

Workplace Fatality Investigation

*Electrocution Above Mills Concert Hall Ceiling
University of Wisconsin-Madison
July 26, 2011*

Summary

On July 26, 2011, two electricians of the UW-Madison Facility Planning and Management (FP&M) Electric Shop were replacing and repairing lights in the ceiling above Mills Concert Hall. At about 4:10 pm, Brad Krause's work partner heard him scream and found him to be unresponsive. Mr. Krause had been electrocuted.

Mr. Krause was replacing components on a light fixture without properly isolating power to that fixture. Failure to isolate power left him at risk of contacting an energized wire. He was not wearing electrically insulated gloves that were provided to him. The tight proximity of the work space made it likely he would be in close proximity to the fixture box and wires. Proper practice is to wear electrically insulated gloves until power is isolated and verified. This investigation revealed that in spite of an electrical safety training session and written policy, glove use and power isolation practices are inconsistent.

A Wisconsin Department of Safety and Professional Services (WI DSPS) investigation was conducted. An inspection report and corrective action orders were issued on August 16, 2011 (see Attachment 1). WI DSPS found that:

1. Workplace hazard assessments have not been completed or documented for electricians and staff has not received the required PPE training based on the workplace hazard assessments.
2. Annual inspection of energy control procedures for specific equipment had not been completed or documented. Employee training and review had not been completed or documented.
3. Lockout/Tagout program training was last completed for Krause in 2007. There was no additional documentation of electrical safety training or review since 2007.

Corrective actions were specified for each of the three violations and a compliance date of October 1, 2011 was specified.

A UW-Madison investigation was also undertaken by the Environment, Health and Safety Department (EHS). The purpose of this investigation was to determine the chronology of events, contributing factors, and corrective actions to prevent further occurrences. Findings and conclusions listed in this report are those of the EHS Department.

The EHS investigation was conducted by a multi-disciplinary team led by the UW Occupational Health Officer. EHS staff members of the investigation team included:

- Jim Morrison, CIH, Occupational Health Officer,
- Karl Stelzer, CSP, Workplace Safety Specialist, and
- Ernest Stracener, CIH, CSP, Industrial Hygienist.

Consulting members to the investigation team included:

- Kurt Johnson, Electric Shop Supervisor, UW Facilities, Planning & Management,
- Charles Forster, Electrical Engineer, Phasor Labs, and
- Mark Hoffman, Business Manager, IBEW Local 159.

Contributing factors to the fatality identified in the UW EHS investigation include:

- Electrically insulated gloves that were issued to Mr. Krause were not used when working on energized equipment.
- Equipment was being serviced in an energized state.
- Power isolation practices and glove use are inconsistent. There was no evidence that the victim nor his partner were using electrically insulated gloves provided to them while servicing the light fixtures. Interviews with other FPM electricians indicated glove use and power isolation practices vary. Electrical Shop safety policy excludes re-lamping and fixture internal component replacement from lockout/tagout procedures. The policy states that appropriate PPE must be used (see Attachment 2). However, safe work practices for performing this work including isolation of power are not otherwise documented in the electrical safety program.
- Supply power was not properly isolated prior to servicing equipment.
- The workspace allowed for only limited mobility and field of view.

As a result of both investigations, the following corrective actions are recommended to prevent future occurrences and to satisfy the corrective action requirements of the WI DSPS orders:

- a. A written hazard assessment¹ program must be instituted that specifies what PPE goes with which task and that assures its proper use. The assessment must be conducted, documented and communicated to affected employees (satisfies DSPS Order No. 1). Though PPE use was covered to some extent in a 2007 training session and written policy, the University must explicitly detail proper PPE use by task and train employees accordingly.
- b. The Electric Shop electrical safety program must include written guidelines for safe work practices for working on energized electrical equipment, including power isolation and the specific personal protective equipment (PPE) to be used during such operations (satisfies DSPS Order Nos. 1 & 2). Questions exist over how the practice of power isolation is regulated under OSHA electrical safety standards. A meeting is therefore

¹ A hazard assessment identifies job tasks performed and hazards associated with those tasks. Requisite precautions such as PPE, training and health surveillance are identified to mitigate the hazards and are communicated to the employee.

suggested with regulatory authorities to clarify regulatory intent to assure that proposed policy revisions and training are compliant with that intent.

- c. Training should be provided on a more regular basis, not less than annually. LO/TO retraining frequency is not specified in the OSHA standard. However, annual refresher training covering NFPA regulations and internal departmental policies is an important method of establishing a culture by which staff are reminded and encouraged to use safe work practices. First Aid/CPR training should be provided as well (satisfies DSPS Order No. 3).
- d. When power cannot be isolated to an electrical fixture, the respective circuit should be locked out or safe work practices must be developed and documented.
- e. Electric Shop supervisors and the Environment, Health and Safety Department must take a more active role in reviewing electrical safety policy and in observing work practices to assure safe work practices are being followed. Observations must be documented and discussed in regular training opportunities. A more aggressive field inspection program of employee work practices could have fostered a stronger organizational culture to ensure compliance with safety policies and procedures.
- f. Where an employee is observed not following safe work practices documented in the electrical safety policy, a standard progressive discipline plan consistent with UW human resources policy should be implemented.

Chronology of Events

A work order was requested by the building manager of the Humanities Building on June 22, 2011 to replace lights in Mills Concert Hall. Preferred times requested included July 5th thru 7th or July 25th thru 29th. Two FPM Electricians responded to the customer work order on July 26th.

Lighting for Mills Hall is accessed through a utility space above the ceiling. The utility space is accessed through a series of two ladders accessed through Room 2400K. The walking surface in the utility space is on boards anchored to the floor. Light fixtures are accessed by climbing on top of the raised ceiling via a small constructed ladder. The structural ceiling is about 2 feet above the raised concert hall ceiling with light fixtures. Plywood sheathing was installed on the raised ceiling as a working surface (See Figure 1).



Figure 1 Photo of ceiling space above Mills Concert hall

The electricians started work at about 10:00 am, broke for lunch at about 12:30 pm, and returned at about 1:00 pm. According to the partner, they wore lightweight Tyvek suits to stay clean and leather gloves for protection. A pair of leather gloves was observed at the scene, but it does not appear they were used by Mr. Krause. (These were not the electrical safety gloves Mr. Krause had been provided).

