



EUROPEAN COMMISSION

**5th EURATOM FRAMEWORK PROGRAMME 1998-2002
KEY ACTION : NUCLEAR FISSION**

Learn Safe

LEARNING ORGANISATIONS FOR NUCLEAR SAFETY

CONTRACT N° FIKS-CT-2001-00162

**STRATEGIES, PLANS AND ACTIONS IN RESPONSE TO
CHALLENGES AT NUCLEAR POWER PLANTS**

Björn Wahlström, VTT Industrial Systems

5.3.2004

Summary: The first phase the LearnSafe project collected challenges as seen by the management at participating nuclear power plants in a comprehensive effort. The collected challenges were analysed to produce eight general groups, which were further addressed to investigate how senior managers cope with them in strategies, actions and plans. One observation is that specific challenges seldom relate to strategies, plans and actions in a one-to-one fashion, but more often show rather complex relationships. This report gives an account of the collected information from nine nuclear power plants in five countries in Europe.

List of content:

- 1 Introduction
- 2 Economic pressures
 - 2.1 Responses to the deregulation
 - 2.2 Acquisitions and mergers
 - 2.3 Outsourcing and downsizing
 - 2.4 Economic planning
 - 2.5 Creation of a cost awareness
 - 2.6 Development of work processes
 - 2.7 Some reflections
- 3 Human resource management
 - 3.1 Compensating for retirements
 - 3.2 Identification of strategic key competencies
 - 3.3 Networking
 - 3.4 Internal training programmes
 - 3.5 Some reflections
- 4 Nuclear know-how
 - 4.1 Adapting to a loss of competency at major vendors
 - 4.2 Adapting to a decreasing number contractors and suppliers
 - 4.3 Maintaining know-how on a national level
 - 4.4 A restructuring of the nuclear field
 - 4.5 Some reflections
- 5 Rules and regulation
 - 5.1 The need for regulatory oversight
 - 5.2 A definition of nuclear activities
 - 5.3 New regulatory requirements
 - 5.4 Requirements on regulatory oversight
 - 5.5 Harmonisation of regulatory requirements
 - 5.6 Some reflections
- 6 Focus and priorities
 - 6.1 Selection and communication of management focus
 - 6.2 Structuring of work
 - 6.3 Management systems
 - 6.4 Procedures, instructions and documentation
 - 6.5 Organisational change
 - 6.6 Maintaining the level of safety
 - 6.7 Some reflections
- 7 Ageing, modernisation and new technologies
 - 7.1 A proactive approach
 - 7.2 Modernisation projects
 - 7.3 Introducing new technologies
 - 7.4 Some reflections
- 8 Public confidence and trust
 - 8.1 Fighting nuclear opposition
 - 8.2 Building interfaces to media
 - 8.3 Visitor programmes
 - 8.4 Environmental certification
 - 8.5 Contacts to local authorities and organisations
 - 8.6 Some reflections
- 9 Organisational climate and culture
 - 9.1 Safety culture
 - 9.2 Motivation, ownership and commitment
 - 9.3 Some reflections
- 10 Conclusions

1 INTRODUCTION

The LearnSafe project¹ has been divided into two major phases of theoretical and empirical investigations. The first phase is devoted to *management of change* in the belief that the adaptation to changed environmental conditions provides one of the major challenges to nuclear power plants today. The second phase is devoted to *organisational learning*, which is seen as an important process in the pursuit of continued improvement of performance measured in terms of both safety and efficiency.

The first phase the LearnSafe project can be seen as divided into three parts. In the first part responses to the research question "*Q1: What are the perceived emerging challenges in the management of nuclear power plants?*" were collected from the participating organisations in a comprehensive effort. The collected challenges were analysed to produce eight general groups, which were addressed in the second research question "*Q2: How do senior managers cope with emerging challenges in the management of nuclear power plants?*" to produce a set of case studies in which used strategies, actions and plans are described. This report gives a summary account of the information collected in the Case Studies sorted under the eight headings. The paper reflect all Case Studies that were collected in the LearnSafe project, but it relies to a larger extent on information from Finland and Sweden, where the author was directly involved in the discussions leading to the case studies.

One introductory observation is that specific challenges seldom relate to strategies, plans and actions in a one-to-one fashion, but more often show rather complex relationships. Furthermore strategies, plans and actions that are implemented may themselves in turn generate new challenges that have to be approached. Therefore it becomes a rather difficult task to paint a true picture of all challenges and coping mechanisms that senior managers use in keeping their plants safe and competitive. Another observation is that some of the challenges the senior managers can approach within their own span of control, other challenges can be influenced only indirectly and some of the challenges they cannot influence at all.

2 ECONOMIC PRESSURES

In this group of challenges the competition caused by deregulation in the electricity market was one of the major themes. The competition on the market has led to the need for cost reductions and adaptations to new conditions. According to the responses there are both national differences and differences between forms for electricity production, which are seen as in taxes and subsidises. The need to maintain competitiveness on the market has increased corporate pressures on the nuclear power plants, which sometimes are seen as causing conflicts between costs and safety.

2.1 Responses to the deregulation

The nuclear industry used to be a part of a regulated electricity supply, where cost could be recovered in tariffs. The situation changed drastically when the electricity supply was deregu-

¹ The project FIKS-CT-2001-00162 "Learning organisations for nuclear safety" funded by 5th Euratom Framework Programme 1998-2002, Key Action: Nuclear Fission by the European Commission. For additional information see the web-site <http://proxnet.vtt.fi/learnsafe/>, which is open for the LearnSafe partners. Access to this web-site can be gained by sending a mail to Ulla.Peltonen@vtt.fi. The project has also established an open web-site at the address <http://www.vtt.fi/virtual/learnsafe/>.

lated and electricity producers were forced to compete on an open market. The United Kingdom and the Nordic countries were the first out in this move towards deregulation, which is expected to continue in Europe.

The deregulation itself would perhaps not have been felt to be that dramatic if the supply and demand would have been in balance, but a few wet years especially in the Nordic countries sent electricity prices on the spot market down far below what was considered to be a level, where the nuclear power plants could compete. The situation has now stabilised especially due to the facts that some production capacity has been mothballed, the demand for electricity has increased and the nuclear power plants have been able to reduce their production costs.

Listening to the comments by the respondents it seems evident that there have been differences in how the change has influenced different plants. At some plants cost awareness had been built as a systematic effort over many years. At other plants expensive modernisation projects seems to have eroded resources that might have been allocated in a different way. Some senior managers actually expressed as their view that the deregulation actually had been positive in forcing the plants to be more cost conscious.

