Operating Experience Summary

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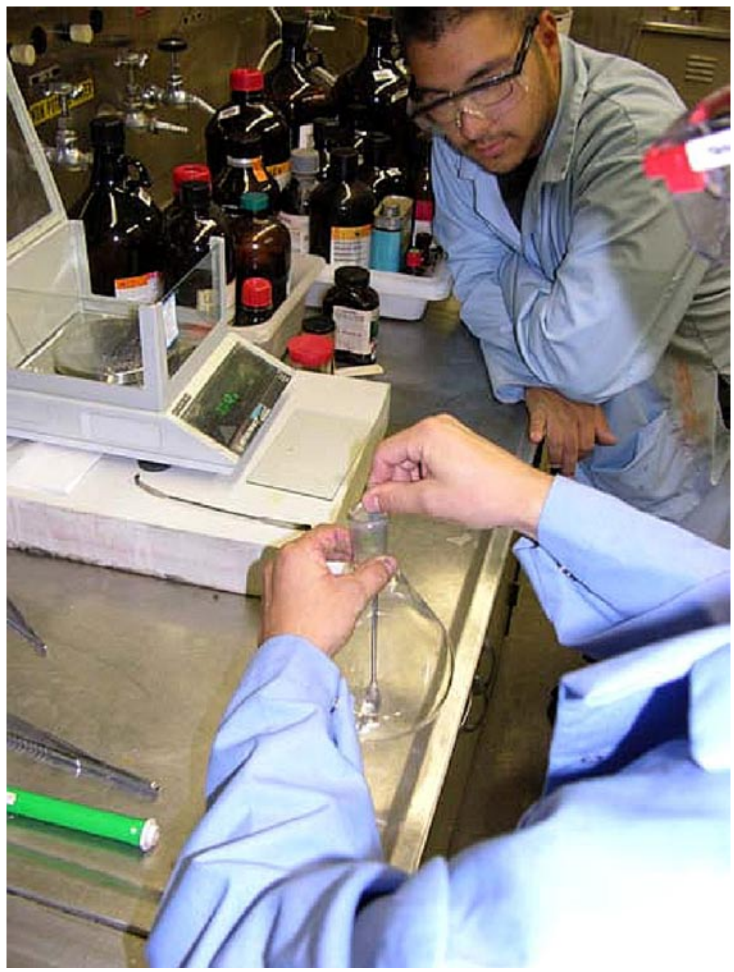

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Helping the field succeed with safe and reliable operations.

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.

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EVENTS

1. *SHARED NEUTRAL CIRCUITS POSE A DANGER IF NOT PROPERLY IDENTIFED DURING SAFETY CHECKS*

Shared or common neutrals in electrical circuits can pose an electrical safety hazard because they are not always identified during zero-energy or safe-to-work checks. It is only after a worker receives an electrical shock or after the neutral has been lifted and checked with a meter that this potentially dangerous condition is identified. The following recent events are examples of this hazard.

On October 31, 2005, at the Hanford Fast Flux Test Facility, an electrician found voltage on the neutral for a switch after he had isolated electrical power and placed his Authorized Worker Lock on a lighting circuit. The electrician was preparing to replace a broken switch. As part of his zero-energy check, he disconnected the neutral and tested it with a voltmeter. When he detected voltage he stopped work. The power source involved with the shared neutral was traced, de-energized, and locked out. The electrician's actions identified an electrical legacy issue not shown on facility drawings. (ORPS Report EM-RL--PHMC-FFTF-2005-0006)

On October 8, 2005, at the Pacific Northwest National Laboratory, a subcontractor electrician received an electrical shock when his forearm brushed against a grounded bus while he was holding a disconnected neutral conductor. The electrician was working on a project to replace switchgear and a motor control center that had been installed in 1974. Lockout/tagouts had been established and zero-energy checks showed no voltage. The voltage only became apparent after the neutral conductor had been disconnected. Investigators determined that the voltage was approximately 139 VAC and that the source was an emergency light, which had the neutral connected to the normal power system. Procedures were revised to treat all load-side neutral conductors as energized during removal and re-termination, even if no voltage is detected. (ORPS Report SC--PNSO-PNNL-PNNLBOPER-2005-0018)

On September 16, 2005, at the Savannah River F-Area Tank Farm, electrical maintenance personnel discovered unexpected voltage on a neutral wire while disconnecting wires in a lighting panel to install a new power supply. Zero-energy checks performed when the lockout/tagout was established did not identify any voltage. When work was initiated, the electrician lifted the neutral wire in the panel, and then (by procedure) performed a voltage check with a high impedance test meter and discovered 110 volts. A second test with a low impedance meter attenuated the voltage to 53 volts. Because the voltage was not reduced to zero, indicating the voltage was induced, he concluded that the voltage came from another electrical source.

