Operating Experience Summary

U.S. Department of Energy
Office of Health, Safety and Security
OE Summary 2009-12
December 31, 2009

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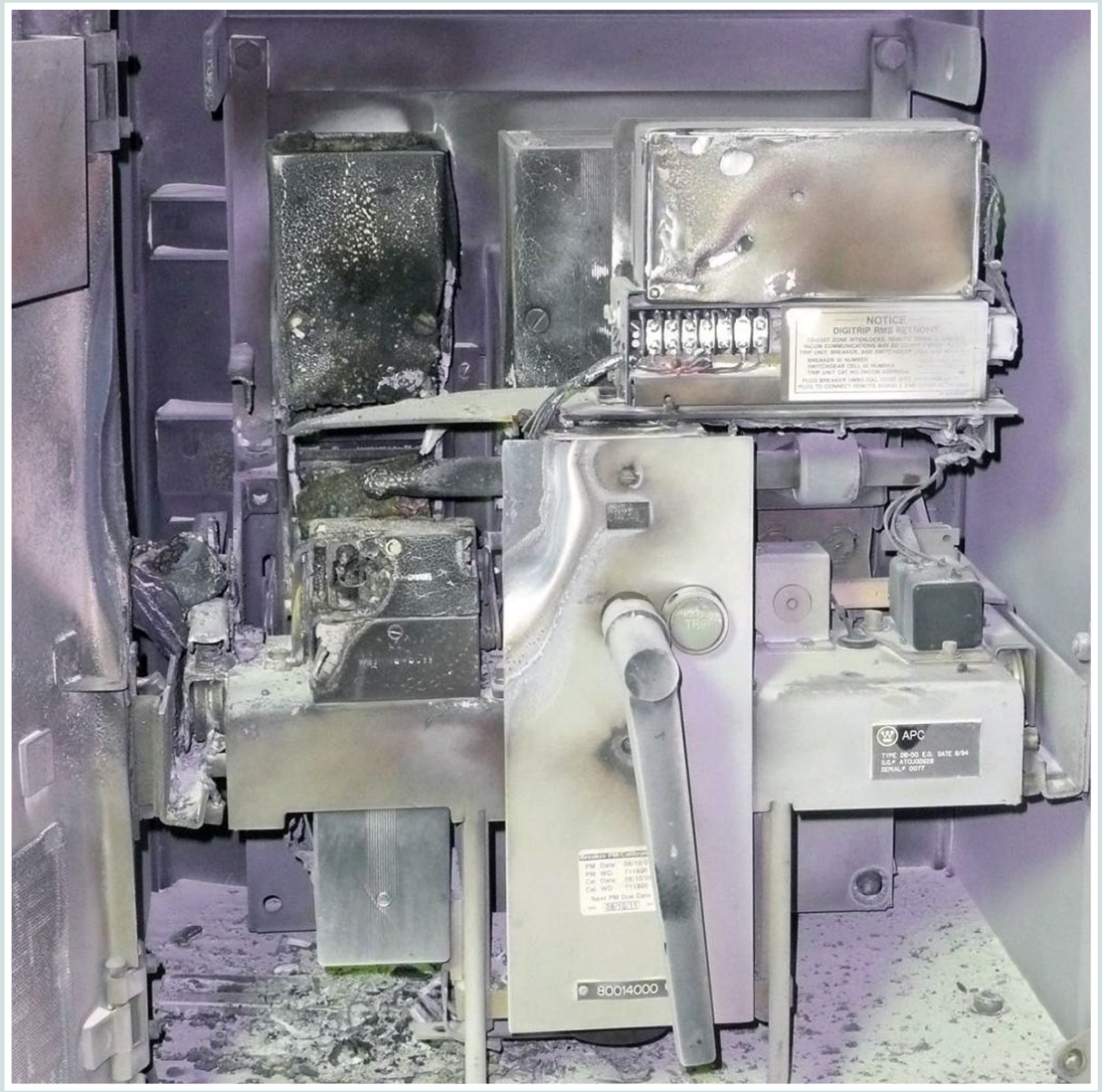

