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REPORTED SIGNIFICANT OBSERVATION (RSO) STUDIES

SYSTEM SAFETY DEVELOPMENT CENTER

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REPORTED SIGNIFICANT OBSERVATION (RSO) STUDIES

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REPORTED SIGNIFICANT OBSERVATION (RSO) STUDIES

Introduction

The Reported Significant Observation (RSO) study, as used in the field of safety, is an information-gathering technique which uses employee-participants to describe situations they have personally witnessed involving good and bad practices and safe and unsafe conditions. This information is utilized in the risk assessment process by helping to monitor the presence of hazards and thereby facilitate their elimination and hopefully prevent their existence in future operations and designs. While capable of playing an integral part in the process, RSO should not be expected to stand alone as the only risk assessment program element.

As used by the Air Force in their aviation psychology program and further developed by John C. Flanagan, RSO is more commonly known as the "Critical Incident Technique". However, the words "Critical" and "Incident" had other connotations in the nuclear safety discipline, prompting early users within the Aerojet Nuclear Company to coin the more fitting title of "Reported Significant Observations". The technique experienced an initial slow start in the safety field primarily due to the fact that the majority of users were researchers interested in after-the-fact data, with the application to everyday problems and behavioral factors not being fully realized or appreciated.

RSO was formally recognized as a significant hazard reduction tool during the development of the Management Oversight and Risk Tree (MORT) program for the U. S. Atomic Energy Commission(1). The Energy Research and Development Administration (ERDA) has, in turn, adopted MORT for its system safety program, and this has resulted in RSO being brought to the forefront as a modern and viable technique to be considered for possible application in all ERDA contractor safety programs.

The RSO flow process described in this paper is depicted graphically in Figure 1. Figures 2-5 show examples of introductory material and forms used in the questionnaire approach to RSO studies. The other approach, interviewing, would use similar material except, of course, it would be related orally to the participants in the study and could be widely varied.

REPORTED SIGNIFICANT OBSERVATIONS

FLOW PROCESS

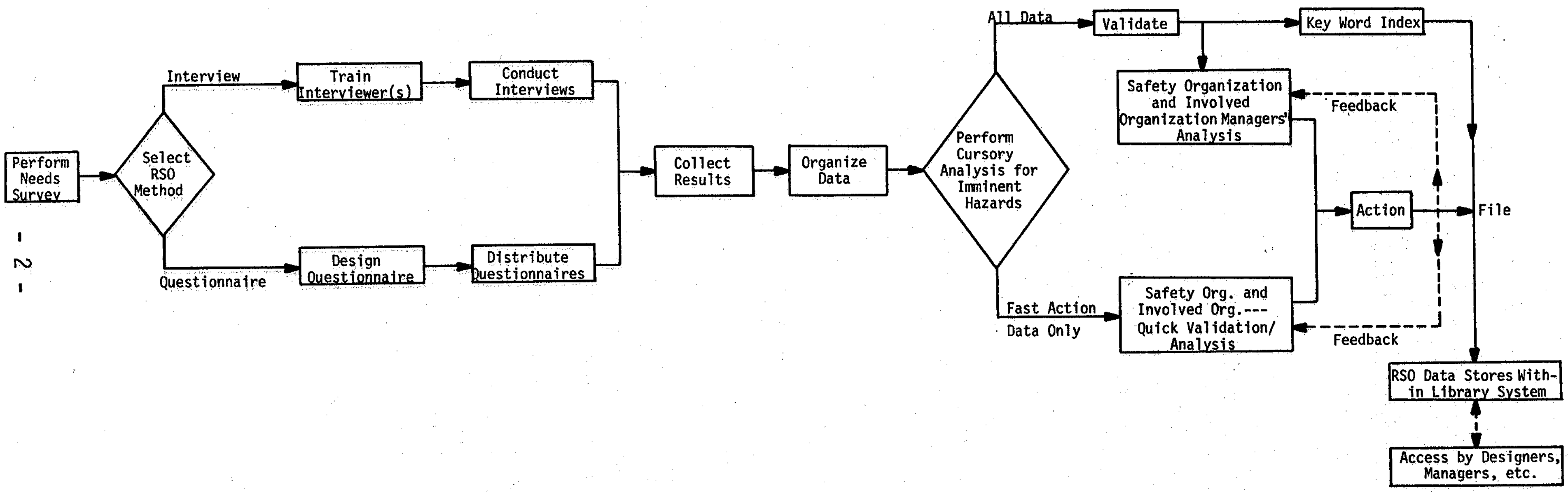

Figure 1

To: RSO Participants --

We are interested in obtaining information relating to design of your facility and more specifically to the way that the plant and equipment "fit" the human operator.

