

## CHAPTER 2

### **CHALLENGES IN THE NUCLEAR INDUSTRY: PERSPECTIVES FROM SENIOR MANAGERS AND SAFETY EXPERTS**

Björn Wahlström

*This chapter discusses present and emerging challenges identified by senior managers and safety experts. Data for this international study has been collected in discussions, structured interviews, group exercises, and questionnaires as part of the LearnSafe project, funded by the European Commission. LearnSafe's main objective is to create methods and tools for supporting processes of organizational learning at nuclear power plants. Organizational learning has become increasingly important for the nuclear industry in its adaptation to a changing political and economic environment, changing regulatory requirements, a changing work force, a changing plant technology, and the changing organizations. The project focuses on senior managers responsible for strategic choice and resource allocation. The first phase of the LearnSafe project concentrates on management of change, and the second phase concentrates on organizational learning.*

#### **INTRODUCTION**

The nuclear industry currently faces many challenges that stem from changes in several domains: changes in the political and economic environment, regulatory requirements, the work force, plant technology, and the organization of nuclear power plants and power utilities. Nuclear utilities and plants have tried to cope with these changes by initiating their own processes of change, which in turn have brought on a number of new safety issues connected to organization and management which need to be resolved.

The Technical Research Centre of Finland (VTT) has initiated and participated in several projects that investigate the relationships between nuclear safety and organization and management. These projects have included the project "Organisational Factors: Their Definition and Influence on Nuclear Safety" (ORFA) (Baumont et al., 2000), funded by the European Union, and activities in the NKS/SOS-1 project "Safety Assessment and Strategies for Safety" (Andersson et al., 2002), funded by Nordic Nuclear Safety Research (NKS). In these projects, an ongoing discussion about the challenges that must be responded to on a medium term have been taking place between researchers on the one hand and senior managers and safety experts from nuclear power plants on the other.

These discussions and perceived needs for more in-depth research (Wahlström, 2001) led to the formation of a new international consortium, which sought and obtained funding from the Nuclear Fission Safety section of the Fifth Framework Programme of the European Union. The "Learning Organizations for Nuclear Safety" project, or "LearnSafe," was started November 1, 2001, and ran for 30 months. It involved a

total of 15 partners from five European countries and two international organizations. The first phase of the LearnSafe project (see Wahlström et al., 2002) concentrates on change management, and the second phase concentrates on organizational learning.

The initiation of the LearnSafe project was part of a systematic effort at VTT to support the nuclear field in Finland with the competency needed to operate the four reactors at the Loviisa and Olkiluoto sites (Wahlström et al., 2000). One important aspect of VTT's skills and know-how related to the nuclear field has been built and maintained through publicly funded research and development, which has been carried out in four-year research programs (Kyrki-Rajamäki, 2002). The knowledge and competencies acquired through these efforts will be further used and developed in the construction of the fifth reactor in Finland, which was accepted in the Finnish Parliament on May 24, 2002.

## THE LEARNSAFE PROJECT

### The consortium

The consortium has created a unique partnership (see Table 2.1). The group of partners, which represents a broad spectrum of experience in nuclear activities, has joined to form an international consortium aimed at research in issues related to organization and management. The research has great potential to improve both safety and efficiency at the plants. Moreover, the formation of the consortium indicates a break with the traditional emphasis on technical aspects of nuclear safety.

**Table 2.1** LearnSafe partners

1.	Technical Research Centre of Finland, VTT Industrial Systems (VTT)	Finland
2.	Berlin University of Technology - Forschungsstelle Systemsicherheit (TUB)	Germany
3.	Lancaster University (ULANC)	UK
4.	The Research Centre for Energy, Environment and Technology (Ciemat)	Spain
5.	SwedPower AB (SWP)	Sweden
6.	UNESA	Spain
7.	World Association of Nuclear Operators (WANO)	
8.	Teollisuuden Voima Oy (TVO)	Finland
9.	Forsmark Kraftgrupp AB (FKA)	Sweden
10.	Kernkraftwerk Grafenrheinfeld (KKG)	Germany
11.	Kernkraftwerk Krümmel (KKK)	Germany
12.	British Nuclear Fuels plc (BNFL)	UK
13.	OKG Aktiebolag (OKG)	Sweden
14.	Ringhals AB (Ringhals)	Sweden

Some of the partners cooperated successfully in the earlier ORFA project. As a result of the emphasis on nuclear utilities, partners in the ORFA project that

represent regulatory bodies were not given a position in the present consortium. This does not mean that regulatory bodies are denied access to generic project results; on the contrary, they shall be invited to participate as discussants at LearnSafe seminars. Access to generic project results is given through a public web site.

