# OPERATING EXPERIENCE SUMMARY

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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/reports.html.

## *Type A Accident Investigation*

The Hanford Site Manager has convened a Type A Accident Investigation to determine the cause of the July 15 fatality involving an offsite contractor who was helping to prepare an excessed office trailer for transport. The results of this investigation will be published in a future edition of the OE Summary.

# *EVENTS*

## 1. SET THE PARKING BRAKE TO PREVENT RUNAWAY VEHICLES

Accidents involving runaway, unattended vehicles occurred at two DOE sites in early July. On July 8, 2004, at the Hanford Site, an unattended truck ran up on a berm and nearly dropped into a 40-foot-deep trench where construction workers were covering a layer of waste. (ORPS Report RL--PHMC-SOLIDWASTE-2004-0008) On July 2nd, at Fernald, an unattended passenger van rolled backward about 160 feet and ran into a concrete jersey barricade. (ORPS Report OH-FN-FFI-FEMP-2004-0020) Both accidents could have been prevented had the drivers set the vehicle's parking brake or turned off the engine.

In the Hanford incident, a nuclear chemical operator left his truck to make a phone call, and did not pull on the parking brake. He left the engine running and the transmission in gear, and the idle speed was sufficient to move the truck about 25 feet uphill. Another operator saw the truck heading toward the trench, jumped into it, and managed to stop it just before it went over the edge into the trench (i.e., approximately 3 feet from the edge). Figure 1-1 shows the trench, the rain cover surrounding it, and approximately where the truck stopped. Following this incident, management established a precautionary 20-foot vehicle exclusion zone around the mixed-waste trenches. The accident is still under investigation.

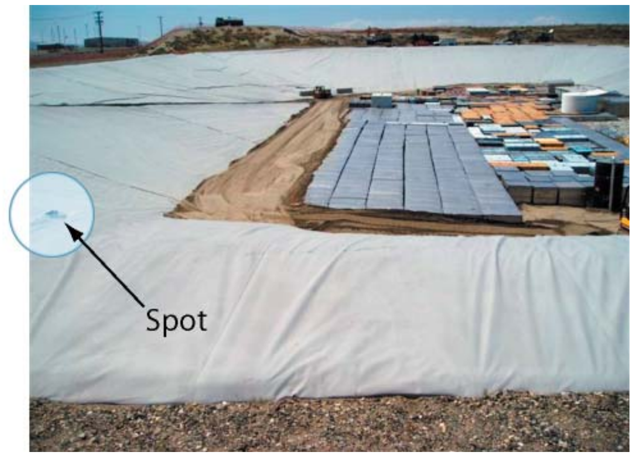


*Figure 1-1. Trench, rain cover, and approximate spot where the truck was stopped*

At Fernald, a driver went to get a drink of water at a nearby trailer, leaving the van in Park, with the motor running. Like the truck operator at Hanford, he did not set the parking brake before exiting the vehicle. The van apparently went into reverse gear, traveled backward at about 5 miles per hour, and hit the concrete barricade. The driver received a radio call from a dump truck driver in the area alerting him that the van was rolling backwards, but no one could reach the truck before it hit the barricade.

Following the accident, the driver's supervisor noticed that the reverse lights were not illuminated, the backup alarm was not engaged, and the gear shift indicated that the van was in Park, but the truck was in reverse gear. Shortly afterwards, the van rolled forward a few inches, even though the gear shift had not been moved or touched.

Although a mechanical problem may have contributed to this accident, investigators determined that the driver did not follow the guidance in the site document, "Safe Work Practices for Mobile Equipment and Project Vehicles." The document includes the following guidance.

- Safe parking procedures include...placing transmissions in neutral and setting the parking brake...anytime the driver/operator exits the equipment.

- When an operator/driver leaves the accessible vicinity (i.e., within an unobstructed 35-foot path) of the equipment, the engine shall be shut down after a normal period of idling…equipment must be placed in a zero-energy condition and have its parking brake set.

