OPERATING EXPERIENCE SUMMARY

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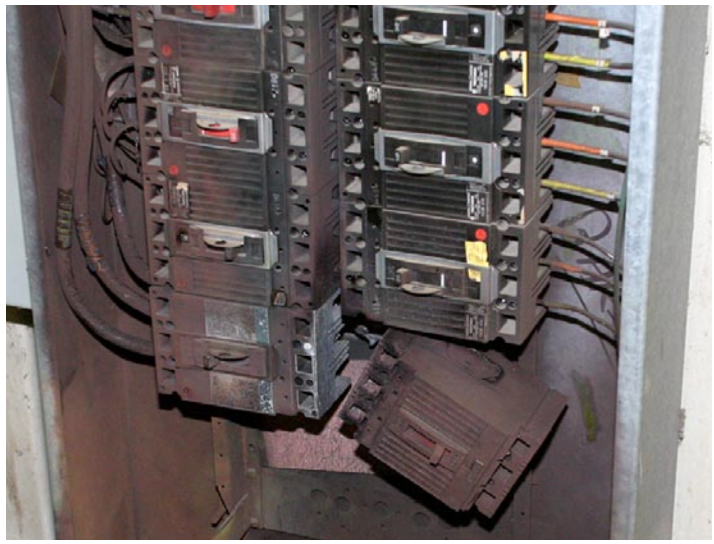

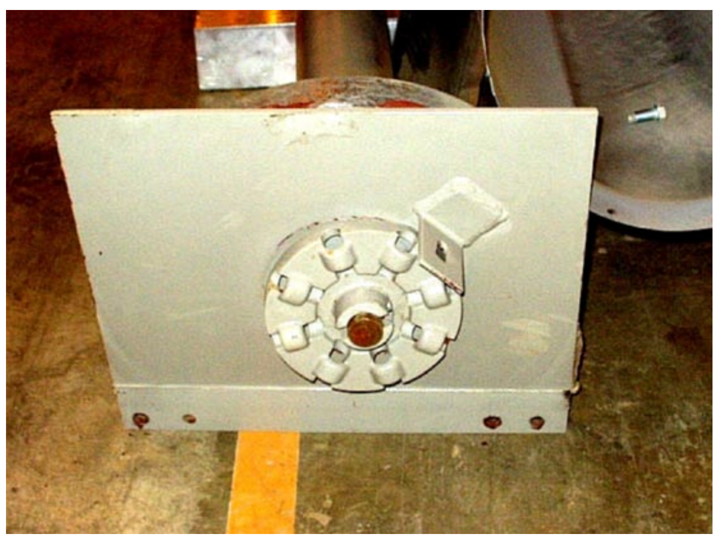

U.S. Department of Energy
Office of Environment, Safety and Health
OE Summary 2005-01
January 10, 2005

The Office of Environment, Safety and Health, Office of Corporate Performance Assessment publishes the Operating Experience Summary to promote safety throughout the Department of Energy complex by encouraging the exchange of lessons-learned information among DOE facilities.

To issue the Summary in a timely manner, EH relies on preliminary information such as daily operations reports, notification reports, and conversations with cognizant facility or DOE field office staff. If you have additional pertinent information or identify inaccurate statements in the Summary, please bring this to the attention of Frank Russo, 301-903-8008, or Internet address Frank.Russo@eh.doe.gov, so we may issue a correction. If you have difficulty accessing the Summary on the Web (URL http://www.eh.doe.gov/paa), please contact the ES&H Information Center, (800) 473-4375, for assistance. We would like to hear from you regarding how we can make our products better and more useful. Please forward any comments to Frank.Russo@eh.doe.gov.

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EH Publishes "Just-In-Time" Reports

The Office of Environment, Safety and Health recently began publishing a series of "Just-In-Time" reports. These two-page reports inform work planners and workers about specific safety issues related to work they are about to perform. The format of the Just-In-Time reports was adapted from the highly successful format used by the Institute of Nuclear Power Operations (INPO). Each report presents brief examples of problems and mistakes actually encountered in reported cases, then presents points to consider to help avoid such pitfalls.

1. Deficiencies in identification and control of electrical hazards during excavation have resulted in hazardous working conditions.
2. Deficiencies in work planning and hazards identification have resulted in electrical near misses when performing blind penetrations and core drilling.
3. Working near energized circuits has resulted in electrical near misses.
4. Deficiencies in control and identification of electrical hazards during facility demolition have resulted in hazardous working conditions.
5. Electrical wiring mistakes have resulted in electrical shocks and near misses.
6. Deficiencies in planning and use of spotters contributed to vehicles striking overhead power lines.

The first six Just-in-Time reports were prepared as part of the 2004 Electrical Safety Campaign. In April, the Office of Environment, Safety and Health published a Special Report on Electrical Safety. The purpose of this report is to describe commonly made electrical safety errors and to identify lessons learned and specific actions that should be taken to prevent similar occurrences. This report can be accessed at http://www.eh.doe.gov/paa/reports/Electrical_Safety_Report-Final.pdf.