The research-and-development organizations involved in the project have long been interested in issues of organization and management for safety in the generation of nuclear power. Some of them are involved in consulting to the nuclear industry and thus are in a good position to support the technological implementation of project results. In addition, the participation of universities enables them to include the early results from the project in their curricula, which facilitates the immediate preserving of knowledge in the field of safety management of nuclear power. The overall emphasis on safety and efficiency is assumed to provide students with a relevant introduction to business activities in the nuclear industry.

### **Hypotheses of the project**

The LearnSafe project is concerned with organizational learning within the nuclear industry. LearnSafe partners are aware that this theme has been studied within the management sciences and that it has been applied in high-risk industries such as transportation, chemicals, and offshore activities. In starting up the LearnSafe project with funding from the Fifth Euratom Framework Programme of the European Union, the partners believed that demands set on the nuclear industry were unique enough to warrant a dedicated study.

The following observations point to just some of the considerations specific to the nuclear industry which set it apart from other high-risk industries:

1. Nuclear reactors require continuous supervision, because even when they are shut down the removal of residual heat must continue to function.
2. Societal concerns about risks connected to nuclear power are greater than actual risk estimates, such as those provided through probabilistic risk assessments.
3. With regard to safety, a nuclear power plant has a higher burden of proof than do other high-risk applications.
4. The nuclear industry is a global industry in that bad performance anywhere is likely to lower trust and confidence in the industry everywhere.
5. Even the suspicion that a nuclear power plant is not safe may be enough to shut it down for extended periods.

In setting up the LearnSafe project the assumption was that senior management has an important influence on the safety of their plants. Hence, the chosen focus for the project was those senior managers at nuclear power plants and at the corporate level who are responsible for strategic choices and the allocation of resources. Observations and discussions confirm that many unique demands are placed on senior management in the ongoing process of adaptation to changed operational conditions. In this connection it is necessary to understand how safety threats can emerge and grow from seemingly unimportant details, becoming problems that pose risks to the business.

### **Objectives of the project**

The main objective of the project was to create methods and tools for supporting processes of organizational learning at nuclear power plants (NPPs). This goal was selected in view of the importance of organizational learning during a process of change management. In recent years the nuclear industry has been forced to adapt to a changing political and economic environment, changing regulatory requirements, a changing work force, changing plant technology, and changing organizations at the power utilities. A sustainable strategy for the continued operation of European NPPs depends on a successful adaptation to all these changes without compromising safety in any instance.

The main objective can be broken down into secondary objectives. Directly connected to the main objective and focus of the project is the need of NPPs and power utilities for practical methods and tools to support their senior management during processes of organizational change. Such methods and tools support the early identification of emerging issues and challenges. Project results also support ongoing change processes by indicating issues that must be considered more carefully than others.

Another objective of the LearnSafe project was to create a close interaction of researchers and practitioners in order to stimulate a search for and exchange of innovative solutions for organization and management. It is believed that such interactions within the project can help in finding new solutions that enable safety management activities to become increasingly efficient.

The project is expected to have an important impact through the collection and documentation of managerial experience from the participating NPPs and through reflection on that experience by means of available theoretical frameworks from the management sciences. The project also aims to be instrumental in feeding this information back to the participating NPPs in the form of seminars and training courses for younger managers.

### **Research questions**

The first empirical and theoretical phase of the project was devoted to change management, in recognition that various mechanisms of change bring new challenges to the senior management at the NPPs. This led to the formulation of the following research questions for the first phase of the project:

1. What are the perceived emerging challenges in the management of NPPs?
2. How do senior managers cope with emerging challenges in the management of NPPs?
3. What improvements could be made with respect to coping with emerging challenges in the management of NPPs?

