct problems with cranes prior to the development of crane damage or wear. The inspection and maintenance of cranes should be documented, and cranes that have an unusually high rate of repairs may require special attention as this might indicate that a serious problem is developing.

<u>Recommendation #6</u>: Modern safety devices, such as load-moment indicators (LMIs), should be used on all cranes to prevent exceeding the maximum critical load.

<u>Discussion</u>: A critical safety parameter for the safe operation of cranes is the maximum critical load, defined as the total weight that a crane can lift under given operational conditions. This is specified by the crane manufacturer and should be carefully followed during all lifts. In particular, crane operators must understand the importance of not exceeding 75% of the maximum rated critical load that can be lifted by a crane. The load lifted by cranes must be accurately determined and lifts should allow for some margin of uncertainty in estimating the load weight. LMI devices allow for the operator to estimate the load weight being pulled by the crane during its operation and therefore greatly enhance the operator's ability to avoid exceeding the maximum critical load of the crane.

<u>Recommendation #7</u>: A change-out schedule for cranes and/or their structural components should be developed to ensure their integrity and safety.

<u>Discussion</u>: This fatal incident involved a crane that was over 20 years old. The age and wear on the crane likely played a role in this crane failure. Cranes handle heavy loads by the very nature of their use and will experience wear from structural stress. Replacing older cranes will eliminate stress and wear problems that are not identified during routine inspections and maintenance. New cranes should have modern safety devices, such as LMIs, incorporated into their design.

<u>Recommendation #8</u>: Load charts should be placed at the location of the crane operator and the charts should be understood and followed by the crane operator.

<u>Discussion</u>: Operators must know how to read and understand load charts to ensure that they do not pull loads that are beyond the recommended capacity of the crane. Crane operators must also understand the importance of not exceeding 75% of the maximum rate load capacity of the crane they operate. A plan must be developed and evaluated by an engineer trained in hoisting operations to determine the proper course of action for operators when they can not determine the forces exerted on the crane.

<u>Recommendation #9</u>: Crane operators should be cognizant of co-workers at all times when operating cranes.

<u>Discussion</u>: The boom was extended during this fatal accident and the location of the boom upon extension was directly over the fatally injured worker. Crane operators and other workers in the area must understand and be aware of the boom movement and respond appropriately when the boom is moved above workers. Workers should move away from the boom if they do not need to be under the boom during operations.

<u>Recommendation #10</u>: Crane operators should follow boom loading specifications and be cognizant of boom dynamics at all times when operating cranes. Side loading and shock loading should be avoided.

<u>Discussion</u>: Crane operators must also understand, as the boom is extended, the critical maximum load that can be lifted with the crane decreases. In addition, side loading and shock loading decrease the rated capacity of the crane and add wear to the crane's structural parts. Side loading occurs when the crane pulls a load that is not directly under the boom tip. Shock loading occurs during sudden stopping, rapid acceleration, sudden load release, and sudden load snatching.

APPENDIX

RECOMMENDED RESOURCES

It is essential that employers obtain accurate information on health, safety, and applicable OSHA standards. NJ FACE recommends the following sources of information which can help both employers and employees:

Specific Crane Resources

OSHA regulations 29 CFR 1910 subpart N and Subpart S and 29 CFR 1919. These standards can be viewed on-line at http://www.osha.gov/SLTC/cranehoistsafety/standards.html.

NIOSH Alert, *Preventing Worker Injuries and Deaths from Mobile Crane Tip-Over, Boom Collapse, and Uncontrolled Hoisted Loads* (NIOSH Publication Number #2006-142, September 2006; Cincinnati, OH). Order via telephone at 1–800–356–4674, Fax @ 513–533–8573, E-mail at pubstaft@cdc.gov, or visit the NIOSH Web site at www.cdc.gov/niosh. This document can be found at the following link as of the date of this report's publication:
http://www.cdc.gov/niosh/docs/2006-142/pdfs/2006-142.pdf

U.S. Department of Labor, Occupational Safety & Health Administration (OSHA)

Federal OSHA will provide information on safety and health standards on request. OSHA has several offices in New Jersey that cover the following counties:

