The National Institute for Occupational Safety and Health (NIOSH)

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Technician Electrocuted While Performing Maintenance on a Walk-in Cooler in Virginia

FACE 91-32

SUMMARY

A 33-year-old male (victim), employed as a heating, ventilating, air-conditioning, and refrigeration (HVACR) technician, was electrocuted while performing refrigeration maintenance on a walk-in cooler at a restaurant. The flexible metal conduit housing the power conductors to the refrigeration unit (RU) of the cooler had been designed to serve as the mechanical ground. The insulation on one of the three power conductors in the flexible conduit was damaged and allowed electrical arcing to a conduit connector on the RU starter box (Figure). The conduit connection to the RU starter box (from the RU) was loose, and effectively disconnected the mechanical ground from the RU. As the victim was servicing the RU, the temperature in the walk-in cooler must have caused the thermostat to close the starter, energizing the surfaces of the RU, and fatally shocking the technician when he touched it. NIOSH investigators concluded that, in order to prevent similar occurrences, employers should:

- **require that all electrical equipment be de-energized before any electrical repairs are performed**
- **provide a mechanical grounding conductor as part of the power feed to an appliance whenever possible**
- **provide ground-fault protection as part of the power feed to an appliance whenever possible**
- **provide employees with education and training in the recognition, avoidance, and prevention of unsafe work conditions.**

INTRODUCTION

On August 20, 1991, a 33-year-old male HVACR technician was electrocuted while performing maintenance on a walk-in cooler. On September 3, 1991, officials of the Virginia Department of Labor and Industries (VAOSHA) notified the Division of Safety Research (DSR) of the fatality, and requested technical assistance. A DSR safety engineer traveled to the area to conduct an investigation, on September 24, 1991. The incident was reviewed with company representatives, the VAOSHA compliance officer, the city electrical inspector, and the rescue team. Incident reports from VAOSHA, the city electrical inspector, and the local police were obtained. Photographs taken of the incident site immediately following the fatality were obtained from local sources.

The employer provided various HVACR maintenance services for commercial and industrial equipment. The company had been in operation for 30 years and employed 14 workers, including 4 refrigeration technicians. The company did not have a safety officer, but did have general written safety procedures. To qualify for employment, employees were required to have

formal training in their specific discipline prior to hiring. It was assumed that safety training was received as part of the technical training. (In this case, the employee had an Associate's degree as an HVACR technician.) No weekly or lunch box safety meetings were held. This was the first fatality for the employer.

INVESTIGATION

The victim was one of four HVACR technicians assigned work orders to repair various pieces of HVACR equipment. On the day of the incident, the company received a 9:30 a.m. call from a local restaurant to repair a walk-in cooler. A restaurant representative met with the victim at 11:00 a.m. to discuss the problem. The victim then placed his vacuum pump, extension cord, and tools on top of the 7½-foot-high by 12-foot-wide, and 8-foot-deep cooler (See Attached). After doing some preliminary work, he partially connected his vacuum pump lines to the refrigerant system without de-energizing the RU. At about 1:15 p.m. the restaurant representative decided to check the progress of the work. When he arrived at the cooler, he saw the victim lying on the roof, and began calling to him. Getting no response from the victim, he summoned the local emergency medical service (EMS). The EMS responded in less than 3 minutes. Once at the site, the paramedic demanded the power be disconnected from the cooler before he would approach the victim. Death was apparent, given the condition of the victim, and no emergency treatment was administered. The victim was pronounced dead at the site, and later taken to a local morgue for autopsy.

