

Factory Worker Dies After Fall From Collapsing Scaffold

DATE: December 17, 1993

SUMMARY

On Sunday, March 14, 1993, a 35 year-old foundry worker was killed when he fell 35 feet from a collapsing scaffold. The worker was involved in the process of relining the interior of an iron-melting furnace (cupola), a process referred to as rebricking. The scaffold was improperly connected to temporary anchors (tack-welded washers) which were not intended for the purpose of suspending the scaffold. At least one of these anchor points failed under the weight of the scaffold and its load, causing the scaffold to collapse and the worker to fall to his death. Two co-workers, also working on the scaffold, were uninjured because they were able to grab on to an independently suspended lifting cage to prevent themselves from falling. NJDOH FACE investigators concluded that, in order to prevent similar incidents in the future, the following safety guidelines should be followed:

- 1. Develop and implement a standard operating procedure for erecting the scaffold and performing the cupola rebricking process.**
- 2. Provide personal fall protection equipment and require its use by all workers on the scaffold.**
- 3. Conduct training on the scaffold erection and rebricking process; and require a demonstration of competence.**
- 4. Inspect the scaffold, scaffold components, and personal fall protection equipment before each use.**
- 5. Instruct welders to remove the tack-welded washers from the cupola wall when no longer needed.**

INTRODUCTION

On March 16, 1993, NJDOH FACE personnel learned about this work-related fatality from a newspaper article. Communication with company officials was initiated on March 17. The company agreed to participate in the FACE project on July 12 and a site visit was conducted on July 16, 1993. Information for this report was derived from the police report, medical examiner's report, discussions with company personnel, and the OSHA file.

Because of the length of time between the fatality and the site visit, we were unable to observe the original scaffold and suspension assemblies. The employer had already initiated engineering controls to prevent a reoccurrence of a similar incident. At the request of the employer, no photographs were taken.

The employer is a manufacturer of cast iron products. They have been in business for over 100 years and currently employ 250 workers. The company had a safety and health committee composed of union and non-union personnel and a full-time safety director.

The victim, who was one of two cupola chargers, had been employed for about ten years by the company and was a union member. At the time of this incident, he was working on a weekend as a general laborer to complete the rebricking operation.

The company did not provide specific training for the rebricking operation. The standard operating procedure (SOP) was reportedly being developed for this relatively new operation during the course of initial rebricking operations.

INVESTIGATION

BACKGROUND

The site of the fatality was the inside of a cupola, which is a large vertical cylindrical furnace used to produce molten iron from a charge of coke, limestone, and scrap iron. The cupola is rated at 70 tons per hour and is approximately 100 feet tall with four main levels. The lowermost level, or ground floor, is a hard packed dirt floor where the waste products from a melt are collected and removed. The drop floor is 28 feet above the ground floor and is a hinged door upon which the charged materials rest during the melting process. (The drop floor was open at the time of the incident as it usually is during certain cleaning and maintenance activities, such as rebricking). The charge floor, located 30 feet above the drop floor (or 58 feet above the ground floor), is where the raw materials are loaded into the cupola (See Figure 1). The uppermost level is the service deck which is 42 feet above the charge floor (or 100 feet above the ground floor).

The inner walls of the cupola are lined with refractory bricks to a height of approximately 16 feet above the drop floor. After a period of about six weeks, the brick lining is worn and deteriorated and must be replaced with new bricks and mortar after the old lining is removed and the surface is cleaned. The cleaning and rebricking is done in a few days so that manufacturing operations can be resumed. The process of lining the cupola with refractory bricks was a change in the company's procedure. Previously, the cupola relied on a water-cooled jacket instead of a brick lining, which allowed only two weeks of operation. The original bricking was done six weeks prior to the fatality; rebricking was being done for the first time.

The suspended scaffold from which the men worked was made of four identical aluminum sections that, when joined together, resembled the shape of a ring. The scaffold sections were bolted together to create a continuous circular working platform 30 inches wide, with a center opening 40 inches in diameter (See Figure 2). Removable guard rails protected workers from falling into the center opening. The cylindrical wall of the cupola protected them from falling over the outer edge.

Workers reached the scaffold via a lifting cage, a round semi-enclosed platform suspended by a cable and powered by an overhead electric winch located at the service deck. The lifting cage was operated by a worker who controlled the winch and raised or lowered it according to instructions from the workers below. The lifting cage was 36 inches in diameter and was designed to pass through the center opening

of the suspended scaffold. Once in position, materials and personnel could be transferred from the lifting cage to the scaffold.

In order to accomplish the rebricking process, the scaffold had to be able to be positioned at two heights, six feet and twelve feet above the drop floor. Working at these heights, as well as at the surface of the drop floor, the workers were able to reach all the surfaces necessary to line the cupola with bricks. The scaffold was raised and lowered by using the lifting cage and its electric hoist. In order to raise the scaffold, the lifting cage was first lowered through the center opening of the scaffold so that the cage floor was below the scaffold floor. Then, two pieces of lumber (such as 2 X 4s), were positioned on the floor of the lifting cage so that their ends extended beyond the center opening of the scaffold. Thus, when the cage was lifted by its hoist, the ends of the lumber caught the bottom of the scaffold and carried it upwards along with the lifting cage.

