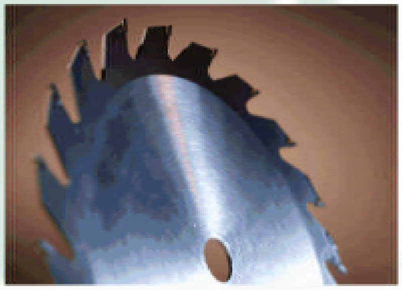
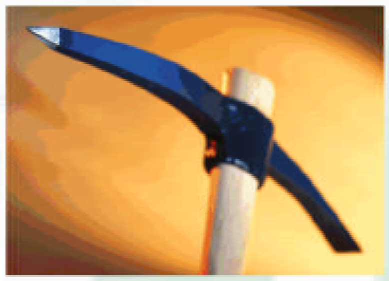
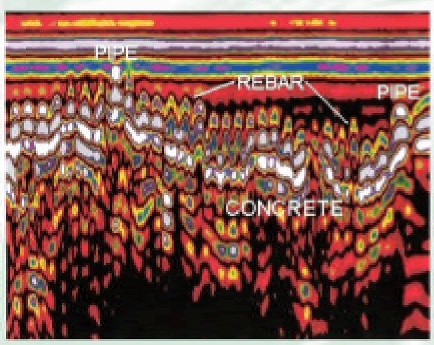
A Review of Electrical Intrusion Events at the Department of Energy: 2000-2001







Office of Performance Assessment and Analysis

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A REVIEW OF ELECTRICAL INTRUSION EVENTS AT THE DEPARTMENT OF ENERGY: 2000-2001

The frequency of electrical intrusion events across the DOE complex doubled beginning in June 2001, as shown in Figure 1. More than four events per month were reported during the June - December 2001 period, compared to only two per month between January 2000 and May 2001.

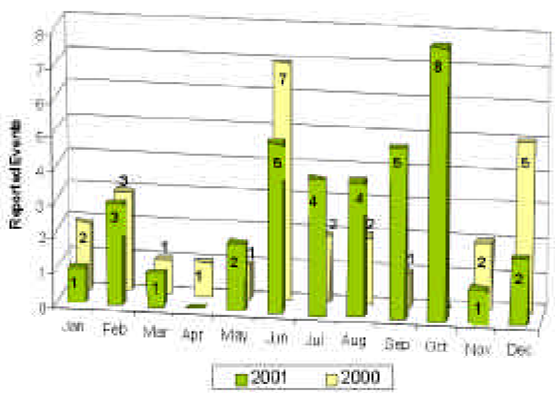

Figure 1. Electrical intrusion events doubled beginning in the summer of 2001

This increase led the EH Office of Performance Assessment and Analysis to examine all 63 electrical intrusion events reported in ORPS during calendar years 2000 and 2001. During 2000, 26 electrical intrusion events occurred, compared to 37 in 2001. These events occurred at nine Field Offices, as shown in Figure 2. Oak Ridge had a dramatic increase in the number of events that occurred in 2001 (10 compared to 2 in 2000). Albuquerque had the highest total number of events (14) during 2000-2001, but had no significant year-to-year change.

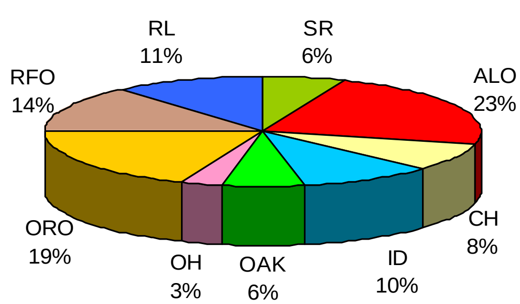

Figure 2. Data for 2000-2001 events by Field Office show they occurred complex-wide

All of the events involved low voltage—the highest being 480 volts and the majority at 120 volts or less. There were no substantial shocks or injuries associated with these intrusion events, and stop-work authority was almost universally used when unexpected conditions were encountered. Approximately 70 percent of these events were reported as near misses.

> Near miss means that either no barrier or only one barrier remained before personnel injury.

This low event severity should not be taken lightly. The U.S. Bureau of Labor Statistics for CY 2000 lists 256 workplace fatalities nationwide from contact with electrical current. Therefore, it must be emphasized that the potential for serious injury was present.

The most serious electrical intrusion injury within DOE in the past 10 years occurred on January 17, 1996 at the Los Alamos National Laboratory. A laborer was burned and rendered unconscious when his jackhammer hit a buried 13,200-volt electrical power cable (Figure 3). This event triggered a DOE Type A investigation.