At about 2:15 p.m., the EMS personnel called a city electrical inspector to the site. By 3:05 p.m., two electrical inspectors had arrived. They observed that the RU starter had electrical burns where the 3-phase, 208-volt AC power conductors left the starter box via the conduit. One of the phase conductors had its insulation damaged and was arcing to the flexible conduit connector on the starter box. Further inspection revealed a discontinuous mechanical ground between the starter and the RU. A separate grounding conductor was not run from the starter box to the RU because the flexible conduit was a functional ground. The connection between the flexible conduit and the conduit connector had loosened enough to disrupt the grounding continuity between the starter box and the RU. Since the cooler was still connected to a power source, the starter must have closed and energized the frame of the RU. At some point, the technician touched the RU and completed a path to ground for electrical fault current.

CAUSE OF DEATH

The medical examiner ruled that a cardiac arrest due to electrical shock (electrocution) was the cause of death.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should require that all electrical equipment be de-energized before any electrical repairs are performed.

Discussion: Before performing maintenance on electrical equipment, the unit should be de-energized. If the cooler had been de-energized, it would not have started before the technician was ready. When troubleshooting requires equipment to be energized for diagnostic tests, the employee should be electrically isolated or insulated from it. In this case, leaving the cooler energized while connecting the vacuum pump was not necessary.

Recommendation #2: Employers should provide a mechanical grounding conductor as part of the power feed to an appliance whenever possible and in compliance with applicable codes.

Discussion: The mechanical grounding of the RU was dependant on the flexible metal conduit and associated mechanical connections between the RU starter box and the RU. This type of grounding system is subject to discontinuity due to corrosion, vibration and metal fatigue. An alternative separate grounding conductor was not a part of the power feed to the RU nor required by applicable codes (1,2). Had a separate grounding conductor been brought to the RU, the arcing to the flexible conduit would have eventually caused a circuit protective device to open the power feed. Although this is not required by all state or local codes, it is an effective intervention to reduce occupational injury. Code promulgating authorities should consider making the use of a separate grounding conductor a requirement.

Recommendation #3: Employers should provide ground-fault protection as part of the power feed to an appliance whenever possible and in compliance with applicable codes.

Discussion: Walk-in cooler electrical circuits should be provided with ground-fault protection such as a ground-fault circuit interrupter (GFCI) or a ground-fault circuit breaker. Such a protective device would have removed power from the cooler when the first arc to the flexible conduit connector (ground fault) occurred. This would have reduced the amount of damage to the starter box, and promptly alerted the restaurant personnel to a problem. It may also have prevented the death of the HVACR technician. The operation, application, and protection afforded by GFCI's are well documented (3).

Recommendation #4: Employers should provide employees with ongoing education and training in the recognition, avoidance, and prevention of unsafe work conditions.

Discussion: In this case, the HVACR technician should have recognized the hazard of not having a readily accessible disconnecting device and used other means to de-energize the cooler prior to servicing. This is a code requirement for all such coolers (4). In this case, the employer assumed that appropriate safety training was provided as part of the employees' technical training. Even though de-energizing the cooler would not have eliminated the electrical problem, it would have eliminated the source of energy which electrocuted the victim. This recommendation emphasizes compliance with 29 CFR 1926.21(b)(2) of the OSHA Act (5) which requires the employer to "instruct each employee in the recognition and avoidance of unsafe conditions."

The company did have general written safety procedures, but it should also require weekly or monthly safety meetings. In addition, prior to each job there should be a review of the pertinent, safe work practices to remind employees of the hazards associated with the work.

References

1. National Electrical Code, National Fire Protection Association, 1990 ed., Art. 250, Par. 250-91(b), p.118.

2. National Electrical Code, National Fire Protection Association, 1990 ed., Art. 350, Par. 350-5, p.234.

3. International Association of Electrical Inspectors News, International Association of Electrical Inspectors, Vol. 63, No. 5, p.29-33, September/October 1991.

4. National Electrical Code, National Fire Protection Association, 1990 ed., Art. 440, part B, par. 440-11 p.398 & par. 440-14 p.399.

5. Office of the Federal Register: Code of Federal Regulations, Labor, Title 29, Subtitle B, Chapter XVII, Part 1926.21(b)(2), p.20, July 1,1990.

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