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LESSONS LEARNED FROM OCCURRENCES INVOLVING PROCEDURES AT LOS ALAMOS NATIONAL LABORATORY IN 1994

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This study used the Department of Energy (DOE) Occurrence Reporting and Processing System (ORPS) data to investigate occurrences reported during one year at Los Alamos National Laboratory (LANL). ORPS provides a centralized database and computerized support for the collection, distribution, updating, analysis, and validation of information in occurrence reports about abnormal events related to facility operation. Human factors causes for occurrences are not always defined in ORPS. Content analysis of narrative data revealed that 33% of all LANL 1994 adverse operational events have human factors causes related to procedures. Procedure-caused occurrences that resulted in injury to workers, damage to facilities or equipment, or a near-miss are analyzed.

INTRODUCTION

Scope and Limitations

This study used the Department of Energy (DOE) Occurrence Reporting and Processing System (ORPS) (EG&G, 1991) data to investigate occurrences reported during one year at Los Alamos National Laboratory (LANL) and found that 33% of all LANL 1994 adverse operational events have human factors causes related to procedures. Other non-procedural human factors contribution to accidents, such as spatial misorientation, lack of attention, complacency, misdiagnosis, or fatigue, were not included in the scope of this analysis.

Occurrence Reporting and Procedural Requirements

LANL is managed and operated for the DOE under a contract to the University of California (UC). All DOE facilities comply with DOE Order 5000.3B *Occurrence Reporting and Processing of Operations Information* requirements to notify DOE Headquarters of any emergency, unusual, or off-normal events within certain time limits, to investigate the root cause of each event, and to ensure that corrective actions are completed to prevent recurrence. UC 1995 Contract Performance Measures for management of LANL also require trending of the environmental, safety, and health reportable occurrence data related to facility operation.

In addition, DOE Order 5480.19 *Conduct of Operations Requirements for DOE Facilities* specifies that preparation, verification, and validation of operations

procedures should receive high-level attention. Operators should have procedures with them and follow them in a step-by-step manner. Procedures should be referenced during infrequent or unusual evolutions when the operator is not intimately familiar with the procedure requirements or when errors could cause significant adverse impact to the facility.

LANL's nuclear, high explosive, chemical processing, and waste management operations are only a small part of the DOE system of national laboratory research and development facilities referred to as "the complex". Events and causal factors at LANL are representative of occurrences throughout the DOE complex. Noncompliance with conduct of operations requirements is associated with high safety risk in DOE facilities.

Human performance factors related to procedural compliance is considered in DOE occurrence investigations. Even equipment/material problems often have root causes related to human factors in noncompliance with procedures for quality assurance, installation, maintenance, or surveillance. Human factors causes for occurrences are not always clear-cut, but this paper demonstrates how ORPS can be used for human factors research and content analysis of narrative data.

Description and Use of ORPS

ORPS is an interactive computer system, designed to support DOE-owned or operated facilities in reporting, processing, and dissemination of readily accessible information concerning abnormal events and occurrences related to facility operation. ORPS provides a central-

ized database and computerized support for the collection, distribution, updating, analysis, and validation of information in the occurrence reports. The system is managed by the System Safety Development Center at the Idaho National Engineering Laboratory (INEL) under the direction of the DOE's Office of Nuclear Energy.

The ORPS database is designed to categorize occurrences and allow search and investigation of the relevant data embedded in narratives. Potential for analyzing data accumulating in the system is enormous. From 1991 through 1994, there are over 25,000 separate occurrences reported in ORPS. Statistical, content, and lessons learned analyses are possible, yet ORPS users are currently more concerned with meeting input requirements than with use of the system as a research tool. Consequently, quantitative studies are usually descriptive rather than inferential.

Root Cause Analysis of Occurrences

A DOE problem occurrence itself is always defined in terms of either people, procedures, or hardware. All ORPS reports assign a root cause to the occurrence. Root cause analysis is a logical chain of cause and effect reasoning that must have a solution that meets three root cause criteria: the solution must prevent recurrence, be within control (be feasible), and meet the program goals and objectives (Gano, 1991).

Root cause categories can be searched in ORPS according to equipment/materials problem, procedure problem, personnel error, design problem, training deficiency, management problem, or external phenomena. Of these, even equipment/material problems or procedure problems may ultimately have root causes related to human factors. Human factors can impact most categories of occurrences.

