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GOOD PRACTICES FOR NUCLEAR SAFETY

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Summary: This report highlights good practices that have been observed within the LearnSafe project and its predecessor the ORFA project. The report relies on empirical material from a large number of data collection exercises and discussions with managers at several nuclear power plants in Europe. The report has been written with an aim to be read by managers at various levels in the nuclear power plants, who are responsible for small or large groups of people. The report concludes that there are many good practices connected to organisation and management, which may have a positive influence on the safety of nuclear power plants. A final conclusion is that there is no mystery to good organisational performance, but only a good understanding of requirements and solutions together with hard and determined work. The report is the deliverable D8 of the LearnSafe project.

[1] The English language of this report has been revised on 24.10.2021 with the help of Laura Wiles.

List of content:

1 INTRODUCTION

The LearnSafe project[2] was divided into two major phases of theoretical and empirical investigations. The first phase was devoted to the *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 was devoted to *organizational learning*, which is seen as an important process in the pursuit of continued improvement of performance measured in terms of both safety and efficiency.

Good practices are documented in several national and international publications. WANO for example has documented performance objectives and criteria that form the basis of the peer review programme and along with other programmes.[3] IAEA has similarly over the years documented good practices in several documents, but these documents are somewhat hard to access due to the sheer volume and due to variations in scope and ambition between different documents. National regulation and other documents supporting regulatory oversight can also be considered to document good practices at least in an implicit way.

The collection of good practices has received less attention than the collection of experience and findings connected to incidents and accidents. One can naturally argue that good practices should avoid practices that have lead to mishaps, but this is usually not enough. Collecting good practices is somewhat difficult, because a good practice is not necessary a good practice when used in isolation. Good practices may also be difficult to identify, because they are often considered as the only natural way to work at a nuclear power plant in consideration.

This report follows the internal structure of the LearnSafe project. It starts with the general structure of good practices of safety management as identified in the ORFA project, the predecessor to the LearnSafe project.[4] The second main chapter is devoted to challenges that managers see in the operation of nuclear power plants and practices that are applied to meet these challenges. The final main chapter is devoted to good practices that can be implied from data collected regarding the facilitators and hindrances to organizational learning. This structure implies that there are some overlaps between the chapters, but the overlaps are also partly due to the fact that issues interact in many ways.

The format that has been selected for the three main chapters is that the subchapters are introduced with a short introduction to the subject area in one paragraph. The good practices are given as short statements that are not motivated in large detail. This format of the report was selected to make the report as short as possible with the intention to make it easy to read by managers at nuclear power plants. For readers, who have not a long experience from nuclear power plants, the selected format may sometimes feel fragmented and perhaps not properly underpinned.

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[2] 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. The project has also established an open web-site at the address http://www.vtt.fi/virtual/learnsafe/.

[3] WANO (1999). Performance objectives and criteria.

[4] Geneviève Baumont, Björn Wahlström, Rosario Solá, Jeremy Williams, Albert Frischknecht, Bernhard Wilpert, Carl Rollenhagen (2000). Organisational Factors; their definition and influence on nuclear safety, VTT Research Notes 2067, Technical Research Centre of Finland, Espoo, Finland.

2 CHALLENGES TO MANAGING NUCLEAR SAFETY

A data set on views on challenges that face the senior managers at the nuclear power plants was collected in the LearnSafe project. The challenges were analysed and grouped to investigate strategies, actions and plans the nuclear power plants are using in response to the challenges.[5] The chapter has been structured according to the eight clusters that were identified in the analysis of the challenges.

2.1 Economic pressures

A sound economy is a precondition for any nuclear power plant to be safe. A plant that cannot generate electricity at a price the market is willing to accept has to shut down. If a nuclear power plant experiences hard economic pressures, this may increase temptations to take shortcuts in vital work activities. The deregulation introduced a change in the operational environment of the nuclear power plant, which introduced the need for a tighter economic planning and follow up. Some plants have used outsourcing to save money and to help the organization put focus on core tasks. This adaptation process of the nuclear power plants has sometimes caused situations that have wrongly been interpreted by the personnel as prioritizing money before safety.

Good practices:

- Create cost awareness within the whole staff.
- Create an awareness of the high costs of not being safe.
- Decouple day-to-day operation of the nuclear power plants from seasonal variations in the electricity price.
- Use PSA-methods to create a feeling for how systems, components and work activities influence availability.
- Use long term plans to evaluate different possible scenarios to create an understanding of crucial issues that influence plant economy.
- Senior managers should be careful in their communication of the need to operate with tighter economic conditions, not to create an impression that safety is traded for money.

2.2 Human resource management

Due to their technology, nuclear power plants need personnel with a broad and deep competency.[6] Training new persons for certain key positions may well take up to ten years and it is therefore important to undertake proper succession planning. It is important that the nuclear power plants are seen as attractive places to work in. All staff should have a good understanding of the special safety requirements within the nuclear industry.