The project's second phase was connected to the concept of learning organizations. A considerable amount of research within organizational and management sciences has been devoted to investigating how learning occurs and what characteristics facilitate organizational learning. At this stage the following preliminary considerations provide indications of the direction of the research during the second phase:

4. What kinds of features and attributes characterize learning organizations?
5. What are the most common barriers to organizational learning and how can they be removed?

6. How are various company cultures and subcultures influencing organizational learning?

### **Project expectations**

One expected result of the project was that it will bring about fruitful interactions between theory and practice. The cooperation between national partners provided contributions to the project which enable cross-cultural comparisons. In addition to these interactions, the partners were encouraged to establish direct connections between each other for the in-depth investigation of interesting issues. Moreover, early results from the project were to be adopted in trial applications at the participating NPPs.

Among the participating NPPs there were expressions of interest to share views on safety management between organizations and countries. A number of interesting questions in this regard might be addressed, such as:

- What activities are seen as important in safety management at NPPs, and how are they connected to other activities?
- Is it possible to set performance standards on safety management activities?

One issue brought up within the project was the possibility of organizational drift. This concept refers to cases in which organizations have drifted into unacceptable situations through a series of decisions that may have been rational in the small but, when taken together, prove to be pernicious, dangerous or destructive. Interesting questions in this case address, for example, under which conditions such organizational drift may occur and what indicators may be used as warning signals.

One important result of the LearnSafe project is a collection of good practices. In their most generic form such practices may even be called organizational safety principles, in correspondence with similar technical safety principles such as the defence in-depth principle and the single failure criterion. If organizational safety principles could be identified, they would have many applications. They could, for example, be used to formulate organizational requirements on safe operation in order to support analysis and review. They could also provide a basis for developing methods and tools for organizational self-assessments.

## **CHALLENGES WITHIN THE NUCLEAR INDUSTRY**

### **What do we mean by challenge?**

When looking up a dictionary definition of the word “challenge,” one finds definitions such as

- (a) summons to engage in a contest,
- (b) a call to fight in a battle or duel, or
- (c) difficulty in an undertaking that is stimulating to one engaging in it.

These definitions quite aptly describe the situation of the nuclear industry today. There have been many changes in the political and economic environment, in regulatory requirements, and in the work force available on the labor market, all of which pose a challenge to be met. Some of these challenges have been approached by introducing new technologies and by

restructuring organizations and ownership at the NPPs and power utilities. These strategies have, in turn, brought on a series of new challenges for senior managers to consider.

### **Challenges in a cause-and-effect relationship**

Challenges are seldom issues that can be approached and coped with in isolation. They are more often complex issues with a multitude of causal relationships, which can be approached at various levels and within different time frames. In order to create efficient coping strategies for approaching these challenges, senior management at NPPs must have a kind of relational model of how the issues interact. In its most simple form one could consider one single step in a causal chain and speak about preconditions for conditions or events. A condition or event may, in turn, have a number of consequences that must be taken into account. Using this simple model to trace relationships between various challenges, one can immediately see that a challenging issue may be either a precondition or a precursor to another challenge and that actions taken to cope with a certain challenge may have a number of other challenges as their consequence.

Challenges may also be considered in terms of a scale ranging from general to specific. To give one example, the creation of awareness and understanding in an organization may be regarded as a very general challenge applicable to many situations. On the other hand, the selection of appropriate methods and tools for implementing an organizational change may be considered a far more specific challenge. One might even hypothesize that specific challenges can be described by using more general challenges.

### **Data collection**

Data collection for the first phase of the LearnSafe project concentrates on processes for the management of change at the NPPs. To support the data collection phases, a list of challenges (see Table 2.2) was generated within the LearnSafe project; this list was based on literature and partners' previous experiences. This list has been used to stimulate discussions during the data collection sessions.

The following groups of people have participated in the data collection so far:

- (a) experts (nuclear safety, occupational safety, regulators),
- (b) top management from the utilities (vice president of nuclear power operations, chairman of the board),
- (c) members of upper management at NPPs, and
- (d) multifunctional managers (operations, maintenance, technical, quality/safety, radiation protection, chemistry, human resources management, training).