CONTENT ANALYSIS METHOD

This study first used field search capabilities of ORPS to focus on occurrences at LANL during the calendar year 1994. A total of 267 reports were retrieved. A word search for "procedur@" was then conducted on the narrative data from the "Description of Cause" field in the targeted reports. Eighty-nine reports, or 33% of the total, cited "procedur@" in the description of cause. Human factors causal categories defined by the ORPS database were recorded.

Because corrective actions are assigned to address the acknowledged root cause of an occurrence, the word search was repeated for the "Corrective Action" field. Of the fifty occurrences that were assigned corrective action related to procedures, a final sort yielded twenty-six reports with a "Final Evaluation" field and lesson learned containing the key word "procedur@".

Content analysis of ORPS reports is necessary for synthesis of meaningful lessons learned for the DOE complex. Narratives of the 26 reports were read in detail. Content was analyzed for common cause factors, related events, or facility-specific incidence of occurrences related to procedures. Many causes are repeated in unrelated occurrences in the LANL ORPS reports which cited "procedur@" in the final evaluation.

Lessons learned about procedures from LANL occurrences in 1994 were grouped into operational "bins":

- Maintenance
- Equipment Startup
- Training
- Transportation, Shipping, and Receiving
- Facility Access Control
- Configuration Control
- Installation Of Equipment
- Lockout/Tagout
- Experimental Research and Development
- Surveillance

Bins were determined by the accumulation of more than one occurrence in any general area of Laboratory operations regardless of location of facility.

FINDINGS

LANL managers and workers could have prevented almost a third of the DOE 5000.3B reportable occurrences in 1994 with development, review, and correct use of procedures in research and development and other operations support activity. The following causal categories related to procedures were cited in 89 LANL occurrence reports in 1994:

- * Management policy not adequately defined, disseminated, and enforced
- * Inadequate administrative control
- * Defective or inadequate procedure
- * Personnel error related to inattention to detail
- * Personnel error related to violation of a requirement
- * Insufficient refresher training on procedures

This study supports findings of strong correlation between the improper use of procedures and the occurrence of accidents (DOE/DP, 1994). Content analysis of these LANL occurrence reports support Defense Programs conclusions that many DOE procedures are poorly written, incorrect, confusing, or used improperly. Injured employees, damage to equipment or the facility, personnel contamination, and environmental release or exposure are often the results of inadequate or improperly used procedures. Facilities or operations may then be shut down for corrective actions or repairs. Resulting lost work time and project delays are costly to customer satisfaction, the budget, and the general reputation of the Laboratory.

This study further validates the DOE *Management Oversight and Risk Tree (MORT)* (EG&G, 1983) assumption of the importance of examining procedures and their use in assessment and accident investigation. System safety analysis at LANL should emphasize procedures and people, as well as their impact on the plant and hardware in risk assessment of tasks in the Laboratory environment.

DISCUSSION

Scenarios

Scenarios of the occurrences can be read in the actual ORPS Reports. Injury to workers or "near-miss" reportables result from events such as electrical shock, chemical explosion, construction collapse, vehicle accident, gas release, equipment drop, unauthorized detonation of ammunition, personnel radiation exposure, crane and forklift operation, and fire. For each reportable occurrence counted in Table 1, likelihood of safe and reliable performance of operators or experimenters in LANL hazardous or nuclear facilities would have been improved by the existence, adequacy, or proper use of procedures.

	LANL	All DOE
1994 ORPS Report:	267	5265
"Procedure" as Description of Cause:	89	1379
"Procedure" as Corrective Action:	50	644
"Procedure" in Final Evaluation:	26	340

Table 1: DOE 5000.3B Occurrence Reports Citing Procedures

A scenario of an event that might occur in any office setting and result in damage or injury due to an inadequate procedure and insufficient training on a procedure was reported from a LANL waste management area. A flipper cabinet and lateral file drawer detached from a wall and fell on an employee's desk. Although a procedure existed that specified materials selection, incorrect anchor bolts had been used. Bolts were not installed at the specified intervals. The top flipper cabinet was mounted too high up on the sheetrock wall because the carpenters did not have sufficient training on the procedure. In addition, installation procedures were not kept updated because a furniture supplier had done all installations prior to the incident. When the furniture supplier discontinued installation services, no review or communication of the procedures occurred. Similar events can occur with installation of critical equipment in hazardous facilities throughout industry resulting in serious consequences to operations and personnel.