The partner stated that they had worked on approximately 20 fixtures. The partner stated that he told Mr. Krause it was time to pack up and Mr. Krause stated he wanted to finish. The partner estimated this was between 4:10 and 4:15 pm.

The partner stated that after Mr. Krause changed the lamp in the fixture it cycled on and off. Mr. Krause indicated he would then change the ballast. According to the police report, the partner stated that the fixtures were energized while they were working on them and this was something that was common practice.

The partner was in the process of removing his tools to the ground level when he heard Mr. Krause scream. The partner feared Mr. Krause was being electrocuted. The partner returned to the utility space as fast as he could and found Mr. Krause lying face down. The partner shook

and yelled to Mr. Krause to get a response. Mr. Krause did not respond, but the partner indicated he was making noises similar to snoring. The partner called 911 at 4:13pm and was instructed by the dispatcher to leave Mr. Krause and return to the ground floor to direct responders.

The partner showed Madison Fire Department (MFD) and UW Police Department (UWPD) where Mr. Krause was located. A UWPD officer arrived and was escorted by the partner up to where Mr. Krause was located. The responding officer found Mr. Krause lying on his left side with his torso on the other side of a stage light fixture box. The officer yelled to Mr. Krause, shook his feet and received no response. The police officer attempted to pull Mr. Krause by the feet, but could not move him.

Madison Fire Department arrived on scene shortly thereafter and tested the power and found that wiring in the fixture was still energized. The police officer radioed for assistance to have power shut off. The building manager did so and the partner reviewed the power shut off and acknowledged it was properly shut down.

Madison Fire Department performed first aid measures until a special unit could arrive that were trained in ropes rescue. Wood railing and metal rebar had to be cut in order to extricate Mr. Krause. At 4:56 pm, Madison Fire Department began lowering Mr. Krause to the ground floor and transferred him to waiting ambulance at 4:59 pm. Mr. Krause was pronounced dead at UW Hospital at 5:15 pm.

An FPM electrician and supervisor were at the scene to lend support. They were asked by UWPD to assure power was off. According to the police report, the electrician confirmed power was off and then checked the fixture Mr. Krause had been working on. The report also stated he found exposed wires inside touching the fixture box.

The electrician left to the main level while UWPD took evidentiary photos. After UWPD completed photo documentation, UW EHS reviewed the scene and took photos, they accompanied the electricians to the electrical panel and found several breakers off including two at an adjacent panel that were tripped.

An autopsy was conducted on July 27, 2011 at 10:30 am by the Dane County Medical Examiner. According to a report of a UWPD Detective, the medical examiner felt the point of entry of electricity was the right chest and exit was the left middle finger.

Contributing Factors

Working on energized equipment

According to the police report, Mr. Krause's supervisor indicated standard work practice was to check lamps live, but then to lockout fixtures for component replacement.² The partner indicated they routinely changed out ballasts live. OSHA advocates a hierarchy of controls by requiring employers to engineer out a hazard before reliance on personal protective equipment. In the context of electrical work, the power supply should be isolated then verified through testing to verify equipment is no longer energized or equipment should be de-energized through lock out methods prior to servicing.

Work can be done on energized equipment when it's infeasible to lockout such as during trouble shooting. However safe work practices must be developed and proper personal protective equipment used. The circuit for the fixture being serviced was not locked out. There was also a fuse to the fixture on the outside of the metal fixture box that could have isolated power to the fixture (see Figure 2). It was not removed.



Figure 2 Photo showing "handy box" with 12 amp fuse

² In a meeting with the electrician supervisor on 10/21/11, the supervisor indicated his statements were not accurately reflected in the police report. Others present at the meeting included the Electric Shop supervisor, Assistant Director of FPM, EHS Occupational Health Officer and EHS Director.

It appears that Mr. Krause may have isolated what he thought was the supply side power. However the single capped black wire was the power lead going to the lamp. The wire disconnected from the power lead to the lamp was the power lead from the secondary side of the ballast (see Figure 3). It is possible that Mr. Krause mistakenly isolated the wrong wire, leaving the power lead from the secondary side of the ballast live and the capacitor wires exposed. An electrician and electrician supervisor were at the accident scene twice before police photos were taken. Interviews with both indicate wires inside the fixture were not disturbed. Figure 3 therefore is thought to represent the condition inside the fixture box after the electrocution.