EH plans to issue more Just-in-Times soon on other safety issues, such as lockout and tagout, fall protection, and freeze protection. All of the Just-in-Times can be accessed at http://www.eh.doe.gov/paa/jit.html.

EVENTS

1. NEAR MISSES FROM FALLING OBJECTS—A DANGEROUS TREND

There was a sharp increase in the number of near misses caused by falling objects in the last 3 months of 2004. More than a dozen fourth-quarter events fell into two categories: objects falling while work was being performed and objects falling while workers were on or near scaffolds. The summaries here provide lessons learned for everyone—workers at heights as well as workers or passersby below. However, when work is being performed at heights (Figure 1-1), the primary responsibility for safety rests with workers above, who are required to adhere to protective measures established in Subpart L, *Scaffolds*, of the OSHA Standard for Construction, 29 CFR 1926.

Figure 1-1. Typical worker on scaffold

On December 7, 2004, at the Hanford Office of River Protection Waste Treatment Plant (WTP) construction site, two laborers were performing cleanup inside a rebar wall while a third laborer was positioned at the top of the wall as a safety watch. At some point, an ironworker began adjusting rebar above the laborers. When he cut the wire at the bottom of a 13-foot piece of rebar that weighed about 59 pounds, it slipped out of its tieoff and fell about 15 feet, landing within a foot of one of the laborers inside the rebar wall. Cramped conditions prevented the laborer on the ground from moving out of the way. Also, the safety watch failed to stop the ironworker above. (ORPS Report RP--BNRP-RPPWTP-2004-0030)

On November 15, 2004, another near miss occurred at the Hanford WTP construction site when a worker on a scaffold dropped a 7-foot-long angle iron, which fell 55 feet and landed in an occupied area. As the angle iron fell, it hit a workstation at ground level, narrowly missing a worker. Investigators discovered that workers had become complacent about the yellow boundary tape and routinely crossed the boundary to perform work. In addition, the worker on the scaffold did not have complete control over the angle iron and had allowed it to slide and drop 10 or 12 inches before it actually fell. (ORPS Report RP--BNRP-RPPWTP-2004-0029)

On November 10, 2004, at the Savannah River Site, a carpenter on a narrow scaffold stairtower stopped work to allow another worker to get by. The carpenter placed his wrench in his pocket while waiting to return to his task. When the carpenter moved, the wrench was dislodged, and fell, bounced once, and landed near the workers below. The wrench should have been stowed in a tool pouch instead of a rear pants pocket, and employees should have adhered to the “not wide enough to pass in opposite directions” warning tag on the stairs. (ORPS Report SR--WSRC-CMD-2004-0007)

On November 2, 2004, at Hanford’s WTP construction site, workers on a 30-foot-high scaffold dropped a scaffolding clamp, narrowly missing an employee on the ground. Investigators determined that the scaffold workers had not followed normal procedure and had loosened both sides of the clamp instead of just one, allowing the clamp to fall. Also, workers had crossed the yellow boundary tape into the area below overhead work and no one prevented them from doing so. (ORPS Report RP--BNRP-RPPWTP-2004-0026)

That same day, after a non-near-miss event involving a pry bar dropped from an aerial lift basket to an unoccupied area below, management issued a Recurring Event Report to acknowledge the negative trend. (ORPS Report RP--BNRP-RPPWTP-2004-0027) The report addressed four near-miss events and five non-near-miss events involving falling tools or objects at the Hanford Office of River Protection site between September 27 and November 2.

The report identified the falling clamp event described above and the following near misses.

1. Side-cutter pliers fell and struck a worker's hard hat.

2. A 10-pound bar, used to bend rebar by hand, fell and grazed an inspector's arm.

3. A 6-foot-long level fell 40 feet and landed near workers.

Subpart L of 29 CFR 1926 provides requirements for maintaining control of tools while working on scaffolds, including the use of toeboards and netting (Figure 1-2). It also requires installing barricades below work areas and requires employees to remain clear of the hazard area.

Figure 1-2. Typical debris net

Although the Hanford Waste Treatment Plant is under construction, non-construction work presents dangers as well. On October 27, 2004, at Oak Ridge K-33, an expansion joint cover fell through the opening and onto the operations floor below, landing within 6 feet of a worker. The employee placing the expansion joint covers on the cell floor above failed to post and flag the corresponding operations area directly beneath as required by the work plan. Expansion joints, which run between building columns that are 20 feet apart, are being removed for survey and decontamination. Following removal of each joint, a temporary cover is placed over the opening to prevent material and debris from falling through; permanent steel covers will be installed after decontamination is complete. (ORPS Report ORO--BNFL-K33-2004-0005)

The text box below contains tips on working safely on scaffolds.

Tips for Safe Overhead Work

- Secure tools and materials to prevent them from falling on people below.
- Barricade hazard areas and post warning signs.
- Use toeboards, screens, or guardrails on scaffolds to prevent falling objects.
- Alternatively, use debris nets, catch platforms, or canopies to catch or deflect falling objects.
- Personnel working below should wear hard hats.