A search of the ORPS database revealed 21 incidents involving runaway vehicles since 1991. Four of these, not including the two most recent accidents, occurred in 2003 and 2004. One near-miss involving a runaway fuel truck occurred on September 4, 2003, at the Oak Ridge National Laboratory New Hydrofracture Facility. The driver of the truck had refueled and tried to drive forward, but the truck would not move. He thought that the fuel pumping system was still engaged, so he exited the truck and walked to the passenger side to cycle the fuel shutoff valve. He did not set the parking brake before exiting the truck, which was on an incline. The truck rolled backwards downhill, striking two pickup trucks and a minivan. One of the pickup trucks was occupied when the fuel truck hit its left rear section, and a number of workers were in the immediate area. Fortunately, no one was injured, but damage to the vehicles was estimated to be in excess of $10,000. (ORPS Report ORO--BJC-X10ENVRES-2003-0012)

The direct cause of this incident was attributed to the driver not following the requirements outlined in the state Commercial Driver License Manual. The manual clearly states the following: "…any time you park, use the parking brake" and "…never leave your vehicle unattended without applying the parking brake or chocking the wheels." More information about this incident is available on the Lessons Learned website (SELLS Identifier Y-2004-OR-BJCMVCP-0501).

Industry also has had its share of accidents attributed to unattended, runaway vehicles. Figures 1-2 and 1-3 show the results of an accident that occurred when a gas company welding truck rolled backwards 162 feet, hit a utility pole, and snapped it in half. The bottom half of the pole (Figure 1-2) stopped the truck from continuing to roll across a busy state highway.


***Figure 1-2. Welding truck after the accident***

Figure 1-3 shows what remained of the top section of the pole, which fell onto the recently topped-off 200-gallon diesel fuel tank. In this case, an unset parking brake and an unattended vehicle nearly led to a major vehicular accident, downed power lines, and contact with electrical conductors.

Each of these accidents resulted in thousands of dollars in damages and could have resulted in injuries or death. If the drivers had simply turned off the engine and set the parking brake when they exited their vehicles, the accidents could have been prevented. At most DOE sites, safety procedures for trucks and similar vehicles direct drivers to set parking brakes and apply chocks when leaving the vehicle unattended. State manuals for commercial driver's licenses provide similar direction. Managers and supervisors should regularly stress the importance of these actions.


***Figure 1-3. Truck and top section of utility pole***

*These events illustrate the inherent danger of taking the performance of routine tasks for granted. An "I've done this hundreds of times before" attitude leads to complacency and a lack of attention that can easily result in a dangerous situation. All drivers should make a final check before exiting their vehicles to ensure that the vehicle is in Park or Neutral and the parking brake is fully engaged, even if they will be gone only a few minutes. Chocking the wheels is also a good practice to ensure that vehicles will not move while left unattended.*

***KEYWORDS:*** *Vehicle accident, near miss, truck, brake*

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

## 2. MODIFIED RADIOLOGICAL CHECK SOURCES MAY LEAK

On June 24, 2004, at the Savannah River Site, an inspector found a leaking check source in a Thermo Electron Gamma Remote Detector (Model DA1-6CC). Further investigation revealed that the strontium/yttrium-90 source did not meet original specifications and that heat-shrink tubing (Figure 2-1) and a washer (Figure 2-2) had been installed on the source to reduce the beta dose rate. (ORPS Report SR--WSRC-HPIH-2004-0001; SELLS identifier 2004-SR-WSRC-0034)

The Radiological Protection Services organization at Savannah River, which has purchased 24 of these detectors in the past year, found a total of 4 sources with activity levels up to 10 times higher than similar models. A