2.2 Acquisitions and mergers

At the corporate level one of the strategic responses to the deregulation was to search for economics of scale through acquisitions and mergers. This strategy can be successful in saving costs if overlapping functions can be eliminated, which implies that reductions in personnel often turn out as a result.

Experience from actual acquisitions and mergers in the nuclear industry, but also in other industries, show that there are many difficulties involved. Staff reductions may lead to the loss of important competency both through early retirements and in response to a feeling of uncertainty among key persons. It also takes time to merge cultures of two companies and the benefits may thus be correspondingly smaller than calculated. On the other hand the merging of two cultures could also be a stimulating process and provide the benefit of picking the best approaches from two companies.

2.3 Outsourcing and downsizing

Outsourcing has been used as a way to create organisational efficiency for a long period before the deregulation. One goal in this process is to concentrate on the core business and thus help senior managers in their task of putting attention and focus on the really important things. Another goal is to ensure that the outsourced functions maintain proper contact with the best available skills and knowledge, which is not always the case if a function is allowed to develop on its own within the mother organisation. In some cases it has been difficult to agree with the regulator, which functions can be outsourced.

Down-sizing has been used to some extent at the nuclear power plants, even to a point when it seems difficult to maintain a minimal staffing for all important tasks. According to the view of one of the respondents organisations have now reached almost an anorectic level. On the other hand as one senior manager noted that the size of the organisation is not that important as long as you are conscious in your efforts to keep it small. Another respondent noted that down-sizing as a mean to save costs easily may backfire as unplanned outages. More generally it seems to be that some problems have been experienced at places, where a tradition has been to do much of the work in-house.

2.4 Economic planning

There was a large consensus among all respondents that the only correct strategy by which the cost pressures can be met, is to do a careful economic planning. This implies for instance that a too blinkered concentration on costs can lead the focus of the senior management group astray. Instead it is important to consider needs for maintaining and possibilities for improving the availability of the plants. This has to be done in a proactive way by building strategies and plans that stretch far into the future. A large economic benefit can for example be obtained by plant life extensions and power upgrades.

Several respondents gave reference to a need for better tools for assessing the long term value creation and to be able to assess how investments compare. Some nuclear power plants use cash flow calculations to assess the impact of different actions, such as modernisations and renewals of major components. Several respondents thought that the economic planning had to be far tighter than before, but all agreed that so far there have not been any real problems to get money for the things needed.

2.5 Creation of a cost awareness

There was a large consensus that cost awareness is an important virtue in any organisation. The means to reach that end seems however to differ. In Sweden there has been a long tradition of using so called buy-and-sell systems, where an internal customer buys certain services from the internal resource organisations. This system has never been used in Finland and some Finnish senior managers actually took an active stand against using this kind of system. There seems however to be a consensus on the need for creating a better cost awareness connected to the pricing of own work.

At one plant the importance of the availability has led to the creation and use of an availability model to assess the importance of components and systems in the yearly load factors in the same sense as PSA models are used for the safety. Calculations with the model have shown to be valuable in targeting maintenance, renovation and modernisation efforts.

There was a large consensus that it is very important not in any way to put the production capacity of the plant in danger, because already a small decrease in the yearly availability can be costly as compared with achievable savings in operations and maintenance costs. This is even more important with components of activities that are safety related, because even a suspicion by the regulator that a plant is not safe, may cause expensive efforts in generating the necessary evidence to avoid forced shut downs.

2.6 Development of work processes

There was a large consensus among the respondents that cost reductions can only be achieved by working smarter and more effectively. Many of the nuclear power plants has tried to enter such a path by introducing process thinking in their work activities together with a thorough mapping of their work processes to find opportunities for improvements. Some nuclear power plants have even envisaged a process oriented organisation, but no definitive steps in this direction have so far been taken.

Process orientation can be introduced in two ways, either the nuclear power plant engages a suitable number of consultants to carry out the work or they train their own people in the basic methodology. Among the respondents there was a clear consensus that the later meth-

odology is better, because only the own personnel knows how the work is carried out. Much of the benefit of introducing process orientation is also achieved by a better understanding of the work processes.

2.7 Some reflections

In listening to views by the respondents on economic pressures it seems that they are perceived in different ways in different parts of the organisations. It is evident that the change in the market conditions has forced the senior management to put cost efficiency into focus in a way that people have not been used to. This may create an impression that safety has been downgraded as a consequence. On the other hand it seems that people before the deregulation sometimes sold their pet projects to the management with an exaggerated emphasis on safety.

The open electricity market has introduced a transparency, which gives certain assurance that politics and other similar considerations cease to be factors in important decisions at the plants. If a plant cannot be operated with required economic gains over its expected lifetime it will be shut down. Similarly if there are possibilities to extend plant life time beyond what was originally planned this often carries a large economic incentive. The varying spot price on the electricity market gives clear signals to the plant operators on what is important and what is not. It is for example not sensible to save one day during the annual revision if you have to pay for it later with a one day of outage in the middle of the operational period.

It is necessary to have a close follow up of all activities to create both cost awareness and a better capability to predict loading on resources. Only then it is possible to have accurate cost estimates for different actions in strategic and yearly plans. It is also necessary to continuously assess possible improvements in work activities, which again is possible only if the present way to work is well known. Finally it is necessary to have a feeling of what are the best practices in different activities within the industry today. This feeling can be created through a benchmarking of work activities both within the nuclear industry and with other industries.

It has apparently been more difficult for some plants than for others to adapt their cost structure to the needs of the market. One reason is certainly technical as some plant constructions appear to need more work than others. Another possibility may be that some of the plants were able to read the signals of a coming change and started a restructuring process earlier. Regardless of these reasons it seems however evident that there today are considerably less margins for additional cost savings today as compared with the time when the deregulation was initiated and a successful strategy in the future is oriented to a wise targeting of investments in maintenance, renovations and modernisations.

3 HUMAN RESOURCE MANAGEMENT

In this group of challenges the main concern was directed to how to maintain the competency needed at the nuclear power plant. Many comments were concerned with the age distribution of personnel and possible early retirements. Concerns were also expressed that recruiting of new personnel would be more difficult in the future. One underlying theme in this group of challenges was connected to the need for maintaining the specialised nuclear competency.

3.1 Compensating for retirements

All respondents were well aware of problems with an ageing work force. Managers follow age profiles in different groups of people closely to be able to handle coming waves of retirement. Many plants have made competency surveys to get a picture of present competencies and to assess possible gaps in the future. Many respondents made a reference to the need to capture and transfer the knowledge of those who originally took the units into operation. For this purpose some plants have started programmes intended to make tacit knowledge explicit to be documented. For the time being there seems however not to be any concrete tools and methodologies available and the programmes are running more as research projects.