These events demonstrate the importance of analyzing all potential work hazards and following requirements to protect both the workers and those outside the immediate work area who may be impacted. It is crucial for workers to follow work plans completely and for passersby and adjacent workers to obey all yellow boundary tapes. Workers at heights hold the primary responsibility for safety, for example, by ensuring that scaffolds are equipped with toeboards or netting; using tool lanyards; and keeping scaffolding clear of debris.

KEYWORDS: *Falling objects, dropped objects, heights, scaffold, near miss*

ISM CORE FUNCTIONS: *Analyze the Hazards, Develop and Implement Hazard Controls, Perform Work within Controls*

2 REPORT SAFETY CONCERNS IMMEDIATELY

On December 7, 2004, the plant shift supervisor at the Idaho Nuclear Technology and Engineering Center (INTEC) was informed that two people had received a mild electrical shock when they simultaneously opened the door to the flammable storage room and turned on the light/fan switch. Preliminary information indicates that the cause was a short in the lighting circuit; however, this problem went unreported for weeks. (ORPS Report ID--BBWI-LANDLORD-2004-0018)

Three weeks earlier, personnel reported that one of the two lights in the flammable storage room was burned out and they had seen some arcing. Maintenance replaced the light bulb, but the replacement bulb did not work. The bulb that had been replaced showed signs of arcing on its exterior. Maintenance realized that the problem could be a faulty fixture and submitted a work request, which was given a low priority, to troubleshoot and repair the fixture. The work request should have been given a safety concern priority. Fire Safety personnel decided to close the door and turn off the circuit, which controls the lights and ventilation fan and is normally on at all times. Entry into the room was allowed to continue, but personnel had to turn the circuit on when they enter the room.

Access to this room requires two keys: one to open the door and another to activate the circuit for the lights and fan. The key that activates the circuit is kept just inside the door. Normally personnel open the door first and then retrieve the circuit key. On December 6, a warehouse worker entered the storage room, using both keys simultaneously, and felt a mild electrical shock. He asked another worker to repeat the unlocking actions, and that worker received a minor shock as well. The two workers reported this problem to their supervisor, who in turn escalated it to his supervision and to the plant shift supervisor. A formal critique followed.

Maintenance personnel confirmed that the light fixture had a short. After capping the feed wires for the faulty fixture, they restored power to the other light and ventilation fan and verified that no electrical energy was leaking across the two key switches. Maintenance concluded that someone had modified the light fixture by installing a household-type ceramic socket in place of the original socket. A toggle bolt that was used to hold the socket in place pinched the neutral wire when it was tightened, wore through the wire insulation, and eventually cut the wire in two, causing the short.

Investigators learned that the first employee was concerned about the safety configuration of the room and the time involved in completing the repair work. He reported his concern to his supervisor, but did not report his concerns through the Safety Concerns portion of the Issue Communication and Resolution Environment (ICARE) system because his previous concerns had not been satisfactorily resolved.

Bongarde Holdings, Inc. publishes weekly *Safety Talks!*. The most recent of these, entitled *Shorts and shocks*, pointed out that electrical shock events often occur after very minor events that go unreported. The following page contains a handout that supervisors can use when conducting safety talks on electrical hazards.

Faulty electrical equipment should be immediately removed from service and repaired or replaced. Also, it is crucial that employees feel confident that safety concerns they raise will be investigated and resolved in a timely manner.

KEYWORDS: *Electric shock, electrical switch, short*

ISM CORE FUNCTIONS: *Analyze the Hazards, Develop and Implement Hazard Controls, Provide Feedback and Improvement*

Safety Talks!

Electrical Hazards ■ T907-08

Shorts and shocks

The thing about electrical injuries is that they always come as such a shock.

But like any type of workplace mishap, electrical incidents can actually be predicted and prevented.

Warning signs of electrical hazards are there if you are paying attention. And not just the signs someone else has posted on a wall, but clues in the equipment and the environment.

Here are some common warnings of electrical problems:

- Someone gets a minor shock. The next time, under slightly different circumstances, someone else could get a fatal shock.
- Electrical connections and cables become overheated. Besides the hazard of fire, excessive heat destroys insulation and can lead to shorts and shocks.
- Noises indicating electrical problems are ignored. The sounds of crackling and hissing from behind a wall panel are never a good sign. Flickering lights also can indicate an overloaded electrical system.
- Electrical equipment shows signs of wear or damage. Connectors become loose because of repeated rough handling. Cords are frayed. Cables have been run over by industrial equipment or slammed in doors. Insulation is broken and the wiring can be seen within.
- Equipment has been tampered with, or repaired by unqualified or unauthorized personnel. Someone may have broken the third prong off an extension cord. (It is necessary for grounding, though)
- Electrical equipment is used around moisture, without appropriate protection such as a ground fault circuit interrupter.
- Electrical circuitry exposed for repairs is unguarded, allowing accidental contact by a passerby. Equipment to be worked on should be locked out so it cannot be energized.
- A particular hazard in industry is the damaged receptacle on a welder or other powered equipment. The loose receptacle allows the plug to be inserted the wrong way, resulting in the frame of the equipment becoming energized.
- Overhead electrical hazards are disregarded. Many workplace fatalities occur when machinery or materials touch a power line, electrocuting one or more workers. Keep a safety margin of at least 10 feet/three meters from power lines, and have the utility company shut off the power if there is any chance of hitting a line.