We would like to call on your experience to date in operating, maintaining, and working around the facility to obtain information regarding the man-machine interfaces.

As one aspect of the study of this subject, we would like to obtain narrative accounts of actual operating events which indicate particularly good design at the man-machine interface and other events which indicate that design is not so good.

On the following pages we will ask for specific examples of operational events which you have personally observed that can be associated with particularly effective or ineffective design from the point of view of the operator (engineer) who has to make the hardware system work or perform maintenance on it.

Each of your examples should be a brief factual account of something that:

1. Happened at a particular part of the complex at a particular time that you personally observed.
2. Was the result of design that you judge to be particularly effective from the point of view of the operator (or ineffective).
3. Resulted in a positive consequence or avoided a potential problem (or resulted in a problem situation or a situation that was potentially a problem).

You may, if you like, choose events from which the consequences were trivial at the time but which could represent more serious consequences under different conditions.

The descriptions which you write should not include the names of the specific personnel involved.

A usable description must:

1. Clearly set the time and situation at the time of the event.
2. Specifically identify the media involved in the event (operating instruction, panel layout, mechanical design of specific components, etc.).
3. Precisely record the way that operations or maintenance personnel reacted to the media (turned controller wrong way, overshot control point, improper assembly or disassembly, misinterpreted instrument indications, etc.).
4. State clearly the consequences or potential consequences (difficulty in maintaining operating conditions, loss of time, difficulty in understanding what's going on, loss of product, etc.).

We would like to have you take time to think over your examples and write them down as you have time. They will be collected by branch supervision and transmitted to us for analysis.

- 2 -

We've tried to anticipate some of the questions you might have regarding this study:

Q. Why are you asking us?

A. The answer to that is very simple. You're the experts. You're professional people and you are doing the work. It's been demonstrated time and again that the people who are doing the job are the ones who know what's going on.

Q. Does this have anything to do with checking up on individual people?

A. Absolutely not! You'll note that we don't ask you to put your names on the reports and we ask you not to put anybody else's name in your examples. We're interested only in how the system works and what branch and division management can do to help you in your professional goal of conducting the safest possible operation.

Q. I've never seen anything like this before. Is this something new and experimental?

A. This is not an experimental method. It's been used a great deal, in applications ranging from aircraft piloting to teaching methods at colleges and universities.

Q. I've noticed that two of the questionnaire sheets are blue and two are pink. Why is that?

A. We're asking you for four examples.

(1) Most recent example of a job or operating situation in which you feel the design at the man-machine interface was particularly good.

(2) Another example of a job or operating situation in which you feel the design at the man-machine interface was particularly good.

(3) Most recent example of a job or operating situation in which you feel the design at the man-machine interface could be improved.

(4) Another example of a job or operating situation in which you feel the design at the man-machine interface could be improved.

If you look at the top of the sheets you'll see that the blue sheets are for good jobs. The pink sheets apply to jobs or operating situations in which you feel the design could be improved.

Your cooperation and assistance in this effort are greatly appreciated.

Figures 2 and 3. These two pages serve as an example of the introductory material which would accompany the questionnaires. These are oriented toward operability/maintainability, a good topic for the first RSO study. They would be appropriately changed to address special considerations for individual facilities or target groups. It may be desirable to include examples of completed questionnaires in the introductory material if it is felt that this can be done without biasing the participants.

From your experience, think of the most recent situation in which you observed a job or operating situation for which it was easy to operate or maintain plant equipment in an effective, error-free manner.

1. When and where did this happen (approximate date and place)?

2. What equipment and/or what type of job was involved?

3. Briefly describe the situation at the time (process or machine running, process or machine shut down, abnormal operating conditions, etc.).

4. Exactly what occurred? (Use other side if necessary.)

5. Why do you classify this as being an especially easy operational or maintenance job?

6. What might have been expected from less effective plant design or procedures in this situation (e.g., more difficult to perform, more chance for error, more chance of equipment damage, etc.)?

