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NIOSH HEALTH HAZARD EVALUATION REPORT

HETA #2003-0383-2942
Alstom Power, Inc.
Chattanooga, Tennessee

July 2004

DEPARTMENT OF HEALTH AND HUMAN SERVICES
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

PREFACE

The Hazard Evaluation and Technical Assistance Branch (HETAB) of the National Institute for Occupational Safety and Health (NIOSH) conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health (OSHA) Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employers or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

HETAB also provides, upon request, technical and consultative assistance to federal, state, and local agencies; labor; industry; and other groups or individuals to control occupational health hazards and to prevent related trauma and disease. Mention of company names or products does not constitute endorsement by NIOSH.

ACKNOWLEDGMENTS AND AVAILABILITY OF REPORT

This report was prepared by Daniel Habes and Manuel Rodriguez of HETAB, Division of Surveillance, Hazard Evaluations and Field Studies (DSHEFS). Desktop publishing was performed by Robin Smith. Review and preparation for printing were performed by Penny Arthur.

Copies of this report have been sent to employee and management representatives at Alstom Power, Inc. and the OSHA Regional Office. This report is not copyrighted and may be freely reproduced. The report may be viewed and printed from the following internet address: http://www.cdc.gov/niosh/hhe. Single copies of this report will be available for a period of three years from the date of this report. To expedite your request, include a self-addressed mailing label along with your written request to:

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For the purpose of informing affected employees, copies of this report shall be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.

Highlights of the NIOSH Health Hazard Evaluation

Evaluation of Jobs in a Power Equipment Manufacturer

NIOSH was asked to evaluate the ergonomics aspects of some welding and fabricating jobs in a plant that manufactures equipment for the electric power generation industry.

What NIOSH Did

- We watched workers as they performed their jobs to see if movements or work postures were causing injuries.
- We looked at injury logs and accident investigation reports to get a better idea of what was causing injuries.

What NIOSH Found

- Most of the injuries were to the back and upper and lower limbs.
- Many injuries were caused by poor housekeeping, moving and gathering materials, and unsafe work practices.
- There were other problems in the plant related to safety and health, such as unguarded machines and poor ventilation in welding areas.

What Managers Can Do

- Study accident and injury reports more closely to better see how workers are getting hurt.
- Arrange parts and work components so they do not interfere with the work being done.
- Train workers in safe work practices and injury prevention.

What the Employees Can Do

- Report unsafe working conditions to managers.
- Be more aware of what can happen if safe work practices are not followed.

What To Do For More Information:
We encourage you to read the full report. If you would like a copy, either ask your health and safety representative to make you a copy or call 1-513-841-4252 and ask for HETA Report #2003-0383-2942

Health Hazard Evaluation Report 2003-0383-2942
Alstom Power, Inc.
Chattanooga, Tennessee
July 2004

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SUMMARY

On September 12, 2003, the National Institute for Occupational Safety and Health (NIOSH) received a request for a Health Hazard Evaluation (HHE) from the Director of Human Services of Alstom Power, Inc., and the President of Local 656, International Brotherhood of Boilermakers. The HHE request was prompted by the realization that recordable injuries classified as strains and sprains had increased over the prior 12 months. The cause of these injuries was not readily known to the company, and they felt they did not have the in-house expertise to effectively evaluate the situation.

During November 10-12, 2003, NIOSH investigators visited Alstom Power, Inc. The NIOSH team included an ergonomics specialist and an industrial hygienist/safety professional. The site visit consisted of an opening conference with representatives of management and Boilermakers Local 656, a general plant walkthrough assessment, a review of accident and injury logs, and detailed analysis of several jobs where recent injuries had occurred. The closing conference took place on November 12, 2003. The management and union were represented.

The ergonomics evaluation indicated that the main hazard was static and sustained trunk flexion postures, mainly among workers who performed welding jobs on large panels. The plant walkthrough assessment indicated that there were safety and health concerns in the plant not related to the musculoskeletal disorders specified in the HHE request. Recommendations pertaining to these issues were sent to Alstom Power, Inc., in December 2003, and are repeated in this report.

Review of the injury logs indicated that many of the lost time entries involving the back and upper and lower extremity musculoskeletal system were the result of acute events that did not involve the routine content of job tasks. Many injuries were the result of poor housekeeping and organization of materials, and unsafe work practices.