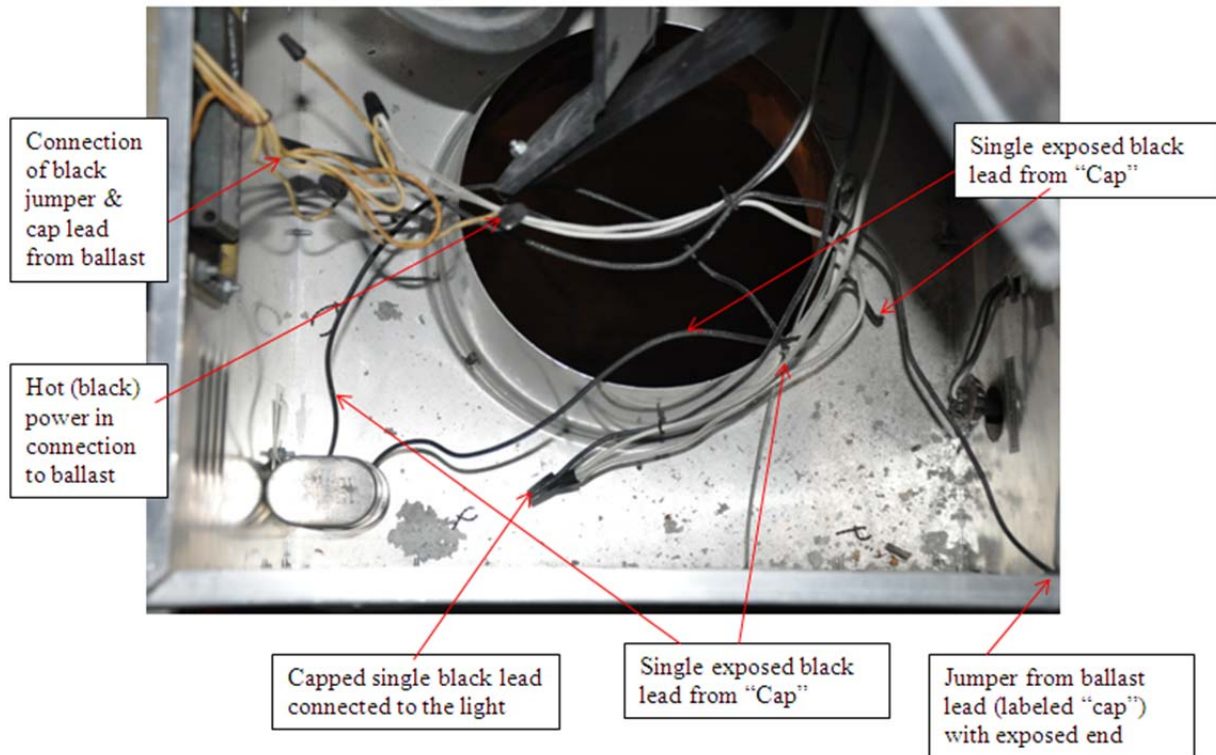


Figure 3 Overhead view of fixture box showing exposed wires and associated labels

Verifying Power was Isolated

It appears that Mr. Krause may have attempted to isolate power but did not verify that the wires were de-energized. A voltage meter was observed on site by an electrician the following morning. Verification is a critical step in that there could always be mistakes made, whether by self or someone previous.

Work in a Confined Location

As stated above, the utility space above Mills Hall ceiling was very tight. Travel was limited to boards laid on the surface and there were conductive surfaces all around. The confining nature of the space made it more likely that body contact could be made with the fixture box.

Personal Protective Equipment

The partner did not know if Mr. Krause was wearing gloves. Gloves were later found in Mr. Krause's work vehicle (see Figures 4 and 5). Electricians are provided a suite of PPE for protection against shock and arc flash (See Figure 6). Lockout equipment is also issued.



Figure 2 Photo showing Krause leather outer gloves



Figure 3 Photo showing Krause electrical gloves



Figure 4 Photo showing Krause electrical PPE

State of Mind

The electrocution occurred at the end of a long day working in difficult conditions. According to Mr. Krause's partner, they had replaced 20 lamps. The last lamp Mr. Krause serviced was not functioning properly. He wanted to stay and replace the ballast. This was at the end of a long extended day. The space he was working in was tight and cramped, lighting was limited and it is likely he was motivated to get on with the task.

Training

Mr. Krause had completed an apprenticeship program and completed an exam for journeyman standing with the local union. He had worked for the university for 7 years as a journeyman electrician. According to the local union he had 20 years of experience as an electrician and had passed the union's journeyman exam. The partner is a Master Electrician with 8 years of service to the university. Both the partner and victim had attended an FPM electrical safety training program in 2007. This training was provided by a consultant. The training provided a comprehensive overview of shock and arc flash prevention and lockout/tagout procedures but did not cover task-specific work practices. While not feasible to cover all possible work practices, there would be benefit to discussing examples that are encountered on campus. That training session was videotaped by FPM. New staff hired since then have been shown the videotaped session of training. It is not repeated annually, though review of the OSHA standard does not identify an annual requirement.

Evaluation of Regulatory Compliance

Regulations

OSHA Lockout/Tagout Standard

The OSHA Lockout/Tagout (LO/TO) standard is designed to protect employees against the unexpected startup or energizing of equipment. It requires employers to develop written machine specific work practices for dissipating and locking out hazardous energy sources. The standard requires that the employer have a written plan and that employees be trained initially and as often as necessary to assure employees understand and follow safe work practices. A sequence of seven steps must be followed when locking out equipment. These include:

- Preparation
- Shut down
- Isolation & Lockout
- Dissipate energy
- Verification
- Release of Lockout
- Notification of return to operation

A consultant was brought in by Facility Planning and Management to deliver electrical safety training in 2007. One of the sessions was videotaped. As new employees are hired, they are shown the video of the 2007 program. The Electric Shop LO/TO policy was finalized in 2008. Two exceptions to LO/TO provisions were written into the adopted policy. These included replacement of light bulbs and servicing light fixtures. In both cases employees are required to “use appropriate PPE” (see Attachment 2). This implies employees would work on light fixtures in an energized state, though the present policy does not identify specific work practices for doing so. It would be appropriate to incorporate written guidelines into the FPM electrical safety program, including descriptions of safe work practices for work on energized systems, provision for shock and arc flash prevention and description of specific PPE.

OSHA Subpart S

Much of the electrical safety standards in OSHA Subpart S are adopted from NFPA 70 and 70E. These standards pertain to the servicing of equipment in an energized state. Employers are not to allow the work on energized equipment except in cases where not doing so would create additional or increased hazards, would be infeasible or create operational concerns. Where work is required on energized systems, it must be done by qualified personnel trained to recognize and mitigate hazards, safe work practices must be developed and personnel protective equipment must be provided and used.

NFPA 70E

NFPA 70E is the standard for electrical safety in the workplace. At the outset, the standard defines the nature of shared responsibility for safety in the workplace.

“The safety-related work practices contained in Chapter 1 shall be implemented by employees. The employers shall provide the safety-related work practices and shall train the employee who *shall implement them.*”

NFPA 70E covers hazards due to shock and arc flash. When work is done on energized equipment, NFPA 70E requires it be done under a permit system. OSHA does not require a permit system, but lists much of the same safe work practices that must be addressed in 1910.333 that are identified in NFPA 70E, Chapter 1. Unless the employer can demonstrate that de-energizing introduces additional or increased hazards or is infeasible due to equipment design or operational limitations the equipment is to be de-energized. Normally, lost production time is not an acceptable reason. An exception to the permit system is granted for troubleshooting, however safe work practices must still be provided.

Personal protective equipment in compliance with NFPA 70E is required when servicing energized equipment. The standard also requires that employees be trained in methods of releasing victims from contact with energized electrical conductors or circuit parts and providing first aid/CPR.

Training conducted in 2007 addressed arc flash and shock protection. The electrical shop also has an energized electrical work permit system when work needs to be done on energized equipment such as electrical panels.