Figure 4

From your experience, think of the most recent situation in which you observed a job or operating situation for which it was not easy to operate or maintain plant equipment in an effective, error-free manner.

1. When and where did this happen (approximate date and place)?

2. What equipment and/or what type of job was involved?

3. Briefly describe the situation at the time (process or machine running, process or machine shut down, abnormal operating conditions, etc.).

4. Exactly what occurred? (Use other side if necessary.)

5. Why do you classify this as being an especially difficult operational or maintenance job?

6. What might have been expected from more effective plant design or procedures in this situation (e.g., easier to perform, less chance of error, less chance of equipment damage, etc.)?

Figure 5

These are examples of one possible format of the "good" and "bad" sheets used in the questionnaire method. If additional questionnaires are used, the first sentence on both examples is changed to: "From your experience, think of another situation ..." for each subsequent questionnaire.

RSO FLOW PROCESS

(Refer to Figure 1)

Discussion

Every organization finds itself subject to varying degrees of scrutiny by the public, consumer action groups, sponsors, customers for contract work, government agencies, and others. If this is a particular concern to your organization, serious consideration should be given to the manner in which RSO study results will be generally handled and made available to individuals other than those involved in the hazard analysis process. The material is sensitive, making it best suited to use internally, and it may be necessary to take precautions to assure that the material is never taken out of the context of the risk assessment system. As a minimum, if an RSO program is to be instituted, the organization should be prepared to act quickly and effectively on identified hazards.

The responsibility for initiating an RSO study lies within the safety organization. If the volume of studies is high and the size of the organization permits, a permanent group may be established to handle RSO's, even though it will not be a full-time activity. Otherwise, ad hoc task groups could be created for individual studies. The need for good analytical work and a general understanding of multi-discipline functions should be kept in mind when selecting RSO group members. In order to prevent an overburden and to allow for development of new experiences, it may be best not to apply the RSO technique to the same organization more frequently than about every six months. However, some groups have expressed an interest in continuous sampling with monthly meetings(2).

Since the widespread responsibilities of most safety organizations have resulted in a general concern over safety resource allocations, it is worthwhile to address here the manpower impact of introducing an RSO program. For a safety organization which already allocates manpower to a risk assessment system, the impact of RSO's will be minimal; the reason being that individuals involved in risk assessment will recognize the RSO as a tool to help them gather a segment of the information they require for a <u>total</u> hazard analysis. Without that segment, a significant amount <u>and</u> type of data will be missing and the hazard analysis cannot be considered complete. Most safety professionals agree that for every accident reported under the usual organization reporting requirements, there are hundreds of "near-misses" that go unreported. The RSO helps in that regard by furnishing quantity data on observed near-misses.

Besides quantity, the type of information included in RSO's is difficult to gather by any other method. When appraisers or observers enter an ongoing activity, they will usually witness an artificially high level (due to their presence) of performance and good behavior. RSO information, on the other hand, is provided by the workers themselves, without fear of punitive action, and is typified by its candidness and specificity concerning hazardous situations. Thus, the RSO work load within the safety organization will be primarily associated with the analysis of study results. For an organization with a formal risk assessment system, the incorporation of these valuable data should evolve as a natural extension of the hazard analysis process.

The manpower impact external to the safety organization is also minimal, since it is spread evenly over a large number of participants. Each participant can furnish his or her response, as time permits, within the framework of the study and the individual's job. If the interview method is used, the work load will be significantly increased for the safety organization, since the participants' time will have to be matched hour-for-hour by the interviewer's time. This added manpower may be partially offset by a possible reduced amount of later data analysis/validation, due to the ability of a skilled interviewer to properly screen participant's responses on the spot; however, validation will still represent a major area of effort. The impact of initiating an RSO program will be more significant for an organization that has no formal risk assessment system. It is not within the scope of this paper to discuss the merits of having a risk assessment system. It can only be stated that if an organization has reached the conclusion that it is time to establish such a system, then the RSO program should be considered as an integral part of that system, but not as a risk assessment entity in itself.

Needs Survey

Having established an RSO group, whether ad hoc or permanent, the next step is to perform a needs survey to determine the scope and extent of "free play" for the RSO study. The needs survey may take on several forms. The line organization can be formally "pulsed" by asking in writing for target areas which managers or supervisors feel are in need of hazard analyses. Audits and appraisals are another good source of target areas. Accident investigation reports will frequently contain recommendations involving a need for hazard analysis. (However, a caution here is that a study conducted immediately after a major incident will have biased results. Participants will make their responses in light of the incident. A sufficient waiting period may be in order before initiating the study.)