Type B Accident Investigation—Arc Flash Results in Burn Injuries

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On September 23, 2009, at the Savannah River Site, two electrical and instrumentation mechanics were troubleshooting a problem in a 480-volt circuit breaker cubicle when a non-insulated metal level fell, contacted one of the energized phases of the breaker, and caused an arc flash. One mechanic (Mechanic 1) suffered second- and third-degree burns to his arms and face. The second mechanic (Mechanic 2) was not injured because he had stepped away from the cabinet before the arc flash occurred. Neither worker was wearing electrical personal protective equipment (PPE), arc flash suits, or flame-retardant coveralls. The arc flash also severely damaged the left side of the breaker and splattered material inside the cubicle and as far as 10 feet away. The results of a Type B Accident Investigation into this event are summarized below. (ORPS Report EM-SR--SRNS-SIPS-2009-0008)

On the morning of the event, the mechanics were troubleshooting in the cubicle because the circuit breaker would not close. They concluded that the track was not level and the breaker was misaligned. That afternoon, following a pre-job briefing with their supervisor, they entered the cubicle intending to reposition the breaker. Mechanic 2 placed the level in the energized cabinet so they could determine the extent of adjustment needed and then left the cubicle. Seconds later, Mechanic 1 saw the level begin to fall, tried to stop it, and failed. The level fell and lodged between the energized "A" phase breaker contact and a breaker support brace, resulting in a short to ground and the arc flash. Figure 1-1 shows the breaker, level, and damage to a rail following the arc flash.