An electrical hazard may not be obvious to the victim, but it was probably obvious to someone else at some point. The person who left a live wire exposed during a renovation or the person who did a makeshift electrical repair probably knew of the danger. A worker who received a slight shock from equipment or noticed a damaged receptacle also knew of the hazard. Failing to report a hazard leaves a trap for another worker.

Never ignore an electrical hazard. You may be the only one who observes the problem in time to save someone else from injury or death.

TEST YOUR KNOWLEDGE*

1. Electrical shock injuries can never be predicted or prevented.
   ❑ True ❑ False
2. One warning sign of an electrical hazard could be a co-worker receiving a minor shock while using a drill.
   ❑ True ❑ False
3. Flickering lights may indicate an overloaded electrical system and should be investigated.
   ❑ True ❑ False
4. It's safe to use a frayed cord that has been mended with electrical tape.
   ❑ True ❑ False
5. Breaking the third prong off an extension cord to make it fit a plug is a widely accepted safety practice.
   ❑ True ❑ False
6. You should never use electrical equipment that has been repaired by unqualified personnel.
   ❑ True ❑ False
7. If operating electrical equipment around sources of moisture, what can help you stay safe?
   A. A spark arrester
   B. A ground fault circuit interrupter
   C. A wetsuit
   D. None of the above
8. Many workplace fatalities occur when machinery or equipment comes in contact with power lines.
   ❑ True ❑ False
9. A wise practice is to ask the utility company to shut off the power when you are working around power lines.
   ❑ True ❑ False
10. If you receive a mild shock, it's not necessary to report it because nobody was injured.
    ❑ True ❑ False

T907-08

PHOTOCOPY THIS PARTICIPANT HANDOUT - © T907-08

* Answers on page 10

3. *ACCIDENT INVESTIGATION OF ELECTRICAL ARC FLASH INJURY*

On October 11, 2004, at the Stanford Linear Accelerator Center (SLAC), a subcontractor journeyman electrician received serious burns from an electrical arc flash. The electrician was installing a circuit breaker in an energized 480-volt electrical panel when the accident occurred. The electrician's clothing caught fire resulting in burn injuries that required hospitalization. A DOE Type A Accident Investigation Board conducted a formal investigation of the accident. (ORPS Report OAK--SU-SLAC-2004-0010)

On the day of the accident, a SLAC field supervisor gave the electrician a circuit breaker and directed him to install it in the 480-volt electrical panel. The supervisor did not obtain an approved permit to conduct electrical hot work before making the assignment. The electrician wore a short-sleeved cotton/polyester shirt, leather gloves over Voltage (V)-rated gloves, safety glasses, and a hardhat. A rubber insulating mat was placed on the floor in front of the panel. The electrician removed the deadfront panel cover to begin the work. A laborer, who was assigned only to pull wire, acted as the electrician's safety backup. The electrician knelt on the mat in front of the panel to install the circuit breaker into position 12 of the panel (Figure 3-1).

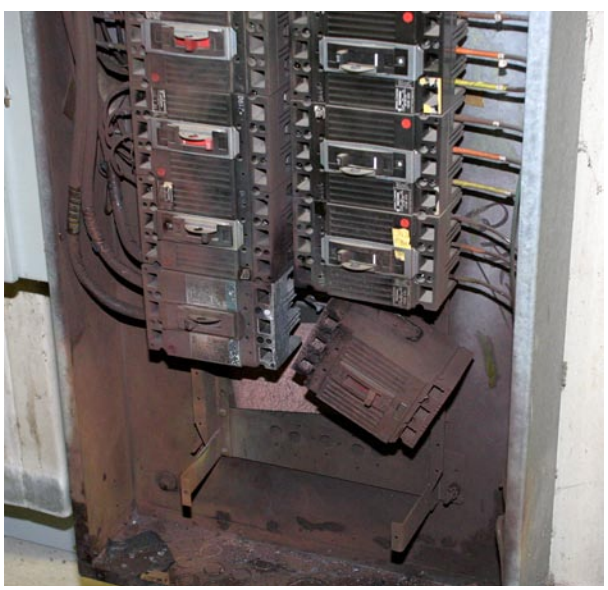

Figure 3-1. Arc-damaged circuit breaker in panel position 12 hanging by the phase C connection

The circuit breaker panel has three vertical buses with phase A on the left, phase B in the center, and phase C on the right. The line-side connection to each circuit breaker is made by a connection attached to the phase by a clip. Insulated jumper bars cross over the B phase to connect the circuit breaker to the A and C phases. Figure 3-2 shows the circuit breaker panel after removal of the damaged circuit breaker, the adjacent circuit breaker, and the two circuit breakers above.