Other inputs for a needs survey might be: accident/injury statistics; routine area surveys; problem priority lists; risk projections; employee suggestions; previous special studies (such as RSO's, research projects, etc.); national trend statistics (from NSC, OSHA, and others); and other monitoring techniques, including routine hazard reviews, error sampling, and quality assurance reports. Using any one or a combination of these will constitute a needs survey. The RSO group or its leader will have to determine the suitability of the available inputs. If the available information is sufficient and satisfactory, then sound judgment must be used to select: 1) the study's scope - a specific topic; a general discipline; or "free play"; and 2) the target group - one particular facility; a single discipline (all welders, all electricians, all machinists, etc.); or a multi-discipline, across-the-board approach.

Select Method and Topic

In choosing between the interview and questionnaire methods, the primary consideration, besides the manpower problem mentioned previously, is the validity of the study results. This consideration has two aspects, biasing and anonymity. The interview method seems to have the edge in being less likely to bias the participant. The reason for this is that a skilled interviewer can sense those opinions that cause individuals to react differently to the same question. If the participant has misinterpreted a question or is trying to voice some personal, non-safety problem, the interviewer has the freedom to change his line of questioning in order to redirect the participant back on track. The questionnaire, unfortunately, has no variability once it is distributed, and there will always be a certain number of invalid results in each study. This can be minimized only through experience in careful wording of the written questions and any examples or introductory remarks included in the questionnaire package. However, similar care is required in the selection and training of interviewers. Unsuitable results might be obtained, for example, from an electrical safety engineer used as an interviewer in a general RSO study, if the engineer is biased toward uncovering electrical safety problems. The skilled interviewer will be able to detect and correct misinterpretation without leading the participant to a predetermined answer. Also, as the required number of interviewers increases, training becomes more important to assure uniformity among interviewers.

Anonymity is important to the individual who fears punitive action against himself or others as a result of information that he reveals. The RSO technique is based on the premise that these individuals will be less inhibited with RSO's, since they will usually be describing "near-miss" situations in which no one was injured and no property was damaged. The questionnaire method further ensures anonymity by not requiring names. The results can even be returned in sealed envelopes to the RSO group. The openness associated with anonymity can help reveal employee attitude and morale information that is difficult to obtain by other methods. The interviewer can only offer oral assurances that the participant's material will remain anonymous. However, this should prove to be less of a problem after the first study has been conducted and employees are able to see that no punitive actions are taken.

Besides the manpower concern in selecting an RSO method, another factor may be the type of human resources available to the organization. An expertise may already exist within the organization for either skilled interviewers or questionnaire designers. Without this expertise, consideration may be given to contracting with outside consultants in the field. Whichever method is selected, upper management knowledge and backing of the study is necessary. The whole program must start with senior management and labor representatives making a commitment and then a joint campaign to educate and enlist the working level people in this program.

If the questionnaire approach is used, for example, the questionnaires should be introduced at the upper management level and passed on with appropriate instructions to supervisors for eventual distribution to the target group. The sealed results would be returned through the supervisors to the RSO group. This display of management backing will enforce the desired participant attention to the study, with the added benefit of having the safety organization remain anonymous to the participants.

The topic for an RSO study should not be so general that participants are not sure of what is desired. Operability/maintainability is a good topic for a facility's first study for two reasons. First, participants being introduced to RSO's find hardware and equipment easier to talk about than less tangible subjects. Second, it is a good idea to eliminate facility operation and maintenance problems before addressing problems related to procedures, standards, etc. Figures 2-5 are examples of introductory material and questionnaires for a study on operability/maintainability. Examples of responses to this study topic are given in Appendix A.