The first group participated by judging the list of challenges as generated by the LearnSafe project according to two dimensions: importance and time frame of influence. Semi-structured interviews were used for the second group, and for the last two groups Metaplan sessions were used to collect challenges and structure them into clusters.

**Table 2.2** List of challenges as generated by the LearnSafe project

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1.	Aging personnel
2.	Contractor competency and skills
3.	Recruiting young people
4.	Motivational problems
5.	New regulatory requirements
6.	Pressures from owners and higher management
7.	Adapting to the role of a skillful customer
8.	Public confidence
9.	Changes in company ownership
10.	Focus on short-term goals and performance
11.	Deregulation and competition
12.	Human and organizational factors
13.	Cost pressures as compared to competing energy sources
14.	Internal debiting for services
15.	Requirements on formalization and documentation
16.	Negative publicity
17.	A decreasing number of vendors
18.	Differences in national regulatory requirements
19.	Handling nuclear waste in a short-term perspective
20.	Asset management when there are multiple owners
21.	New technologies
22.	Loss of confidence in national and international regulators
23.	Diverging views between regulator and utility
24.	Aging plants
25.	Decommissioning of plants
26.	Terrorism and sabotage
27.	Dissimilarities in regulatory philosophy by different authorities
28.	Maintaining nuclear competency
29.	Changing societal priorities

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In the Metaplan session the participants are first asked to fill in three to five short sentences on small cards in response to one question posed to the group. The cards are then collected, read out loud, and pasted on the wall for all to see. The next step is to rearrange the cards to form clusters, which are given names according to a consensual suggestion from the participants. Finally, the clusters and statements are evaluated according to their importance. Obviously, there is some room for variation in how the Metaplan sessions can be carried out; this description is meant to give a general idea.

In the actual Metaplan sessions at the NPPs the question posed was research question one (see above). As an intermediate step in the Metaplan sessions, before moving to the formation of the clusters, the LearnSafe list of challenges was used to ensure that a reasonably complete picture had been obtained. The Metaplan sessions took about 1.5 hours and involved about ten persons each.

### **Preliminary results**

The following results are based on results from Finland and Sweden, when about 90% of the data were collected. These preliminary results are not based on a thorough

analysis, but may still reflect some interesting qualitative impressions from the material.

Overall, the list of challenges collected by the LearnSafe project has covered the challenges as perceived by different persons within the industry reasonably well. Some of the issues brought up during the Metaplan sessions led to an increase in the number of challenges and suggestions of additional cause-and-effect relationships. One comment on the LearnSafe list of challenges was that they were rather detailed in comparison with the more general issues to which managers devote their attention.

The expert opinions from Finland on the LearnSafe challenges were quite similar. The most important challenges were (1) aging personnel, (8) public confidence, (24) aging plants, (28) maintaining nuclear competency and (21) new technologies (see Table 2.2). The challenges of (13) cost pressures from competing energy sources, (22) loss of confidence in national and international regulators, (25) the decommissioning of plants and (19) the handling of nuclear waste in the short term were viewed as rather unimportant. The most urgent challenges to be dealt with were (10) a focus on short-term goals and performance, (15) requirements for formalization and documentation and (21) new technologies.

Top management in the utilities identified issues related to competency, deregulation, aging and renewal of the plants, and management of safety as the main challenges. They were unanimous in seeing the largest challenge facing the nuclear industry as the ability to maintain competency in the nuclear field worldwide. All saw a new upswing for nuclear power in the future, but feared it might take time.

The Metaplan sessions have generated large data sets, and final analysis of the material was started after the data collection was completed. Some qualitative observations can be made. First, there are considerable similarities in the material. Second, the clusters and challenges seem to fall well within the following larger metaclusters: regulators; aging, modernization, and new technology; economy; competency; management and organization; and society.

### **A set of generic challenges**

In an attempt to identify generic challenges from the material, a helpful approach is to consider the balances between contradictory demands (see Table 2.3) identified by the ORFA project. The balance between economy and safety can clearly be seen in the responses, as an instance of the balance between costs and benefits, which requires management to take a position on how much it is willing to spend resources on certain issues of importance. In the regulatory domain there seems to be a need to balance between tradition and renewal, a circumstance in part connected to regulators' hesitation in the face of new organizational structures.