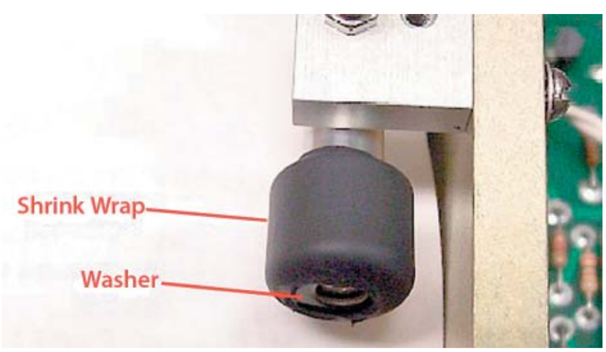


***Figure 2-1. Modified check source***

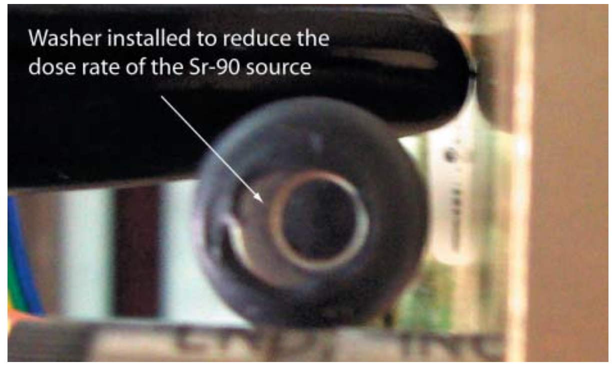


***Figure 2-2. Closeup of washer installed in source***

site representative contacted Thermo Electron (formerly Eberline) to determine the reason for the altered configuration. Figure 2-3 shows an unmodified check source.

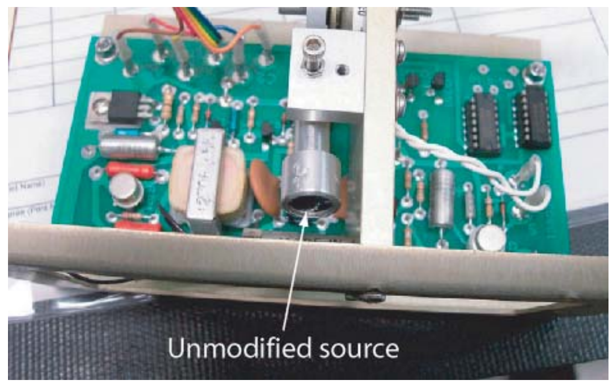


***Figure 2-3. An unmodified source***

Thermo Electron investigated and found that a modified process for applying the source material caused the subcontractor it employed for manufacturing certain check sources after August 30, 2000, to inadvertently apply excess material. When Thermo Electron received the assembled sources and detected high source readings, factory workers installed washers and applied heat-shrink tubing to reduce the dose rate. However, heat-treating degraded the Mylar window containing the source material, causing leakage from some sources.

Sites using Models DA1-1, DA1-6, and DA1-8 containing CS-19, CS-19S, and CS-20 check sources manufactured after August 30, 2000, should check them for external contamination. Any contamination should be removed before opening the housings. Personnel should leak-test the check sources. If a source is leaking, the detector should be treated as potentially internally contaminated. Sources that are not leaking should be checked to see if they were modified using heat-shrink tubing around the check source body. Those with the shrink tubing should be contained and removed from the detector housing. Unmodified sources can be reassembled and returned to service.

Thermo Electron will provide free replacement sources upon request until November 1, 2004, and at prevailing prices thereafter. Click here to download the form that will accompany returns. Contact Scott Lamb at Thermo Electron with any questions at (800) 678-7088, ext. 3453.