Based on observations and review of injury records and accident investigations, NIOSH investigators conclude that job tasks at Alstom Power, Inc., are associated with a large number of injuries to the back and upper and lower extremities. Many of these injuries were acute and not directly related to production tasks, but to poor housekeeping and unsafe work practices. Recommendations to reduce the risk of injury to workers are contained in this report.

Keywords: SIC 3443 Fabricated Plate Work (Boiler Shops), ergonomics, back, upper and lower extremity musculoskeletal disorders, housekeeping, worker safety practices, welding processes

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INTRODUCTION

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At the opening conference there was also a discussion of the company's quality improvement team and the Six Sigma approach, which includes avoidance of injury, that Alstom Power, Inc. uses to improve quality. Six Sigma is a measure of quality that strives for near perfection in any process - from manufacturing to transactional and from product to service. Despite the use of this approach, management felt that the safety and health staff at Alstom Power, Inc. lacked expertise in evaluating ergonomics issues at the plant.

BACKGROUND

The Alstom Power, Inc. facility in Chattanooga, Tennessee, fabricates components for coal-fired boilers in the utility industry. Most components start out as tube stock which is cut, bent, and welded together to form panels and elements of various lengths and widths. The Chattanooga facility employs 525 workers, with 325 in production and support functions. Most of the production work force is represented by the International Brotherhood of Boilermakers, Local 656, and the rest are represented by the International Association of Machinists and Aerospace Workers, Local 56.

METHODS

NIOSH investigators reviewed the Occupational Safety and Health Administration (OSHA) Injury and Illness Logs for the year 2002 and the first 10 months of 2003. The ergonomics evaluation consisted of a general walkthrough assessment of the plant and some detailed evaluations of specific jobs where injuries to workers had recently occurred.

EVALUATION CRITERIA

Overexertion injuries and musculoskeletal disorders, such as low back pain, tendinitis, and carpal tunnel syndrome, are often associated with job tasks that include: (1) repetitive, stereotyped movement about the joints; (2) forceful manual exertions; (3) lifting; (4) awkward and/or static work postures; (5) direct pressure on nerves and soft tissues; (6) work in cold environments; or (7) exposure to whole-body or segmental vibration.[1,2,3,4] The risk of injury appears to increase as the intensity and duration of exposures to these factors increases and the recovery time is reduced.[5] Although personal factors (e.g., age, gender, weight, fitness) may affect an individual's susceptibility to overexertion injuries/disorders, studies conducted in high-risk industries show that the risk associated with personal factors is small compared to that associated with occupational exposures.[6]

In all cases, the preferred method for preventing and controlling work-related musculoskeletal disorders (WMSDs) is to design jobs, work stations, tools, and other equipment to match the physiological, anatomical, and psychological

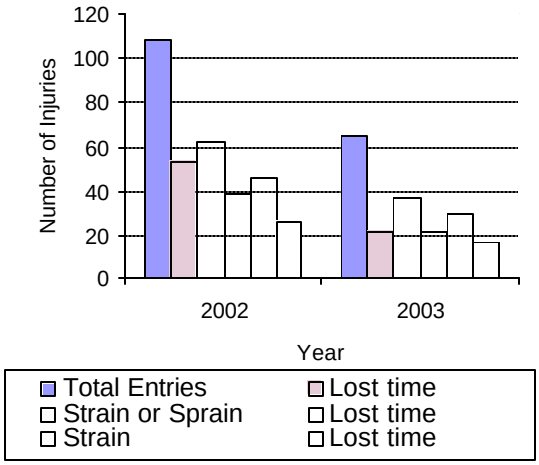
characteristics and capabilities of the worker. Under these conditions, exposures to task factors considered potentially hazardous will be reduced or eliminated.

RESULTS

Injury Log Review

For the year 2002, there were 108 entries, 53 with lost time. The number of lost days was 2500. Of these, 62 (57%), were classified as "strains or sprains", 39 with lost time. Forty six (43%) were categorized just as "strain", which were thought by the company to most likely be musculoskeletal disorders. Of these 46 strains, 26 resulted in lost time. Through October 2003, there were 65 entries, 39 with lost time. The number of lost days was 2015. Of the 65 entries, 37 (57%) were classified as "strains or sprains", 22 having lost days. There were 30 entries (46%) classified just as strains, 16 with lost days (see Figure 1). The percent of injuries attributable to strains or sprains was comparable for both years, and 2003 was on a pace to result in almost the same number of total lost days as 2002.