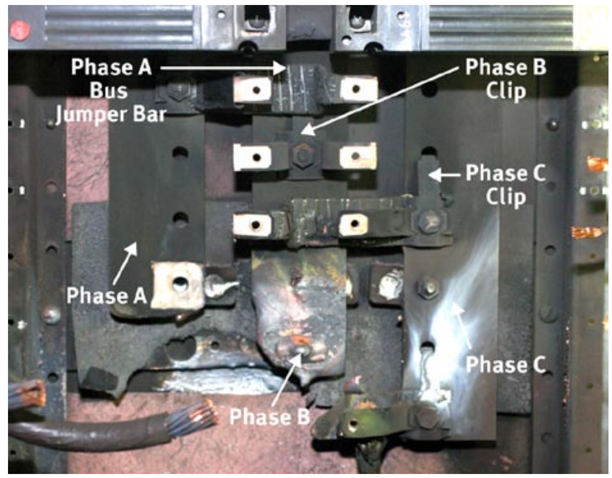

Figure 3-2. Circuit breaker panel with melted and damaged buses, jumper bars, and phase clips

When the accident occurred, the electrician had connected phases B and C and was in the process of connecting phase A. None of the mechanical connections (two bolts into the side rail) had been made to first stabilize the circuit breaker before he made the electrical connections. The electrician was having difficulty getting the screw to hold the circuit breaker to the threaded hole in the jumper bar for the A phase, when a phase-to-phase short circuit occurred behind the circuit breaker.

The arc flash ignited the electrician's clothing, and the blast knocked his safety backup, who was standing 2 to 3 feet behind him and to the right, down to the floor. A second electrician, working about 14 feet away on an unrelated task, heard the electrical blast and saw the electrician on the floor with his clothing on fire. He rushed to the scene and attempted to smother the flames with his own shirt. Paramedics from the onsite fire department arrived and stabilized the electrician for transport to a burn center. The electrician had burns on 50 percent of his body. He received third degree burns on the face, chest, and legs and second degree burns on his arms.

The Investigation Board reconstructed the accident by having another journeyman electrician install the same type circuit breaker in the same position above the incident circuit breaker while the panel was de-energized. The electrician connected the phases in the same sequence and with the circuit breaker not fastened (as during the accident). He was able to install the circuit breaker without any difficulty.

There are several reasons why the electrician might have had difficulty getting the screw to hold. The threads on the tip of the screw or the threads in the hole on the jumper bar could have been damaged. Also, the jumper bar or the circuit breaker could have been slightly misaligned. The Board believes that the electrician was pushing with his uninsulated screwdriver harder than would normally be necessary to engage the threads when the arc flash occurred.

The Board also believes that when the electrician applied additional force to engage the screw with the phase A jumper bar (which is supported in a cantilever fashion above the center B phase), the jumper bar deflected toward the B phase and compressed the B phase stabilizing clip (Figure 3-3).

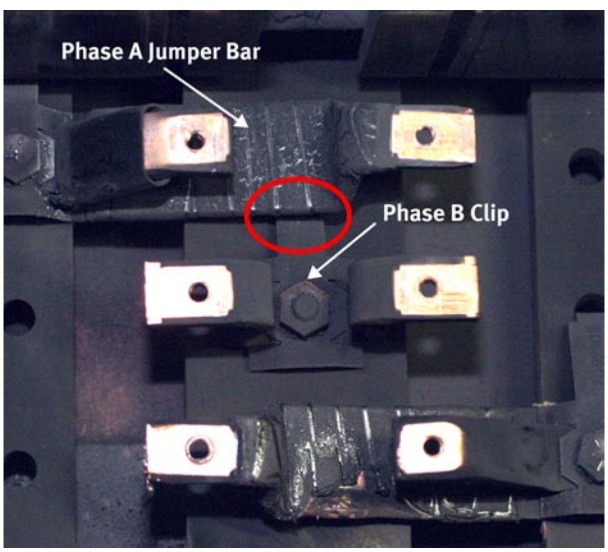

Figure 3-3. Close up of jumper bar and clip with the believed location of the fault circled in red

The compression of the rubber insulation increased the electric field stress, causing the insulation to fail and initiate an arc flash behind the incident circuit breaker.

The Board determined that the accident resulted from deficiencies in SLAC's work control planning and implementation processes and violation of every ISM core function and guiding principle. The events at SLAC leading up to and during the installation of the circuit breaker and the arc flash are characteristics of an unstructured and largely undocumented approach to work that does not ensure the safety and health of the workers. The Board identified the following key deficiencies associated with the installation of the electrical circuit breaker.

- A Pre-Work Hazards Analysis form was not completed.
- There was no approved electrical hot work permit.
- The workers did not wear the appropriate flame resistant clothing, and all required personal protective equipment.
- The subcontractor laborer was not trained to be a backup for an electrician.
- No one in the SLAC management chain had been informed of the decision by the field supervisor to install the circuit breaker in an energized panel.
- The SLAC safety officials were not involved.