One concrete action is the mentorship programmes that many nuclear power plants are using. Some of the programmes have been more successful than others and it seems that when they have been successful, they have been connected to concrete programmes for modernising the plants. At some plants there have been projects aimed at capturing the design base of the plant, which for some of the older plants were not documented according to modern standards. In the collection of this information, teams were assembled especially with an eye on a successful transfer of knowledge between team members.

Some respondents gave reference to the need to plan for early retirements. One reason for early retirements may simply be the need to reduce the workforce for example due to various rationalisation efforts. Another reason is that the absorption of later retirement waves may introduce the need for early actions to ensure more favourable age profiles. Finally an increased stress in work may also induce the wish in the work force for earlier retirements.

Presently there seems not to be any major problem in recruiting people to the nuclear power plants, but many respondents voiced a concern that the situation may change. Many plants have initiated systematic efforts to build up images of attractive places to work at. Some plants have had successful trainee programmes running for many years

3.2 Identification of strategic key competencies

Strategic key competencies were by some of the respondents viewed as a tool to support human resource management. Strategic key competencies or core competencies as some plants are talking about them, can be defined as those competencies that have to be controlled by the nuclear power plant itself and should therefore not be outsourced.

In the discussion there was a large agreement that the core competency should include the specific nuclear competency that is required to operate the plants. At the same time it was concluded that a much specialised competency most likely could serve more plants than what is usual today and that this kind of competency might be under-stimulated if people are working in isolation from colleagues in the same field. If the local organisation is kept small the competency at the plant should apparently include a competency to buy support activities and to supervise them at the plant.

At some plants there have been projects given the task of defining the concept of core competency. In some cases the ambitions seems to have been very high and consequently not completely reached, but it still seems that these activities have had the benefit of making the concept of core competency reasonable practical. Another use of the concept has been in trying to get an agreement with the regulator on what should be considered as safety related activities that cannot be given as a task to some other party not within the local organisation at the nuclear power plant.

3.3 Networking

Different kinds of networking were used by all plants in support of their human resource management. Networking can occur formally through co-operation contracts, informally through participation in various events and virtually through e-mail and web-services. The international ownership was in some cases seen as providing new interesting forms for networking through contacts within the own group of companies.

WANO is seen as the most important of the international nuclear organisations. It however seems to be differences in the way the contacts to WANO are perceived. Those nuclear power plants, which have direct contacts to WANO seemed to be more satisfied than those which are communicating through an intermediate organisation. As compared to WANO, IAEA and OECD/NEA seem to be more distant among the international organisations, but several plants have well functioning contacts especially to IAEA through various working groups.

Meeting colleagues in person at international conferences and meetings held in various areas with a focus on the needs of the nuclear industry are considered important. These meetings serve as an important component in building a network of colleagues to whom you can call when there is something coming up. The international meetings are further supported by national meetings, which then consequently are broader and have a slightly different function.

Many nuclear power plants network directly to national and local organisations, such as technical universities and colleges, research organisations, etc. In Sweden for example the nuclear field is jointly participating in funding professors and PhD students as a strategy to ensure a long term availability of skilled persons.

3.4 Internal training programmes

All nuclear power plants have their internal training programmes, but there seems to be differences in their organisation and magnitude. According to one respondent there has over the years been a transfer from a rather unplanned training, where whoever could attend whatever interesting course almost anywhere, to a more planned assessment of actual training needs.

One important part of the internal training is the training of control room operators that is carried out using replica training simulators. Over the years there seems to have been a transfer from having the training simulators at a centralised site to have them at the plants. Training simulators on a generic level are used at some plants for the training of maintenance people. The training given to external contractors in the form of introductory courses is another important part of the training activities at the plants.

After the introduction of the safety culture concept after the Chernobyl accident many nuclear power plants have been conducting extensive training courses in safety culture for their whole personnel. The format and content of these courses have varied, but they have undoubtedly been efficient in increasing the safety awareness of people at the plants.

Formal training has always to be supported by on-the-job training. As one of the respondents noted, you have always to give your personnel something challenging to do. This should be done in a positive sense by improving work practices or the plant, to challenge the personnel to take part in a program of continuous improvements, only then can you keep your personnel motivated and focused on the job they are supposed to do.

3.5 Some reflections

In the human resource management there are many demands that should be attended to at the same time. The age profile of the personnel should be reflected against many years of future production. The competency profile should reflect present and new technologies. It is necessary to assess what can be bought from the outside and what should be done with your own personnel. Finally all this should be done in parallel with efforts to maintain the image of the nuclear power plant as an attractive place to work at. According to some respondents all these needs should be reflected in the activities and tasks given to the personnel and information departments.

With the outspoken strategy to keep the own organisation small, which some nuclear power plants have, it is even more important to follow closely what happens in the outside world, because time constants are large when new trained personnel is needed. It is also important to note that competency declines with time if it is not maintained. The crucial question in this group of challenges is however directly related to the next group of challenges, what do you have to know for yourself and what you can buy on the market.

4 NUCLEAR KNOW-HOW

This group of challenges addressed especially the decreasing number of vendors. A concern for the competency of contractors and other suppliers was also expressed. Also here the problem of maintaining the specialised nuclear competency was expressed, but with a slightly different direction as compared with the strategies as described in the chapter before. There was a large agreement that nuclear power plants will rely on the availability of external competency support, but it seems difficult to predict how the availability of various services will develop.

4.1 Adapting to a loss of competency at major vendors

The number of major vendors in the nuclear field has been decreasing through mergers and acquisitions. This development is only to be expected in the practical standstill of building new plants in the world. The after-market in supplying fuel and services to the operating nuclear power plants has been large, but it has not had the volume to sustain the competency that the nuclear power plants were able to buy in the more dynamic situation, where new construction projects were in the pipe-line. Many respondents voiced a concern that the competency at the major vendors will decrease even more in the coming years.

In some countries with major nuclear vendors this concern has initiated national programmes of different kind, but their actual impact seems to have been relatively small. Some nuclear power plants have responded to this challenge by taking a larger share themselves of the planning and co-ordination activities needed for example in various plant modification projects. At some plants there have been systematic efforts to decrease the dependency on a single large vendor by inviting also others than the original vendor of the nuclear steam supply system to renovation and modernisation projects. Some of the respondents viewed an increased co-operation between the nuclear power plants as one possibility to combat this trend.

