TO: Director, National Institute for Occupational Safety and Health

FROM: Iowa FACE Program

SUBJECT: **Sheet metal roofer slips and falls through joint in ceiling --Iowa.**

SUMMARY

A 20-year-old sheet metal worker, part of a crew constructing a new metal building, died when he fell through a joint in the ceiling panels of the roof, landing on the concrete floor 21 feet below. The man was working on the roof laying down insulation prior to attaching the top layer of metal. While walking on a purlin, he apparently slipped and his foot landed adjacent to the purlin, at an overlapping joint in the sheet metal. The ceiling panel was 29-gauge corrugated steel attached with #12 self-tapping screws every 9 inches. Several heads of these screws immediately popped off or tore through the metal, and the man fell through the seam in the metal ceiling. The man was not wearing any fall-protective equipment and suffered fatal head and neck injuries. The builder had been constructing this type of building for 15 years, and assumed the ceiling was safe since workers had occasionally stepped on the ceiling without incident. Fall protective equipment was available on site, but workers were not required to use it.

RECOMMENDATIONS based on our investigation are as follows:

1. *Builders should design roof systems to include attachment points for fall protection lifelines.*
2. *Builders and roofers should comply with OSHA fall protection standards at all times.*
3. *Builders should develop a procedure for testing electric screwdrivers to determine the proper torque setting for each application.*

INTRODUCTION

In November 1996, a 20-year-old sheet metal worker died after falling through the ceiling panel of a new metal building. The Iowa FACE program became aware of the incident from a newspaper article and began an immediate investigation. A site visit was conducted shortly after the fall by the FACE investigator accompanied by an industrial hygienist from WORKSAFE IOWA, an industrial consulting service of The University of Iowa. Photographs of the building (still under construction) were taken including the repaired section of ceiling where the man fell through.

The employer was a general contractor who had been in business for 23 years. He employed a 6-man crew, and had constructed pre-engineered metal buildings of this type for the last 15 years. The crew worked through the winter whenever possible.

New workers received written safety instructions covering a variety of safety issues relevant to their work, and on-the-job safety meetings were held weekly. Fall protection was discussed and demonstrated using full-body harnesses and lifelines which were provided by the

company. Workers also received a wage bonus if they maintained a specified amount of injury-free worktime.

Training for this type of building construction was done on-the-job, and safety issues were covered in the normal process of construction. The victim had been with the employer for 1½ years, and had acquired experience with this type of metal building construction. This was the second fatality for this employer. The first occurred five years ago and involved a roofer who fell 12 feet off a wooden-framed structure. Recently another man fell five feet off a scaffold and suffered a broken arm.

INVESTIGATION

The pre-engineered metal building was being constructed on a concrete slab, and was to be used for production and assembly work. It had a ½ inch pitch, which means ½ inch of rise per horizontal foot, making the roof fairly flat. The construction was typical for a metal building, with 8-inch metal purlins in the roof, covered inside and out with corrugated steel, with 8 inches of fiberglass insulation in-between.

The crew had completed attaching the entire ceiling from the inside of the building. This ceiling was made of 29-gauge corrugated steel sheets, 3 feet wide by 30 feet long. These sheets were fastened every 9 inches to the purlins by #12, 1-inch long self-tapping sheet metal screws with hex heads. The screws were attached with an electric screwdriver equipped with a variable ratchet clutch, with the torque set by the degree of pressure applied to the screwdriver. Workers state that it is possible to apply too much pressure and strip the heads off the screws.

The crew were in the process of insulating the roof and applying the top layer of sheet metal to the building. Normally at this stage workers walk on the metal purlins and not on the top surface of the ceiling panels. The victim was working alone on the top of the building at the time of the fall. He apparently was walking on the purlin and slipped, with his foot landing on an overlapped seam in the ceiling panels. He weighed over 200 pounds, which was sufficient to break screws directly under his foot, allowing the seam to split open. The man apparently had one leg over the purlin when he fell, which turned his body to the side as he fell. This caused him to fall head-first onto the concrete floor 21 feet below, suffering a broken neck which killed him instantly.

The employer states that occasionally a worker has slipped off a purlin and stepped onto a ceiling panel, without resulting in a fall. There was a general feeling among the workers that it was safe to occasionally step off the purlins onto a new ceiling. This may result in the cosmetic damage of a ceiling panel, therefore workers were highly motivated to avoid slipping from the purlins. Falling off a purlin, if only 8 inches high, would significantly increase the force on any ceiling panel. If this occurred in the middle of a panel, the weight would be distributed to several screws providing adequate support, yet this would reinforce a false sense of safety for workers on the roof not wearing fall-protective equipment. In this case the fall occurred at a seam which opened up instantly allowing the man to fall through.