> Remember: The **neutral** is a current carrying conductor!

Investigators determined the voltage was feedback from a neutral for a photohelic gauge. When the gauge was wired 20 years ago, there was no design document to clearly indicate how it was to be wired. Instead of routing the neutral back to the panel that provides normal power to the gauge, electricians electrically routed it to a lighting panel through a duplex receptacle. Only after splitting the circuit wiring was the voltage detected. The electrician followed his procedures verbatim, which required the additional voltage check after lifting wires. (ORPS Report EM-SR--WSRC-FTANK-2005-0009)

On May 12, 2005, at the Hanford Plutonium Finishing Plant, an electrician received an electrical shock from a neutral wire while terminating the wire on a relocated electrical panel. Voltage did not show during the zero-energy check because the neutral wire created a complete circuit through the neutral bus. The voltage potential to ground was identified only after the neutral wire was de-terminated. Investigators determined that the neutral belonged to a security circuit in a different panel. In the early 1990s, an electrician had relocated a 120-volt security camera circuit but did not wire it according to plan. (ORPS Report EM-RL--PHMC-PFP-2005-0011)

A review of 14 occurrence reports that involved discovering shared neutral conditions revealed that almost half of these events resulted in an electrical shock. In many of the events, a zero-energy check was performed, but it failed to identify an energized condition until it was too late. Nine of the 14 reported events occurred since 2000, including 4 occurrences in 2005.

Guidance for Working on Common Neutral Circuits

- Treat the neutral as energized even though the circuit is locked out at the source panel. NOTE: PPE should be used because of this assumption.
- Maintain the continuity of the neutral by breaking only the single white wire connecting the device being worked on. Many common neutral circuits use wire nut or pigtail-type connections. If you only break the single lead to the device from the connection, the neutral is maintained back to the source and prevents voltage on the neutral wire connecting the device. If the neutral is wired through the device and not connected using a pigtail, then a common neutral should be suspected.
- Use caution and measure for absence of voltage to ground immediately after lifting leads when more than one neutral must be lifted from a device (e.g., lighting ballast).
- Test the neutral circuit with a proximity-type current detector to identify a common neutral configuration before lifting neutral leads or breaking a neutral connection. NOTE: Current will exist only if one or more circuits sharing the neutral have a load energized at the time of measurement.
- Include instructions in work packages where common neutrals are known to exist to remind workers to attempt to maintain continuity of the neutral circuit.

When two circuits share a common neutral line, they are also referred to as an "Edison circuit." This configuration has been used in non-industrial service on circuits for lighting and receptacles. At DOE, the problem of shared/common neutrals has been found mostly in older facilities or where neutrals were misplaced because of convenience or shortcuts. This condition is not only an electrical safety hazard for the unknowing worker, but it can also produce unbalanced loads that induce current in conduits. In addition, neutrals that are not protected by fuses or circuit breakers can become overloaded and cause fires.

The common or shared neutral is used to save wire, to permit the use of smaller diameter conduit, and to reduce the voltage drop in lighting and receptacle circuits. Common neutrals are typically used on 120/240-volt, single-phase systems and on 208Y/120-volt and 277Y/480-volt, three-phase systems. The common neutral wire carries the unbalanced load current during normal circuit operations as shown in Figure 1-1. If the common neutral is disconnected (broken), as shown in Figure 1-2, an unsafe condition occurs because line voltage appears on the broken lead. A worker who touches the broken neutral could receive a severe electrical shock.

Because voltage can only appear on a common neutral after the wire is broken, normal zero-energy checks will not show the presence of electrical energy. The only positive way to prevent potential electrical shock is to open all circuits that share the common neutral wire. The present edition of the National Electrical Code (NEC) allows single-pole circuit breakers to be physically tied together so that all circuits that share the neutral can be de-energized simultaneously. Information and guidance on multi-branch circuits can be found in Article 210.4 of the NEC Code (NFPA 70).

