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IMPROVING SAFETY THROUGH ROOT CAUSE ANALYSIS (U)

by

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INTRODUCTION

Operations at the U. S. Department of Energy - Savannah River Site (SRS) include such diverse facilities as reactors, fuel fabrication, chemical processing, coal burning power houses, analytical laboratories and research facilities. To enhance the safety of operations at SRS, a Root Cause Analysis process has been developed. Root Cause Analysis is a three-step process designed to evaluate and correct problems by identifying WHY an occurrence happened. Although this involves correction after a problem occurs, it is also used to prevent future problems by identifying the Root Causes. Root Causes are the most basic causes that can reasonably be identified, that management has control to fix and for which effective recommendations for preventing recurrence can be generated. Making corrective actions based upon Root Causes lowers the risk of future operation.

DESCRIPTION OF WORK

The Westinghouse Savannah River Company (WSRC) Root Cause Analysis process was initially implemented in 1987. The three-step process consists of Events and Causal Factors Charting, Root Cause Coding, and Recommendation Generation.

Events and Causal Factors Charting was originally developed by the National Transportation Safety Board and has been adopted by DOE as an investigative tool. It was chosen as the first step in the SRS process because it is a simple tool that can be taught to the large pool of occurrence investigators at the site and it provides consistency to investigations.

Events and Causal Factors Charting provides a way for investigators to organize and analyze the information gathered during the investigation and to identify gaps in knowledge as the investigation progresses. The Events and Causal Factors Chart is simply a sequence diagram that describes the events leading up to and following an occurrence as well as the conditions surrounding these events. The end product of Events and Causal Factors Charting is identification of Causal Factors. Causal Factors are events or conditions which, if eliminated, would have prevented the occurrence or reduced its severity.

The second step of Root Cause Analysis involves Root Cause Coding. A Root Cause Tree has been developed to aid the investigator in identifying the WHYs (Root Causes) of the incident. It is used to categorize the Causal Factors identified during Events and Causal Factors Charting. Starting at the top of the tree, the investigator codes each Causal Factor, one at a time, by working down through the tree as far as known information will allow. The identification of Root Causes helps the investigator of a specific incident determine the reasons the incident occurred so that the problems surrounding the occurrence can be fixed.

The Root Cause Tree is a decision diagram divided into many different nodes. The tree is divided into two major parts. Nodes on the left side of the tree are used to code Causal Factors associated with equipment failure. The right side of the tree is used for categorizing Causal Factors related to personnel error. The two sides of the tree are not mutually exclusive. Equipment problems can often be traced back to mistakes made by personnel. To accommodate this, the two sides of the tree intersect at nodes dealing with personnel activities associated with fabrication, installation, maintenance, or misuse of equipment. This allows coding from the equipment side of the tree to extend over to the personnel side.

The Root Cause Tree is divided into 16 segments. Each segment is made up of related nodes. For example, all nodes related to training difficulties are grouped together in a single segment. All nodes related to problems in the management system are located in another segment. In addition to dividing the tree into segments, it has also been divided into six major levels (i.e., Level A through Level F). Each level on the tree corresponds to a particular class of nodes.

When coding a Causal Factor, Level A nodes require the investigator to make only broad distinctions. Level F nodes require that very specific question be answered and correspond to basic root causes.

The third step of the process involves Recommendation Generation, perhaps the most significant aspect of Root Cause Analysis. Following identification of the Root Cause(s) for a particular Causal Factor, achievable recommendations for preventing its recurrence must be generated. The identification of effective corrective actions is addressed explicitly in the definition of Root Cause. The emphasis is on correcting the problem so that it will not be repeated. The three steps of Root Cause Analysis are summarized in Figure 2.

To implement Root Cause Analysis at the Savannah River Site, a workshop and information handbook[1] were developed. In 1991, both the workshop and handbook along with the Root Cause Tree were revised. Input from investigators was used to revise the tree to better reflect the types of problems that occur at SRS. The original version of the handbook and workshop covered only the first two steps of the process. Review of investigation reports along with the related recommendations revealed the need for training on generating corrective actions. Thus, the third step was incorporated into the revision effort. In addition, the workshop was expanded from one to two days to provide more exercises on the three steps.