4.2 Adapting to a decreasing number contractors and suppliers

It is not only the major vendors in the field that have been decreasing in numbers, but also the full range of contractors and suppliers. Some of the nuclear power plants have systematically been inviting tenders also from companies that have not been in the nuclear business before. One strategy selected at some nuclear power plants has been to establish long term contracts with the most important contractors and suppliers to create a win-win situation of a better predictability of tasks to come in the future and thereby to maintain and create the necessary competency within the supplier company. In these cases there has also been a policy to decrease the bureaucracy needed when some restricted support is needed urgently.

In a discussion of possible strategies to approach this challenge many respondents thought that the nuclear utilities might be forced to create new organisational structures to meet the needs the present plants have for their remaining operational life. One possibility would be to rely on an extended exchange with other nuclear utilities to sell and buy specialised services that are difficult to get on the open market. It is also evident that it in the future will be necessary for the plants to rely on some international division of labour by acquiring necessary services on a truly global market.

4.3 Maintaining know-how on a national level

The concern for a hollowing out of nuclear know-how on a national level has been addressed in several of the LearnSafe countries. High level committees have produced consultation documents together with action plans. These have in some countries resulted in national research programmes and industrial support to universities.

Many of the respondents viewed the IAEA Convention on Nuclear Safety as one way to enforce governments not to further decrease the support to nuclear curricula at the universities. An increasing autonomy at the educational institutions make it however difficult to reverse the trend of a decreasing number of nuclear professors at the universities and a decreasing number of students entering a nuclear career. The strategies selected by some of the nuclear power plants are to channel financial support more directly to universities and colleges.

4.4 A restructuring of the nuclear field

Some of the respondents thought that there is a need for a larger restructuring of the nuclear field in Europe or perhaps even on a global level to cope with the need for maintaining a nuclear know-how. Such a restructuring may however be difficult to reach if it has to occur in response to market conditions.

Some respondents raised a concern that there is a hidden cost component on longer term connected to functions that earlier were taken care of by other actors and are now moved to the operators of the nuclear power plants. This cost component is connected to all the other groups of challenges such as for example human resource management, rules and regulation, development of new technologies, and public confidence and trust.

A further response to this development may introduce the need for some "in-sourcing" to the nuclear power plants of functions and/or competence that earlier was found on the open market. This may be expensive if the costs cannot be properly shared among a larger group of nuclear power plants. In its simplicity the nuclear industry will still need top competency, but top competency is always expensive to maintain.

4.5 Some reflections

Also in this connection there does not seem to be any single strategy that can be efficient in approaching the whole range of emerging issues. The uncertainties in respect to a future development are connected to two overriding questions. The first is the expected life-time for the present units and thus the expected volume of the modernisation projects in the years to come. The second question is to what extent new nuclear power plants will be built either to meet new demands for electricity or compensate for old nuclear power plants being decommissioned. Because these questions are closely connected to the public confidence and trust in nuclear power on a global level and to the development of new forms for electricity production it is possible to make only short term predictions of the development. These uncertainties will evidently influence the price of the services supplied on thus also the price of the electricity sold to the final customers.

5 RULES AND REGULATION

Many challenges in this group addressed new regulatory requirements. Another large group was concerned with the excessive need for bureaucracy and paperwork. Many of the collected statements identified the need to maintain an open communication with the regulator. Some of the challenges were questioning the regulatory focus together with an expressed fear that regulatory action in some cases might be counterproductive for safety.

5.1 The need for regulatory oversight

The history of nuclear power so far clearly indicates the need for regulatory oversight. The regulatory interest in the safety of nuclear power is therefore a legitimate concern that has to be borne in mind in all nuclear operation. In discussions about rules and regulation, no-one challenged the need for regulatory oversight, but several respondents criticized aspects of regulatory focus. The respondents viewed their possibilities to influence regulatory decisions to be very small, but stressed the importance of a continuing dialogue.

The general principle of regulatory oversight is that the nuclear power plant has the full responsibility for the safety of the plant. This principle also implies that the regulator should not move too near to the operational decisions at the plant, but should only define the requirements set on the activities. This principle is straightforward and sound, but it is sometimes difficult to set the borders for what should be considered as an interference with matters that are the responsibility of the nuclear power plant. The difficulty of defining this borderline has been seen in connection with issues of organisation and management in the countries, where the regulatory requirements call for a notification of major organisational changes.

5.2 A definition of nuclear activities

Traditionally regulatory oversight has focussed only on safety, but incidents and accidents have shown that this borderline is difficult to draw, as almost everything through some conceivable sequence of events can be argued to have an influence on safety. One illustration of this difficulty is the statement of several respondents that only a plant with a good economy can be safe.

This issue has in some countries grown to a discussion between the nuclear utilities and the regulator on what should be considered as nuclear activities. The source is that most national

legislation requires that the operator of a nuclear facility should be in full control of the nuclear activities. The question is then how this requirement should be interpreted. In some countries it interpreted for example to mean that nuclear activities cannot be outsourced. The concern at the nuclear power plants is that such an interpretation will lock out certain activities from important innovations at the same time an unreasonable management attention has to be spent on simple activities. Despite of any position taken on this issue it seems however important to find an agreement on general principles to applied and how they are interpreted.

5.3 New regulatory requirements

The development of regulatory requirements is a continuous process that has been going on since the first plants in the world were taken into operation. Over the years incidents and accidents have been reflected in the requirements, which then correspondingly have led to retrofits at the nuclear power plants. It seems that there are differences in the national regulatory policies in this regard, which is reflected in the question if the plants should only maintain or instead should actively develop their safety.² Depending on the structure of national regulation the enforcement of new regulation will sometimes imply a rather formal assessment of the impact of the changes.

In the collected data there are many concerns related to the possibility to meet new regulatory requirements, but it seems clear that whenever incidents or research has brought a better understanding of crucial components of safety, this understanding should be reflected also in the old plants. It is clear that there are several restrictions in the constructions of the old plants that sometimes can make it very difficult to meet the requirements typically placed on new plants. In these cases it is evident that the regulator and the nuclear power plants should engage in a negotiation of what can be considered as reasonable improvements.

In Finland the plans for building a new nuclear power plant have served as one incentive to continuously develop the regulatory requirements. Correspondingly the presently operational plants have for the increase in the thermal power of their reactors been forced at least partly to apply the new requirements.

In Sweden new reactor safety requirement are expected to be enforced during the year 2004, after which the plants are given a transition period to modernise. Most plants in Sweden have already developed rather detailed action plans for the modernisations and they will be finalised when the length of the transition period is set. Some respondents expressed a fear that a short transition period may introduce additional costs and difficulties to meet manpower demands.