OSHA PPE Standard 29CFR 1910.132

The OSHA personal protective equipment standard requires that the employer conduct a written hazard assessment of employee tasks and identify necessary PPE to protect against the hazards associated with the tasks. PPE must be specified and the assessment must be formally documented.

“The employer shall verify that the required workplace hazard assessment has been performed through a written certification that identifies the workplace evaluated; the person certifying that the evaluation has been performed; the date(s) of the hazard assessment; and, which identifies the document as a certification of hazard assessment.”

Though a written certification of hazard assessment had not been completed, a suite of PPE had been provided to electrical shop staff for both shock and arc flash protection. Use of this equipment was addressed in the 2007 electrical safety training.

As stated earlier, PPE is a last resort for employee protection. When troubleshooting electrically insulated gloves with protective outer leather gloves must be worn. Gloves were

provided to Mr. Krause and were tested. These gloves were in his service vehicle, but not used at the worksite.

Standards of Practice

Standard of Care

As part of the investigation, officials at both apprenticeship training programs, International Brotherhood of Electrical Workers Local 159 and Associated Builders and Contractors were consulted. There were no uniform recommendations offered on how lights must be serviced. Electrical safety is covered in both apprenticeship programs. Program officials felt lockout practices and working on non-energized equipment were becoming increasingly part of the standard of care.

Interviews with Other Electricians

In the weeks following the fatality, FPM electricians were randomly selected for interviews to discuss work practices, PPE use and safety culture. Both management and staff were selected for interviews. Of 85 employees, 12 were randomly selected and interviewed and 2 additional staff had volunteered. Two of those interviewed were supervisors. Mr. Krause's working partner was also interviewed.

The electric shop employees were all provided with and knowledgeable of the electrical PPE bags and lockout kits. Employees did say that if they need additional safety equipment or devices the department was very good about getting it for them. What was not clear and consistent was when and what PPE is required for the various tasks that they perform. A few employees did carry with them the NFPA 70E PPE table as a reference for when and what PPE is required. The employees also stated that when using the electrical PPE it was difficult to do their work. When wearing double gloves (insulated rubber gloves and leathers) detail work such as working with wire nuts was difficult to perform. The use of the tinted face shields made it difficult to identify the color of the wires. Employees were also not consistent on lockout requirements and would use their judgment as to when to lockout and when not to lockout. For example if they have line of sight on a disconnect, they may not lock it out and there were others that always lockout. The electrical permit system was also not consistently used within the department.

It was also observed that there should more focus on safety within the department. Many employees gave examples from previous employers that had regularly occurring safety talks, meetings and training.

A common observation is that electricians report routinely working on energized systems. Many of the electricians contacted during this investigation, both on campus and elsewhere indicated personal experience with being shocked. This underscores the need to push standard practice more toward isolation and lockout and less toward live work.



Figure 7 Photo showing mis-labeled junction box cover (should have been 16)

Discussion

The light fixture serviced was manufactured by Kirlin and used a 250 Watt high intensity discharge lamp. Input voltage on the fixture was 120 volts with output from the ballast at 400 volts.

The Lockout/Tagout policy allowed replacement of internal light fixture components without application of lockout procedures, but did not specify the safe work practices for properly isolating the equipment from the power source. There is a lack of consistency in how electricians choose to handle the isolation of power prior to servicing equipment. Some choose to lockout power while others will simply disconnect it, particularly if it is within line of sight. At a minimum, it seems the regulations would require that safe work practices be described for safely isolating power. There seemed to be general agreement among electricians that power should always be isolated prior to servicing and that experienced electricians would be expected to have this knowledge. Nonetheless, the employer has a duty to assure that a minimum standard of safety is followed and steps should be taken to document those expectations. This reflects the shared responsibility for workplace safety described in NFPA 70E.

During the investigation, questions were raised about whether the junction box covers were labeled with the right circuit number. Prior to the accident, it appears that the circuit in question may have been mislabeled as circuit 13 (see Figure 7). It was later changed to circuit 16, the correct number. Because there appeared to be no attempt to shut down power to the circuit, this error did not have bearing on the accident. However, it underscores the importance of verifying that power has been successfully isolated before proceeding.

There was also a question raised about whether the fuse was properly sized for the fixture. The inline fuse for the fixture is a 12 amp fuse. Electric shop personnel felt the fuse appeared to be original to the fixture. The data sheet for the ballast recommends an 8 amp fuse for 120V. The main purpose of the inline fuse is to prevent one light fixture from tripping an entire branch circuit. The use of a 12 amp fuse is not believed to be a contributing factor.

There are three possibilities of how Mr. Krause was electrocuted.

- 1) He contacted an exposed wire on the secondary side of the ballast (power lead for the capacitor),
- 2) He contacted an exposed lead coming off the capacitor, or
- 3) An energized lead contacted the fixture box, thereby energizing it.

Police photos show three exposed wires (see Figure 8). One could speculate that Mr. Krause was progressing to replacing the capacitor and/or ballast after he had changed the lamp. If an energized wire touched the metal fixture box, electrical engineers and electricians consulted felt arcing marks should have been observed and the breaker should have tripped, neither of which were observed. However, the electrical engineer consulted during this investigation felt that since the short would have been on the secondary side of the ballast, the maximum current would have only been about 2.75 amps, much less than would be expected to trip the breaker. All electricians and engineers consulted during the investigation felt that had an energized wire contacted the box, an electrically safe condition would still have existed by virtue of grounding. The fixture box was grounded through the ground wire, conduit and metal tie-ins of the fixture to the building structure.