Figure 1: Injury and Illness Entries



Observations

The main areas where injuries have occurred are Super Heater Assembly (Bay 42 South), Panel Assembly (Bay 44) and Burner Panel (Bay 41 South). During the time of the NIOSH plant walkthrough assessment, the busiest part of the plant was Bay 42 South, where workers were performing custom welding tasks. The panels were situated on metal I-beams placed perpendicular on two other I-beams that formed a track. The number and spacing between the perpendicular I-beams was determined by the specification of the panel being fabricated. The height of the I-beams was about 26 inches above the floor. The main components of the panels were tube stock that had already been cut and bent in this or other bays. The panels are formed by welding spacers between adjacent tubes. A panel is usually about 20 or 30 feet long, up to 12 feet wide and 10,000 pounds in weight. Workers weld the spacers near the edge of the panel by reaching across the panel. When spacers are welded to tube stock closer to the center of the panel, the workers climb onto the panel and sit on it as they weld. The panel can be rotated or moved as needed during fabrication by means of an overhead crane system. Another job evaluated during the walkthrough assessment took place at the "scarfing table." During this operation, tubes are cut with a portable band saw and the tip is prep welded.

Alstom Power, Inc. was formerly a mass-producer of power plant equipment. Now the plant does mostly custom repair work for large municipal power companies, and the workforce has been reduced from thousands of workers to hundreds of workers. Because each job is a custom order, and components are not produced on a large scale, the shop floor is not configured like a mass production facility that produces the same product over and over. There are no shelves or complex parts delivery systems. When assembly of a replacement panel is begun, the parts and components are delivered as close as possible to the assembly area. Spaces between adjacent panel assemblies are cluttered, and workers often have to walk appreciable distances carrying parts and components through these areas.

The welding jobs observed in Bay 42 South were self-paced with little manual content, but required that workers maintain unsupported, flexed (bent) trunk postures for prolonged

periods as they welded. This was particularly the case when welding took place on the middle portion of panels. When tubes were welded together at the edge of a panel, the workers often sat on makeshift pillows placed on the I-beams, but still had to lean forward as they welded. Sitting was possible because the panels were usually not as wide as the I-beams situated on the I-beam tracks. These pillows were often foam or cloth covered with duct tape. The 26-inch working height was too low for the edge welding, requiring flexed trunk postures, but a higher work surface (30-36 inches) would have made climbing onto the panels to weld in the middle more difficult.

Not observed, but likely time-consuming and physically stressful, was the repositioning of heavy cross member I-beams during set up for a different panel assembly. The I-Beams on which the panels are placed are moved by striking them with sledge hammers until they are in the position specified by the panel to be assembled. As beams approach the desired position, they are often placed in their exact position by pushing them manually. This job is not performed regularly given that an entire panel assembly can last a month or more, but is nonetheless physically demanding.

The cutting of tubes at the scarfing table required the worker to operate a portable band saw using flexed and deviated wrist and hand postures. This task required the worker to press down forcefully as the blade cut through the metal tubes. The tool, which was fairly light, vibrated considerably during the cutting process.

During the plant walkthrough assessment there were a number of safety and health issues noted, not related to ergonomics, that needed attention. These mainly involved machine guarding, wearing of safety protection, and lack of ventilation in welding areas. The recommendations addressing these issues that were sent to the company in December 2003 are repeated at the end of this report.

Detailed Job Analyses

To better characterize the nature of reported injuries, the NIOSH investigators looked at the detailed investigation reports that were available for 29 of the 30 strains that occurred in 2003. We found that 10 (34%) were musculoskeletal disorders resulting from chronic overuse or overexertion, and 19 (66%) were actually acute injuries. For example, a strain to the knee in Super Heater Assembly was caused by a worker stepping on a tube on the floor and twisting his knee. A worker in Panel Assembly who sustained a shoulder strain did so by using his hands to stop the movement of a panel that was being rotated with the overhead crane system instead of using a tag line to guide the panel. Another worker whose knee injury was classified as a strain actually twisted it by stepping in a hole in the floor. The 10 strains that were not acute involved repetitive operations such as welding, grinding, and tightening of clamps. Poor housekeeping and organization of assembly materials, unsafe work practices, and inadequate safety training and awareness were major causes of acute injuries that were thought to be the result of repetitive job content.