Of the LearnSafe countries the United Kingdom and Sweden have introduced a requirement that nuclear power plants should notify the regulator when larger organisational changes are carried out. In response the plants have developed their own instructions on how organisational changes should be carried out and notified. According to some respondents this requirement has given certain posture to the processes used in organisational change, but it has also introduced confusions and delays.

² OECD/NEA (2002). Improving versus maintaining nuclear safety, NEA#03672, ISBN: 92-64-18493-7.

5.4 Requirements on regulatory oversight

Regulatory oversight will have and should evidently also have a large influence on strategies and policies at the nuclear power plants. In spite of this general agreement there were in the collected data quite many concerns that regulatory actions actually might be counterproductive for safety. If this is the case it would be important to settle the issues that abrade the confidence in regulatory oversight. In one country the regulator has voluntarily tried to settle these kinds of questions in initiating a study on utility views regarding regulatory requirements and oversight.³

Another issue mentioned in this context was the fact that there in addition to the nuclear safety and radiation protection authorities are many other regulators that in their area of jurisdiction are placing requirements on the nuclear power plants. It may sometimes be difficult for the nuclear power plants to navigate between all the requirements and styles of inspection these agencies use.

In a medium time frame it may be motivated to bring up the general principles of regulatory oversight to a more open debate. Just from the perspective of the nuclear power plants there is a clear advantage if the regulatory requirements are documented and understandable. There should also be stability in how they are interpreted and the interpretations should be independent of persons doing the inspections. There was also a clear view at the nuclear power plants that national regulation easily could interfere with the requirement that actors on the market should have equitable positions.

5.5 Harmonisation of regulatory requirements

Some of the respondents pointed the need for a harmonisation of regulatory requirements in the new situation, where electricity is sold over the national borders and the utility companies have become international actors. Already a brief assessment of the regulatory requirements in the five LearnSafe countries point to a large variation in the details, which make comparisons almost impossible. There seems also be a large variation in how the same technical requirements are interpreted by different national authorities.

In the discussions the IAEA Convention on Nuclear Safety was seen as one mechanism to initiate a path towards a larger harmonisation of national regulatory requirements. WENRA was another important forum mentioned in this connection. The development of the European Utility Requirements was also seen as one important step in a path towards harmonised requirements. It is evident that the development in this area has to be led by the safety authorities without too much interference by the nuclear utilities, but an involvement of the European Commission was seen as welcome.

Some respondents also brought up the need for a harmonisation of the general principles that are applied in different regulatory regimes such as nuclear safety, radiation protection, industrial safety, labour protection, environmental protection, etc. If the regulatory requirements are diverse and place very different requirements for instance on quality activities, audits and reporting, they may introduce much additional burden without any impact on the final result.

³ Björn Wahlström, Risto Sairanen: Views on the Finnish nuclear regulatory guides, report displayed at the website <http://www.stuk.fi/english/convention/yvl-review.html>.

5.6 Some reflections

The development of the rules and regulation to be applied in different countries is naturally an issue for the national regulator and politically elected decision makers, but this development should always be reflected in a larger context. The nuclear utilities can for obvious reasons not participate too much in this process, but it seems still important that they are willing to provide material to support the necessary decision making. One forum for this kind of discussion that has been used in several countries is to have regular meeting between senior managers at the regulatory body and at the nuclear power plant for proactive discussions in an attempt to identify and remedy emerging problems.

The development of the regulation in a country is typically given to the regulatory agency. It is a common practice that applicable regulation is remitted for comments to the nuclear utilities before they are enforced. This practice was seen as very important. Still some respondents found the task of following the development of regulatory requirements to be sometimes very time consuming. Some respondents also thought there should be a division between the two roles of defining requirements and inspecting that they are fulfilled.

6 FOCUS AND PRIORITIES

This group of challenges made an urge for selecting focus and setting priorities. Management focus and commitment together with a wise use of resources are a necessity for reaching the goals of the organisation. The challenges mentioned in this group also made a reference to the need to keeping procedures, instructions and documentation up to date. Some comments could even be interpreted as indicating an excessive focus on formalities. Organisational change and their consecutive influences were also brought up in this connection.

6.1 Selection and communication of management focus

The need for a proper selection and communication of a management focus is perhaps the most important message in this group of challenges. The change in market conditions that was the result of the deregulation implied a management focus on the actions to be taken to make the necessary adaptation timely and smoothly. In the light of the responses, it is clear that the changed messages from the senior management sometimes introduced concerns in the organisations that the focus on safety has been compromised. Listening however to top and senior managers this has not been the case. It is difficult to make a proper judgment if this is true and such a judgment will most certainly vary from case to case. From a rational point of view the business risk of a degraded safety is however so large, that there should not be any real danger that deliberate shortcuts are taken. On the other hand it would still be important that senior managers in their messages and actions never give reasons for such fears to develop.

In the discussions some respondents pointed to the need for better prioritisation of programmes and activities. If everything is defined as top priority there is a danger that the really important things are getting less attention. Many nuclear power plants have taken into use the so called balanced score cards and many respondents expressed their satisfaction with this concept as a tool for targeting the activities.

In comments on various needs on the management focus respondents sometimes pointed to the need for a better understanding of societal change and the implicit assumptions on which the present level of plant performance has been built. In this area concepts such as craftsmanship, proficiency and professional pride were mentioned. The outsourcing was mentioned also

in this context as a strategy to off-load managers from less important activities and allowing them to concentrate on the core business.

6.2 Structuring of work

Structuring work is one of the most important means to reach the ends of an efficient use of resources. A proper use of competency, achieving of reasonable workloads for everyone and with enough slack in resources it should be possible to meet unexpected demands. There are several ways to organise work, but on a general level all plants seem to be using a division into operations, maintenance and technical support. There are variations in this fine structure and additional support functions are located in different places on the organisational charts.

A clear line organisation with delegation from the CEO, through senior managers to middle management gives areas of responsibilities and a division of work. There is some diversity in how this delegation is given and how the senior management group are composed. Some sites have actually moved to somewhat novel solutions in separating between responsibility for the units and for the personnel resources. Many respondents stressed the importance of making delegation of authority and responsibility transparent and well understood.

All the nuclear power plants visited have introduced the concept of process orientation in their work activities. This concept has mainly been used as a tool to ensure a smooth flow of errands over organisational borders. Most of the respondents agreed on that more efforts has to be spent before the full benefit of this concept has been achieved.

6.3 Management systems

The management systems that are used at the nuclear power plants are to some extent influenced by national regulation, but they are on a general level quite similar. The quality system has a special position and it is often mentioned explicitly in the national nuclear regulation. The quality system is often seen as the link between the management system and procedures, instructions and documentation.