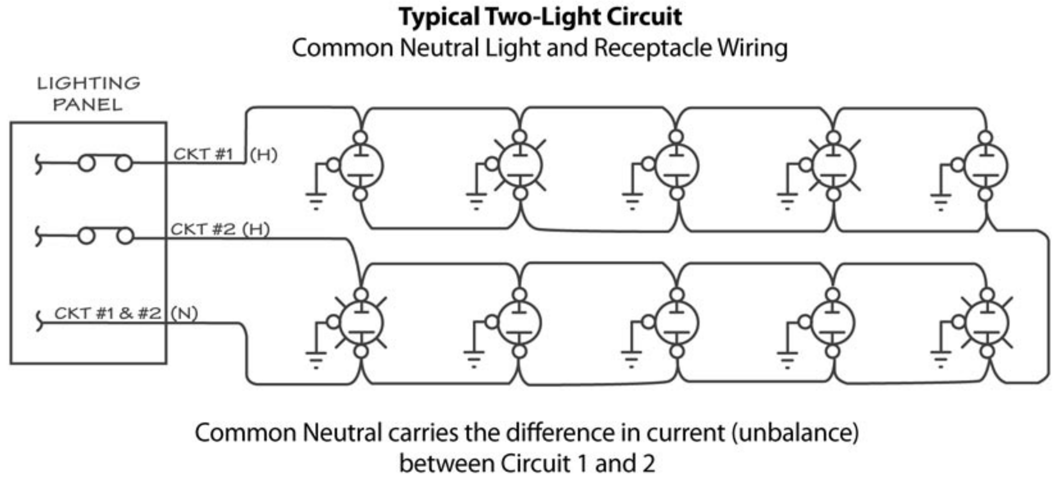

Figure 1-1. A typical two-light circuit with common neutral

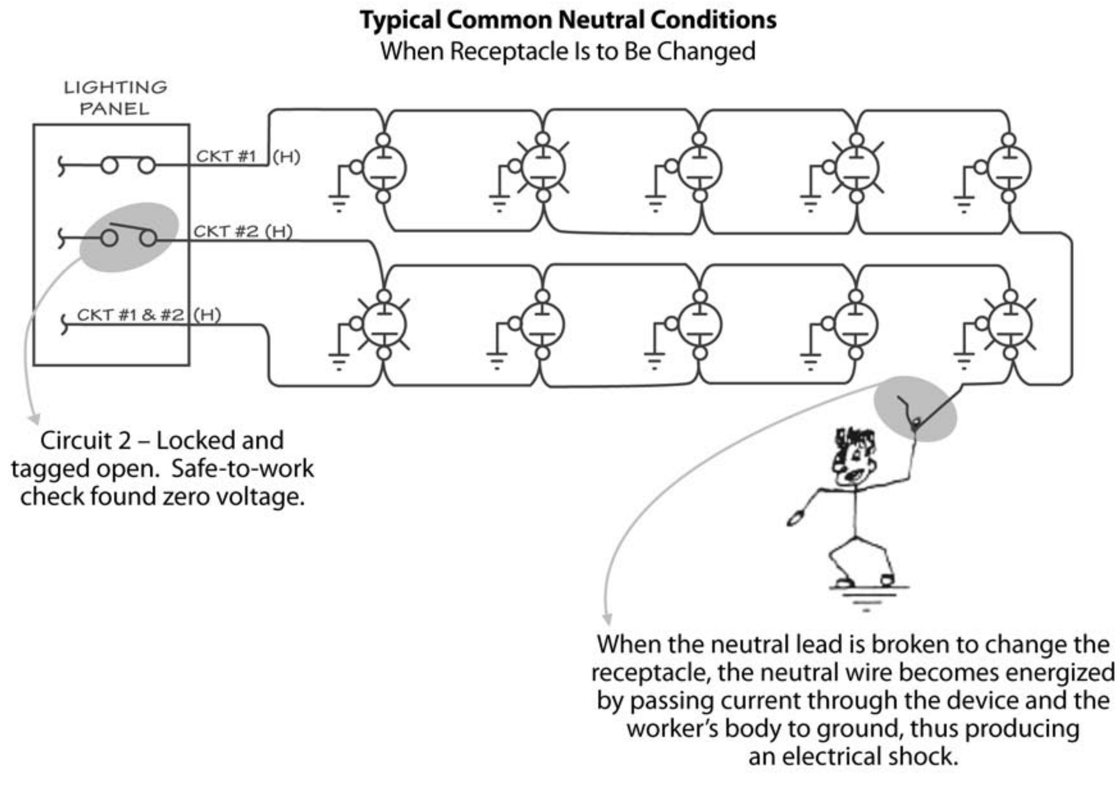

Figure 1-2. Example of unsafe condition when common neutral is broken

Recommendations for Multiwire Branch Circuits

- Ensure panelboard directories indicate which circuits are used in multiwire applications and identify common neutrals with all associated circuit numbers.
- Use permanent wire markers on neutrals at all accessible device or junction boxes to indicate which circuits are associated with the neutral conductor.
- Consider using two (or three) pole protective devices for multiwire circuits where simultaneous tripping of multiple circuits would not create an additional safety hazard or other undesirable condition. This would prevent using circuit breakers that are not adjacent (i.e., circuit 1 and 7) to eliminate confusion

These events highlight the fact that standard lockout/tagout procedures may not require a zero-energy verification of the neutral line. It is, therefore, important for job planners to consider the potential for common neutral connections and include appropriate guidance in electrical work packages.