As part of the Root Cause Analysis process at SRS, a database has been developed that allows tracking of Root Causes. When Root Causes are entered into the database, the entire path through the tree is entered. Additional information from occurrence reports, such as facility, department, date and time of the occurrence, is also entered. This allows evaluation of particular facilities as well as the entire site. It also enables determination of trends. Evaluation of Root Causes over a period of time allows determination of areas of the tree that are frequently coded (cluster analysis). For example, cluster analysis may reveal a procedure problem, indicated by frequent coding of the node "Procedure incomplete/situation not covered". The database provides further analysis of the problem. Is this a continuing problem? Are improvements being made as evidenced by fewer incidents with this problem over a period of time? Is it a site wide problem or is it specific to a particular department or facility? Does the problem occur during particular shifts, i.e. midnights? Do all procedures have this problem or is it only with specific procedures, such as maintenance? The database provides management with information about systemic problems, not just isolated incidents. This aids management in setting priorities and allocating resources by identifying major problem areas.

RESULTS

Root Cause Analysis at SRS has provided two mechanisms for improving safety. Feedback to management on the Root Causes of particular incidents provides management with information for improving operations. Root Cause Summary Tables are provided which show causal factors, their Root Causes and recommendations for preventing recurrence of the causal factors. Figure 3 shows the incorporation of the three steps of Root Cause Analysis into a Root Cause Summary Table. Further feedback from cluster analysis gives additional information about systemic problems. Both types of feedback provide management with key information useful for allocation of resources to improve the overall safety of WSRC facilities.

Reference

1. Root Cause Analysis Handbook (U), WSRC-IM-91-3, January 2, 1991

Levels of the Root Cause Tree

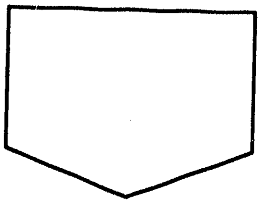
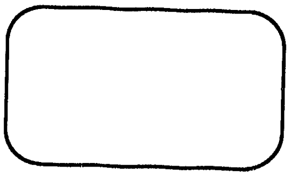
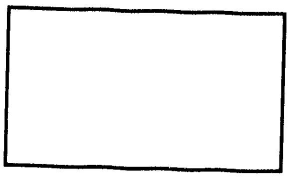
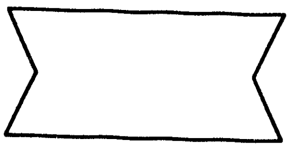
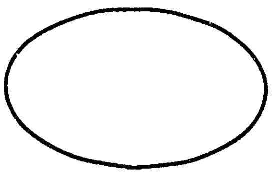
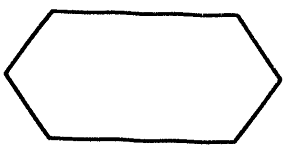
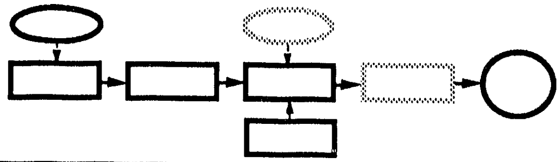
Level	*Shape*	*Description*	*Examples*
A		Primary Difficulty Source	• Equipment Difficulty • Operations Difficulty • Technical Difficulty
B		Area of Responsibility	• Equipment Reliability/ Design • Production Organization • Technical Support Organization
C		Equipment Problem Category	• Design • Installation/Corrective/ Preventive Maintenance Difficulty • Fabrication Difficulty
D		Major Root Cause Category	• Design Review/ Verification • Training • Management Systems
E		Near Root Cause	• Procedures Followed Incorrectly • Workplace Layout • Supervision During Work
F		Root Cause	• More Than One Action Per Step • Conflicting Layouts • No Supervision

Figure 1

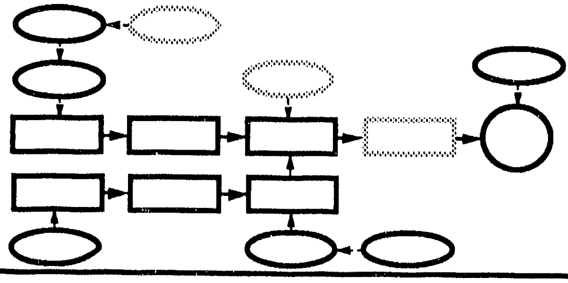
The Root Cause Analysis Process

STEP 1 ***Events and Causal Factors Charting***

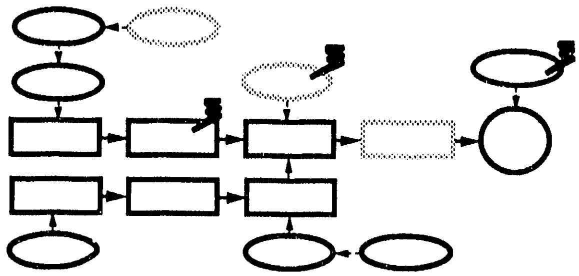
At the start of the investigation, a "skeleton" Events and Causal Factors Chart is generated.