Figure 3. Penetrated 13,200-volt cable during construction

WORK ACTIVITIES AND ERRORS

The majority of the electrical intrusion events occurred during construction (52%) and decommissioning (24%). Intrusion during these two activities most often involved drilling into structures or cutting conduit, requiring the use of hand tools. The use of hand tools

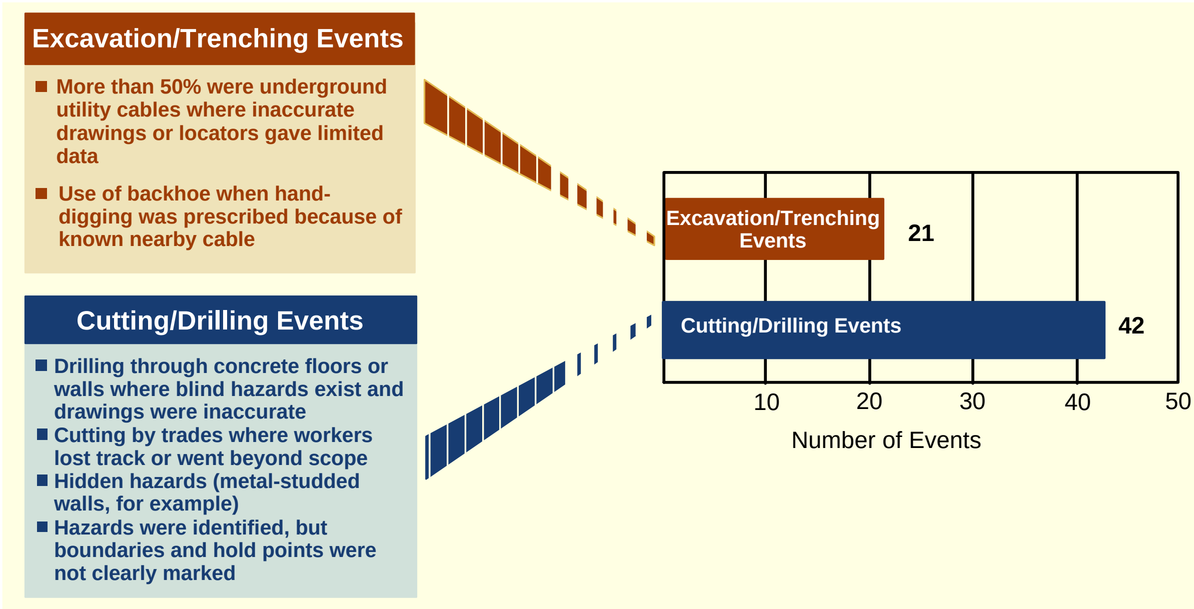

Figure 4. Cutting and drilling events and excavation/trenching events each contributed significantly to event totals, and each have multiple causes

is significant because it places the worker in close proximity to the hazard; i.e., energized source.

Twenty cutting and drilling events and 13 excavation and trenching events occurred during construction. This work primarily involved routing new services within a facility and installing utilities or piping systems.

Similarly, 13 cutting and drilling events and 2 excavation and trenching events occurred during decommissioning. Decommissioning activities involved the removal of electrical conduit from facilities undergoing closeout and demolition. In many cases, some electrical systems may need to remain energized (such as lighting circuits) while other conduit and electrical systems are being removed. Figure 4 summarizes these events.

Commonly made errors are listed in the box below. Attention to commonly made errors can best reverse the increase in electrical intrusion events that began in the summer of 2001.

PERSONAL PROTECTIVE EQUIPMENT

Detection of hidden utilities is an industry-wide problem, and even with the use of survey equipment, the exact location of a potential hazard cannot always be guaranteed. That makes the use of personal protective equipment all the more important.

The identification of electrical hazards and the appropriate application of personal protective equipment to mitigate these hazards are addressed in 29 CFR 1910.331 – .335, 29 CFR 1910.132, and 29 CFR 1926.416. Workers should use personal protective

COMMONLY MADE ERRORS

- Relying on inaccurate or out-of-date drawings to locate utilities
- Taking shortcuts due to schedule pressures (e.g., using heavy equipment versus hand-digging)
- Failing to verify zero energy before conduit removal
- Failing to adequately trace electrical wiring before cutting
- Assuming subcontractors understand the excavation and penetration permitting processes
- Failing to perform a subsurface investigation for potential hazards
- Working outside the boundaries of the approved excavation/penetration permit

equipment that is appropriate for the specific parts of the body to be protected and for the work being performed.

- Use double-insulated electrical tools that have insulated handles.
- Use drill-stop equipment when core drilling (stops drill when grounded metal is contacted), an example of which is shown in Figure 5.
- Use ground fault circuit interrupters with power tools.
- Use fiberglass-insulated shovels and picks when excavating by hand.
- Use rubber mats.
- Wear eye protection and electrically-rated protective gloves and footwear.