For nuclear utilities, the balance between cooperation and competition has shifted with deregulation, and it may be necessary to take this situation into account when the challenges are addressed. Earlier there had been a decentralization of nuclear organizations, but it now seems the pendulum has swung in the direction of more centralized organizational forms. The balance between discipline and flexibility emerges with the issue of the renewal of quality systems; the need for providing a better overview also has been identified with respect to this issue.



**Table 2.3** Balances in management

<b>Conservative</b>	<b>Liberal</b>
Traditions	Renewal
Formality	Informality
Self-confidence	Willingness to listen
Cooperation	Competition
Centralised authority	Distributed authority
Discipline	Flexibility
Focus on details	Maintaining an overview
Monitoring and reporting	Confidence and accountability
Short-term optimization	Long-term optimization
Specific/practical	Generic/theoretical

Fears have been expressed that ownership and responsibility may be weakened in the process of organizational change, which may indicate the need to give adequate attention to the balance between monitoring and reporting, on the one hand, and confidence and accountability, on the other. There are also fears that cost pressures may introduce short-sightedness in decision-making at the plants. In consideration of the need for a long-term outlook with regard to investments in plant renewal and employee competency, this development could be counterproductive for the nuclear industry as a whole.

## **STRATEGIES FOR COPING WITH THE CHALLENGES**

### **Regulators**

The issues addressed on this point were related to new regulatory requirements under development. Another issue that was raised is related to the role-play between the regulator and the NPPs. Some also touched on the fear that the focus of the regulator may shift away from issues that are relevant for safety only and include formalities that are not considered necessary. In this connection it is also necessary to note that it is not only the safety authorities that place requirements on NPPs but other authorities as well, which issue requirements on environmental protection, labor safety, competition, and so forth.

One issue mentioned in this connection is that it has been somewhat difficult to agree on a suitable safety standard for old reactors which takes due consideration of the costs involved in bringing them up to modern standards. Another problem is related to the licensing of programmable instrumentation and control systems, an area where considerable difficulties have been encountered.

Many participants mentioned the need for a harmonization between regulatory requirements, especially in consideration of the fact that nuclear utilities in Europe compete on the same markets. The establishment of the Western European Nuclear Regulatory Association (WENRA) was welcomed in this regard. Generally, it was believed that better international cooperation in comparing and assessing systems of requirements could help in coping with some of these challenges.

### **Aging, modernization and new technology**

These issues are related to the need to follow and predict when certain components must be replaced. This requires careful optimization of the remaining life span of main components and will also involve the introduction of new functions using advanced instrumentation and control systems. The increasing obsolescence of certain components has forced plants to modernize. In some cases these modernizations have been connected with safety requirements, which have made it cost-effective to replace old materials with new ones.

These issues were viewed as important, but relatively well under control. There are efficient methods and programs for following the aging of main components. Many plants have voluntarily initiated large-scale modernizations, with the aim of extending plant lifetime far beyond 40 years. One major difficulty seems to be finding agreeable methods for the licensing of programmable instrumentation and control systems.

### **Economy**

The deregulation of Europe's electricity market has increased pressures to decrease costs at NPPs. This pressure is attributed sometimes to owners and sometimes to companies' upper management. Continued safety depends on conservative decision-making, which also builds trust and confidence between the NPP and the regulator. Many individuals pointed to the danger that a conflict may emerge between economy and safety, but others pointed to the need for a good economy in order to maintain the safety of plants.

Deregulation in Finland and Sweden occurred in 1995–1996, a period characterized by a large surplus of hydropower in the Nordic system, which put more strain on the adaptation process. It seems that some plants have had greater difficulties than others in their adaptation to the deregulation of the electricity market. Most participants, however, expressed satisfaction with the present situation, though they also pointed out that the issue requires continued efforts. So far no plant had experienced difficulties in getting their investment programs accepted by their boards.