As the investigation progresses, the Events and Causal Factors Chart is modified to accommodate the findings. Data collection continues until investigators are satisfied with the thoroughness of the chart.

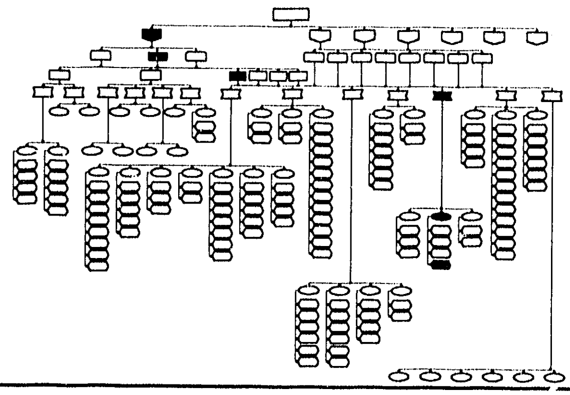


Using the completed Events and Causal Factors Chart, the major contributors to the incident are identified. These causal factors are marked using a common symbol.



STEP 2 ***Root Cause Coding***

A causal factor is categorized using the Root Cause Tree.



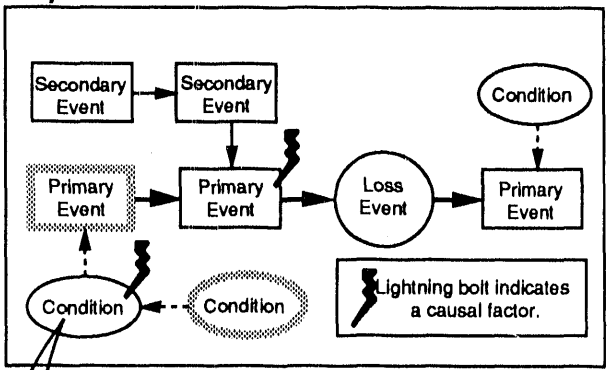
STEP 3 ***Recommendation Generation***

Recommendations for preventing recurrence of this causal factor are generated.

The occurrence report is prepared.

Figure 2

Step 1



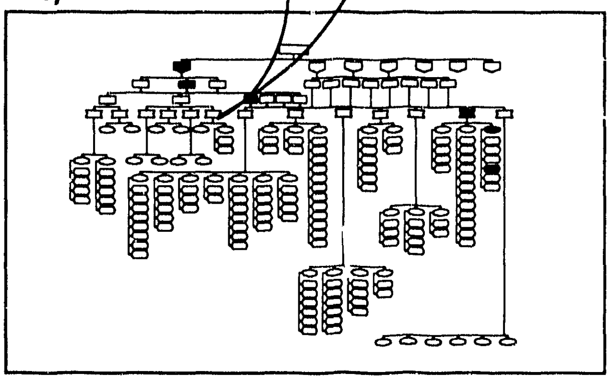
Step 3

Corrective Actions

- ☑ Correct drawing to show acid stream which had been tied into the line several months earlier. (Engineering Department)
- ☑ Perform a spot review of system drawings to assess extent of discrepancies. (Engineering Department)
- ☑ Implement a procedure to require verification of all drawings for accuracy following changes to the system. (Engineering)t (Department)
- ☑ Implement a procedure to require a system walkthrough to check accuracy of system drawings as part of the procedure for any line break activities. (Operations Department).

Root Cause Summary Table		
Causal Factor #1	**Paths Through Root Cause Tree**	**Recommendations**
A line break was made and acid spilled from the line. **BACKGROUND:** An acid spill occurred during a line break by maintenance personnel. Lockouts had been performed based on current drawings. The drawings did not show an acid stream that had been tied into the line several months earlier.	• Equipment Difficulty • Construction/Fabrication • Installation/Corrective/ Preventive Maintenance Difficulty • Management Systems • Configuration Control • Control of Design/Field Changes LTA	Correct drawing to show acid stream which had been tied into the line several months earlier. (Engineering) (Department) Perform a spot review of system drawings to assess extent of discrepancies. (Engineering) (Department) Implement a procedure to require verification of all drawings for accuracy following changes to the system. (Engineering Department) Implement a procedure to require a system walkthrough to check accuracy of system drawings as part of the procedure for any line break activities. (Operations Department).

Step 2



Root Cause Summary Table

Figure 3

DATE
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8/04/92