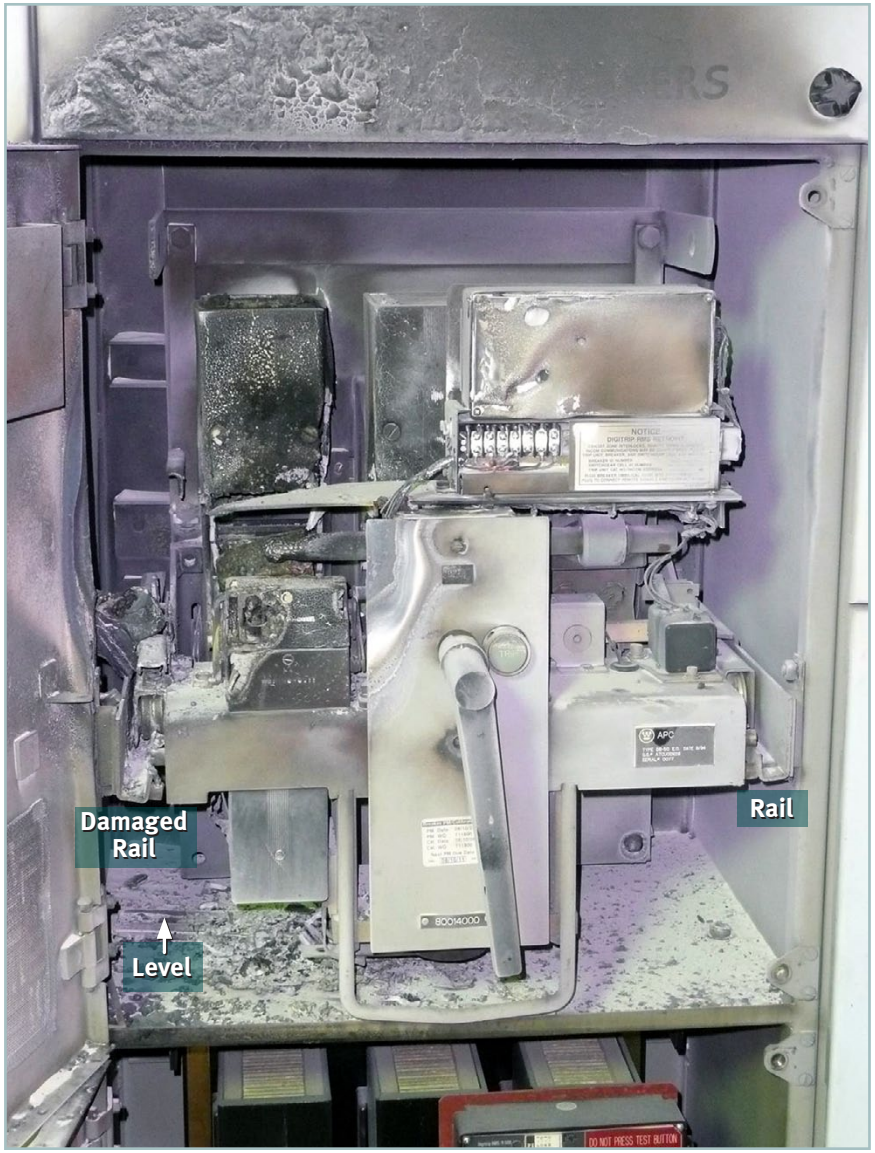


Figure 1-1. Damaged circuit breaker and position of level post-event

The Type B Accident Board determined that the mechanics performed the work using a generic troubleshooting work package that did not include a hazard analysis or identify hazard controls and did not clearly identify work limitations or stopping points. In addition, troubleshooting the 480-volt circuit breaker was outside the limitations of the generic troubleshooting work package. By the time the troubleshooting work package was developed, the job had progressed beyond troubleshooting into repair and adjustments to correct the problems identified during morning activities. The work then required implementing a corrective maintenance work order with a fully defined work scope, thorough analysis of hazards, and specifically developed hazard controls.

Beginning corrective maintenance with no specific authorization or work package and later continuing corrective maintenance with a work package that did not cover the scope of the activities being conducted were contributing factors to this event. The Board determined that the troubleshooting task was poorly defined and was outside the scope of both site procedures and the generic troubleshooting work package.

The Board also determined that the pre-job briefing for troubleshooting activities failed to address the specific tasks the mechanics would perform and the tools they needed. The potential for an arc flash and the required electrical PPE for the work also were not discussed. In addition, neither the supervisor nor the mechanics verified that the generic prescreen hazard analysis was adequate to identify the hazards associated with the work scope, and they did not discuss the potential hazards before returning to the cubicle to reposition the breaker.

The generic package permitted only work tasks for which standard PPE (e.g., hard hats, safety glasses, leather gloves) was used, which excluded nearly all electrical work. The site electrical review board should have been consulted to approve the work package before work was performed because of the potential for arc flash; however, review board approval was not obtained. Arc flash calculations for the breaker had been completed and labels had been clearly affixed to the front of the cabinet door (Figure 1-2) in accordance with NFPA 70E, *Standard for Electrical Safety in the Workplace*. The potential for an arc flash indicated the need for arc flash-rated clothing, and the workers would have been required to wear appropriate PPE had the review board been involved in the work planning.

Figure 1-2. Arc flash warning label

The Board concluded that although the direct cause of this event was the non-insulated level falling into the circuit breaker, the root cause of the event was that experienced workers did not comply with required and expected safe electrical work practices. Among the contributing causes of this event were work control processes that failed to prevent work activities from occurring in the vicinity of energized equipment and the lack of an effective pre-job briefing.

The Board's Judgments of Need included the following.

- Develop a process to ensure adequate control of tools and equipment used on or near energized electrical components.
- Ensure that work documents contain specific activities that are defined in sufficient detail to permit proper identification of hazards and implementation of hazard controls.

- Ensure that work is reviewed, authorized, supervised, and performed by personnel who clearly understand the work scope, limitations, hazards, and controls before work begins.
- Ensure that effective pre-job briefings are performed that include discussing the specific work scope, limitations, associated hazards, and controls necessary to perform work safely.