Value of ORPS as a Research Tool

DOE is much more diversified in operations than is, for example, the Nuclear Regulatory Commission for the private sector. Because operations are so diversified, ORPS cannot be used to do relatively simple system or component breakdown in investigation of occurrences. Human factors causes for occurrences are not always obvious or standardized either, so it is a challenge to manipulate the search capabilities of the database to investigate data embedded in narratives and to reliably group events in order to generalize from statistical or content analysis.

As the reporting itself becomes routine and standard, the value of the ORPS database will increase considerably. The DOE Headquarters Program Manager for ORPS has indicated that the system has not been used before for human factors research. Methods developed at Los Alamos National Laboratory for deriving lessons learned related to human factors as a direct or contributing cause of abnormal events or unusual occurrences are also of interest to DOE Headquarters Office of Nuclear and Facility Safety. Los Alamos National Laboratory Lessons Learned Program publishes bulletins which are derived from ORPS research to master management within the Lab. These bulletins are also disseminated to the complex via the Internet. Electronic readers may access the DOE Lessons Learned, including the LANL postings, using the following URL address: <http://dewey.tis.inel.gov/tri/II/II.html>.

Inferences

Specific lessons learned statements about procedures related to occurrences were published in a recent bulletin distributed to LANL master management. (It is available as handout with this conference presentation and accessible to the "Global Village" on-line on the Internet using the address mentioned previously.) These statements infer some basic factors required for successful task performance, assuming the worker has mental and physical skills and capability to perform the task:

- 1) Existence, training, and review of a procedure provides knowledge of the task and its requirements (what needs to be done and how).
- 2) Access to and use of a procedure supports identification and allocation of necessary qualified personnel, equipment, and time to perform the task.
- 3) Motivation to develop and consistently use procedures must be reinforced by both management enforcement of policy and reward for improved performance.
- 4) Careful preparation and use of procedures can anticipate and alleviate many common human factors problems, such as:

- Cognitive overload
- Habit intrusion
- Lapse of memory or recall
- Mindset or preconceived data
- Unawareness
- Wrong assumptions
- Reflective or instinctive action
- Thinking and actions not coordinated
- Shortcuts evoked to complete job
- Confusion

Procedures Assessment and Corrective Action

Procedures provide administrative control of risk associated with operations. Procedures reliability should be optimized to reduce human contribution to accident initiations and accident progressions. Access and adherence to current, well-written procedures is paramount to prevention of occurrences. Procedures must be reviewed and revised as work conditions change. At LANL, procedures assessments are conducted by audits and assessments personnel. Methods include walk-through, reference, simulation, and tabletop analysis.

Observation of actual work being performed using procedures is the preferred method for assessment. If work is stopped at the time of an assessment and plant conditions permit, walk-through is preferred.

The flowchart on the following page is adapted from the DOE *Management Oversight and Risk Tree (MORT)* (EG&G, 1993) system of safety analysis and accident investigation. It is used as a project evaluation checklist to remind managers of the essential elements of procedures during assessments.

CONCLUSION

Safety theory assumes that there may be as many as 10 unsafe conditions underlying every near-miss, 100 unsafe conditions underlying every incident, and 1000 unsafe conditions underlying every accident (Systems Improvements, Inc., 1995).

This paper raises questions related to the number of inadequate, ignored, misused, or unenforced procedures that exist given the number of occurrences reported. If consistent policy consequences for violation or inadequate supervision of procedure use are not enforced, worker morale in DOE hazardous facilities will suffer due to fear for safety or lack of confidence in management.

Reportable events caused by human factors related to procedures occur throughout the operations of the Laboratory and DOE. Procedure problems are not confined to just a few selected operations. Closer inspection of the facility sources of the reports shows more recurrence of similar incidents in the research and development operations which do not adequately anticipate hazards in innovative experiments. This sample of ORPS reports from LANL is representative of the DOE complex.

The bottom line for managing risks associated with safety and reliability of a diverse workforce in diverse hazardous operations is simply: develop, review, train, and enforce use of procedures in operations!

Figure 1: Project evaluation procedures assessment flowchart

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