***KEYWORDS:*** *Eberline, Thermo Electron, check source, leaking, remote detector, modification*

***ISM CORE FUNCTION:*** *Provide Feedback and Improvement*

## *3. NEAR MISS — CRANE CABLE UNWRAPS FROM HOIST DRUM*

On June 7, 2004, at the Argonne National Laboratory–East, a near miss occurred when a fully paid-out crane cable re-wrapped on the drum in the reverse direction, confusing the crane operator. The crane operator reported that the crane control was responding backwards (i.e., the "up" control lowered the hook). Facility management categorized the event as a near miss because the cable could have fallen off the drum when it unwrapped, allowing the cable, hook, or load to fall on nearby personnel. (ORPS Report CH-AA-ITSI-ANLEITSI-2004-0001; final report filed June 23, 2004)

The crane operator was using the 10-ton bridge crane to lift loads from a pump room located below the operating floor of a building in support of decontamination and decommissioning (D&D) activities. On the sixth lift of the day, the crane operator experienced problems with the controls as he was positioning the hook to pick up a load. Neither the crane operator (on the operating floor) nor his spotter, located below in the pump room, paid any attention to the number of turns of cable that remained on the drum. After they stopped work, they determined that only 3/4 of a turn of cable remained on the drum.

Investigators learned that the crane operator was trained and aware of the height/position limitations of the crane hook, but he did not pay adequate attention during the evolution. The crane operator and the spotter were unable to see the cable drum from their positions. In addition, there was no lower-limit switch on the crane travel, and there were no visual aids to indicate the range of travel with respect to maintaining an adequate number of turns on the cable drum. To correct this problem, the crane cable will be marked with paint to provide visual indication of the limit of travel.

The following two crane events are similar and both resulted in near misses.

At the West Valley Site, a crane operator was lowering an overhead crane hoist hook through a floor hatch to a lower level so that a D&D worker could attach the hook to a sling rigged to a gearbox. As the hook was lowered to within 2 feet of the floor, it suddenly fell. The D&D operator stepped back away from the fallen hook as the full length of crane cable came off the drum and fell to the floor. During previous use, the hook had been lowered approximately 5 feet from the floor without incident. (ORPS Report OH-WV-WVNS-CF-2002-0002)

The cable is secured to the drum by friction forces when at least two wraps of cable are maintained. Investigators determined that too much cable (wire rope) was unwound from the drum.

The requirement to maintain a minimum of two wraps of cable on the hoist drum was not addressed in the initial hoisting and rigging training course. In addition, the crane operator was not cautioned that the crane was not equipped with a lower-limit switch through labels, operator aids, procedures, or a crane-specific daily checklist. Corrective actions included installing a lower-limit switch and revising the initial hoisting and rigging training course to include instructions on operating hoists that do not have a lower-limit switch.

At Argonne National Laboratory–East, two workers were attaching rigging to a crane hook that had been lowered near the bottom of a fuel storage pit. The workers heard a "whirling" sound and immediately moved away from the hook. The end of the crane cable came off the drum and fell into the pit, hitting the shoulder of one of the workers. There was no injury. (ORPS Report CH-AA-ANLE-ANLEER-1998-0003)

As in the West Valley event, investigators determined that too much cable unwound from the drum. The qualified crane operator failed to maintain the required number of cable wraps even after he was reminded during the pre-job briefing of the facility requirement to maintain at least three wraps. Also, the crane was not equipped with a lower-travel limit switch. Corrective actions included posting operator aids to remind crane operators of limitations and placing a mark on the pit wall to indicate the lower limit of hook travel that maintains three wraps of cable on the drum.

Chapter 8 of DOE-STD-1090-2004, *Hoisting and Rigging (Formerly Hoisting and Rigging Manual)*, provides guidance on hoist operation and maintenance. Section 8.1.10.2, "Lower-Limit Switches/Devices," states that electric- or air-powered hoists shall not be installed where, during normal operating conditions, the hook can be lowered beyond rated hook travel, unless the hoist is equipped with a lower-limit device. Lower-limit devices should be provided for hoists where the load block enters pits or hatchways in the floor.