Collect and Organize Results

The piecemeal method of conducting interviews makes it possible to perform a cursory hazard analysis of incoming data as it becomes available, rather than waiting until the interview series is completed. Usually, the interviewer(s) would be capable of making this type of judgment as individual interviews are completed. Otherwise, a copy of the results should be sent to the RSO group following each interview, if the series will not be completed for some time. This quick analysis will permit identification of imminent hazards so that necessary action can be taken. For the questionnaire method, there may be situations which lend themselves to batch collection of the results. An organization may find it beneficial to use time normally assigned to a periodic safety meeting for the completion of questionnaires by participants (a significant cost/benefit factor). A typical session might require four questionnaires for each participant - two examples of observed "bad" situations and two "good" situations. The total time involved per participant may vary from 30 to 60 minutes, depending upon ease of recall of observed cases. Some organizations may find it desirable to not place a limit on the number of questionnaires used. The batch results from the session would be transmitted through the appropriate supervisor to the RSO group. The collected data should be organized in a manner that lends itself to later analysis and followup actions. Each organization will have its own preferences as to arranging the material by facility, discipline, or subject matter.

Cursory Analysis

One of the immediate benefits of an RSO study is the uncovering of imminent hazards that other monitoring systems have failed to detect. If the RSO analysis group is furnished with a clear definition of what the organization considers an "imminent hazard", then the study results can be easily skimmed through to pull out such cases. Copies are made of these cases and are sent on a fast action cycle to Safety and to the involved line organization(s) for a quick validation/analysis and followup action, if required. The complete study results package remains intact and is routed through the standard validation/analysis process.

Fast Action Cycle

When the safety organization and the involved line organization receive RSO data for fast action, their first concern is validation. They must quickly determine whether the situation, as described in the RSO, actually exists or could have existed. In a few serious cases, it may be necessary to shut down the operation until the RSO can be validated. Generally, the line organization would be responsible for making this determination while Safety would confirm their finding. If it is found that an imminent hazard situation does exist or could recur, the case should be analyzed for the best course of remedial action. Safety should offer advice on ways to eliminate the hazard or on taking other corrective actions needed. The line organization should see that the action is taken and should receive feedback as to the success of eliminating the hazard.

Standard Validation/Analysis

All data produced by the study must be validated to some extent. This can be accomplished through personal knowledge of the situation, discussion with the responsible supervisor, or confirmation by the local safety representative. If a piece of data turns out to be invalid, it should not be included with valid data to be analyzed, key worded, and filed. However, for safety purposes, it is a good idea to determine the cause for data being invalid. If a participant misunderstood an observed situation, he should be informed of the pertinent details so that he is not left with the impression that the RSO study was unresponsive to his contribution, nor should he be left with an improper concern about a nonproblem situation. If the study was conducted anonymously, feedback to participants can be accomplished through such means as periodic safety meetings, toolbox talks, plant newspaper, bulletins, board notices, etc. A participant may use the RSO to get attention for a nonsafety or personal complaint. These, too, may deserve further investigation since their effect on attitude and morale can have later safety implications. Attitude and morale problems can also serve as indicators of possible topics of concern that may develop further at labor negotiations.

Valid data should be carefully analyzed for patterns, systemic problems, hidden problems, and positive features. Time should not be expended to synthesize possible accidents/incidents using various combinations of RSO cases. However, if the organization is concerned over a postulated accident of severe consequences, it may be worthwhile to examine RSO results for mechanisms which could lead to that particular occurrence. Such mechanisms may be necessary links in the causal-flow chain leading to the undesired incident, or they may be situational events that have an indirect yet relevant effect on the major chain events (see Appendix C). If the validation process was done properly, identification will have been made of patterns caused artificially by the use of leading questions or by conducting the RSO study too soon after a major incident has occurred. The analysis of legitimate patterns can indicate areas in need of more attention and effort from the safety resources.

Likewise, systemic problems are indicated when a "fix" applied to an RSO case will solve only that specific situation, and will not prevent recurrence of a similar situation. Improvements would then be in order for the general management system or its implementation. Hidden problems are frequently found in participants' descriptions of supposedly "good" situations (see Appendix A). Many of these are simply cases where something went wrong and an individual was observed taking the right corrective action. Taken in this light, these cases can be analyzed with the "bad" RSO cases. It is possible to correlate these cases with national industry experience, as has been done in Appendix B. RSO's that describe actually good situations are of value for determining program features that: 1) should not be suspended or reduced in effort; 2) could be applied in other ongoing operations; and 3) should be considered for future operations and designs.

All actions taken as a result of RSO data analysis are the responsibility of the line organization, although the division of work (in the validation/analysis process) between this group and Safety may vary considerably from one organization to another. A definite feedback route needs to be established so that the impact of remedial actions can be monitored. This also provides a measure of success of the RSO technique.

