

OPERATIONAL PROCEDURES - INDUSTRY OBSERVATIONS AND OPPORTUNITIES FOR IMPROVEMENT

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ABSTRACT

The purpose of this paper is to relate some of the commonly encountered problems with operational procedures in the nuclear industry and offer practical suggestions for their elimination. The paper is based on recent consultant experience in assisting industry clients with human performance related design and assessment initiatives.

Operational procedures are a key part of an integrated system design. Procedures provide the specified instructions for actions people are to undertake in operating a facility to achieve production and safety goals. While organizations continue to make substantial investments in procedure development and maintenance, problems with procedures continue to occur, as evidenced through operating inefficiencies, errors, and events.

The paper reviews the role procedures play in facility operations, comments on current development and maintenance practices, discusses the extent of human performance related problems attributed to procedure deficiencies, reviews commonly encountered problems with design and implementation of procedures, and offers suggestions on how some of these issues might be addressed in the future.

BACKGROUND

Deficiencies in operational procedures and their misapplication continue to be the most frequent and prominent causal factors contributing to human performance problems in the nuclear industry. A number of studies based on root cause analysis of operating events have shown that procedure related factors are key causal contributors in 22% to 31% of the events studied [1,2,3]. Similar experience has been confirmed in the airline transport industry where the National Transportation Safety Board in the United States has reported procedural factors accounting for 24% of all crew errors in the accidents studied [4].

The overall impact on facility operations from procedural deficiencies is likely to be substantially greater than the impacts as characterized by operating events alone. The recurring costs and operational impacts from day-to-day work inefficiencies and operating errors resulting from procedural deficiencies that do not lead to events are unquantified by the industry and likely considerable.

The types of procedural related problems that contribute to human performance problems can be broadly grouped into three classes [2]:

- Problems of Specification - This class of problems is associated with deficiencies in procedure definition. These type of problems comprise 48% of procedure related problems and can be further subdivided into two subclasses, as follows:
 - Content - Problems associated with incomplete or incorrect information in relation to task needs, and
 - Form - Problems associated with variability and complexity of procedure organization or expression.
- Problems of Infrastructure - This class of problems is associated with weaknesses in organizational infrastructure. These type of problems represent 34% of procedure related problems. Problems in this class fall primarily in two areas:
 - Training - Problems associated with mismatches between task requirements as specified by procedures and delivery of training in procedure usage to support task accomplishment, and
 - Revision - Problems associated with breakdowns in organizational procedure revision processes.
- Problems of Application - This class of problems is associated with non-compliance in procedure usage. These type of problems comprise 18% of procedure related problems and can be subdivided into two subclasses as follows:
 - Unintentional Deviations - Problems associated with unintentional failures in individual or team behaviours (e.g., Action omissions, information transposition, or quantitative errors) that result from breakdowns in information processing, or adverse environmental influences such as distractions and interruptions.
 - Intentional Deviations - Problems associated with intentional contravention of preferred operating practice (e.g., shortcuts, workarounds, or operating violations).

For the balance of this paper, the discussion will focus on problems of specification - deficiencies associated with procedure specification.

A central contributor to problems of procedure specification is the common use of procedures as a last means of facility and operational design accommodation. During initial facility design, the physical design (i.e., Systems, structures, equipment, and instrumentation) is specified and implemented prior to operating practice definition. This often creates situations where procedures become the formal means to specify operational workarounds for limitations in equipment capabilities or operating practices not

recognized during design specification. Similarly during facility use, ongoing changes to equipment capabilities, usage and operating practices, again are routinely accommodated through procedural change. Such procedural fixes are too often considered as the expedient and low cost means of accommodation in comparison to more fundamental facility design changes. These two environments requiring expedient change accommodation can limit the context and depth with which procedural changes are examined and implemented, thus contributing to incompleteness or inaccuracies in procedure specification.

Over the past five years, the author has assisted a number of industry organizations with human performance related design and assessment initiatives. With many of these projects, identifying and resolving problems with operational procedures has been either a central or secondary aspect of the assignment. This work has provided a varied experience with production and safety related procedures in the following operational environments and facilities:

- Power and isotope production reactors,
- Isotope and waste processing facilities, and
- Research accelerators and reactors.

The observations and suggestions in the balance of this paper are drawn from this experience.

ROLE OF PROCEDURES

The successful operation of any industrial facility is based on the adequate and complementary provision of structures and systems, operational practices, and personnel. The structures and systems provide the physical implementation that establishes facility capabilities. The operational practices establish the rules and methods that define the manner of facility operation. The personnel provide supervisory oversight and control for directing facility operation to achieve production and safety objectives. Procedures are an essential element of the operational practices.

A procedure is a set of written instructions that defines how a task is to be performed. A procedure is essentially a workplace 'job-aid' that removes operator dependence on memory recall of task specific details from previous task experience and training to support task accomplishment. The provision and use of procedures can reduce the incidence of operating errors, and promote the standardization of task performance across a group of workers with variations in training and operational experience.