KEYWORDS: *Electrical safety, zero-energy checks, shared neutral, common neutral, electrical shock, Edison circuit*

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

2. *DON'T OVERLOOK THE IMPORTANCE OF PRE-JOB HAZARD ANALYSIS*

Recent events at DOE sites demonstrate the importance of pre-job planning. The events described below demonstrate near-miss situations where the failure to plan safe work could have resulted in serious injuries.

On May 27, 2005, at Los Alamos National Laboratory, a post-doctoral researcher and an undergraduate student observer suffered face, neck, and hand lacerations when a glass reaction flask they were using to synthesize a non-explosive material shattered following the unexpected explosion of reaction byproducts. Fortunately, the researcher and student were wearing safety glasses, which likely protected their eyesight. However, the researcher's unprotected left ring finger was cut severely enough to require surgical skin grafting. (ORPS Report NA--LASO-LANL-FIRNGHELAB-2005-0007)

Earlier that month, a principal investigator wanted to synthesize the material for research using a new technique from an article in the journal *Inorganic Chemistry* that he had peer-reviewed. Unlike the only other known technique for synthesizing this material, the new technique uses a known non-energetic material and does not cause the explosive byproduct, lead azide, to form. The principal investigator synthesized the material twice: once at scale, which was unsuccessful; and once scaled up 5 times, which was successful. Three weeks later, the material needed to be produced again, so the researcher decided to synthesize a batch while a student watched. He was aware that the principal investigator had synthesized this material twice before undertaking the procedure himself, but did not know that the initial attempt was unsuccessful.

On May 25, the researcher decided to scale the original experiment up 20 times to produce about 14 grams of material. The journal article did not mention the fact that azidotetrazole, a very sensitive material, and 5-hydrazinotetrazole, a contaminant, are routinely formed during the synthesis procedure. The authors included a generic caution statement at the beginning of the experimental section that stated: "Appropriate safety precautions should be taken, especially when these compounds are prepared on a larger scale," and goes on to state that the use of Kevlar gloves, leather coats, face shields, and ear plugs is "necessary." However, the researcher and student wore only safety glasses, believing that the reaction products were non-explosive.

The synthesis procedure consists of a reaction phase and a purification phase, after which the liquid is slowly evaporated off, leaving pure crystals. Between the 25th and the 27th, the researcher ran several nuclear magnetic resonance tests to determine material purity. Each of the tests showed evidence of impurities; but, instead of stopping to determine what contaminants remained in the solution, the researcher continued to purify and dry the precipitate.

Finally, on the 27th, the material was dry. The researcher wanted to remove the material from the round-bottomed glass flask it had been created in and place it into a smaller container for weighing. He used a small metal spatula to scrape the material out of the flask. Figure 2-1 shows a re-enactment of the researcher's actions just before the material exploded.

Figure 2-1. Re-enactment of the scene

Investigators determined that the root cause of the event was that the synthesis procedure was ambiguous and failed to disclose the potential for synthesizing a sensitive byproduct. However, the researcher had changed some of the parameters of the experiment without analyzing those changes. For example, the experiment described drying the material under vacuum with pure nitrogen gas. The researcher used a stream of air instead, believing that the change would not affect the experiment's outcome.

A contributing cause was that the Laboratory's integrated work document for hazardous chemical operations at this facility was very broad and loosely implemented because the approval time for more specific integrated work documents had become somewhat lengthy. The broader document helped personnel bypass the process. The broad-scope integrated work document authorizes general chemistry operations and includes a list of 25 activities, among which is "non-energetic materials synthesis." It did not include a detailed description of the activities involved or a cross-reference to another document that included such a description. The Laboratory permitted personnel to attach an established procedure to the integrated work document if it met seven specified criteria, but it did not have a mechanism for verifying that procedures were evaluated to these seven criteria.

In this case, the procedure was not established; it was taken from a published article. As a result, it was not screened to the specified criteria or to the core functions and guiding principles of ISM, DOE's process for working safely that is described in DOE P 450.4, *Safety Management System Policy.* The principal investigator and researcher recognized *Inorganic Chemistry* as a well-respected publication and failed to consider that the procedure could contain potential unanalyzed hazards. The accident investigation team also recognized that the procedure was carried out in an older facility with equipment in need of upgrading.

Accident investigators recommended that the Laboratory re-evaluate its use of broad-scope integrated work documents and develop a mechanism for ensuring that any activity under this type of work document is adequately screened for potential hazards before work begins. They also recommended that the Laboratory re-emphasize the importance of applying ISM principles while working and that the facility be upgraded to provide better analytical capabilities.