Key Wording and Filing

It is recommended that to make the study data more usable and readily accessed, all RSO cases be key word indexed. If the organization is not experienced with key wording, one approach is to distribute copies of the first RSO study to safety personnel representing various disciplines, in order to have them indicate those words in each case which are important to them in their work. This will provide the RSO group with an idea of the areas of interest that need to be considered for future key wording. The key words must be functional to the users; otherwise, the index is just a useless exercise. In addition to the list of key words, the index might include the location of the observation, as well as the study number and case number within that study. The index should be updated after each study. The volume of cases makes this task adaptable to a basic computer program.

Each safety reference/resource area within the organization is supplied with copies of all RSO studies, including the updated index. Easy access by managers and designers is required to fulfill the objective of preventing mistakes in future operations while reinforcing positive aspects that have proven benefits. Consideration should be given to proper command documents being issued, which require the query of RSO files during all hazards analyses, risk assessments, and other evaluations in need of a thorough literature search, <u>before</u> committing a design to manufacture, fabrication, or construction.

APPENDIX A

On the following pages are a sampling of four responses to RSO studies on operability/maintainability. For the first two cases (A and B), the participants were asked to describe a situation involving a "good" design, while the second pair (C and D) were to have involved a "bad" design.

Case A actually does describe a good design, which would be worth considering for new facilities in which inter-room communications might be critical.

Case B, while intending to describe a good situation, reveals an underlying problem of poor tool design, which may have caused delays or damage in the past and could do so in the future.

Case C describes a "bad" situation, as requested. This case shows that design problems are not limited to complex equipment or processes, but can also be found in the more basic and common elements of a facility.

Case D involves a situation which probably would not result in personal injury, although property damage appears likely. Even if there were no property damage, there could certainly be delays, downtime, loss of product, or lowered efficiency. If this were true, the case serves as an example that RSO's can have programmatic as well as safety benefits.

(A)

From your experience, think of the most recent situation in which you observed a job or operating situation for which it was easy to operate or maintain plant equipment in an effective, error-free manner.

1. When and where did this happen (approximate date and place)?

   June 1967. A-Building Process Room and Control Room.

2. What equipment and/or what type of job was involved?

   Building phone system.

3. Briefly describe the situation at the time (process or machine running, process or machine shut down, abnormal operating conditions, etc.).

   Acceptance testing of new process machine required constant communication between Process Room, Control Room, and Utility Room.

4. Exactly what occurred? (Use other side if necessary.)

   D.C. phones were plugged in and the patch panel set up so that there was three-way communication.

5. Why do you classify this as being an especially easy operational or maintenance job?

   In the time it takes to plug in a socket, three-way communication was set up.

6. What might have been expected from less effective plant design or procedures in this situation (e.g., more difficult to perform, more chance for error, more chance of equipment damage, etc.)?

   Without the phone setup we would have had to resort to other means of communicating which might not have been as fast or as accurate as a direct phone system.

(B)

From your experience, think of the most recent situation in which you observed a job or operating situation for which it was easy to operate or maintain plant equipment in an effective, error-free manner.

1. When and where did this happen (approximate date and place)?

   August '67 at the A-Building Process room.

2. What equipment and/or what type of job was involved?

   Module removal tool.

3. Briefly describe the situation at the time (process or machine running, process or machine shut down, abnormal operating conditions, etc.).

   Process was shut down for removal of modules.

4. Exactly what occurred? (Use other side if necessary.)

   Tool functioned as designed and modules were removed from their positions with little or no delay and with no chance of dropping the pieces.

5. Why do you classify this as being an especially easy operational or maintenance job?

   Many of our tools are too heavy to use or ineffective for the job they are designed to do. This is not the case with this tool (2 tools).

6. What might have been expected from less effective plant design or procedures in this situation (e.g., more difficult to perform, more chance for error, more chance of equipment damage, etc.)?

   More time consumed during the operation with possible damage to the modules.

From your experience, think of the most recent situation in which you observed a job or operating situation for which it was not easy to operate or maintain plant equipment in an effective, error-free manner.

1. When and where did this happen (approximate date and place)?

   9/22/75. On path between Building 7 and Building 12.