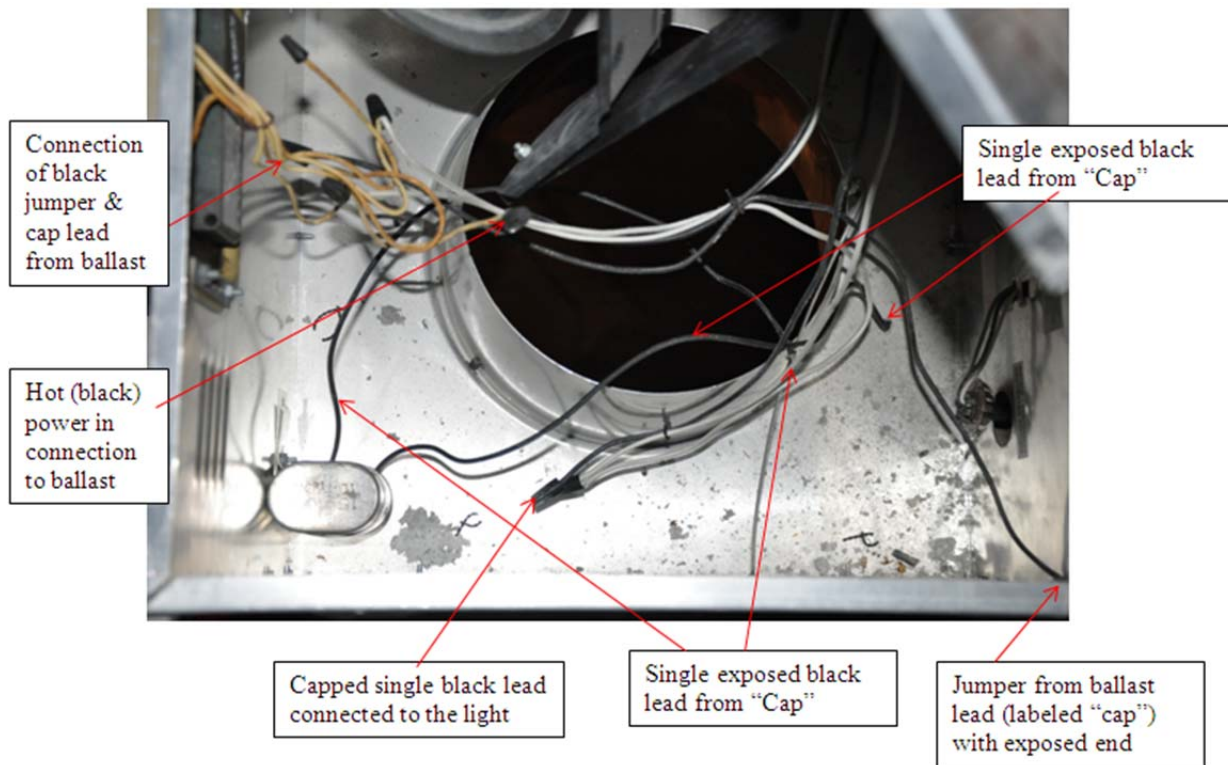


Figure 8 Photo showing overhead view of fixture box with labeled wires

According to the UW Police Report, the medical examiner felt the point of entry for electrical contact was the right chest with exit point being the tip of the left middle finger. Electrical engineers consulted during the investigation felt assignment of entry and exit sites for alternating current is difficult due to a number of factors and that it is more appropriate to think of wound sites as simply contact points. The police photo (See Figure 9) seems to show the power lead from the secondary side of the ballast either touching or at least very close to the fixture box.



Figure 5 Photo showing exposed power lead coming from secondary side of ballast

The observation of breakers tripped on a small electrical panel near the larger lighting control panel was not felt to be related to the event by all electricians consulted because it served different equipment.

While training helps one learn how to manage and protect against the hazards, it is prudent to eliminate the hazard where ever possible. There are obvious hazards inherent in working with and around electricity. As such, it is not surprising there are apprenticeship and certification programs designed to develop and certify requisite experience.

With the magnitude of campus facilities to maintain, diversity of those facilities in age, complexity and nature of space and the variety of staff both internal and external that may have serviced those facilities, it is likely that mistakes will sometimes be made. It is essential that verification of energy status be adopted as a universal safe work practice.

When an electrician is hired at a journeyman or master level, it is expected that he or she has acquired a certain level of competency to identify and correct electrical hazards by virtue of their certification credential. This is an appropriate expectation. However, it is also important that because electrical work involves exposure to life threatening hazards, that the university assure there is a culture that encourages the discussion and following of safe work practices and the shared ownership of such.

The use of PPE and in particular electrically insulated gloves should be a last defense against hazards and not the primary one. Using both the rubber gloves with outer leather gloves introduces great difficulty in performing work requiring high dexterity. As such, the temptation to remove gloves will be ever present. It is critical therefore that hazards be eliminated as a first course of action. There were a number of options for doing so in this case. There were no indications in electrician interviews that guidance had been offered on when to isolate power. Therefore, it must be made clear by management that employees are expected to and authorized to take the requisite time to safely isolate power prior to servicing equipment.

Regular training is encouraged to offer a forum for dialogue, understanding and compliance with safe work practices. Training should also be provided for both electricians and UW Police in dealing with first aid associated with electrical emergencies. It was mentioned in police reports that Mr. Krause was shaken on two separate occasions to determine consciousness. It is critical that assurances are made that power is shut off before a victim of electrocution is contacted. Because electricians are at greater risk for electrocution, they should be given first aid and CPR training. This is also required under NFPA 70E.

Findings

Mr. Krause was replacing components on a light fixture without properly isolating power to that fixture. Failure to isolate power left him at risk of contacting a live wire or energizing the fixture. He was not wearing electrically insulated gloves at the time. According to communication with the Medical Examiner's office, the path of electrical contact was through the chest exiting the left finger. For reasons stated earlier, it is unlikely that Mr. Krause received a fatal shock from an

energized box, but more likely that he somehow contacted the live wire as a point of entry and completed a circuit through contact with the box. The tight proximity of the working space made it likely he would at some point have contact with the fixture box. It also appears that he did not verify power was off before servicing the light. Proper practice should be to wear electrically insulated gloves while checking or changing lamps and once a determination is made to replace components, steps must be taken to either isolate power under control of the employee or to lockout the fixture circuit at the breaker panel following procedures in 29CFR1910.147. If de-energizing the system cannot be done, then safe work practices described in NFPA 70E should be documented and followed.

Corrective Action

A number of corrective actions are recommended to prevent re-occurrence.

Electrical Safety Program Changes

The following changes should be made to the FPM electrical safety program.

- No work on energized equipment should occur unless safe work practices consistent with NFPA 70E are documented and followed.
- If power lockout/tagout cannot be implemented on the appropriate equipment or circuit due to additional hazards or operational concerns, safe work practices must be followed, including isolation of power where feasible.