If proper permitting procedures had been followed, the work would not have been done. Moreover, the severity of the injuries could have been significantly reduced or eliminated if proper Fire-Resistant (FR) clothing and personal protective equipment were used.

When insulation or isolation between energized conductors is breached or can no longer handle the applied voltage, an arc flash (Figure 3-4) can occur. The temperatures can reach 35,000° Fahrenheit, causing direct burns to the skin and igniting clothing.

Arc flashes can kill at distances of 10 feet. Each year more than 2,000 people are admitted to

Figure 3-4. An electrical arc flash test

burn centers with severe arc flash injuries. A major cause of burns and death is the ignition of non-FR clothing.

In order to limit a worker's potential injury from an arc flash to 2nd degree burns, employers are required to establish a flash boundary around each potential flash source. The boundary is established at the distance from the source where the incident energy equals 1.2 calories. The greater the energy the farther the boundary must be from the source. Unprotected workers must be kept outside the boundary and anyone inside the boundary must wear enough protective equipment so that the energy their skin is exposed to is 1.2 calorie/cm^2 or less. The following is a list of the personal protective equipment and clothing that the journeyman electrician should have been wearing while working in the energized panel.

- V-rated gloves with leather protectors
- V-rated tools
- Non-melting or untreated natural fiber T-shirt and underwear
- FR pants and shirt (8 calorie/cm^2) – Or, FR coverall over cotton long-sleeved shirt and pants
- Safety glasses and hearing protection
- Double-layer switching hood (with FR face shield)
- Leather work shoes

If energized parts are not placed in electrically safe work conditions, other safety-related work practices shall be used to protect workers from and contact with energized parts and arc flash.

The danger of working on energized equipment is illustrated in the following DOE events, where workers failed to follow procedures for energized work and did not use a lockout/tagout.

On May 10, 2004, a warranty service technician at the Pantex Plant received minor flash burns to his eyes when his screwdriver touched an energized 460-volt terminal connection while repairing a new chiller system. (ORPS Report ALO-AO-BWXP-PANTEX-2004-0046)

On July 15, 2002, a subcontractor electrician at the Hanford Cold Test Facility received minor flash burns to his left forearm and neck when his screwdriver accidentally grounded the C phase line-side lug while installing a circuit breaker into an energized 480-volt panel. (ORPS Report RP--CHG-TANKFARM-2002-0075)

OSHA 29 CFR 1910.333(c)(2), "Work on Energized Equipment," states "only qualified persons may work on electrical circuit parts or equipment that has not been de-energized under the procedures of paragraph (b) of this section. Such persons shall be capable of working safely on energized circuits and shall be familiar with the proper use of special precautionary techniques, personal protective equipment, insulating and shielding materials, and insulated tools."

Hazards of Electricity

- **Electrical Shock and Burns** – Contact with electrical energy can result in nerve and tissue damage, severe burns, and electrocution as current flows through the body.
- **Arc Flash Burns** – An arc flash can heat the air to temperatures as high as 35,000 °F, vaporizing metal, and cause severe sin burns by direct heat exposure and by igniting clothing.
- **Arc Blast** – The heating of air and vaporization of metal creates a pressure wave that can damage hearing, cause a concussion, and produce injuries from flying metal and parts. Copper expands by a factor of 67,000 times when it vaporizes and molten metal can be expelled at speeds of 700 miles per hour.

NFPA 70E-2000, *Electrical Safety Requirements for Employee Workplaces*, provides guidance in determining the severity of potential exposure to arc flash and selecting protective equipment. Equations for calculating incident energy and flash protection boundaries are provided in NFPA 70E and IEEE 1584-2002, *IEEE Guide for Performing Arc-Flash Hazard Calculations*.

Tips for Electrically Safe Work Conditions (NFPA 70E)

- Determine all sources of electrical power.
- Open disconnecting devices for each source.
- Visually verify devices are open (where possible).
- Apply lockout/tagout devices.
- Test voltage on each conductor to verify that it is de-energized.
- Apply grounding devices where stored energy or induced voltage could exist.
- Perform a flash hazards analysis before working on energized equipment.
- Wear required personal protective equipment and use insulated tools.

These events illustrate the dangers associated with an electrical arc flash caused by unsafe work practices on energized equipment. The hazard analysis process should include provision for lockouts/tagouts, job specific walk-downs, integration of work activities, determination of required personal protective equipment, and justification for energized work. Pre-job briefings, facility procedures, and training programs should emphasize the danger of electrical arc flash while working on or near energized equipment.