To further assess the nature and causes of reported injuries, we looked at some injury reports made in the year 2002. These were picked by the plant environmental health and safety expert because they resulted in appreciable lost work days. In one instance, a worker in TPM panels sustained a contusion by falling off a board that he was sitting on while welding. Another worker fractured his finger trying to realign a tube in a straight tube welder by making contact with the tube stop. According to the investigation report, the machine had been modified without the knowledge of the worker performing the operation. Finally, a maintenance worker strained his left hip trying to squeeze through a tight space to make a repair or adjustment on a machine. The accident investigation indicated that if the machine had been disassembled more before the worker had attempted to crawl in, the tight space would not have existed. As in 2003, there were entries in 2002 that were caused by overexertion and

repetition such as a knee strain from pulling on heavy tubes, straining a shoulder while removing an orbital sander from a tube, and straining a shoulder by welding with the arms elevated.

Based on the detailed investigation reports, NIOSH investigators identified jobs where workers had recently sustained injuries that resulted in lost work days. Since only one of these jobs was being performed at the time of this NIOSH evaluation, we relied on accounts from the workers and inspection of the job layout to understand how the injury occurred. Jobs which were observed included the following: Burner Panels; Pre-Panel Assembly; Tube Bending; and Orbital Welding.

Burner Panels

At this job, a journeyman Boilermaker injured his back lifting a welding feeder box weighing 40 pounds to another panel located in the area, resulting in 70 days of lost time. A feeder box provides wire and power to a welder. The worker lifted the feeder box and transferred it to the other side of the panel by crawling under the panel, the bottom of which was 36 inches above the floor. He chose this method to avoid having to disconnect the air and power lines that were attached to the feeder box. At the initiation of the lift, the feeder box had to be lifted over a 9-inch high I-beam that served as the base for the cross members that supported the panel. The worker walked under the panel in a crouched position while carrying the feeder box between the I-beam and the underside of the panel. There was 27 inches of clearance between the I-beam and the panel. As the worker began to make his way over the I-beam and under the panel, he strained his back. Had there been a feeder box on the other side of the panel or if the worker had taken the time to disconnect the lines attached to the feeder box and carry it around the panel to the other side, this incident could have been prevented.

Pre-Panel Assembly

During this operation, a worker injured his back lifting tube rollers while setting up for an operation. The rollers serve as spacers for the metal tubes during the work process. The rollers are stored in a large, shallow wooden box which is brought into the area with a fork lift. A permanently-positioned ladder is situated between the shop floor and the machine, which necessitated that the box be placed about 15 or 20 feet away from the location where the rollers are installed during the set up. The worker carries several of the rollers (usually 4 at a time in each hand) into the work area to prepare for the set up. Carrying them in this manner allowed completion of this lifting task in 20 back and forth trips, with a total load for each trip of about 35 pounds. While carrying a load of rollers, the worker hurt his back and was out for 34 days. Carrying 35 pounds for 15 feet is not necessarily an excessive load for most workers. However, if the ladder that obstructed the path between the machine and the shop floor could be redesigned to be removable, the fork lift could deliver the box of spacers directly to the machine and the worker could lift them out of the box one at a time. This measure could have prevented the injury. An alternative would be to pack the spacers in smaller boxes that can be delivered via a dollie or a wheeled table that could be pushed closer to the work area. A rolling table would also position the spacers at a comfortable work height rather than on the floor.

Tube Bending

In this area of Bay 42, a numerical control machine bends tubes 40 or 50 feet long as much as 180 degrees. The operation takes place on a huge metal platform. When the machine has bent the tube about 90 degrees, the worker has to assist the machine to complete the bend. He uses a long handle rod with a large hook on one side of the tip and a smaller hook on the opposite end of the tip. Using the large hook to couple with the tube and the smaller hook as a “rudder”, the worker propels (forcefully shoves) the tube with a quick motion of the hand and body, resembling a move made while playing shuffle board. Sometimes the platform is lubricated to facilitate pushing the tube, but it makes it slippery if the worker has to walk further out on the platform to adjust the position of the tube. While performing this maneuver a worker hurt his back and hip and was out of work for 82 days. At the time of

the NIOSH visit, this job was designated for a change. A proposed remedy was to replace the small hook on the tip of the long rod with a wheel that the rod could ride on while the worker propelled the tube. The wheel would reduce the force that the worker had to exert, but would not eliminate the maneuver needed to push the rod during the bending operation. A mechanical means to assist the machine in bending the tubes would be a better alternative, particularly for large-diameter tubes.