*These events illustrate that care must be taken to ensure that an adequate number of wraps are maintained on the cable drum when crane operations involve lowering the crane hook below floor level. Multiple visual aids should be provided to assist crane operators. Pre-job briefings should include a review of hoist limits and safety precautions for operation. Crane operators should not rely solely on lower-limit switches when paying out cable. The absence of a lower-limit switch adds an additional burden of responsibility for crane operators to operate a crane with care.*

***KEYWORDS:*** *Crane, hoist, cable, drum, load, dropped*

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

## *4. USING MULTIMETERS SAFELY ON ENERGIZED CIRCUITS*

The most common piece of electrical test equipment is a multimeter. The multimeter, as the name implies, can be used to test for voltage, alternating and direct current, and resistance (ohms). Multimeters are used throughout the Department by various members of the workforce, including electricians, electronic technicians, and mechanics. In some cases, multimeters are also used by scientists and researchers high-voltage applications. Using a multimeter safely is extremely important. In the hands of a trained, competent technician the multimeter is an effective tool, but in the hands of someone unaware of its proper use, it can be a source of danger when connected to an energized circuit.

The following event, reported on the Network for Safety Professionals web site (URL http://www.SAFTENG.net), illustrates what can happen when a multimeter is used incorrectly. A worker was attempting to take voltage measurements with a multimeter inside a 480-VAC circuit breaker cabinet. He had the meter selected to read voltage but had the test leads plugged into the meter sockets for measuring current. This meter configuration produced a short circuit and electrical arc that burned the worker over 40 percent of his body. Figure 4-1 shows the remains of the multimeter, and Figure 4-2 shows the inside of the electrical cabinet.


***Figure 4-1. Accident victim's clothing, destroyed digital multimeter, and damaged safety glasses***

*Figure 4-2. Damaged electrical cabinet*

The report does not provide any information as to the worker's skill level or experience, but it is clear that this event resulted from the worker's inattention to detail.

A similar event occurred at the Nevada Off-site Facilities, where a journeyman electrician received second-degree flash burns over 18 percent of his face and hands when his multimeter blew up. He connected a 1,000-volt-rated Beckman Tech 310 digital multimeter to the primary side of an energized 4,160-volt transformer. The electrician was wearing sunglasses instead of safety glasses. A second electrician standing 6 feet away had his hair singed. (ORPS Report NVOO--RSNO-OFFNTS-1991-0009)

There is a danger in using an underrated meter when testing to determine if a high-voltage circuit is de-energized, because a phase-to-ground short can occur. It is important to ensure that multimeters are correctly set up to perform the required measurement (i.e., voltage, current, resistance) and properly rated for the circuit to be tested. However, it is also important to be careful when connecting test leads to the circuit or meter, as illustrated in the following events.

A beam line scientist at the National Synchrotron Light Source received an electrical shock when he touched a metal bayonet-type (BNC) connector to a multimeter that was energized at 1,000 VDC. The scientist was using the multimeter to measure current in series with a DC power supply operating at 1,000 volts. He was using the multimeter to precisely measure the DC current to heat a sample. He connected the multimeter into the high-voltage circuit using low current/voltage-rated accessories: coaxial cables, bayonet connectors (BNC), alligator clips, and a banana plug. (ORPS Report CH-BH-BNL-NSLS-2002-0001)

A technician at Sandia National Laboratory–Albuquerque received an electrical shock while troubleshooting a 900-VDC power supply with a multimeter. The multimeter had been connected to the output of the power supply, the power supply was energized, and then the power supply was de-energized. After 2 seconds, the technician pulled the banana plug for the test lead out of the multimeter and was shocked between the fingers and thumb of his left hand. The technician had no previous experience in making high-voltage measurements and was not attentive to the voltage-decay time of the power supply. The design of the banana plug to BNC connector allowed contact with the energized prongs. (ORPS Report ALO-KO-SNL-2000-2000-0001)

A technician at Rocky Flats received a minor electrical shock on a low-voltage (121.3 VAC), low-amperage (500 mA) switch while using a non-insulated alligator clip. The technician was connecting a digital multimeter to read resistance across a normally open common terminal on a photohelic gauge. The technician assumed the circuit was de-energized because his procedure step required a resistance measurement. (ORPS Report RFO--EGGR-ANALYTOPS-1994-0008)

