

ORGANIZATIONAL FACTORS AND NUCLEAR POWER PLANT SAFETY*

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BACKGROUND

There are many organizations in our society that depend on human performance to avoid incidents involving significant adverse consequences. As our culture and technology have become more sophisticated, the management of risk on a broad basis has become more and more critical. The safe operation of military facilities, chemical plants, airlines, and mass transit, to name a few, are substantially dependent on the performance of the organizations that operate those facilities. The nuclear power industry has, within the past 15 years, increased the attention given to the influence of human performance in the safe operation of nuclear power plants (NPP). While NPPs have been designed through engineering disciplines to intercept and mitigate events that could cause adverse consequences, it has been clear from various safety-related incidents that human performance also plays a dominant role in preventing accidents.

Initial efforts following the 1979 Three Mile Island incident focused primarily on ergonomic factors (e.g., the best design of control rooms for maximum performance). Greater attention was subsequently directed towards cognitive processes involved in the use of NPP decision support systems and decision making in general, personnel functions such as selection systems, and the influence of work scheduling and planning on employees' performance. Although each of these approaches has contributed to increasing the safety of NPPs, during the last few years, there has been a growing awareness that particular attention must be paid to how organizational processes affect NPP personnel performance, and thus, plant safety.

The direct importance of organizational factors on safety performance in the NPP has been well-documented in the reports on the Three Mile Island and Chernobyl accidents as well as numerous other events, especially as evaluated by the U.S. Nuclear Regulatory Commission (NRC). A systematic approach to the understanding and assessment of these factors and the ways in which they affect safety in the context of a NPP setting has been the focus of organizational factors research at Brookhaven National Laboratory. Research conducted for the NRC, in collaboration with other colleagues, in particular, Pennsylvania State University, has resulted in the identification of organizational factors related to the safety of NPPs. In addition to identifying the categories of organizational factors relating to NPP safety, measurement devices for the assessment of these organizational factors have been specified and defined. Finally, it is the ultimate goal of the research initiative to include measures of organizational factors in diagnosing plant operations and eventually incorporating these measurements into risk applications.

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RESEARCH ISSUES

Twenty organizational dimensions have been identified, consensually agreed upon, and categorized into five broader factors. A review of past efforts in organizational research within the nuclear field, as well as related fields, provided information on the parameters of safety from an organizational perspective. From this information, 20 organizational factors, or dimensions, were specified that were consistently linked to safety. Based upon the findings, there appear to be five more general categories that help to describe and organize the dimensions. The dimensions and their categories are:

Control Systems

Coordination of Work
Formalization
Organizational Knowledge
Roles and Responsibilities
Technical Knowledge

Decision-Making

Centralization
Goal Prioritization
Problem Identification
Resource Allocation

Communication

Intra-departmental
Inter-departmental
External

Personnel Systems

Performance Evaluation
Personnel Selection
Training

Culture

Safety Culture
Organizational Culture
Ownership
Time Urgency
Organizational Learning

Measurement methodologies have been developed and adapted to assess these dimensions for the purposes of understanding and evaluating their contribution to safe performance. As a result of field work conducted by Brookhaven National Laboratory, and work done by other researchers, four viable measurement methodologies for the assessment of organizational factors have been identified. These methods include:

- Research Surveys,
- Behavioral Checklists,
- Structured Interview Protocols, and
- Behavioral Anchored Rating Scales.

While these assessments can provide valuable information to the plant regarding strengths and weaknesses, we are still in the process of better understanding other features of the assessments. Among the most important issues facing this line of inquiry are:

- What is the connection between scores on the various organizational dimensions or sets of dimensions and other indicators of nuclear power plant performance?;
- What is the relative importance of the 20 organizational factors relative to safe power plant operations?; and
- What is the level of correlation or dependence among the 20 dimensions?.

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All of these questions represent important topics for organizational factors research and the application of organizational factors data to other research areas.

Applications of interest to this research are focussed in primarily two areas, use in regulatory and inspection activities and the incorporation of organizational factors data in probabilistic safety assessment. Both applications are concerned with research issues such as:

- Where and how the organizational factors data are collected; i.e., primary (at the plant) or secondary (retrospective analysis from prior documentation) sources?;
- What is the inter-rater reliability in collecting these data; i.e., is it replicable across different researchers?; and
- What are the dimensions validated against in order to use them for indexing organizational performance; i.e., do different scores discriminate between 'good' and 'bad' performance?.

Initial efforts in both applications have been successful in demonstrating the usefulness and comprehensiveness of the dimensions and the reliability of the methods to assess them. However, a recurrent issue is the identification of the relationship of organizational factors to other performance shaping factors in assessing plant safety performance. Many models and ideas have been proposed, but little, if any empirical data exists to establish this relationship.

SUMMARY

The identification of organizational factors important to safety performance in the nuclear industry and methods to assess these factors have been developed. Issues surrounding their relationship to each other, to other performance factors, and the most appropriate means to integrate them into other applications evaluating safety performance, remain to be resolved. A discussion of the collective experience of those involved in organizational factors research may provide some insights into how these issues can best be addressed.

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