The Type B Accident Report, which includes all of the Board's conclusions and Judgments of Need, can be accessed at http://www.hss.energy.gov/csa/csp/aip/accidents/typeb/Type_B_Savannah_River_Arc_Flash.pdf

This event points out the importance of ensuring that all potential hazards are identified and controlled before beginning a work task. The event also illustrates the importance of ensuring that all issues related to the work scope and its hazards are identified and discussed during pre-job briefings, as well as the importance of ensuring that work involving electrical hazards is reviewed by subject matter experts so that workers are aware of the PPE required for their protection and any specific electrical hazards. When performing work beyond the original scope (e.g., troubleshooting) both supervisors and workers should determine whether the procedure being used is appropriate for the work task, addresses all potential hazards, and identifies appropriate hazard controls.

KEYWORDS: Type B, arc flash, injuries, circuit breaker, troubleshooting, level, PPE

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

Index of *Operating Experience Summary* Articles Published in 2009

OE Summary 2009-01	Article Title	Event	Lessons Learned
	Winter Safety Reminder—Watch Your Step	An Office of River Protection review identified several effective corrective actions after numerous workers slip and fall on ice. (N/A)	*Most slips and falls can be prevented by taking a few simple precautions.*
	Adherence to Fall Protection Requirements is Essential to Safety	A worker inspecting a vintage railroad tank car at the Oak Ridge Y-12 site climbed onto the top of the tank car without wearing fall protection and without being secured to any structural member of the railroad car. (Lessons Learned Identifier Y-2008-OR-BWY12-1203)	*It is essential for workers to receive appropriate fall protection training that clearly identifies the dangers of falls, proper use of fall protection equipment, and the need to follow fall protection plans.*
	The Hazards of Pop-Up Vehicle Barriers	A security guard inadvertently activated a pop-up barrier while a garbage truck was driving across it. (ORPS Report NA--LSO-LLNL-LLNL-2008-0052)	*Operators must never become complacent about the dangerous consequences of the equipment they operate and should be re-trained on any configuration changes.*
	Bicycle Safety Onsite and In Your Neighborhood	Two bicycle accidents occurred at Lawrence Livermore National Laboratory and one occurred at Sandia National Laboratories; all three of the workers involved suffered broken bones. (ORPS Report NA--LSO-LLNL-LLNL-2008-0064)	*It is important to take all necessary precautions when riding a bicycle not only to prevent an accident, but to protect yourself in case of an accident. Wearing a helmet when riding is the most important safety measure you can take.*

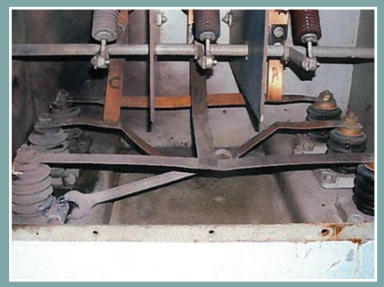
OE Summary 2009-02	Article Title	Event	Lessons Learned
	Type B Accident Investigation—Worker Injured When Rocket Motor Fires Unexpectedly	A rocket motor ignited prematurely, began moving down the track, and knocked a worker to the ground resulting in burns, a broken femur and a gash on his leg. (NA--SS-SNL-1000-2008-0014)	*Supervisors should ensure that all procedures are properly documented and communicated to workers and that workers understand both the hazards they might encounter and the purpose of following procedures to the letter.*
	Impact of Non-Safety Electrical Support System Vulnerabilities on Safety Systems	NRC Notice 2008-21 informs licensees about the effect of potential vulnerabilities in non-safety electrical support systems on safety systems. (N/A)	*Electrical maintenance managers should ensure that they have a strong circuit breaker maintenance program and that safety systems vital to facility operations are not vulnerable to failures associated with non-safety-related electrical components or electrical protection schemes.*
	The Brownfields Solution—What Happens to Formerly Contaminated Industrial and DOE Sites?	New technologies are advancing the ability to clean up and reuse contaminated sites across the country that, until recently, would have been fenced and locked. (N/A)	*Brownfield projects illustrate the importance of a vision supported by the cooperation and funding of public-private partnerships. Managers must balance the vision with constraints imposed by the chemical and industrial dangers inherent in an old site.*