OSHA indicated that the company would be cited for failure to use fall protective equipment. The builder had been aware of fall protection regulations, and purchased fall arrest harnesses for his workers the previous spring. He recommended their use but did not require it in this work situation. No fall-protective equipment was used during this stage of construction because of the low pitch of the roof, the apparent safety of the attached ceiling panels, and the difficulty of finding attachment points while workers moved across the roof. This builder believed it was entirely impractical and cost prohibitive to comply with fall protection guidelines for this type of metal building construction. The employer was aware that the ceiling was not engineered to be walked upon, however, his workers had been operating this way for several years without incident. He indicated he would prefer to engineer the panels so they could be assured they were safe to walk on without fall protection.

During our site visit we saw the repaired area of ceiling that gave way. We also found the sheered off heads of some screws on the concrete below this part of the ceiling. Screws are attached using an electric screwdriver equipped with a variable strength clutch, adjustable by the degree of force applied to the tip. This technique does require some training, as it is possible to apply too much torque and shear off the heads of screws. Therefore it is possible that the failed seam was secured with screws that were applied too tightly--to the point of metal fatigue. We also noticed one area of the ceiling which was missing a screw, possibly one that broke off during installation or broke off later. The builder reported this was happening more than usual and was concerned that he may have an inferior batch of screws. The possibility of testing the screws was mentioned, but this option had not been pursued. The screws were not rated.

This builder is currently consulting with engineers about how to improve safety while still retaining his current building methods. He would like to engineer the ceiling panels so they would be approved to walk upon, by increasing the gauge of the metal or increasing the number or type of screws holding up the panels.

CAUSE OF DEATH

The cause of death from the County Medical Examiner was “head trauma due to a fall.” No autopsy was performed.

RECOMMENDATIONS / DISCUSSION

Recommendation #1 *Builders should design roof systems to include attachment points for fall protection lifelines.*

Discussion: The builder, in this case, appeared willing to change his construction methods to increase the strength of the sheet metal ceiling. This engineering change would likely improve safety, however, it may be equally cost-effective to install anchor points along the iron roof structure as it is being erected. Then workers would have suitable attachment points to use as they work on the roof adding insulation and securing the top layer of metal. These anchor points would be useful for future maintenance and other work requiring anyone to work on the roof. Anchors for fall protection systems could be installed on structural members or provided by specifying them directly from the structural steel fabricator. Use of

self-retracting lifelines would allow workers great freedom of movement, and yet provide adequate fall protection according to OSHA guidelines. Use of fall-protective equipment in this case could have saved this man's life.

Recommendation #2 *Builders and roofers should comply with OSHA fall protection standards at all times. [CFR 1926.501]*

Discussion: Employers or competent persons responsible for site safety should adapt fall protection to, at minimum, meet the OSHA standard. Builders should not rely on their workers to work safely overhead without fall protection. Workers may not be able to always work safely due to sickness, minor injury, lack of sleep, personal stress, or even a fear of heights, etc. Therefore, it is the responsibility of the employer to require their workers to wear proper safety equipment. The owner of this company states that fall protective harnesses and lifelines were available for all workers. However, this work situation was assumed to be safe, and workers were not required to wear fall protection. The misconception about the strength of the ceiling panels is not limited to this specific contractor, for working without fall protection is a common practice among sheet metal contractors. Persons responsible for health and safety on building construction sites should ensure that OSHA guidelines regarding fall protection are followed in roof construction.

Recommendation #3 *Builders should develop a procedure for testing electric screwdrivers to determine the proper torque setting for each application.*

Discussion: The screws holding the panel of corrugated steel were not designed to support a man who might be walking on the top side. Since the screwdriver had a variable ratchet clutch, it is possible that some screws were attached too tightly, to the point of partial weakening of the screw head. This may be the reason we saw some panels with missing screws (missing heads), and this may have caused a weakened area in the ceiling where the victim fell through. Perhaps this joint was weakened in this manner and easily failed when the man slipped off the purlin.

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Fatality Assessment
&
Control Evaluation Program
(FACE)

The University of Iowa, in conjunction with the Iowa Department of Public Health is investigating the causes of work-related fatalities in the State of Iowa. FACE is a surveillance program funded by the National Institute for Occupational Safety and Health (NIOSH), that identifies all occupational fatalities, conducts in-depth, on-site investigations on specific types of fatalities, and makes recommendations for employers, employees, farmers, and others to help prevent similar fatal accidents in the future.

NIOSH funded state-based FACE Programs include: Alaska, California, Colorado, Indiana, Iowa, Kentucky, Maryland, Massachusetts, Minnesota, Missouri, Nebraska, New Jersey, Wisconsin, and Wyoming.

Additional information regarding this report or the Iowa Face Program is available from:

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