☏ Hunterdon, Middlesex, Somerset, Union, and Warren counties....................732-750-3270
☏ Essex, Hudson, Morris, and Sussex counties..973-263-1003
☏ Bergen and Passaic counties..201-288-1700
☏ Atlantic, Burlington, Cape May, Camden, Cumberland, Gloucester,
Mercer, Monmouth, Ocean, and Salem counties..856-757-5181
💻 Web site: *www.osha.gov*

New Jersey Public Employees Occupational Safety and Health (PEOSH) Program

The PEOSH Act covers all NJ state, county, and municipal employees. Two state departments administer the Act; the NJ Department of Labor and Workforce Development (NJDLWD), which investigates safety hazards, and the NJ Department of Health and Senior Services (NJDHSS) which investigates health hazards. PEOSH has information that may also benefit private employers.

NJDLWD, Office of Public Employees Safety

☏Telephone: 609-633-3896

💻 Web site: *www.nj.gov/labor/lsse/lspeosh.html*

NJDHSS, Public Employees Occupational Safety & Health Program

☏Telephone: 609-984-1863

💻 Web site: *www.state.nj.us/health/eoh/peoshweb*

On-site Consultation for Public Employers

☏Telephone: 609-984-1863 (health) or 609-633-2587 (safety)

💻 Web site: www.*state.nj.us/health/eoh/peoshweb/peoshcon.htm*

New Jersey Department of Labor and Workforce Development, Occupational Safety and Health On-Site Consultation Program

This program provides free advice to private businesses on improving safety and health in the workplace and complying with OSHA standards.

☏Telephone: 609-984-0785

💻 Web site: *www.nj.gov/labor/lsse/lsonsite.html*

New Jersey State Safety Council

The New Jersey State Safety Council provides a variety of courses on work-related safety. There is a charge for the seminars.

☏Telephone: 908-272-7712.

💻 Web site: *www.njsafety.org*

Internet Resources

Other useful Internet sites for occupational safety and health information:

CDC/NIOSH - *www.cdc.gov/niosh*

USDOL Employment Laws Assistance for Workers and Small Businesses - *www.dol.gov/elaws*

National Safety Council - *www.nsc.org*

NJDHSS FACE reports - *www.nj.gov/health/surv/face/index.shtml*

CDC/NIOSH FACE - *www.cdc.gov/niosh/face/faceweb.html*

REFERENCES

Job Hazard Analysis. US Department of Labor Publication # OSHA-3071, 1998 (revised).

USDOL, OSHA/OICA Publications, PO Box 37535, Washington DC 20013-7535.

Fatality Assessment and Control Evaluation (FACE) Project
Investigation # 05-NJ-099

Staff members of the New Jersey Department of Health and Senior Services, Occupational Health Service, perform FACE investigations when there is a report of a targeted work-related fatal injury. The goal of FACE is to prevent fatal work injuries by studying the work environment, the worker, the task, the tools the worker was using, the energy exchange resulting in the fatal injury, and the role of management in controlling how these factors interact. FACE gathers information from multiple sources that may include interviews of employers, workers, and other investigators; examination of the fatality site and related equipment; and reviewing OSHA, police, and medical examiner reports, employer safety procedures, and training plans. The FACE program does not determine fault or place blame on employers or individual workers. Findings are summarized in narrative investigation reports that include recommendations for preventing similar events. All names and other identifiers are removed from FACE reports and other data to protect the confidentiality of those who participate in the program.

NIOSH-funded state-based FACE Programs include: California, Iowa, Kentucky, Massachusetts, Michigan, New Jersey, New York, Oregon, and Washington. Please visit the NJ FACE Web site at *www.nj.gov/health/surv/face/index.shtml* or the CDC/NIOSH FACE Web site at *www.cdc.gov/niosh/face/faceweb.html* for more information.

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Daniel Lefkowitz, PhD
FACE Project Coordinator
Occupational Health Surveillance Program

James Blando, PhD
FACE Investigator
Occupational Health Surveillance Program

Donald Schill, MS, CIH
Research Scientist
Occupational Health Surveillance Program

David Valiante, MS, CIH
Program Manager
Occupational Health Surveillance Program

Gary Ludwig, MS
Director
Occupational Health Service