### **Competency**

Competency was a theme brought up by all respondent categories. One concern was connected to maintaining competency at the NPPs in view of the future generation changes foreseen for many European plants. One special challenge in this connection is to select and train senior managers for the nuclear industry. A second issue was connected to the competency of vendors and contractors, and some respondents expected a possible increase in prices if competition were to disappear. Some concern about the competency of regulatory bodies was also voiced. More generally, many felt that maintaining competency in the entire nuclear field is the greatest challenge currently facing the nuclear industry.

At the plants the competency issue has been addressed in many ways. All plants have initiated projects to create an inventory of their own competencies together with a projection of the expected situation in the future in order to identify possible gaps and the need for action. One organization has even brought in the average

age of the employees to be monitored, using this as a performance indicator.

The competency of major vendors was especially seen as problematic. Recently, there have been mergers among them. Some persons expressed satisfaction with this concentration of resources. Still others expressed a fear that it may lead to a weakening of competencies in the long term. The competency of contractors was seen as somewhat easier to cope with; some NPPs, for example, systematically employ contractors in long-term contracts in order to reinforce the development of their competency and skills.

### **Management and organization**

The development of management practices and organizational structure was perceived as a major challenge. Some expressed a fear that frequent organizational changes may weaken ownership and responsibilities. The curtailment of complacency was also considered an important challenge. Mention was made of the special challenge of maintaining employee alertness even when plant performance is good and has been good for several years. Many comments on the importance of maintaining a sound safety culture were made in this regard.

Many of the NPPs have gone through organizational changes as part of a strategy to become more efficient. Many indicated that they had been successful in their rationalizing efforts. Some plants have outsourced some peripheral activities, but this strategy has not been very common in Finland and Sweden.

Many plants have implemented major changes in their quality systems, in part with the intention to become more efficient and in part to make procedures and practices more transparent. In the transition to increasingly integrated systems for activity planning and implementation, which many of the nuclear power plants now use, the so-called balanced scorecard concept has been utilized for goal definition and follow-up.

### **Society**

The need to maintain confidence among the local and national public was mentioned by many participants. The importance of openness in communicating with the media was stressed in this connection. Political issues, such as taxes, can have a considerable influence on many of the other challenges and can easily make a difficult situation worse. Another consideration was the need to take into account the possibility of terrorism and sabotage.

Public trust and confidence in the NPPs in Finland and Sweden seem to be well established. Polls from Sweden, for example, reveal that there is much greater support for nuclear power from the public than from the political establishment. Many NPPs conduct regular polls to assess public opinion, both regionally and nationally. The plants have good relationships with the regional authorities, providing information and supporting various local activities. The political gauntlet leading to the premature closing of one plant in Sweden was considered grotesque and not in support of safety at the rest of the plants.

## CONCLUSION

NPPs today are faced with many challenges. It is apparent that these challenges are matters that require continuous management attention and that various approaches to address them have been taken. A satisfactory resolution of some of the challenges may require a coordinated action from several nuclear operators, but the competitive situation today may make such actions more difficult. It is clear that the challenges currently facing managers at NPPs have increased the burden on people. Fortunately, at the same time, new ways to structure work, new tools, and new management practices have been found to make the use of resources more efficient.

Initial results from the LearnSafe project support the conclusions of earlier projects showing that research addressing issues related to management and organization is important. Discussions with senior managers also tend to confirm that they have a tremendous number of issues to which they must attend. At the same time, earlier research has demonstrated that incidents seldom are the consequence of some major mistake or error, but rather are the outcome of a large number of seemingly minor issues that are combined to create an unlucky coincidence (Hollnagel, 2002). This finding implies that senior management must approach all details with similar rigor to ensure that no hidden deficiencies are introduced into the systems.

Discussions within the LearnSafe project have tended to confirm anecdotal evidence that senior managers greatly influence organizational culture. It is therefore important that they be aware of the impact that minor slips can have and that these slips are responded to and acted on with necessary force and efficacy. In the larger picture it is hoped that the LearnSafe project will contribute to the awareness and understanding that is needed to maintain a good safety record. This safety record is crucial for continued public support of nuclear power and, thus, also an essential factor in the efficient use of available energy resources in Europe.

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