Management systems usually split into two parts, one that is formally documented and the other, which mostly is reflected in internal practices. The formal part usually starts with a definition of values and mission for the company. Many of the nuclear power plants have recently invested a considerable amount of work in discussing, formulating and communicating their values and mission.

Many nuclear power plants have recently been revising their management systems for various reasons. One obvious reason is that organisational changes have made it necessary to update the formal parts of the management system. Another reason is that there has been a wish to integrate the formal and informal parts of the management systems more closely to each other and at the same time select a reasonable level for how the management system is documented.

Strategic and annual plans are another important part of the management at any organisation. The development of the plans typically relies on an assessment of needs to which resources with respect to manpower and money should be allocated. It seems that this planning some years ago was more a matter of routine, but today it is used as one of the most important instrument in setting priorities and in the allocation of resources.

6.4 Procedures, instructions and documentation

A formal system of written procedures and instructions is used at the nuclear power plants to structure work. This system has had an important contribution to the present high level of safety at the nuclear power plants. Some comments pointed to increasing problems of ensuring that procedures and instructions or more generally documentation is kept up-to-date. The sheer volume of instructions and other documents has grown to a point, where it is difficult to keep track of single documents. Some of the plants have initiated systematic efforts to solve this problem and other are planning such efforts.

Plants have made various efforts to introduce modern information technology into the management of procedures, instructions and documentation. The systems used for documentation management provide many valuable tools for document search, cross referencing and updating. There seems however to be a difference in the approaches used as some plants have selected large standardised systems, whereas other have relied on smaller systems that have been based on internal development efforts. All plants have placed or are planning to place their procedures, instructions and documentation for access through their Intranets.

An excessive formality was also mentioned as a challenge. Asked for comments to this view most respondents pointed to the general need for formality. It is not enough to just have good practices, but they should also be possible to inspect and scrutinise. There are also many checks and cross-checks that have to be carried out to ensure that no undue threat to safety nor availability is introduced. Many of the respondents actually saw the expression of such a challenge as something to be approached with training and education. Only if people understand the reasons behind the formality and accept them, it is possible to maintain a continued high performance. Some qualification of this statement was also given by some respondents in their comment that forgetting the reasons for certain practices sometimes may be diluting them to something not giving much added value.

6.5 Organisational change

A change in the environment in which the nuclear power plant operates will ultimately be reflected in new organisational structures. Many nuclear power plants today are searching for more efficient organisational structures for tasks and activities. Among the respondents there was a clear consensus that one should never be afraid of reorganisation, although they often turn out to need more efforts and resources than originally expected. This orientation could also be seen in the fact that many of the nuclear power plants have done or are planning to do some kind of reorganisation.

There have been a few cases, where new organisational forms have been adopted. The perhaps largest change as compared with more commonly used organisational forms was introduced by OKG in Sweden during the year 2002.⁴ In their new organisation they have made a separation between the responsibility of the plants and the responsibility for personnel resources. Co-ordinators in the areas of operations, maintenance and technical support are then formally located to their corresponding resource organisations, but are working in close co-operation with the plant owners.

⁴ Björn Wahlström, Carl Rollenhagen, Lennart Wallin, Edward Dunge (2003). The path to a new organisational structure, PLEM- LearnSafe – W006_2.

6.6 Maintaining the level of safety

All respondents stressed the importance of a close monitoring of the level of safety. Many plants have in addition to their normal incident reporting systems taken into use systems to report also near misses. Efforts have also been directed towards the use of safety performance indicators such as those proposed by the SPI-project.⁵ The balanced score cards in use at the nuclear power plants also make efforts to assess the level of safety.

At some of the plants tools for risk monitoring have been taken into use. These tools are typically based on PSA applications and one plant makes a reference to successful use of this methodology also to assess threats to unavailability. Safety culture measurements are also used to give indications of possible areas for organisational development.

6.7 Some reflections

This group of challenges encompass issues that are in the direct control of senior managers at the nuclear power plants. It is also obvious that these issues cannot be treated in isolation, but are instead coupled to all the other groups of challenges. In developing routines for allocating focus and setting priorities it is important that the senior managers have a good feeling for the efforts that are needed for the organisation to move from one way of handling things to another. Only then they can make wise and long ranging decisions.

There are some additional issues that also may be touched on in this connection. One of them is that a consensus and mutual trust between the members in the senior management group is needed together with a proper understanding of roles taken in internal discussions. If there are large differences in views among the members of the senior management group on strategies and policies to be applied it may have devastating consequences for the whole organisation.

In building up principles of action for the whole organisation it is important to remember that they should be understood and accepted to be efficient. This could only be achieved only if they are considered fair, logical and consistent. To reach this end it may sometimes be necessary to engage some experienced senior person to review the management documents.

7 AGEING, MODERNISATION AND NEW TECHNOLOGIES

This group of challenges made reference to the need for maintaining plant technical condition. Many comments pointed out the gradual ageing of the plants. This general trend can only be met in modernisation projects, which themselves may have an impact on several other challenges. Many comment also made reference to new technology, which should be taken into use.

7.1 A proactive approach

There are two different ageing mechanisms that have to be taken into account, when planned for the remaining lifetime of the plants. One mechanism is connected to the wear and tear major components are exposed to in the day-to-day operation and during transients. The other mechanism is connected to the growing obsolescence of certain technologies, which makes it

⁵ Evaluation of alternative approaches for safety performance indicators for nuclear power plants, EU contract number FIKS-CT2001-20145.

increasingly difficult and expensive to find spare parts and the skills needed for maintaining certain systems and components.

Most plants have created proactive plans for the abatement of these two ageing mechanisms. One important part of these plans is to identify the scope of the modernisations and their most suitable time frames. One important part in planning for modernisations is to evaluate possibilities to carry out the modernisations during the normal refuelling shut downs or if it is necessary to have one or a few extended shut downs. There have been modernisations in the past, which have been carried out during extended shut downs, but presently the majority of views seem to favour modernisations over several refuelling shut downs, which in case of pressing needs may be extended with a few additional days. This strategy has the benefit of losing the least production and loading personnel resources less, but it has the disadvantage that it is necessary to live with parallel technologies over a transition period.

A proactive approach to plant ageing involves condition monitoring for crucial components aiming at making realistic prediction of their remaining life-time. Pre-emptive renewal has also been used as a systematic strategy at some plants, which additionally in some cases have been connected to cost and dose savings in the corresponding testing programmes. Preventive and risk based maintenance are other more operational components in the abating of aging of systems and components.