OE Summary 2009-03	Article Title	Event	Lessons Learned
	Trackhoe Tips Over from Momentum of Rapidly Swinging Boom	A contractor trackhoe operator was clearing tumbleweed from a spoils pile when the trackhoe tipped over on its side. (SC--PNSO-PNNL-PNNLBOP-ER-2008-0020)	*It is essential to stay within the scope of the task, and workers should not make unilateral decisions that could lead to a hazardous situation.*
	NRC Identifies Concerns with Biodiesel Use in Diesel Engines Used for Safety	The Notice alerts licensees of nuclear power reactors and fuel cycle facilities to the potential for diesel fuel oil to contain up to 5 percent biodiesel (B5), which could adversely impact the performance of diesel engines used for facility safety. (N/A)	*Managers at DOE facilities that use diesel-driven equipment to support emergency and backup power generators or fire-fighting systems need to be aware of the potential for B5 in their fuel supply and the issues associated with using B5 in fuel systems.*
	Preventing Power Tool Injuries	A production line worker waiting for a part to come down the line inadvertently actuated a powered, slow-speed torque wrench that caught and bent his left wrist before he could release the trigger and sustained a hairline fracture of his wrist. (NE-ID--BEA-SMC- 2009-0001)	*When using powered hand-held tools, it is important to ensure that all manufacturer-required auxiliary handles are used and that all instructions in manufacturer operating manuals are followed.*

OE Summary 2009-04	Article Title	Event	Lessons Learned
	Industry Arc Flash Event Results in Serious Burn Injuries	Three workers at the Jubail Project in Saudi Arabia were removing a 480-volt, molded-case circuit breaker from the bucket of an energized Motor Control Center when an electrical arc flash occurred, severely injuring them. (N/A)	*Workers should never perform work on energized electrical equipment without an energized electrical work permit that clearly identifies the hazards and appropriate controls, and flame-resistant clothing and required personal protective equipment (PPE) should always be worn if there is any chance that an arc flash could occur.*
	Vehicle Accidents and Fatalities Reinforce the Need for Safe Driving	Seven work-related fatalities have been reported to DOE since 2006, and four of those fatalities (57 percent) resulted from a vehicle accident that involved a DOE or contractor employee. (Multiple)	*It is essential to be aware of hazardous driving conditions, to take appropriate safety precautions, and to stay focused on driving safely, avoiding distraction.*

OE Summary 2009-05	Article Title	Event	Lessons Learned
	Type B Accident Investigation—Electric Cart Passenger Injury	A waste handling technician participating in a trailer spotter activity suffered internal injuries when he was pinned between a trailer and the front seat of an electric cart. (EM-CAFO--WTS-WIPP-2009-0003)	*Workers need to communicate any safety issues that they identify to supervisors in a timely manner and even low risk tasks require a job hazard analysis to ensure that the necessary controls are in place.*
	Clear Communication—An Important Element of Worker Safety	Less than adequate communication can result in injuries and near misses that could have been avoided if all required information about potential hazards, work activities, and hazard controls are communicated properly to workers before they perform a task or between workers engaged in a task. (N/A)	*It is essential for pre-job briefings and procedures to accurately communicate hazards and appropriate controls. It is equally important for workers to communicate with each other while performing a work task.*

OE Summary 2009-06	Article Title	Event	Lessons Learned
	Worker Injured When Length of Safety Line Exceeds Distance of Fall	A subcontractor worker attempting to reinstall a lightning protection system as part of a roofing task lost his balance and fell about 13 feet to the ground when his self-retracting safety line locked because he had run out nearly all of the line. (NA--PS-BWP-PANTEX-2009-0029)	*Those who work at heights must take responsibility for remaining alert to any hazards and for wearing the proper fall protection equipment, using it correctly, and complying with all safety procedures.*
	Careful Work Planning Required for Tasks in Confined Spaces	Several events across the Complex that involved workers performing tasks in confined spaces had a similar causal factor—inadequate work planning. (Multiple)	*Workers must have clear guidance for safe confined space entry and exit and must be provided with all personal protective equipment (PPE) required for their safety.*
	Legacy Beryllium Carries Potential for Contamination and Exposure	Workers moved a crate for which the manifest indicated that the contents were contaminated with beryllium, but the exterior of the crate was not so labeled. Swipes taken after this event occurred indicated that there was beryllium contamination in areas believed to be clean. (NA--LASO-LANL-LANL-2008-0006)	*Without documentation to guide them, workers must be vigilant and maintain a questioning attitude. Workers should never assume a work area is clean; its history is revealed only when swipes are taken and analyzed.*