Training

The videotaped training session can be a part of the electrical safety training program, but it cannot be the sole component. The videotaped session should be delivered in smaller portions, with opportunity to ask questions, and to review encountered work conditions. Supervisors must play a role in regular training that occurs no less than annually. More regular discussion of practical challenges in isolating or locking out equipment will do more to assure such practices are followed. First aid/CPR training should be given to all electricians. This is required in NFPA 70 E.

Assurance

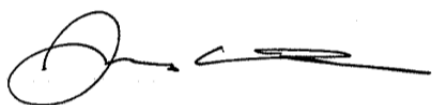
Supervisors must periodically review work practices and observe whether staff are following those practices. Observations must be recorded. The Environment, Health and Safety Department must play a role in oversight and assurance as well. An option would be to provide EHS viewer access to FP&M work orders to enable spot checking of projects for electrical safety compliance. EHS must also assist with regular program review and training. Where staff is observed not following safe work practices documented in the electrical safety policy, a progressive disciplinary plan should be implemented.

Compliance Schedule

The schedule for achieving the corrective action recommendations is as follows. The timeline below is consistent with the compliance order and dates required in the Wisconsin Department of Professional Services and Safety orders of August 16, 2011.

Corrective Action	Basis	Compliance Date
EHS and Electric Shop management shall review FPM electrical safety program and make changes as indicated in this report	OSHA 1910.147 (c)(6)(i), element of existing FP&M Electric Shop policy (program review)	10/1/11
EHS and Electric shop management shall develop personal protective equipment policy for FPM Electric Shop	OSHA 1910.132	10/1/11
EHS shall develop and Electric Shop management shall implement written hazard assessment for PPE selection and use for electric shop employees	OSHA 1910.132	10/1/11
EHS and Electric Shop management shall conduct electrical safety training including personal protective equipment review and demonstration	OSHA 1910.147 (c)(7), 1910.132 (f)	11/1/11
Supervisors and EHS shall document a minimum of 12 work practice observations to evaluate compliance with health and safety requirements	Element of existing FP&M Electric Shop policy (program review)	10/1/12
FPM shall arrange for First Aid/CPR Training for electrical shop employees	NFPA 70E	2/1/12

Report Submitted by:



James M. Morrison, CIH
Assistant Director/Occupational Health Officer
Environment, Health and Safety- Facilities, Planning & Management
University of Wisconsin- Madison

Attachment 1

Wisconsin Department of Safety and Professional Services
Inspection Report and Orders
File 1906
August 16, 2011



commerce.wi.gov

PUBLIC EMPLOYEE OCCUPATIONAL SAFETY & HEALTH INSPECTION REPORT AND ORDERS

Wisconsin Commerce Department
Safety and Buildings Division
Bureau of Field Operations
P.O. Box 2538
201 W. Washington Ave
Madison, WI 53701

To The Attention Of: Jim Morrison	Inspection Date: 7/28-8/2, 2011	File Number: 1906	Number of Violations: 3
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Employers Address: 30 E. Campus Mall, Rm. 260, Madison, WI 53715

Safety Program Evaluation X	Work Site Inspection X
Violations Explained To: Jim Morrison	Located At (number and Street address): 455 N. Park St.
Title: Occupational Health Officer/Assistant Director	City: Madison County: Dane

Compliance Date: 10/1/11

NOTICE: Employer must post a copy of this report at site of violation for minimum of 3 days or until all violations are abated, whichever is longer - Wis. Stats. 101.055(6). All violations noted must be abated by the above compliance date, with extensions granted only if a good faith effort is established. Extensions are not automatically granted, and must be accompanied by an accepted compliance/abatement plan and approved by the compliance officer.

The information you provide may be used for other government agency programs [Privacy Law, s. 15.04(1)(m)].

NOTE: All violation orders starting with "1910" are referenced through Comm 32.50(2) referencing: 29 CFR 1904, 1910 & 1926 (OSHA Codes)

This DEPARTMENT ORDER is issued as a result of an occupational safety or health inspection of the employer listed above. The following violations were revealed:

THESE ORDERS ARE A RESULT OF A FATALITY INVESTIGATION INVOLVING ELECTROCUTION

1. **Code Section Violated: 1910.132 (a)(1)** The employer shall assess the workplace to determine if hazards are present, or likely to be present, which necessitate the use of personal protective equipment. If such hazards are present or likely to be present, the employer shall:

- Have employees use the PPE that will protect them from the identified hazard.
- Communicate selection decisions to each affected employee.
- Select PPE that properly fits each affected employee.
- Verify that the required workplace hazard assessment has been performed through a written certification that identifies the workplace evaluated; the person certifying that the evaluation has been performed; the dates of the hazard assessment; and which identifies the document as a certification of hazard assessment.
- Provide training for employees who are required to use PPE. The training will include;
 - When PPE is necessary
 - What PPE is necessary
 - How to properly use PPE
 - The limitations of the PPE
 - The proper care, maintenance, useful life and disposal of the PPE.
- Verify that each affected employee has received and understood the required training. This shall be done through a written certification that contains the name of each employee trained, the date(s) of training, and that identifies the subject of the certification.

Condition Found: Workplace hazard assessments have not been completed or documented for Electricians and staff has not received the required PPE training based on the workplace hazard assessments.

Action Required: Perform workplace hazard assessments to determine proper PPE requirements for staff and provide required and regular PPE training. Document all training.

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commerce.wi.gov

PUBLIC EMPLOYEE OCCUPATIONAL SAFETY & HEALTH INSPECTION REPORT AND ORDERS

Wisconsin Commerce Department
Safety and Buildings Division
Bureau of Field Operations
P.O. Box 2538
201 W. Washington Ave
Madison, WI 53701

2. Code Section Violated: 1910.147(c)(6)(i) *Periodic Inspection*. The employer shall conduct a periodic inspection of all the energy control procedures at least annually to ensure that the procedure and the requirements of the standard are being followed.

- a) The periodic inspection shall be performed by authorized employee other than the ones(s) utilizing the energy control procedures being inspected.
- b) The periodic inspection shall be conducted to correct any deviations or inadequacies identified.
- c) Where lockout is used for energy control, the periodic inspection shall include a review between the inspector and each authorized employee, of that employee's responsibilities under the energy control procedure being inspected.

1910.147(c)(6)(ii) The employer shall certify that the periodic inspections have been performed. The certification shall identify the machine or equipment on which the energy control procedure was being utilized, the date of the inspection, the employees included in the inspection, and the person performing the inspection.