2. What equipment and/or what type of job was involved?

   Two-wheeled cart. Moving heavy filing cabinets and desk from one building to another.

3. Briefly describe the situation at the time (process or machine running, process or machine shut down, abnormal operating conditions, etc.).

   Rocks and sunken path.

4. Exactly what occurred? (Use other side if necessary.)

   Dropped things off cart.

5. Why do you classify this as being an especially difficult operational or maintenance job?

   Need some kind of hard path between buildings.

6. What might have been expected from more effective plant design or procedures in this situation (e.g., easier to perform, less chance of error, less chance of equipment damage, etc.)?

   Keep cart level and not damage contents.

From your experience, think of the most recent situation in which you observed a job or operating situation for which it was not easy to operate or maintain plant equipment in an effective, error-free manner.

1. When and where did this happen (approximate date and place)?

   Whenever weather is cool or cold. At Building 207, Room C.

2. What equipment and/or what type of job was involved?

   Cooling tower pump house.

3. Briefly describe the situation at the time (process or machine running, process or machine shut down, abnormal operating conditions, etc.).

   Two roof vents running, also heaters.

4. Exactly what occurred? (Use other side if necessary.)

   Two roof vents running cooled the room to a point where piping froze up.

5. Why do you classify this as being an especially difficult operational or maintenance job?

   There should be more variation in the flow of air out of the building. One vent on is often too much but yet some flow is needed.

6. What might have been expected from more effective plant design or procedures in this situation (e.g., easier to perform, less chance of error, less chance of equipment damage, etc.)?

   At a set temperature one or both roof vents could shut down and at a set high temperature one or both could come on automatically. Or there could be switches to control a variable speed exhaust fan in roof vents.

APPENDIX B

RSO's can be correlated to data stores external to the organization as well as internal. The value of comparison is that it may reinforce an indication of trends and patterns, allowing for one of two conclusions to be drawn:

1. If RSO data agree well with other data stores, this would tend to support the commitment of safety resources to those areas indicated as being high hazard in both the RSO and other sources;

OR,

2. RSO data may appear to not correlate well with other statistics. Assuming that the RSO data base is sufficiently large and that the validation process eliminated any biasing, then the data conflict may be due to a basic difference in either the type of operation (including plant and equipment) or the program/procedures (including resource allocation). It is also possible that the source of comparison is in error. Even if the RSO data differ favorably from other data, it is still necessary to determine the reason for the difference. Knowing the cause of a desirable pattern will allow it to be reinforced; understanding the faults behind a poor pattern will permit corrective actions to be taken.

The total data base of 1300 RSO cases at Aerojet Nuclear Company was compared with OSHA 1974 statistics to evaluate the correlation of electrical problems. It was found that 25% of the 32,000 OSHA violations in 1974 were electrical problems. The Company's own OSHA-type inspection revealed electrical violations as 25% of the total, too. A precise correlation of 25% of the RSO's was also found to be electrically related. This finding would appear to support a significant safety resource commitment to the electrical discipline, proportionate to other discipline requirements as determined by the organization's monitoring and risk assessment systems. Further analysis would be necessary to determine proper resource allocation to specific subgroups within the electrical area.

APPENDIX C

Since RSO studies were initiated at Aerojet Nuclear Company over seven years ago, there have been about a half-dozen incidents which occurred subsequent to the collection of closely-related RSO data. It should be noted that RSO studies were being evaluated as a monitoring technique during this period; therefore, a rigorous analysis and corrective action process had not yet been implemented. Otherwise, these six cases probably would have been prevented.

In each case, the relevant problems revealed by RSO studies prior to the event were judged to be "relevant" because:

a. Each represented a situation specifically revealed in the accident investigation, or

b. Each represented a general problem which was closely related to the specifics of the actual event.

This is not to suggest that RSO material can or should be combined to predict future events. Rather, these incidents and their related RSO material demonstrate that:

1. There are numerous "causes" or mechanisms which lead to the main event.

2. RSO participants are excellent at pointing out problems that, sooner or later, can contribute to undesired events.

3. By fixing only a few of the RSO type items, the incident causal chain could have been broken.

4. Review agents, designers, and procedure writers should be aware of the RSO material in order to avoid repeating past mistakes and/or placing new systems in an accident provocative situation.

Following are two incidents of the six cases mentioned. Remember that all of the problem items were reported prior to the incident, and they were not uncovered by any other monitoring method. Note how closely the RSO data correlate to the actual occurrence.