OE Summary 2009-07	Article Title	Event	Lessons Learned
	Near Miss—Work in the Wrong Electrical Cabinet Results in Arc Flash	An electrical worker attempting to remove the links from the power side of a circuit interrupter dropped a wrench, which came in contact with an energized 13.8-kV bus bar and caused an arc flash. (EM-ORO-- BJC-K25GENLAN-2009-0001)	*Workers should always perform zero energy checks before beginning work on electrical systems and should be alert to any signs that a system is energized, even if the expectation is that they will be working on a de-energized system.*
	Good Practice—Proactive Steps to Improve Safety	Management at the Jefferson Lab initiated a program that emphasized reporting all medically related events that occurred onsite. (N/A)	*Taking a proactive approach to identifying the underlying cause of worker injuries, including minor injuries that require only first-aid, can assist management in determining the changes necessary in work planning to address the causes of such injuries and reduce the potential for their occurrence.*

OE Summary 2009-08	Article Title	Event	Lessons Learned
	Inadequate Shift Turnover Results in Serious Burn Injuries	Two workers repairing a leaking check valve (non-return valve) on a high-pressure recirculation pump for a heat recovery boiler at Rye House Power Station in England received serious burn injuries when they were engulfed by a wave of hot condensate. (N/A)	*If workers or supervisors have doubts or questions about the task ahead, they should stop and ask questions or seek clarification; there is no blame for invoking Stop Work authority or having a questioning attitude.*
	Near Miss—Worker Pinned While Working on Aerial Lift	A worker installing cross-bracing to construct a temporary work tent received a compression bruise injury while working in an aerial lift basket when the basket operator extended the basket too far into a support brace and caught the worker between the basket side rail and the brace. (EM-SR--PSC-SWPF-2009-0006)	*It is essential for workers to pay close attention to their surroundings and be alert to any hazards when performing tasks that require use of an aerial lift.*
	Rigger Severs Thumb While Removing Chain Between Trucks	A worker started to remove a tow chain attached between a flatbed truck and a track loader before the vehicles had come to a complete stop, and his right thumb tip was severed when the chain suddenly tightened. (SC-ORO--ORNL-X10BOPLANT-2008-0007)	*It is essential to stay focused when performing a work task and evaluate any change in conditions for newly introduced hazards so that appropriate hazard controls can be implemented before work continues.*

OE Summary 2009-09	Article Title	Event	Lessons Learned
	Seemingly Unimportant Changes Result in Crane Accidents	A tower crane operator attempting to locate and pick up a trash skip hit the pendant of a stationary track crane with the boom of the tower crane. (EM-RP--BNRP-RPPWTP-2009-0011)	*Crane operators and workers must be aware of changes that have occurred since they last performed an evolution, particularly in frequently performed operations when it is easy to become complacent.*
	Configuration Control Errors Can Affect the Operation of Safety-Related Equipment	The Nuclear Regulatory Commission issued an Information Notice to inform licensees of configuration control errors that can affect the operation of safety-related equipment. (N/A)	*Configuration control errors can render technical safety-required systems inoperable or result in a violation. Proper configuration control is particularly important when a single component, if mispositioned, would cause the system to become inoperable.*
	Unidentified Drilling Hazards Result in Two Near-Miss Events	Two near-miss events occurred during operations at a Hanford drilling project within days of each other. One event resulted in a worker receiving a minor burn that required first-aid; the other resulted in damage to equipment, but could have resulted in a serious injury. (EM-RL--CPRC-GPP-2009-0006; EM-RL--CPRC-GPP-2009-0005)	*Although a detailed job hazard analysis may be in place, potential hazards outside the scope of the job hazard analysis may impact safety during the drilling operations, which are among the most dangerous types of operations.*