Another example of laboratory work for which the hazards were not identified and addressed occurred at the Pacific Northwest National Laboratory (PNNL). On January 29, 2004, a 45-liter glass carboy burst from overpressurization. Fortunately, no one was in the room and there were no injuries. (ORPS Report SC--RL-PNNL-PNNLNUCL-2005-0005)

Researchers were introducing nitrogen gas into the carboy, which held 30 liters of a culture medium. They knew that the potential existed for excess pressure to build up, but did not consult a subject matter expert. Instead, they decided to insert a 1½-inch needle into a rubber septum in the carboy head plate to act as a redundant vent for the 2-inch flat membrane filters. Figure 2-2 illustrates this configuration. PNNL's internal oversight organization investigated the accident and determined that the membrane filters became clogged with condensation and the redundant vent was inadequate to reduce the pressure. Because

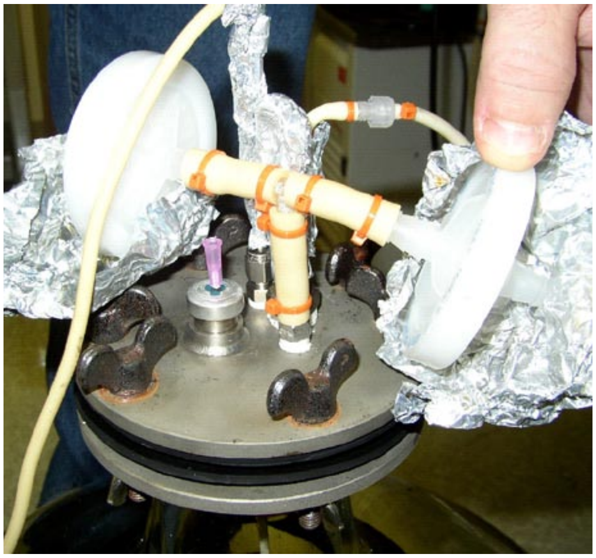

Figure 2-2. The vent in the head plate

no written procedure existed for this activity, the hazardous situation caused by pressure building up within the carboy was insufficiently addressed.

PNNL recognized the deficiencies that caused this accident and took the following corrective actions.

- Walked down similar laboratories to identify other potential hazards that may have been overlooked.
- Evaluated the need for subject matter expert review of potentially hazardous laboratory work.
- Developed and disseminated a PNNL lessons-learned document on the event.

These events serve as a reminder not to overlook the hazard analysis part of work planning, even for tasks that appear to be simple or routine. In the Los Alamos event, the researcher made assumptions about the experiment based on what he already knew about the material involved and because the experiment was published by well-respected scientists in a reputable publication. The broadly written integrated work document allowed him to circumvent a thorough hazard analysis before proceeding. He also did not stop to consider the impacts of unexpected conditions when they arose or of deviations from the written procedure.

In the PNNL event, the researchers understood that pressure could build in the carboy but assembled a makeshift vent system on their own (thereby making an assumption as to how much pressure could accumulate) without checking with a subject matter expert. Making assumptions like these without verifying conditions can result in equipment damage or personal injury.

KEYWORDS: *Explosion, injury, hazard analysis, laboratory, pressure, carboy*

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

3. BE ALERT FOR "HIDDEN" ELECTRICAL HAZARDS WHEN PERFORMING D&D ACTIVITIES

A series of electrical events occurred at Savannah River earlier this year while deactivation teams were performing electrical isolation activities. In each case, workers believed that all electrical hazards had been evaluated and no hazardous energy was present. However, as the following examples show, incorrect assumptions and inaccurate drawings led to errors in determining that no electrical hazards remained.

On June 16, 2005, at the Savannah River F-Canyon, a deactivation team cut into a conduit with a portable bandsaw, contacted the energized electrical wiring inside the conduit, and caused a ground fault circuit interrupter (GFCI) to trip. The team was tasked with air-gapping electrical conduits for a chemical storage area and thought that all circuits had been de-energized. No injuries resulted from this incident. (ORPS Report EM-SR--WSRC-FCAN-2005-0004; final report issued July 28, 2005)

Engineering staff had evaluated hazardous energy sources to the area, reviewed the electrical drawings, and performed a walkdown. They concluded that no hazardous energy was present before specifying the air gap locations. Workers had also performed voltage checks and detected no voltage.

Investigators determined that several factors contributed to this event, including the following.

1. Electrical circuits in the building were interconnected with electrical control panels in other facilities, most of which were abandoned and de-energized when the service was no longer needed. However one of the panels was not completely de-energized when it was removed from service, leaving one circuit energized.

2. Based on drawings that were unclear and could be interpreted in more than one way, engineering staff incorrectly assumed that the power source had been completely removed from the facility.

3. The electrical source was located in a contaminated area that was not included in the walkdown.

4. The field condition (e.g., rust on conduit and wire ends that were not readily accessible) made it difficult to perform accurate voltage checks.