7.2 Modernisation projects

A nuclear power plant is at some point of its life-time faced with the decision to shut down or to modernise. With proper background data available it is relatively straightforward to do the comparison, but different possibilities to modernise partly and to extend the plant life-time with shorter periods may introduce a large number of cases to be assessed.

Earlier modernisation efforts were often carried out by the nuclear power plants as purchases of functions from one major vendor. Today it seems to be more common that the nuclear power plant itself takes a more active role in the modernisation projects. Regardless of the exact distribution of responsibilities for a modernisation project, there is a clear recognition today is that they place a burden on the whole personnel of the nuclear power plant. This implies that the manpower resources may emerge as a limiting factor on the rate of the modernisations. Another difficulty is the availability of vendor resources if many new modernisation projects are entered at the same time.

There is often an economic benefit if the nuclear power plant can take a larger share of the planning and implementation of the modernisation projects, because this strategy could reduce risk taking for the nuclear power plant itself and for the vendors that get involved. If this strategy is used it may be necessary for the nuclear power plants to build up their own expertise in managing large projects.

7.3 Introducing new technologies

The development has been very rapid in many technical areas over the last twenty-five years. Especially the development of new materials and achievements in computer and communication technology have brought many new and improved products on the market. The problem is however that they have to be qualified if they are going to be used in safety or safety related systems. Some respondents found the qualification procedures difficult and expensive to the

extent that they rather used old products that were qualified in connection with the original construction. Some respondent viewed this state of affairs as a threat to safety in the long run.

Advancements in information and communications technology have the potential to introduce many new methods and tools for an increased safety. These include, but are not restricted to, analysis tools, computerised instructions, smart transmitters, operator and maintenance support systems, building management systems, locators, handheld control devices, on-line monitoring, etc. One obstacle is however that their embedded computers may make them difficult to license in safety related applications.

The licensing of programmable instrumentation and control systems was one area, where considerable difficulties have been experience at some nuclear power plants. Similar difficulties have been seen in the case of screen based control rooms. This is worrying, because old instrumentation and control equipment is rapidly becoming obsolete and new equipment contain many functions, which have a clear safety and reliability benefit.

7.4 Some reflections

The most important question for the plants to respond to in this group of challenges is for how long time is it possible to operate the plants. This is from a technical point of view set by the ageing mechanisms of major components. In those countries, where there is a political decision to phase out nuclear power it can be more difficult to answer this question and this fact may introduce an unwillingness by the owners to invest in renovation and modernisations.

The most important component in strategies for fighting obsolescence and ageing of the plants is the establishment of a long term plan towards the end of life for each of the units at a site. This plan gives a possibility to assess different modernisation strategies, to evaluate the need for resources and to select the most suitable time for the modernisation. A typical approach is to take into account the possibility to upgrade the rated power output of the units when they are modernised. A few nuclear power plants also saw the modernisation projects as an opportunity for improving the competency of their own staff.

In a consideration of this group of challenges it seems evident that there is a benefit for the nuclear power plants if they can find partners with which they can share some of the costs. This has been done on a relatively modest level in the qualifying new products nuclear use, but the diversity in national regulatory requirements introduces obstacles in this regard. Finally a sharing of R&D efforts already takes place, but there should be potential for doing more.

8 PUBLIC CONFIDENCE AND TRUST

This group of challenges was concerned with the societal acceptability of nuclear power. Some comments made a reference to the irrationality in anti-nuclear attitudes and other pointed to the hostility in mass media. There are also misunderstandings that are necessary to combat. There were comments concerning distrust in local or regional authorities. A few comments did explicitly take up the global position of nuclear power inherent in the statement an accident anywhere is an accident everywhere.

8.1 Fighting nuclear opposition

Nuclear power has since its introduction been a political technology and the initial opposition has during the years been fuelled by two serious accidents and a number of real and alleged

misconducts. Today the political opposition has been brought to a point that the governments in Germany and Sweden has decided to phase out their fleets of nuclear power plants. The present opposition towards nuclear power was seen by many respondents as a major failure to explain its benefits to the general public.

According to some of the respondents there have during the years been withdrawal responses even within the nuclear utilities, where senior managers have not been willing to put themselves at stake in taking a favourable position towards nuclear. Today according to many of the respondents nuclear power seems today to be somewhat off the public agenda, but any serious event may change this matter in a few hours. Especially in Sweden the general polls indicate a far larger support of a continued operation of the present plants among the general public as compared to views held by politicians.

There is a diversity in how nuclear power themselves have engaged on a national level in discussions. In many cases the nuclear power plants have selected to act on a local level and the owners on a national level. Some persons from the nuclear power plants have been actively involved in the lobbying for nuclear power both nationally and internationally.

8.2 Building interfaces to media

There is no doubt that media some ten to fifteen years ago were very hostile towards nuclear power. According to some respondents this situation has changed today to be more neutral. There seems also to be a larger willingness among media representatives to accept arguments in favour of nuclear power that are connected to generation costs, the need for electricity and concerns with carbon dioxide emissions. This opening up has apparently created a larger willingness for people within the industry to take stand and explain their position.

Most nuclear power plants have created their own strategies and plans for communication with media. These plans are today better adapted to an understanding of the roles and the working practices of media. They also contain explicit guidance for emergency communication, which stresses the need to be open and not to hide negative information. One of the respondents pointed to the need to be first out with any information, but he noted that this gets more difficult with the free access to market information, which actually means that anybody can get accurate information on plant conditions almost in real time through open channels.

8.3 Visitor programmes

All plants have erected visitor's centres to which there is a continuous access. In Finland and Sweden the centres are typically visited by around 15000 persons a year. Some of the nuclear power plants have systematically been inviting all pupils at a certain grade from the schools in their local neighbourhood to inform about their activities and at the same time tell about employment opportunities. Unfortunately the tragic events at 11 September 2001 have made it more difficult for the nuclear power plants to accept visitors from the outside.

8.4 Environmental certification

All nuclear power plants in Finland and Sweden have applied for and been awarded environmental certification. In addition one plant has made an environmental product declaration (EPD) for electricity produced. The environmental strategy have been seen at the plants mainly as a way to create goodwill, but also as a mean to create an environmental awareness among the personnel. The business benefit of the environmental certification was however

seen as relatively small, but it may tip the decision in the case of a tie between competing bids to sell electricity.

8.5 Contacts to local authorities and organisations

Many nuclear power plants have defined their local communities as their own target audience for communication. This has resulted in standing bodies with the local communities, which have regular meeting to share information. The nuclear power plants have also engaged in various activities for the public good and supported the participation of their staff in various local organisations. The nuclear power plants conduct regular polls in their neighbouring counties to collect estimates of public trust locally. A common observation is that the support of nuclear power in the local communities usually is higher than on a national level.