Orbital Welding

This job involved use of an orbital welder in the TPM Elements area. An orbital welder is a tool which, when attached to a circular tube, automatically produces a consistent clean weld on both the outside and inside of the tube perimeter. These tools, while expensive, reduce finish work and use of abrasives to clean a weld. Once attached, a safety latch secures the welder to the work being joined. In this instance, the safety latch failed and the welder was about to slip off the tubes and fall to the floor. The worker reached over the tube and caught the welder before it hit the floor, but the weight of the tool pulled the worker's arm and tore muscles and ligaments in his shoulder. The injured worker was off for 106 days. The safety latch has since been redesigned to prevent another occurrence of the welder slipping off of a tube.

This injury was another example of an acute event being classified as a musculoskeletal strain. It also illustrated a general sentiment in the plant of "getting the job done," no matter the consequences. The worker's instinctive reaction put himself at risk of serious injury.

Miscellaneous

After viewing the orbital welding job, we encountered a situation where two workers were unloading timbers from a pallet. The timbers were being used as spacers between two panels that were to be banded together and sent to another department for vertical welding. The timbers were made of white oak, 7 inch x 7 inch cross section, and five feet long. The pallet was positioned about 90 feet from where the timbers were being used in Bay 42 South. Assuming that white oak weighs about 45 pounds per cubic foot, these timbers averaged about 76 pounds each. After carrying one timber to the panel in his arms, one of the workers was observed pulling a timber off the pallet and rolling it on its edges to the panel. There was a fork lift truck parked in the area that could have been used to bring the pallet to the edge of the panel that they were being placed on. (The pallet was initially placed where it was on the shop floor because there was an obstruction near the panels which prevented the fork lift truck from getting any closer when the pallet was originally delivered.) The workers could not explain why they did not move the pallet, or at least use a two-man lifting technique to carry the timbers to their destination. Taking the time to move the pallet would have saved time due to the distance the timbers had to be carried. This is another example of the "get it done" attitude of the workers. However, unlike the orbital welder case, this was an instance where awareness for safety or an attitude of "there is always time to work safely" could have resulted in a more desirable approach to getting this job done.

DISCUSSION

Alstom Power, Inc. is a large facility that produces products weighing several tons. The parts used are large and heavy, providing many opportunities for workers to sustain injury from seemingly routine tasks such as moving parts, retrieving parts, and packing and loading finished product.

Most of the routine work taking place during the NIOSH evaluation occurred in the Super Heater Area where replacement panels were being assembled. While many of the workers were welding in sustained positions that appeared to be stressful to the low back, most of the injuries (acute and chronic) seemed to be associated with activities outside production routines such as carrying parts, stepping off lift trucks, applying force to untangle tubes, and machine set up. In 2003, three of 10 entries which were chronic in nature occurred while welding, chipping and grinding, and performing hammering tasks. The

remaining 26 (chronic and acute) occurred during the non-routine parts of the production process and many could have been prevented through better safety awareness by employees and supervisors.

CONCLUSIONS

1. Job tasks at Alstom Power result in acute and chronic musculoskeletal disorders, many of which are not directly related to production tasks, and are preventable.

2. Better organization of work materials, housekeeping, selection of tools, and work methods could reduce the occurrence of injuries.

3. Careful analysis of the circumstances of injuries that have occurred would better characterize problematic areas and would serve as a basis for more effective preventive practices.

4. Many of the injury log entries that are coded as chronic resulting from repetitive motion are acute in nature.

RECOMMENDATIONS

1. Install bins or fixtures that hold or hang parts in the areas where panels are assembled so that aisles and walkways will be clear. This would make parts more easily retrievable and prevent accidents that occur when workers walk throughout the panel assembly area looking for parts and components.