KEYWORDS: *Electrical safety, arc, flash, burn, injury, electrician, circuit breaker*

ISM CORE FUNCTIONS: *Analyze the Hazards, Develop and Implement Hazard Controls, Perform Work within Controls*

4. STORED ENERGY A HAZARD IN ROLL-UP DOOR TORSION SPRINGS

Rollup and overhead doors are widely used throughout the DOE complex for building access. These doors, while very useful, can present some unique hazards. OE Summary 2004-10 featured an article entitled *Roll-up Door Failures Result in Near Misses* that addressed the hazard arising from failures to perform preventive maintenance. This article will instead discuss the stored-energy hazard from the torsion spring counterweight mechanism commonly used on these doors.

On October 1, 2004, a worker at Rocky Flats was injured while assisting with the removal of a truck dock rollup door. The motor and torsion bar assembly were being lowered to the floor by a forklift when energy stored in the torsion assembly suddenly released, rotating a 16-inch-square mounting bracket on the end of the assembly. The worker who was injured was guiding the assembly away from the wall when he was struck twice in the arm by the rotating bracket (Figure 4-1). He was taken to a local hospital and received 20 stitches in his arm. (ORPS Report RFO--KHLL-371OPS-2004-0024)

Figure 4-1. Mounting bracket

During the pre-evolution briefing, the job supervisor discussed the potential for stored energy in the torsion assembly. The door was previously inspected and verified to be electrically de-energized. The lead worker on the job had been involved with the installation of similar rollup doors, but had never disassembled one before. He was the only crew member with any roll-up door experience. He verified that the door was de-energized before proceeding with the work. The door was raised to a fully open position, and the remaining tension on the door spring was relieved by removing a drift pin and rotating the door spring mechanism two and one-half revolutions, consistent with manufacturer recommendations. However, the worker then replaced the drift pin, fully closed the door, and removed the door. By reinserting the drift pin before lowering the door, the worker unknowingly re-wound the spring in the torsion assembly, re-energizing the system.

The crew secured the torsion assembly to a forklift and unbolted the assembly from the wall. The lead worker was prying the assembly away from the wall when the stored energy in the spring suddenly released, spinning the mounting bracket. Apparently, there was enough friction in the system to hold the spring in the wound state until it was jarred by the workers pulling it away form the wall. The bracket struck and cut the worker twice in the right forearm.

Further review of the work package being used indicated that the Job Hazard Analysis used in the pre-evolution briefing did not specifically cover this type of stored energy. The crew was experienced in door installation, but not in removal. No procedure was provided for door removal; instead, the work was left to the job knowledge of the worker.

The causal analysis concluded that inadequacy in implementing work control program requirements led to insufficiently developed controls to address the stored energy hazard. The hazard control permitted the engineer or the job supervisor to determine tension relief methods and was only discussed in the introductory section, not in the package's job hazard analysis or the work steps. The work control document scope included miscellaneous removal of items such as pipe, conduit, supports, hangers, wall shelves, metal floor stands, scaffolding, and tank framework. Because the work scope was for general removal of various items, detailed work instructions were absent from the package.

Overhead Door Operation

An overhead door (Figure 4-2a) is made up of a number of large panels that are hinged horizon-tally with rollers mounted at each end. The rollers ride in tracks attached to the building. These tracks run vertically to a certain point from the floor and then turn horizontally. As the door is raised, it is displaced overhead. The door's weight is counterbalanced with torsion springs attached to a steel shaft mounted to the wall above the door opening (see Figure 4-3). At the shaft ends are cable spools or drums that hold the cable that connects the shaft to the bottom of the door. Force is transferred to the cable, creating a lift that neutralizes the excessive door weight when the correct amount of torsion is placed on the spring. Turning the shaft that these springs are attached to will raise the door. The shaft of both the overhead door and rollup doors may be turned either electrically or manually.

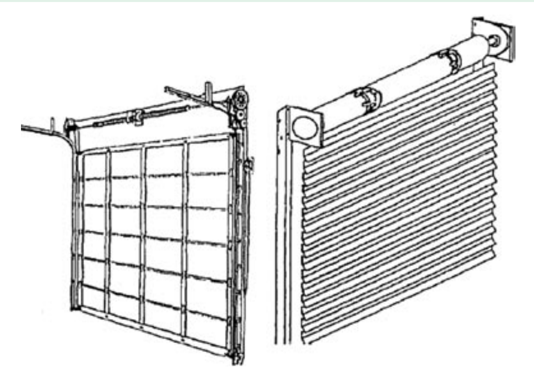

Figure 4-2a and 4-2b. Overhead (left) and rollup (right) doors

Rollup Door Operation

A rollup door consists of a curtain of metal slats that roll up around a tube or a shaft as it is raised (see Figure 2b). This tube contains torsion springs, much like those used for the overhead door, which counterbalance the curtain weight. The metal slats comprising this curtain are variously shaped depending on the manufacturer, but all are relatively small to allow the curtain to roll into a small cylinder when raised. The curtain is at-tached to the shaft by several metal collars that bolt to the curtain, then wrap around the shaft and bolt to it. Both ends of the slats are inserted in tracks mounted to the building. Normally there is a chain-operated gear reduction assembly used to turn the shaft that raises the door. There are many assembly variations—direct gear, power-driven, and gear reduction, to name a few.