On May 23, 2005, at the Savannah River Facilities Disposition Project, another group of workers air-gapping conduit saw sparks when they cut a conduit that entered a junction box. While securing the area after the incident, the workers discovered that the 110-volt electrical control wiring for the junction box was energized. The workers were wearing appropriately rated electrical gloves and PPE, and no one was injured. (ORPS Report EM-SR--WSRC-FDP-2005-0007; final report issued July 14, 2005)

Investigators determined that an isolation engineer failed to trace the conduit all the way to the end after he came to a "T." The electrical drawings indicated that conduit stemming from the "T" went to pushbuttons that had been used to start a pump. The voltage came from a control circuit that was fed from a lighting panel in another building. Modifications made during construction of the new building switched the power source from a pushbutton that had been removed in the older building to one in the new building, but only the drawings for the new building were updated to show the modification.

In another event at Savannah River F-Canyon, on March 17, 2005, a deactivation team member removing electrical conduit from an exterior wall with a portable electric bandsaw contacted energized electrical wiring inside the conduit, causing sparks and tripping the breaker. No one was injured, but work was suspended. (ORPS Report EM-SR--WSRC-FCAN-2005-0002; final report issued April 13, 2005)

Investigators determined that the team members incorrectly assumed that the system was de-energized and in a safe state to perform work on the conduit. They had air-gapped the breakers associated with a lighting system and performed zero-energy checks on some (but not all) lights and circuits, and assumed that the lighting panel supplied power to both an upgraded lighting system and an older system.

Workers believed that the electrical service to both systems was removed when the panel was de-energized. However, they did not know that when the older lighting system was taken out of service and abandoned in place, the electrical service to the system was not removed. A more thorough review of available drawings and design documents would have revealed that there were two lighting panels and led the workers to find the energized wiring.

Following these and several similar electrical events at the Savannah River Site, management issued a sitewide stop-work order for work involving electrical lockouts/tagouts; electrical D&D, including equipment abandonment; tasks involving drilling into walls, ceilings, and floors; and excavation work.

Electrical hazards may also exist in facilities that have been rendered "cold and dark" (i.e., all service lines have been shut off). Workers often assume that electrical hazards have been controlled in these facilities. However, when temporary power sources (e.g., for lighting and power tools) are used, workers may become confused and believe they are working on de-energized sources.

Measures to Prevent Electrical Work Occurrences

- Walk down the work site to (1) identify equipment to be worked on, (2) ensure that equipment to be isolated is clearly marked, (3) verify or modify drawings to reflect as-built conditions, and (4) identify additional hazards or safety issues.
- For decommissioning work, re-evaluate electrical hazards as systems and equipment are dismantled and isolations are removed.
- Ensure that lockout/tagout procedures or work instructions include a zero-energy check to confirm the effectiveness of the lockout/tagout installation. Always perform a zero-energy check on the circuit to be worked, as well as on other nearby circuits and terminals. Perform these checks any time new areas or equipment are accessed.
- Use lockout/tagout processes if there is a possibility that work may be performed in proximity to energized electrical conductors.

From Electrical Safety Lessons-Learned Report, April 2004

After subcontractor electricians discovered a live, 120-volt wire in a cold and dark building at Rocky Flats in July 2002, for example, management issued a cold and dark operations order to ensure that all cold and dark buildings would be totally isolated from building power and temporary power. The order also directed that temporary power sources be unambiguously marked as temporary and tasked management with verifying cold and dark status, including the identification of all potential energized hazards.

In the spring of 2004, the Office of Corporate Performance Assessment issued an electrical safety lessons-learned report (*Electrical Safety*, April 2004) that describes commonly made electrical safety errors, identifies lessons learned, and details specific actions for preventing similar occurrences. Analysis indicated that a lack of accurate drawings, which are needed to safely isolate electrical systems, is a continuing problem across the Complex. The report also points out that changes in system configuration due to upgrades, construction, and decommissioning work are not always incorporated into electrical drawings, and outlines measures for preventing electrical hazard events, as shown in the textbox on the left.

Section 1910.333 of the OSHA Standard, *Selection and Use of Work Practices*, delineates OSHA requirements for safety-related measures that must be taken to prevent "electric shock or other injuries resulting from either direct or indirect electrical contacts, when work is performed near or on equipment or circuits which are or may be energized." Requirements for lockout/tagouts are given in 1910.333(b)(2)(iii);voltage-check requirements are outlined in 1910.333(b)(2)(iv)(B).

These events illustrate the importance of performing a thorough hazard assessment before electrical work begins, particularly during D&D activities. It is essential to take the following actions.