Condition Found: Annual inspection of energy control procedures for specific equipment had not been completed or documented. Employee training and review had not been completed or documented.

Action Required: Complete and document annual periodic inspection as well as employee training and reviews

3. Code Section Violated: 1910.147(c)(7)(i) The employer shall provide training to ensure that the purpose and function of the energy control program are understood by employees and that the knowledge and skills required for the safe application, usage, and removal of the energy controls are acquired by employees. 1910.147(c)(7)(iii)(A) Retraining shall be provided for all authorized and affected employees whenever there is a change in their job assignments, a change in machines, equipment or processes that present a new hazard, or when there is a change in the energy control procedures.

Condition Found: Lock Out/Tag Out program training was last completed for Krause in November 2007. There was no additional documentation of electrical safety training or review since 2007.

Action Required: Ensure that employees are being kept up to date and regularly trained in the latest Lock Out/Tag Out program. Ensure that employees are retrained whenever there is a change in their job assignments, a change in machines, equipment or processes that present a new hazard, or when there is a change in the energy control procedures.

Department Orders are issued as a result of an inspection on the above referenced site. You are hereby ordered to have the violations corrected to conform to the indicated provisions of the Wisconsin Administrative Code and/or Wisconsin Statutes. These violations must be corrected by the compliance date noted, and upon correction of violations, I must be notified. If you fail to comply, this order is enforceable in circuit court pursuant to s. 101.02(13), Stats, with forfeitures ranging from \$10-\$100 per day for each violation. If you have any questions regarding this matter, please feel free to contact me at the number listed.

Ch. 101.02(6)(e) stats. Any employer or other person interested either because of ownership in or occupation of any property affected by any such order, or otherwise, may petition for a hearing on the reasonableness of any order of the department in the manner provided in this subchapter.

Deputy Signature:

8/16/11
Date Issued:

Deputy Name: April Hammond

Deputy Phone Number: (608) 225 - 6593

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Attachment 2

UW- Madison Facilities, Planning & Management
Electric Shop Lockout/Tagout Policy and Procedures
May 1, 2008



**UNIVERSITY OF WISCONSIN-MADISON
PHYSICAL PLANT**

**Electric Shop
LOCKOUT/TAGOUT
Policy and Procedures**

Approved by:

**Faramarz Vakili
Associate Director of Physical Plant**

Date:

May 1, 2008

1. Purpose

The University of Wisconsin-Madison Energy Control Physical Plant Electric Shop Lockout/Tagout Policy establishes the means to protect Electric Shop employees and other people during machine and equipment servicing and maintenance where the unexpected energization, start up or release of any type of energy could occur and cause injury. In accordance with the Occupational Safety and Health Administration (OSHA) Standard, 29 CFR 1910.147, *Control of Hazardous Energy*, this Policy includes specific lockout/tagout (LOTO) procedures, training requirements, and periodic inspection requirements.

2. Description

Lockout is the process where individuals isolate and secure energy sources prior to maintenance or construction activities. The energy sources remain secured by locks during the work and are not removed until the work is completed. The lock is placed by the worker exposed to the hazard and is removed by the same person. The key remains in the exposed worker's possession throughout the entire process. Tagout is a similar process where tags are used instead of locks. Tagout is only permitted on equipment or systems without lockout capability. Specific procedures are required for tagout because of the ease in defeating tagout systems. This policy does not apply to certain types of work. Section 7 identifies what is exempted from the requirements for LOTO.

3. Compliance

Electric Shop employees are required to comply with the restrictions and limitations imposed upon them during the use of lockout. Electric Shop employees authorized to lockout machines/equipment are required to perform the lockout in accordance with this policy. Electric Shop employees upon observing a machine or piece of equipment which is locked out to perform servicing or maintenance shall not attempt to start energize or use that machine or equipment. Failure to comply with this Lockout/Tagout Policy is cause for disciplinary action up to and including dismissal.

4. Definitions

Affected person: A person whose job requires operation or use of equipment on which maintenance is being performed under the lockout/tagout policy, or whose job requires work in an area where such work is being performed.

Authorized person: A knowledgeable individual to whom the supervisor has given the authority and responsibility to lock or implement a lockout/tagout procedure on machines or equipment to perform maintenance or repair. An authorized individual and an affected person may be the same individual when the affected person's duties also include performing maintenance or repair of a machine or equipment, which must be locked and tagged out.

Energy Isolating Device: A mechanical device that physically prevents the transmission or release of energy, including, but not limited to, the following: a manually operated electrical circuit breaker, a disconnect switch, a manually operated switch, a slide gate, a slip blind, spectacle flange, a line valve, blocks, and similar devices with a visible indication of the position of the device. Check valves, push buttons, selector switches, and other control-circuit type devices are not energy isolating devices.

Energy Source: Any electrical, mechanical, hydraulic, pneumatic, chemical, thermal, or other energy source that could cause injury to personnel.

Lockout Device: A device that utilizes a lock and key to hold an energy isolating device in the safe position and prevents a machine or equipment from being energized.

Personal Controlled Lock: Permanently issued lock with one key that shall not be duplicated, used specifically by workers who are going to work under an existing LOTO. The worker SHALL affix this lock to a multi-lock hasp or lockbox. The worker controls the lock and key.