8.6 Some reflections

There is perhaps not so much to nuclear power plants can do themselves in influencing the public opinion. On the other hand it is evident that smooth and undisturbed operation keeps the plants off the headlines and therefore off the minds of people. It is also clear that the plants have to have a large local support, because otherwise a national support will rapidly be eroded. It also seems to be important to get assumed obstacles with nuclear power off the agenda, such as for example the issue of high radioactive waste. This has been seen in Finland after the decision to continue with the project of building a repository for the high radioactive waste at the Olkiluoto site.

It is apparent that the nuclear industry has entered a development towards a more global view on many of the challenges referred to above. This has not only to do with ownership over national borders, but also to do with the procurement of services and goods on a global market. This development seems to be well in line with present needs for a higher efficiency in work processes applied locally. A global division of labour has at least in principle the possibility of creating better solutions to be shared between players in the nuclear field. Finally the wisdom in the saying that an incident anywhere is an incident everywhere is still applicable and this means that the nuclear industry has an incentive in ensuring that the worst performers should be lifted to a reasonable level. The international organisations such as WANO and IAEA have an important mission in this respect.

9 ORGANISATIONAL CLIMATE AND CULTURE

Motivation and attitudes were the major issues addressed in this group of challenges. Many comments on safety culture were also a part of this group together with the need for fighting complacency. There were a few comments in this group on mental and emotional strains. Many respondents gave a reference to organisational and human factors and these comments were also a part of this group.

9.1 Safety culture

Organisational climate and culture are concepts that often at the nuclear power plants are associated more specifically to the concept of safety culture, which was introduced by IAEA after the Chernobyl accident. Most plants have been active in introducing the concept of safety culture to their personnel. Some plants have for example very systematically conducted a safety culture course for everyone employee within their organisation.

Web-based safety culture questionnaires have been used at all Swedish nuclear power plants for a number of years. Because the questionnaire has a common root, it is possible to have some kind of reference that is based on a large sample of answers. The results are compared between years and between groups within the organisations.

In a discussion of the meaning of the concept safety culture, one of the respondents gave an analogy to fire-fighting. In a nuclear organisation the heroes should not be considered to be the fire-fighters, but the people who prevent fires.

9.2 Motivation, ownership and commitment

Motivation, ownership and commitment are addressed in many programmes and activities at the nuclear power plants. Many of the respondents expressed as their opinion that small investments in these soft factors actually could have a larger relative benefit as compared with more technically oriented investments in safety. The plants in Finland and Sweden are using participative decision making to give the personnel a real sense of their ability to influence. This is supported with leadership training programmes in which most upper and middle managers participate.

Performance appraisals are used regularly for the whole personnel in which the immediate superior discusses performance goals and achievements with all his or her subordinates. The balanced score cards are brought down to set goals on a group level. Achieved goals on a company and a group level may give a premium for good achievements to each member of the group rising to the level of one month's salary. One plant have taken a system of systems responsibility within the maintenance department to give a possibility for people to grow in their tasks and in that way get a salary increase.

Open and honest communication, both vertically and horizontally, is important in establishing commitment. This also involves a careful wording of management messages on all levels in the organisation. Many respondents expressed as their opinion that they have to serve as paragons for their subordinates.

9.3 Some reflections

Responses to the challenges in this group reflect the attitudes, beliefs and action practices of senior managers at the nuclear power plants. They have to be persons with visions and a willingness to put themselves on stake in actions to make their visions to become true. It is evident that no-one could fulfil all requirements and therefore it is likely that management in the future to a larger extent will be based on teams, which have been welded together in internal discussions to find a common language and position on important issues.

The strategies and actions in use to cope with this group of challenges are very much oriented towards explaining, training and educating. It is not likely that a better performance will be reached through the introduction of more instruction and control, but instead through persons that understand the essentials of the business and are committed to their tasks. If this can be achieved through wise decisions in the senior management group it should not be too difficult to meet all the challenges that were collected in the LearnSafe project and thus to make nuclear power a true asset for many years to come.

10 CONCLUSIONS

After going through the strategies, plans and actions the nuclear power plants use to cope with the challenges in each of the groups it may be interesting to come back to the model that was used to generate the clusters. This model was based on five areas that require continuous monitoring and management attention, i.e. money, people, technology, practices and the environment. A set of general strategies can actually be summarised shortly under each of these headings as follows:

- *Money*. Create cost awareness within the personnel. Share costs with partners in co-operation. Create efficient work practices. Do a careful planning of investments and out-ages. Use best available practices.
- *People*. Take care of people. Invest in internal training. Do career planning. Provide interesting tasks for people. Pay fair salaries. Express clear expectations on people. Give frequent feedback. Do regular competency surveys.
- *Technology*. Keep plants in top condition. Build away problems with materials and equipment. Create a long term technical development plan and keep it updated. Invest in R&D. Keep plant documentation up-to-date.
- *Practices*. Promote leadership. Make priorities explicit in strategies and plans. Motivate all decisions taken. Encourage open communication. Define borders for acceptability. React rapidly in the case of malpractices. Use conservativeness in decisions.
- *Environment*. Maintain good contacts to stakeholders. Network broadly. Avoid isolation. Follow what is going on within the industry. React already when changes are emerging. Try to understand trends. Behave as a good citizen.

In going through the strategies, plans and actions the senior managers at the nuclear power plants use in coping with the challenges it becomes evident that they are not addressed in isolation. Instead they are considered in the normal planning and implementation processes that encompass both long and short term issues. A planning process that is addressing strengths, weaknesses, opportunities and threats should be able to detect needs for improvements in practices, staff skills and plant conditions. A careful allocation of available resources should furthermore make it possible to create realistic plans that people find challenging. With a proper orientation of the minds of people working at the nuclear power plant, they should at least in theory have good opportunities to become efficient learning organisations.

When nuclear power was introduced it was a national decision and electrical energy was considered as a strategic resource. The deregulation and the internationalisation of electric utilities have today changed the nuclear to be more like any other business. This is a development that has benefits, but it also carries a danger. Nuclear is still different as compared with other energy sources and this fact has to be properly recognised. If owners of the nuclear power plants or senior managers at the plants would forget this difference or how it should be handled, there is a danger that the safety of the plants is eroded with dire consequences for the whole industry. On the other hand there are many excellent plants in the world and there is an institutional network that promotes a sharing of good operational practices. If the senior managers give themselves time to listen to advice from their colleagues all over the world, there should not be any difficulty utilise the benefits of electricity generated with nuclear power plants for their remaining technical life-time.