- *Conduct walkdowns in all areas where work is to be performed.*
- *Ensure that all drawings are accurate and reflect current conditions.*
- *Verify that all circuits have been de-energized and all potential hazards have been identified.*
- *Clearly identify temporary power sources in cold and dark facilities to ensure that workers cannot mistake temporary power sources for de-energized sources.*

KEYWORDS: *D&D, electrical hazard, conduit, energized, wiring, air gapping, GFCI, cold and dark*

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

4. COLD WEATHER HAZARDS: FROZEN SPRINKLER HEADS, POWER OUTAGES, SLIPS AND FALLS, AND VEHICLE ACCIDENTS

Each year, with the advent of cold weather, DOE sites begin reporting events to ORPS that resulted from sub-zero weather, freezing rain, snow, and ice. In addition to frozen sprinkler heads and power outages, there are also many reports of vehicle and slip-and-fall accidents resulting from poor weather conditions. Preparations for inclement weather should be underway across the Complex, as many weather-related events occur early in the season. Several weather-related events reported during the winter of 2004–2005, including two that occurred in late November, are described on the following page.

On January 6, 2004, at Los Alamos National Laboratory (LANL), two freeze-damaged fire suppression sprinklers released water into a hallway and two storage closets, activating the building fire alarm system. The Los Alamos Fire Department responded, ensured there was no fire, and closed the indicator valve to stop the flow of water through the building. All employees evacuated the building without injury. (ORPS Report NA--LASO-LANL-MATSCCMPLX-2004-0001)

Following the Christmas holiday break, building occupants had complained of cold temperatures in two rooms. On January 5, technicians discovered that the three building Air Handling Units (AHUs) were not operating correctly and the air intake dampers were partially or fully open. Normal automatic control of the HVAC system would have closed the dampers in cold weather conditions and then recirculated preheated air within the building. The technicians traced the problem to failed switches on the damper lever arms and to other AHU control problems.

When the technicians returned to continue troubleshooting the HVAC system the following day, they saw water dripping from a re-heating coil located above ceiling tiles in the hallway.

They isolated the coil and notified the building facility coordinator. A short time later, water began to flow through a damaged fire-suppression sprinkler in the storage closet near the coil, and a second sprinkler in another closet also began leaking. The suppression water flow and resulting system pressure changes activated the fire alarm.

Because of freeze events that occurred at LANL in the past, facility-specific freeze protection plans were to be implemented across the Laboratory. Investigators identified the primary causal factor of this event as "failure to adequately implement required facility-specific freeze protection controls." They determined that no one verified that the HVAC system was operating properly before the Christmas break and the freeze event that followed. Problems with the system were not identified until technicians responded to complaints that the system was not adequately maintaining building temperatures.

Corrective actions included the following.

- Develop and implement a freeze-protection plan that complies with site requirements.
- Implement a procedure to increase the frequency of facility walkdowns when temperatures fall below freezing.
- Ensure that temperature alarms are installed in critical facilities and rooms.

A weather-related event at Rocky Flats on January 6, 2004, resulted in the unexpected startup of a fire pump. Fire personnel responded quickly when notified of the pump actuation and determined that the fire system was at full operating pressure. (ORPS Report EM-RFO--KHLL-UTILITIES-2004-0001)

Site personnel determined that a low-pressure sensing line on the skid-mounted fire service pump froze because of extremely low temperatures. The frozen half-inch line caused a sensor reading that indicated a low-pressure condition within the firewater system even though the pressure was adequate. The pump was removed from service until the sensor line could be returned to operable status.

Investigators determined that the fire service pump and controls are located in an enclosure designed to protect the equipment from the elements. However, the system was not adequately designed to withstand temperatures that are well below freezing, despite the fact that such temperatures are a common winter occurrence at Rocky Flats. The frozen sensing line was located near floor level of the elevated steel floor, where temperatures were approximately 40 degrees cooler than at the ceiling of the enclosure.

Corrective actions entailed providing additional freeze-protection measures, including the following.

- Install weather stripping around doors
- Cover building vents
- Install heat trace and insulation on the sensing line
- Secure a tarp around the outside of the enclosure to reduce exposure of the steel floor to cold weather
- Reposition electric heaters to provide improved circulation of warm air

In addition to ensuring that facility systems remain operable during the winter season, it is also important to consider that inclement weather can lead to slip-and-fall events and vehicle accidents, as the following examples show.

In one of the numerous slip-and-fall events reported to ORPS during the winter of 2004-2005, a LANL employee slipped on black ice in a parking lot on November 24, 2004, and suffered serious injuries. The Los Alamos area had received several inches of snow on November 21. During the daytime hours of November 23, the snow melted and, when overnight temperatures dropped below freezing, ice formed in the parking lot. On the morning of the 24th, the employee stepped out of her vehicle onto the pavement of the parking lot and fell on a patch of black ice, hitting her face on the pavement. She sustained a fractured left humerus, lacerations requiring stitches above her left eye, and three facial fractures. (ORPS Report NA--LASO-LANL-PHYSTECH-2004-0006)

Following this incident, LANL management issued a lessons-learned bulletin to site employees concerning slips, trips, and falls and included prevention tips. Also, because the Laboratory's snow removal plan places priority on cleaning and sanding primary and secondary roads, the parking lots onsite had not been sanded before the incident, so management undertook a review of options for maintaining parking lots and walkways. The review included studying new methods for cleaning and maintaining parking areas and walkways, evaluating equipment and resources needed to perform the tasks, and requesting the funding needed to ensure that the areas would be maintained.