UTILITY-LOCATING EQUIPMENT

There are many types of utility and near-surface structure or hazard detection equipment available to DOE. These locating and survey instruments include ferroscan for locating rebar, electromagnetic and radio frequency for locating cables, metal piping, and power lines, and ground-penetrating radar (GPR) (Figure 6) that can locate plastic, ceramic, metallic objects, and even voids in the ground and structures. Ground-penetrating radar refers to the use of radio waves to detect embedded or buried objects. Radio waves penetrate the surface and are reflected back when an object or a change in composition is encountered.

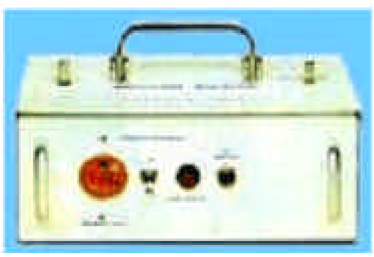

Figure 5. Example drill stop box

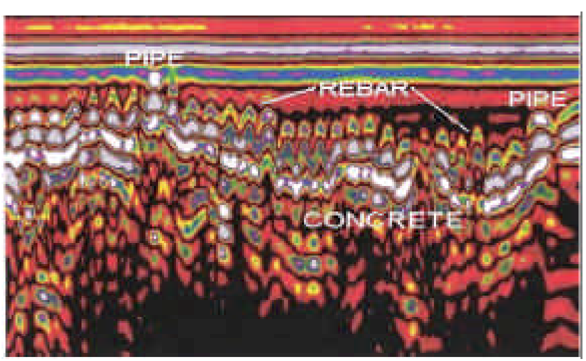

Figure 6. Example GPR scan

Metal detection devices can be used to detect electrical cables by locating the conduit surrounding the cable. Magnetic field detectors can locate energized conductors by the magnetic field produced by current flow.

Figure 7. Using GPR to survey a structure

Organizations responsible for excavation and penetration work need to research and evaluate survey and locator equipment that best fits their needs and methods. Many manufacturers of survey instruments are members of the National Utility Locating Contractors Association (NULCA), and they can be contacted at http://www.nulca.org. NULCA is an organization of contract locators, facility owners, One-Call centers and industry suppliers that share a common interest in safety and damage prevention. Their mission is to define, establish, and maintain high standards and practices in the underground utility contract locating industry. Another organization is the Common Ground Alliance (CGA), which provides best practices and has

Figure 8. Using GPR on a ground survey

a research and development committee made up of industry manufacturing groups that keep a pulse on industry applications and new technology. The CGA website can be reached at http://www.commongroundalliance.com.

Table 1 provides information from a survey of DOE sites on utility-locating equipment.

Equipment	Facility	Rating
Geophysical Survey Systems Inc. System 2000 GPR	Hanford	Excellent
Pipehorm Model 5000 Radio Frequency Locator	Hanford	Excellent
Metrotech 50/60 Electromagnetic Field Locator (energized lines)	Hanford	Excellent
Metrotech Audio Frequency Line Tracer 810	Rocky Flats	Good
Metrotech Audio Frequency Line Tracer 9800	Rocky Flats	Fair
SIR System 2P Model DC-2P GPR	Rocky Flats	Poor
Metrotech Metal Detector 880B	Rocky Flats	Fair
Metrotech Metal Detector Witching Rod	Rocky Flats	Fair

Table 1. Survey of utility-locating equipment

RECOMMENDATIONS

- Clearly mark components to be removed and establish boundaries and holdpoints for zero-energy verification when performing demolition work.
- Conduct source checks for energy near the work, and not just at known energy sources.
- Use appropriate personal protective equipment that has proper electrical ratings.
- Hand-excavate near the expected location of the utility.
- Standardize methods for identification and location of concealed or buried electrical utilities.
- Employ the use of utility locator services or use the latest survey technology available.

REFERENCES

- DOE/EH-0564, Lessons Learned, *Penetrating Hidden Utilities*, Issue No. 98-02
- DOE/EH-0560, Safety Notice, *Electrical Safety*, Issue No. 98-01
- DOE/EH-0541, Safety Notice, *Underground Utilities Detection and Excavation*, Issue No. 96-06
- L-2001-OR-BJCPORTS-1101, Blue Alert, *Excavation Good Practices*
- EH-33 *Electrical Safety Report,* May 21, 1999
- DOE-EH-33, *Hazard and Barrier Analysis Guide*, November 1996
- DOE-HDBK-1092-98, *Electrical Safety*
- 29 CFR 1926.651, *Excavation General Requirements*
- 29 CFR 1926.416, Subpart K, *Electrical – Safety-Related Work Practices*
- FY01-266-KH, *Joint Electrical Safety Assessment*, RFETS
- DOE O 440.1A, *Worker Protection Management for DOE Federal and Contractor Employees*

This Special Report on Electrical Intrusion Events is distributed by the Office of Performance Assessment and Analysis. Contact: Frank Russo at (301) 903-1845 or at frank.russo@eh.doe.gov.