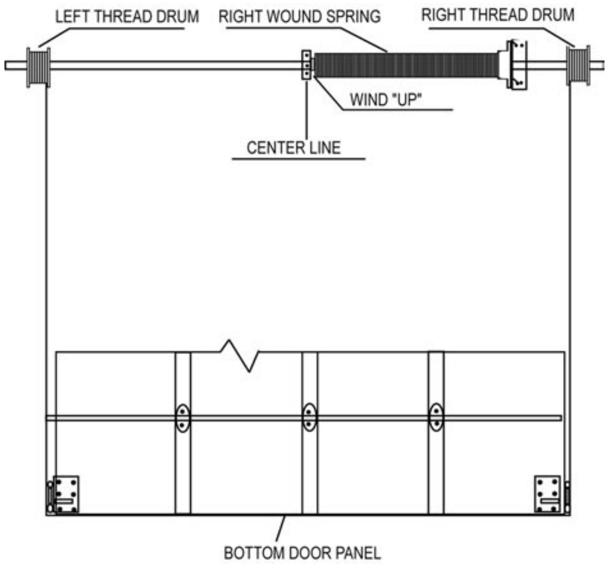

Figure 4-3. Overhead door counterbalance assembly

The site immediately reviewed all other active work control documents to verify that they contained adequate instructions on identifying potential hazards for work that involved or could involve stored energy. Three of 37 work packages reviewed did not adequately address stored energy issues and were updated accordingly.

Another worker suffered injuries from released energy on October 16, 2004, at the East Tennessee Technology Park where a roll-up door spring released energy and pulled the worker's left arm into the spring bar, fracturing it. (ORPS Report ORO--BNFL-K32-2004-0004)

A three-member crew was dismantling a roll-up door in the K-903 Supercompaction Facility. The crew had already removed the door slats and was in the process of removing the door torsion assembly. The worker who was injured operated a plasma-arc torch from a scissors lift along with a second worker who served as firewatch. A third worker assisted at ground level.

The torchcutter was cutting the door drive shaft near the motor drive gearbox. Anticipating that that the drive shaft would turn when it was cut, the torchcutter cautioned the firewatch to stand clear. The shaft broke sooner than expected and began to turn and jump upwards. When the drive shaft jumped upwards, the torchcutter's sleeve or glove caught on a door slat collar and the turning drive shaft pulled the worker's arm into the mechanism. The firewatch pulled the worker free from the spring-loaded shaft and contacted supervision. The worker was treated at the onsite medical clinic.

The dismantling of the roll-up door was conducted as part of the Supercompaction Facility demolition. The enhanced work plan included neither a specific reference in the work steps to the dismantling of rollup doors nor a specific reference to unreleased mechanical energy in the hazard assessment section. Although the potential for stored energy in the mechanism was known, the work plan failed to address the hazard other than to warn workers to stand clear.

These two incidents illustrate that an item as commonplace as a door asssembly can pose hazards during maintenance. Pre-job planners must recognize the hazards of stored energy. Written procedures for releasing stored energy prior to work can help prevent injury.

KEYWORDS: *Overhead door, rollup door, near miss, stored energy*

ISM CORE FUNCTIONS: *Analyze the Hazards, Develop and Implement Hazard Controls, Perform Work within Controls*

SHORTS AND SHOCKS

Quiz Answers (from page 4)

1. False	6. True
2. True	7. B
3. True	8. True
4. False	9. True
5. False	10. False

Commonly Used Acronyms and Initialisms

Agencies/Organizations	
ACGIH	American Conference of Governmental Industrial Hygienists
ANSI	American National Standards Institute
DOE	Department of Energy
DOT	Department of Transportation
EPA	Environmental Protection Agency
INPO	Institute for Nuclear Power Operations
NIOSH	National Institute for Occupational Safety and Health
NNSA	National Nuclear Security Administration
NRC	Nuclear Regulatory Commission
OSHA	Occupational Safety and Health Administration
SELLS	Society for Effective Lessons Learned

Units of Measure	
AC	alternating current
DC	direct current
psi (a)(d)(g)	pounds per square inch (absolute) (differential) (gauge)
RAD	Radiation Absorbed Dose
REM	Roentgen Equivalent Man
v/kv	volt/kilovolt

Job Titles/Positions	
RCT	Radiological Control Technician

Authorization Basis/Documents	
JHA	Job Hazards Analysis
NOV	Notice of Violation
SAR	Safety Analysis Report
TSR	Technical Safety Requirement
USQ	Unreviewed Safety Question

Regulations/Acts	
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
RCRA	Resource Conservation and Recovery Act
D&D	Decontamination and Decommissioning
DD&D	Decontamination, Decommissioning, and Dismantlement

Miscellaneous	
ALARA	As low as reasonably achievable
HVAC	Heating, Ventilation, and Air Conditioning
ISM	Integrated Safety Management
ORPS	Occurrence Reporting and Processing System
PPE	Personal Protective Equipment
QA/QC	Quality Assurance/Quality Control