5. Responsibilities – Listed below are responsibilities for Electric Shop personnel:

Supervisors

- identifying and labeling all work area hazardous energy sources or equipment that require LOTO
- developing, documenting, implementing, and enforcing specific energy control procedures for each hazardous energy source
- maintaining LOTO a record log that records the following: the date and time a LOTO was issued, the name of the “authorized person” performing the LOTO, the exact location of the LOTO, the name of the system being locked out, the reason for the LOTO, and the date and time the LOTO was removed
- providing the resources, including tags, locks, and keys, as appropriate, and direction necessary to ensure that an effective program is in place and followed
- ensuring that only authorized persons trained in LOTO procedures perform lockout work
- ensuring “Affected person(s)” are notified before LOTO is applied and after the LOTO is removed, but before the equipment is started
- publishing the University’s *Energy Control Program – Physical Plant Electric Shop Lockout/Tagout Policy and Procedures*
- providing classroom training on this policy and in accordance with the OSHA Standard, 29 CFR 1910.147

Authorized Person

- providing persons in the affected area (Affected Person) with the expected start date, start time, and duration of the project and a description of all the systems affected
- implementing the energy control procedure, including positioning the energy isolation device and physically testing the equipment to ensure the equipment is isolated

6. Requirements

- Specific energy control procedures for hazardous energy sources shall be written.
- A log shall be maintained that records the date and time a LOTO was issued, the name of the “authorized person”, the exact location of the LOTO, the name of the system being locked out, the reason for the LOTO, and the date and time the LOTO was removed.
- All Electric Shop employees that provide or support maintenance, utility distribution, construction and renovation services, shall be familiar with the significance and requirements of lockout/tagout procedures. Electric Shop employees must be able to recognize locked/tagged equipment and must not attempt to defeat these controls.
- Only “Authorized person(s)” are permitted to lockout/tagout systems and equipment.
- Notification must be given to people in areas affected by a shutdown that a loss of service will occur.
- No “Authorized Person” shall install a lockout/tagout on any system without first notifying the responsible supervisor.
- Electric Shop subcontractors who perform work on energized equipment on University property must have an implemented lockout/tagout policy and perform work according to this policy.
- If an energy isolation device is capable of being locked out, then LOTO shall be used.
- Tagouts alone may only be used when it is not possible or feasible to use locks, and an additional safety measure has been implemented, that provides a level of safety equivalent to that obtained by the use of a lockout.
- If the equipment is operating, the equipment must be shut down by the applicable operations procedure before lockout or tagout is applied. Residual energy must be relieved, restrained and checked as described by the operating procedure. Appropriate means must be employed to prevent energy from being induced into a LOTO system.

7. Lockout/Tagout Is Not Required

- Unless required by the work control document(s)
- Live electrical systems or components that operate at less than 50 volts to ground are not required to be LOTO if there will be no increased exposure to electrical hazards. An example of increased exposure to electrical hazards is working on equipment connected to a high amperage battery bank operating at less than 50 volts where severe and explosive arcing could occur in short circuit conditions.
- For work on cord and plug-connected electric equipment for which exposure to the hazards of unexpected energization, startup of the equipment, or release of hazardous energy is controlled by unplugging the equipment from the energy source. In addition, the plug is under the immediate control of the person performing the servicing or maintenance.
- For re-lamping activities (Electric Shop employees must use appropriate PPE).
- Electrical lighting fixture-internal component replacement (Electric Shop employees must use appropriate PPE).

8. Energy Control Procedures

Listed below are steps that must be addressed prior to initiation of a lockout or tagout. Procedures shall be written and maintained for each piece of equipment or process that identifies all energy sources and the energy isolation devices. The procedures must identify the type and magnitude of the hazardous energy, the means and methods that will be used to protect persons during servicing or maintenance operations, and the identity of the relevant machine or equipment.

1. **Preparation** - Notify all affected persons that servicing or maintenance is required on a machine or equipment and that the machine or equipment must be shut down and locked out to perform the servicing or maintenance.
2. **Machine or Equipment Shutdown** - If the machine or equipment is operating, shut it down by the normal stopping procedure.
3. **Machine or Equipment Isolation** - Operate the switch, valve, or other energy isolating device(s) so that the equipment is disconnected or isolated from its energy source(s).
4. **Release of Energy** - Ensure that all energy is dissipated or restrained (such as that in capacitors, springs, elevated machine members, rotating flywheels, hydraulic systems, and air, gas, steam, or water pressure, etc.) by methods such as grounding, repositioning, blocking, bleeding down, etc.
5. **Application of Lockout/Tagout** - Lock out the energy isolating device(s) with the assigned individual lock.
6. **Verification of Isolation** - After ensuring that no personnel can be exposed, operate the push button or other normal operating control(s) or by testing to make certain the equipment will not operate.
7. **Removal of Lockout Devices** - Before lockout or tagout devices are removed and energy is restored to the machine or equipment, the authorized person must take the following actions:
 - **Inspect** the work area to ensure that non-essential items have been removed and that machine or equipment components are intact and capable of operating properly.
 - **Check** the area around the machine or equipment to ensure that all people have been safely positioned or removed.
 - **Notify** affected persons immediately *after* removing locks or tags and before starting equipment or machines.
 - **Ensure** that locks or tags are removed **ONLY** by those people who attached them. (In the very few instances when this is not possible, the device may be removed under the direction of the employer, provided that he or she strictly adheres to the specific procedures outlined in the standard.)

Procedure involving more than one individual - If more than one individual is required to lockout or tagout equipment, each shall place his/her own personal lockout/tagout device on the energy isolating device(s). When an energy-isolating device cannot accept multiple locks or tags, a multiple lockout or tagout device (hasp) may be used. If lockout is used, a single lock may be used to lockout the machine or equipment with the key being placed in a lockout box or cabinet, which allows the use of multiple locks to secure it. Each person will then use his/her lock to secure the box or cabinet.

Tagout - The tagout system includes all of the steps of this lockout policy except the actual use of a lockout device on that particular energy isolation device. Additional means to be considered as a part of the demonstration of full protection shall include the implementation of additional safety measures such as the removal of an isolating circuit element, blocking of a controlling switch, opening of an extra disconnecting device, or the removal of a valve handle to reduce the likelihood of inadvertent energization.

9. Training requirements

- Initial training shall be provided to any person before starting service or maintenance activities that fall under the scope of this Policy.
- Each authorized person shall receive training in the recognition of applicable hazardous energy sources, the type and magnitude of the energy available in the workplace, and the methods and means necessary for energy isolation and control.
- Retraining must be provided whenever there is a change in job assignments; a change in machines, equipment, or processes that presents a new hazard; or a change in energy control procedures.
- Additional retraining must be conducted whenever a periodic inspection reveals, or whenever the employer has reason to believe that there are deviations from or inadequacies in the employees' knowledge or use of the energy control procedure.

10. Annual inspections

Annual inspections must be performed to assure that the department's LOTO program is adequately implemented. The inspection will include the following:

- a review of the LOTO record log
- a review of the descriptive list of hazardous energy sources
- a review of written energy control procedures
- an interview with applicable personnel to verify their knowledge and use of LOTO