The scaffold was suspended by four scaffold support assemblies, each comprised of two attachment lugs, two shackles, a chain, a hook, and a steel loop (See Figure 3). Four steel wall attachment lugs were welded to the interior wall of the cupola at a height of approximately 17 feet, and located at 90 degrees from one another. The scaffold had steel loops attached by shackles at four 90 degree positions along its outside edge. Four lengths of chain, each fitted with a shackle at one end and a hook at the other end, were used to suspend the scaffold from the wall attachment lugs inside the cupola. To locate the scaffold at its lower position, each shackle of the support assembly was attached to one of the welded wall lugs and each hook was connected to a corresponding loop at the outer edge of the scaffold (See Figure 3A). To locate the scaffold at its upper position the scaffold was lifted, as described above, and the hook end of each support assembly was passed through the corresponding ring of the scaffold so that the chain was essentially doubled along half its length (See Figure 3B). The platform was then secured at this position by connecting each hook to the corresponding shackle that was attached to a wall lug.

INCIDENT

On the day of the fatality, two night shift workers had spent several hours cleaning the furnace wall, preparing for rebricking. They worked from the suspended scaffold and started laying bricks around 4 a.m. One worker loaded the lift and sent supplies to them. With the change of shift at 7 a.m., the two workers continued to work on the scaffold and sent the service cage down to the dirt floor of the furnace for the victim who had just started his shift. He loaded the lift with bricks and mortar and rode it up to the working area. It is not known if he was to assist with the bricking or if his job was to assist with supplies. The three men, standing on the scaffold, had almost finished unloading the supplies and placing them on the scaffold when it collapsed. The victim and half of the scaffold fell 35 feet to the hard packed dirt floor below. The other sections stayed in place. The victim's co-workers were able to save themselves by grabbing and getting into the lifting cage. Although co-workers administered cardio-pulmonary resuscitation (CPR), the victim died at the scene.

A key factor which contributed to the cause of the incident was the presence of four large washers, each of which was tack-welded next to a support lug (See Figure 3). These washers were not intended to support the weight of the suspended scaffold. The purpose of the washers was to enable the welders to more easily weld the wall attachment lugs into place. Because the welders were in a 36 inch diameter cage, they needed to position themselves closer to the cupola wall in order to weld the attachment lugs. To do so, they reached out from the cage to the wall and tack-welded a washer near where they wanted to weld an attachment lug. They then attached a rope to the washer and pulled the cage closer to the wall

so that they could more effectively weld the attachment lug to the wall. When they completed this operation for all four lugs, they allowed the washers to remain in place where they had been tack-welded. Then, when the workers performing rebricking were repositioning the scaffold to its higher position, the worker responsible for connecting the hooks of the chain assemblies connected the hooks to the washers instead of the shackles attached to the wall lugs (See Figure 3C). As the weight on the platform increased when bricks, mortar and a third man were loaded onto it, the welds on at least one of the washers failed, causing the scaffold to collapse.

None of the workers wore independent fall protection in the event of the failure of the scaffold system. The bearing weight capacity of the scaffold is unknown. The scaffold, at the time of its collapse, was loaded with bricks, pails of mortar, and three men.

CAUSE OF DEATH

According to the medical examiner, death was caused by multiple trauma due to a fall.

RECOMMENDATIONS/DISCUSSIONS

Recommendation #1: Develop and implement a standard operating procedure (SOP) for erecting the scaffold and performing the cupola rebricking process.

Discussion: At the time of this incident, during the first rebricking, the SOP was being developed. It is necessary that an SOP for any process that requires working from a suspended scaffold be developed and implemented prior to workers starting such a task.

Recommendation #2: Provide personal fall protection equipment and require its use by all workers on the scaffold.

Discussion: In this incident, workers had no protection against a fall when their scaffold collapsed. Fall protection systems should be independent of the surface the workers men are on. Using harnesses attached to retrieval lines and hoists would have afforded protection as well as rescue capabilities. The company reportedly has initiated a fall protection program with their new lifting cage system, following this fatal fall. Each fall protection system must be evaluated for appropriateness and capabilities, including the characteristics of the workers who will use it.

Recommendation #3: Conduct training on the scaffold erection and rebricking process; and require a demonstration of competence.

Discussion: No organized training program existed for the rebricking and scaffold erection. Workers who will be carrying out these procedures should be thoroughly familiar with correct procedures and processes. A training program, conducted by an individual knowledgeable about the scaffold, the

rebricking, and fall protection, should be given to each involved worker. Their competence should be evaluated before they are allowed to proceed with the rebricking or work from a suspended scaffold.

Recommendation #4: Inspect the scaffold, scaffold components, and personal fall protection equipment before each use.

Discussion: The employer should require a competent person to inspect the scaffold, its components, and fall protection devices for defects before each shift or planned time of use. Detection of any visible defect should result in that equipment immediately being removed from service. Workers should also be trained to evaluate the scaffold, its components, and fall protection. This would foster greater safety awareness and compliment the inspection done by the competent person.

Recommendation #5: Instruct welders to remove the tack-welded washers from the cupola wall when no longer needed.

Discussion: Since an untrained worker mistakenly attached the supports for the scaffold to the tack-welded washers, it is very important that there is no opportunity for this to occur again. Whenever an anchor for suspending a scaffold is installed, any temporary anchors should be removed to eliminate the chance of confusion.

FATALITY ASSESSMENT AND CONTROL EVALUATION (FACE) PROJECT

Staff members of the FACE project of the New Jersey Department of Health, Occupational Health Service, perform FACE investigations when there is a work-related fatal fall, electrocution, or confined space death reported. The goal of these investigations is to prevent fatal work injuries in the future by studying: the working environment, the worker, the task the worker was performing, the tools the worker was using, the energy exchange resulting in fatal injury, and the role of management in controlling how these factors interact.

To contact [New Jersey State FACE program personnel](#) regarding State-based FACE reports, please use information listed on the Contact Sheet on the NIOSH FACE web site. Please contact [In-house FACE program personnel](#) regarding In-house FACE reports and to gain assistance when State-FACE program personnel cannot be reached.