OE Summary 2009-10	Article Title	Event	Lessons Learned
	Type B Accident Investigation of Hanford Worker Fall from Catwalk	A millwright working on an elevated catwalk to prepare a bridge crane for removal fell through an open hatch to the floor below, struck the guardrail of a midpoint platform 25 feet below the catwalk and then fell another 25 feet to the concrete floor. (EM-RL--WCH-DND-2009-0005)	*Distractions, lack of hazard identification and control, schedule pressures, the addition of an unplanned work task, and a belief that originally planned work had been completed culminated in a fall that could have been fatal.*
	Time to Prepare for Winter Weather	Events from the winter of 2008/2009 show the types of problems that inclement weather brings. (N/A)	*Managers should ensure that current policies, procedures, and work planning efforts reflect the lessons learned from previous inclement weather and that systems with outdoor components or vehicles that are parked outdoors for long periods of time are included in freeze protection planning and maintenance programs.*

OE Summary 2009-11	Article Title	Event	Lessons Learned
	Type A Accident Investigation—Vehicle Fatality	An employee, who was transporting boxes of personal property from one building to another in a government-owned pickup truck, sustained a fatal head injury when he was ejected from the vehicle. (NA--LSO-LLNL-LLNL-2009-0028)	*It is important to become familiar with the location of all vehicle safety controls (e.g., emergency brake) before attempting to operate a vehicle, especially if it is a type of vehicle that you have never driven.*
	Chemical Safety Board Releases Report on Imperial Sugar Dust Explosion	The Chemical Safety Board released their investigation report on the 2008 dust explosion at the Imperial Sugar facility in Port Wentworth, Georgia, which resulted in 14 worker fatalities. (N/A)	*Housekeeping is an effective method of identifying and removing potential hazards, and it is important to ensure that appropriate housekeeping polices are in place and adhered to. Proper maintenance of dust collection systems is also essential to ensure that all dust removal equipment is performing effectively.*

OE Summary 2009-12	Article Title	Event	Lessons Learned
	Type B Accident Investigation—Arc Flash Results in Burn Injuries	Mechanics were troubleshooting a problem in a 480-volt circuit breaker cubicle when a non-insulated metal level fell, contacted one of the energized phases of the breaker, and caused an arc flash. (EM-SR--SRNS-SIPS-2009-0008)	*It is important to ensure that all potential hazards are identified and controlled before beginning a work task and that all issues related to the work scope and its hazards are identified and discussed during pre-job briefings.*

The Office of Health, Safety and Security (HSS), Office of Analysis publishes the *Operating Experience Summary* to promote safety throughout the Department of Energy (DOE) complex by encouraging the exchange of lessons-learned information among DOE facilities.

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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

Units of Measure	
AC	alternating current
DC	direct current
mg	milligram (1/1000th of a gram)
kg	kilogram (1000 grams)
psi (a)(d)(g)	pounds per square inch (absolute) (differential) (gauge)
RAD	Radiation Absorbed Dose
REM	Roentgen Equivalent Man
TWA	Time Weighted Average
v/kv	volt/kilovolt

Job Titles/Positions	
RCT	Radiological Control Technician

Authorization Basis/Documents	
JHA	Job Hazards Analysis
JSA	Job Safety 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
D&D	Decontamination and Decommissioning
DD&D	Decontamination, Decommissioning, and Dismantlement
RCRA	Resource Conservation and Recovery Act
TSCA	Toxic Substances Control Act

Miscellaneous	
ALARA	As low as reasonably achievable
HEPA	High Efficiency Particulate Air
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
SME	Subject Matter Expert