WALKING-WORKING SURFACES INCIDENT

Résumé

Connections were being made to a large holding tank, requiring welding, cutting, and other operations to be performed on, in, and around it for an extended period. The tank was cylindrical and positioned horizontally. A design engineer walking on the curved tank surface slipped and fell. This resulted in a lost-time back injury.

RSO Results

Listed below are two specific RSO responses pertaining to working on tank surfaces. These should have been used by the designers of the holding tank, since the responses were reported for another facility well before construction of the holding tank was started.

1. "There is no platform around the boiler tank surface to work on. There is nothing to stand on when using a wrench to change valves. One slip of the wrench and down you will come to the floor."

2. "To me it is unsafe to be working off of a 12' ladder and on the round part of the boiler tank top. It is not safe to work there without a platform."

Listed below are specific problems mentioned in an RSO study conducted at the building of the holding tank, during the tank's fabrication but <u>before</u> the incident:

1. "Ladders are grossly unsafe as used around the tank. Rope, step-ladders, and steel ladders are slippery."

2. "No staging - nothing to walk on while on tank top. Lucky no one has slipped off of tank!"

3. "The area is not suitable for a portable ladder, and the operator must lean over a sizable area of free space in a most precarious position to operate the valves. No catwalks near valves."

4. "There is a safety hazard from climbing on or over piping some of which is 10-20 feet above the ground with no walkways."

5. "There isn't room for temporary ladders and there are no permanent ladders. It would be easy to break your neck."

CASK* TRANSFER INCIDENT

Résumé

In performing a transfer of radioactive material from a water tank to a storage canal, a large transfer cask was used.

The material was drawn only part way into the cask, and a shielding door at the bottom of the cask was only partially closed. The material then protruded from the cask bottom, suspended by a cable which passed through a pulley mounted on the cask upper superstructure.

The crane operator began to raise the cask from the tank, realized that the sample was not completely inside the cask, and attempted to perform a horizontal traverse to the storage canal. The cask superstructure struck an overhead obstruction, causing the material to drop (on its supporting cable) to the building floor. The building was evacuated. A recovery plan was developed and the material was later transported to the storage canal without further incident.

RSO Results

Listed below are specific problems associated with this event (which are also relevant problems reported by RSO prior to the event):

1. Casks were improperly loaded (wrong cask, wrong sample, or "sample pulled too far") (reported 8 times).

2. A Health Physics radiation survey instrument was inoperative (reported 5 times).

3. Constant Air Monitors, Remote Area Monitors, and Personnel Friskers were ineffective as indicators of the highest radiation situations (reported 5 times).

4. Cask doors were mismanipulated (procedural inadequacy or procedural deviation) (reported 5 times).

5. There were too many people around the tank area (reported 5 times).

6. The Health Physics monitoring was insufficient to evaluate the job hazards (reported 3 times).

7. Personnel failed to react to Health Physics direction (reported 3 times).

8. Radiation was streaming between a cask and a shielding block (reported 2 times).

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*A shielded container for radioactive material, which essentially prevents escape of radiation during transport of the material.

9. There was insufficient Health Physics awareness of job conditions or Operations-Maintenance awareness of sources and fields (reported 2 times).

10. Crane operator-rigger inattention resulted in radiation exposure of personnel (reported 2 times).

11. Rigger identification is difficult when other personnel are standing around the job area (reported once).

12. A Maintenance Foreman stood around without any effort to guide or assist the crew (reported once).

13. The Operations Assistant Shift Supervisor felt that no action could be taken in item 12, above, unless the "situation became dangerous" (reported once).

14. There were ambiguities in craft responsibilities (reported once).

15. An individual "reading along" with a procedure failed to track the work of a craftsman who was working without referring to the procedure (case cited omitted step) (reported once).

16. A Health Physics radiation survey instrument pegged at full scale due to the improper choice of instrument (reported once).

17. There was a failure to back out of a detected high radiation situation (reported once).

18. Crane motion was initiated with a sample in wrong position (reported once).

19. A stuck sample was freed by raising the cask and realigning (reported once).

20. An exact duplicate of the cited incident occurred, up to the point at which the crane operator successfully reinserted the material into the tank rather than attempting to transfer it to the storage canal (reported once).

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