INFORMATION ELEMENTS

The task specification provided by any procedure should include consideration of the following information elements:

- Identification - The name, type and revision of the procedure,
- Purpose - The operational objective to be served by the procedure and the task to which the procedure applies,
- Applicability - The conditions under which the procedure should be applied (e.g., entry, on-going, termination and completion conditions), and who is authorized to be perform it,
- Precautions and Limitations - Identification of hazards and task performance restrictions,
- Compliance Level - Specification of the degree of formality/flexibility permitted in procedure application, and
- Task Description - Description of the sequence of actions to be performed, and supporting equipment identifications, warnings, cross-references, and performance criteria.

COMMONLY ENCOUNTERED PROBLEMS

In the author's experience, there are many examples of improvements in procedure specification and preparation practice in the Canadian nuclear industry since the beginning of the 1990s. Even with this progress, several types of deficiencies are still routinely encountered. Some of the most critical and common deficiencies noted in the author's recent experience with several clients include:

Problems of Content

- Narrow Context - Procedures that are written for a limited system state, event, or single task context. This limited perspective can create application uncertainty and difficulties when broader operational contexts are encountered in day-to-day operations.
- Lack of Appreciation for Human Performance Capabilities - Procedural actions that establish performance demands beyond the capabilities of human performers and the supporting environment. Such situations can contribute to incomplete or incorrect task performance.
- Missing Information - Incomplete procedural information contributes to procedure application delays or operating errors from substitution of incorrect information. Information elements that are frequently missing or incomplete include:

- Action specification,
 - Equipment identification,
 - Entry and termination conditions, and task completion criteria,
 - Warnings and cautions, and
 - Cross-references to related procedures.
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- **Misplaced Description Emphasis** - Procedural actions where the description doesn't reflect the operational purpose of the action can contribute to degradation of situation awareness as the procedure is performed. This can occur where the description focus is on lower-level component actions at the expense of higher-level action purpose criteria.
 - **Poor Page Identification** - In many operational situations, multiple procedures can be in use at one time. Where the procedure name and section identity is not prominent on each procedure page, the secondary task of procedure page management and maintaining workplace layout organization can become burdensome.
 - **Undefined Level of Adherence** - The level of adherence establishes how closely operator task accomplishment must conform to procedure specification. Inadequate or unspecified procedural adherence requirements are a prime contributing factor to variability in task accomplishment.
 - **Missing Aids** - Many procedures lack integral record sheets or decision aids specifically prepared to support task use. This forces users to improvise and divert effort to accessing, preparing or adapting alternatives, and increases the risk of introducing variability and/or incompleteness in task performance.

Problems of Form

- **Complexity of Expression** - Long or complicated descriptions of procedural actions, especially embedded conditional logic or multiple option selections often contributes to procedural usage difficulties and operating errors.
- **Lack of Identification of Critical Actions** - Critical actions are task steps that are actions of major consequence, can not be easily reversed, or may require ongoing monitoring requirements. If not differentiated or highlighted, they are more prone to not being recognized for their operational importance. This can increase the risk of inadvertent execution without due regard to operational significance.
- **Inconsistency of Expression** - Lack of standardization in identification, labeling conventions, or use of vocabulary can contribute to misinterpretation of procedural information from original intent.

- Poor Placement and Identification of Warnings - Poor differentiation of warnings from procedural action steps and placement of warnings as supplementary information following action descriptions reduces their visibility and overall effectiveness. Missed warnings can result in performance errors and safety challenges.

OPPORTUNITIES FOR IMPROVEMENT

The following suggestions have been shown to be both practical and effective in reducing common procedure specification limitations:

- Context Definition - Fully characterizing the operating context within which a procedure is to be applied should be undertaken prior to initial procedure design or modification. Context should be defined on an operational state rather than event basis and should characterize what other tasks must be supported during procedure use.
- Task Understanding - A complete understanding of task requirements, task characteristics and human performance expectations should be identified prior to initial procedure design or modification. There are a number of simple techniques for assisting in specifying this information that can be drawn from conventional task characterization methods.
- Writer's Guide - Standardization and specification of procedure content requirements, preferred formats, vocabulary and conventions of expression can go a long way to simplifying procedure preparation, and ensuring consistency and adequacy in implementation. Particular aspects that should be addressed include:
 - Analysis Requirements - Definition of the information to be characterized prior to procedure preparation,
 - Content Requirements - Definition of the information elements to be included,
 - Vocabulary - Definition of action and equipment terms, abbreviations and acronyms,
 - Format - Definition of procedure organization and layout, and
 - Conventions - Definition of the conventions to be applied for action description, especially conditional and continuing actions, warnings, and highlighting of critical actions.
- Operational Assessment - Evaluation of draft procedures prior to operational use can be especially effective in confirming procedure completeness and identifying remaining procedure limitations. Such assessments should be conducted in representative operating situations with facility operations staff. Periodic assessments can provide confirmation of procedure adequacy or alert to the need for upgrade in an operational environment of ongoing change.

CONCLUSION

This paper has outlined some of the commonly encountered problems with nuclear industry operational procedures and offered some suggestions for their reduction. The elimination of procedure deficiencies will continue to be an important industry initiative in order to improve human and overall system performance in operational activities.

REFERENCES

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