2. Provide seating for workers who weld panels together. Dedicated seating would allow workers to sit between adjacent support I-beams instead of on them, thus stabilizing their position while welding and enabling them to get closer to their work. There are chairs available that have backs that can serve as a front rest for welding in a forward trunk posture. See for example:
http://www.officeorganix.com/NPAbstool.htm
http://www.pnwx.com/Accessories/Seating/Dental-Optical/
http://www.a-dec.com/html/Products/Seating/1622AssistantStool.asp
http://www.ampcodental.com/stoolsdeluxe.htm

3. Carefully investigate all injuries to identify root causes of the event for purposes of identifying unsafe work stations, careless work practices, and inadequate tools.

4. Increase worker awareness of safety practices and work methods by initiating training classes covering the nature of work-related musculoskeletal disorders, anthropometry, work physiology, and back and upper/lower extremity anatomy.

5. Select tools that are designed for specific tasks such as scarfing, chipping, and grinding, and provide personal protective equipment such as anti-vibration gloves where appropriate. Tools that are low in vibration would be most desirable.

6. Use mechanical lifts and overhead cranes to move parts and configure panel assembly platforms, particularly in Bay 42 South where I-beam cross members are used.

Safety and health recommendations sent to Alstom Power, Inc. in December 2003:

1. Safety requirements were not uniformly observed and enforced. While signs are posted requiring safety glasses, safety shoes, and hearing protection, many employees were not wearing the required personal protective equipment. In general, personnel working in a hazardous noise area must participate in a Hearing Conservation Program requiring annual audiograms and training among other requirements per OSHA standard 29 CFR 1910.95 (Occupational Noise Exposure).

2. Unguarded moving machine parts were noted in some areas of the plant. OSHA standard 29 CFR 1910.219 for guarding requirements for Mechanical Power Transmission Apparatus addresses these omissions.

3. There was no local exhaust ventilation to control welding fumes in some cases. A strong odor of burning metal was noted upon entering the work area. Air sampling for hazardous components of welding fumes should be conducted to determine if the ceiling exhaust fans are maintaining exposures to hazardous chemicals below applicable occupational exposure limits. Air sampling should consist of not less than a full metal scan per NIOSH analytical method 7300. If welding stainless steel, sampling for hexavalent chromium should also be conducted. Direct reading methods should be used to measure nitrogen dioxide, nitric oxide, and ozone levels.

4. Welding was performed in some parts of the facility without the use of UV screens. OSHA standard 29 CFR 1910.252(b)(2)(iii) requires employees adjacent to welding stations to be protected from arc welding rays. Where the work permits, the welder should be enclosed in an individual booth, or shall be enclosed with noncombustible screens. Booths and screens shall permit circulation of air at floor level. Workers or other persons adjacent to the welding areas shall be protected from the rays by noncombustible or flameproof screens or shields or shall be required to wear appropriate goggles.

5. A sign warning employees of carbon monoxide (CO) poisoning was affixed to an X-ray machine. While it is important for employees to be aware that CO is a health hazard it is more important that they be protected against CO exposure. CO has no warning properties, and is colorless and odorless. One approach is to install CO alarms in the facility. Propane heaters and propane operated forklifts should be checked periodically for excess CO emissions.

6. Employees were smoking and chewing tobacco in the work area. Two picnic type tables were located in the open bay work area for employee breaks. Eating and smoking should not be allowed in the work area. Since there is no local exhaust ventilation in the facility, welding fumes can settle on surfaces and hazardous metals can adhere to employees' hands and subsequently be ingested while smoking or eating.

7. Beams used to lay panel assemblies have sharp unprotected ends which can injure employees if they bump against them. Edges should be covered with foam or other impact absorbing material.

8. Numerous sources that can lead to trips and falls were noted in many work areas. Pedestal fan power chords, welding lines, tubes, collars, and other objects were on the floor. Options for pedestal fans, tables and storage bins for locating materials, and other ways of routing welding lines so they do not pose a tripping hazard should be used. Many lost work days injuries found on the OSHA logs were a result of tripping over objects.

9. The process that uses chromium to harden component surfaces should be evaluated for health hazards. Residual powder used to treat the components was seen on the floor. Heating the chromium may convert it to hexavalent chromium which has been classified as a potential human carcinogen by NIOSH and a human carcinogen[7] by the International Agency for Research on Cancer (IARC), which is part of the World Health Organization. Chromium is also an irritant and can cause dermatitis.

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