A technician at the Thomas Jefferson National Accelerator received a minor electrical shock while testing power supply cables. The technician used a high-voltage probe and a Fluke multimeter and assumed the power supply was off. When he inserted the male connector into the cable female connector, he received an electrical shock. (ORPS Report ORO--SURA-TJNAF-1992-0004)

The most common use of a multimeter is to measure voltage, which is the primary safety measurement taken as part of electrical lockout/tagout procedures. If voltage is the only measurement required, electricians should consider using a single-function voltmeter rather than a multimeter to prevent multimeter configuration errors. Analog and digital multimeters require the user to manually set the function switch and manually plug the test leads into the appropriate connections on the meter, increasing the opportunity for error.

Most multimeters have thermistors, varistors, and fuses to prevent instrument damage from internal short circuits. However, these protective devices may not protect the user from electrical shock or arc flash, because the device may not open the circuit in time.

The input impedance (resistance) on the amps terminal can be as low as 0.01 ohm while the input impedance on the voltage terminal can be as much as 10,000,000 ohms. If the test leads are left in the amps terminals and then connected across a voltage source, the low impedance becomes a short circuit, even if the selector switch is turned to volts; the leads are still connected to the low-impedance circuit. Some multimeters have a warning feature that beeps if the multimeter is not configured correctly.

There are many makes of multimeters, and each instrument has unique features that even experienced electricians may not fully understand. Training should be provided to address any instrument limitations or potential hazards associated with its use.

Safety standards for electrical measurement equipment are addressed in IEC (International Electrotechnical Commission) 1010-1, which replaced IEC 348 in 1988. Meters designed to the new standard offer a higher level of safety for overvoltage and transient protection over meters designed to IEC 348.

DOE-HDBK-1092-98, *Electrical Safety*, provides guidance on safe electrical work practices in section 2.13. Standards for safe use of test

## Good Practices for Multimeters

- Know the limitations of the instrument.
- Ensure the meter is properly set up for the measurement (e.g., proper scale, correct leads, proper mode, correct connections).
- Restrict the use of multimeters when voltage is the only measurement needed.
- Check meters for damage and test for operation and accuracy.
- Retire older multimeters that do not meet newer safety standards.
- Never attempt to read resistance or continuity on an energized circuit.
- Always test for both AC and DC voltage when checking a circuit de-energized and between all pair-combinations of conductors and between all conductors and ground.
- When taking a voltage measurement on an energized circuit, connect the ground clip first and then the hot lead (remove in reverse order).
- Avoid holding the multimeter in your hands to minimize exposure to any transients (e.g., hang or rest the meter),
- Use the three-point test method when checking a circuit that is de-energized (i.e., check the meter on a known energized source, measure the circuit of interest, recheck the meter on an energized source).
- If possible, use one hand when taking measurements to lessen the chance of a closed circuit across the chest and through the heart.
- Always use a multimeter that is protected by a high-energy fuse and never replace a blown fuse with the wrong fuse.
- Always wear/use personal protective equipment (e.g., gloves, safety glasses, hardhat, rubber mats).

instruments and equipment can be found in OSHA 29 CFR 1910.334, *Use of Equipment.*

- 1910.334(c)(2), “Visual Inspection.” Test instruments and equipment and all associated test leads, cables, power cords, probes, and connectors shall be visually inspected for external defects and damage before the equipment is used.

- 1910.334(c)(3), “Rating of Equipment.” Test instruments and equipment and their accessories shall be rated for the circuits and equipment to which they will be connected and shall be designed for the environment in which they will be used.

*These events underscore the need to safely use multimeters and electrical testing equipment on energized circuits. In addition, it is very important to (1) choose a multimeter that is rated for the proper voltage, (2) inspect it for damage, and (3) verify that it operates before use. Users should consider voltage test instruments as part of their personal safety equipment.*

***KEYWORDS:*** *Meter, multimeter, plug, connector, shock, injury, arc, flash, electrical safety*

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

## 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 |

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