Tips to Help Prevent Slips and Falls

- Wear the proper footgear (e.g., shoes, boots, or overshoes with anti-slip soles).
- Keep both hands free for balance, rather than in your pockets.
- Be careful of wet shoes on a dry floor; they can be just as slippery as dry shoes on a wet floor.
- Keep walkways and parking lots clear of water, snow, and ice.

From Prince Edward Island Workers Compensation Board Winter Alert, October 2005

Among the vehicle accidents that occurred last winter, a snowplow driver at Rocky Flats lost control of his vehicle following a November snowfall and hit a ground-mounted HVAC unit and the protective barriers surrounding it. The driver was not injured, but the snowplow had to be towed to the site garage. Investigators determined that the blade of the snowplow caught on an out-of-service railroad track while the truck was moving at 25 to 35 mph. The snowplow slid out of control into the opposite lane and struck the HVAC. (ORPS Report EM-RFO--KHLL-FACOPS-2004-0004)

To prevent similar events, snowplow operators were made aware of onsite areas that may have similar conditions. Management also considered using alternate equipment in those areas.

In addition to preparing facilities for freezing temperatures and other severe winter weather, it is essential to remind employees of the risks involved when driving their personal or government vehicles and when traversing sidewalks and parking lots in snow, ice, and freezing rain. Notices about the hazards of winter weather should be disseminated to all employees, and a policy should be in place that guides supervisors in determining whether outside work tasks should be cancelled due to inclement weather.

Section 4.18 of DOE G 433.1-1, *Seasonal Severe Weather and Adverse Environmental Conditions Maintenance,* provides guidance for cold-weather preparation. Guidance is provided to assist facility maintenance organizations in reviewing existing freeze protection plans and developing methods for establishing seasonal maintenance programs. Additional freeze protection recommendations can be found in an Institute of Nuclear Power Operations (INPO) Just-In-Time Report issued in October 2003. The report, *Cold Weather Preparations*, discusses the impact of cold weather on recirculation and instrumentation lines and cooling systems and provides a list of actions to prepare for cold weather.

OE Summaries 2002-22, 2003-23, and 2004-19 contain freeze-protection guidance based on occurrences reported to ORPS in each of those years. Issue 2004-19 also includes an example of the cold weather checklist provided in DOE G 433.1-1.

Typical Freeze Protection Measures

- Examine wet-pipe sprinkler systems for areas susceptible to freezing and develop preventive or compensatory measures to ensure operation.
- Inspect dry-pipe fire suppression systems and ensure that all water is drained.
- Review procedures to ensure that compensatory measures are in place if power is lost.
- Inspect, service, and test facility heating systems and ensure that power and temperature controls cannot be inadvertently deactivated.
- Install temperature alarms or automatic backup heat sources on vulnerable systems.
- Inspect outside storage pads and unheated storage areas and provide additional protection if needed to ensure that stored materials are not affected by inclement weather or freeze damage.
- Inspect heat-trace tape for signs of degradation and replace as necessary.
- Inspect and repair outdoor circuits (e.g., those used for vehicle block heaters and power tools).
- Test ground fault circuit interrupters to ensure they are working properly before heavy seasonal usage begins.

These events show the importance of being prepared for inclement weather. It is essential to ensure that freeze-protection plans are in place before the onset of winter weather, which may arrive as early as October at some DOE sites. Preventing freeze damage requires performing preliminary inspections, correcting any deficiencies, incorporating lessons learned from previous years, and continued monitoring of at-risk equipment during cold weather.

In addition, these events show the importance of reminding employees of the hazards of walking and driving on snow and ice to ensure that they take appropriate precautions to avoid slips and falls or vehicular accidents.

KEYWORDS: *Freeze protection, sprinkler heads, maintenance, power outage, snow, ice, slips, falls*

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

Commonly Used Acronyms and Initialisms

Agencies/Organizations	
ACGIH	American Conference of Governmental Industrial Hygienists
ANSI	American National Standards Institute
CPSC	Consumer Product Safety Commission
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
MSDS	Material Safety Data Sheet
ORPS	Occurrence Reporting and Processing System
PPE	Personal Protective Equipment
QA/QC	Quality Assurance/Quality Control