Good practices:

- Identify core competencies on which the organizational performance relies.
- Identify activities and tasks that should be carried out within their own organization.
- Give people interesting and challenging tasks to work with, as a kind of on-the-job training.
- Do career planning within the organization.
- Be aware of the fact that competency has the tendency to wither away over time. Various specialists have to be stimulated through interactions with other people in the same professions.

[5] Björn Wahlström (2004). Strategies, plans and actions; a set of responses to various challenges at nuclear power plants, PLEM – LearnSafe – W007.
[6] Björn Wahlström, Jari Kettunen, Olle Andersson, Markku Friberg (2004). A discussion of core competencies, PLEM – LearnSafe – W012.

- Define what kind of people you need in terms of abilities and competency. Use systematic assessments to define training needs. Use personalized training programmes.
- Use training simulators not only for control room operators, but also for other groups of people to build an understanding of main issues of operation.
- Provide regular training courses to mixed participants from different plant functions on the concept of safety culture.
- Perform regular competency surveys to identify possible competency gaps.
- Evaluate possible loss of competency due to retirement. Ensure that the necessary competency is carried over to the younger generation of employees.
- Conduct regular safety culture seminars for key people within the organization.

2.3 Nuclear know-how

The building of new nuclear units around has come to a practical stand-still. The after-markets have not been able to maintain a large business among the vendors, which has led to a shrinking vendor base. The societal support of nuclear education and research has decreased considerably over the years. This has led to a situation where it is difficult for the nuclear power plants to find a suitable recruitment base.

Good practices:

- Evaluate what can be bought on the market and what has to be supplied in-house.
- Search for contractors and vendors outside the traditional nuclear industry.
- Use long-term contracts with vendors and contractors to build a win–win situation in which competency can be developed.
- Support research and development projects at universities and research organizations to provide fresh talents to the field.
- Network with other nuclear power plants to find joint projects to fund.
- Put pressure on public institutions for them to take their share of responsibility for maintaining education and training in the nuclear field as stipulated within the IAEA nuclear safety convention.

2.4 Rules and regulation

The nuclear field is governed by safety regulation. There is a large diversity in national regulation. Research and development have brought a better understanding of how safety is designed into the plants and the operational practices. This new knowledge has also been reflected in new regulations, which may introduce a need for modernisation of the plants. In planning for action to take on regulatory initiatives it is important to have an understanding and agreement between the utilities on the approaches to take.

Good practices:

- Create an open communication interface towards the regulator.
- Allow direct contacts between different offices at the plant with their counterparts at the regulator, but ensure that contacts and exchanged documents are properly monitored and documented.
- When necessary, challenge the views of the regulator on what should be considered as good practices for safety.
- Have regular high-level meetings with the regulator.

– Integrate into work activities approaches from different safety domains, such as nuclear safety, radiation protection, industrial safety, labour protection, environmental protection, etc.
– Support a harmonisation of national views for technical and operational safety requirements.

2.5 Focus and priorities

Focus and priorities are the most important control instruments managers have at their disposal. Focus and priorities manifest themselves in the organization through the allocation of resources. Focus and priorities should be communicated within the organization to enable vertical dialogues on needs and possibilities.

Good practices:

– Set focus and priorities to ensure that resources are allocated in such a way that workloads are reasonable.
– Ensure that there is slack in the resources for the organization to be able to cope with unforeseen demands.
– Ensure that instructions and documentation are kept up-to-date. Ensure that the instructions are manageable and easy to find.
– Create focus and priorities in a vertical negotiation process in which goals are matched with available resources.

2.6 Ageing, modernisation and new technologies

The nuclear power plants represent very large investments with pay-back periods of tens of years. To utilise the full value of the plants, the asset represented in their technical condition has to be protected very carefully. Failures in this regard may easily bring a plant to a state where the only prudent strategy is to shut it down prematurely. Such failures may be triggered by operational transients or by neglect in maintenance. New regulatory requirements sometimes imply modernisations, which have to be fitted into a general long-term operational strategy.

Good practices:

– When possible, build away identified problems in operation and maintenance.
– Keep the facilities in good condition. Communicate this message to everybody in the plant. Demonstrate this strategy in actions.
– Engage plant staff in modernisation projects. This strategy has many benefits in terms of costs, transfer of knowledge and development of competency.
– Use modern information technology to support document management and communication.
– Create a long-term development plan for the facilities. Update this plan at regular intervals. Cover not only technical and economic issues, but also issues connected to human and organizational factors.

2.7 Public confidence and trust

Nuclear power plants depend on public confidence and trust. Openness in communication is a precondition for maintaining public confidence and trust. The local community where the nuclear power plant is located is an important stakeholder in successful operation, with which regular contacts should be maintained.

Good practices:

– Develop and implement a media communication strategy.
– Encourage visits to the plants and the visitors' centre.
– Ensure that the nuclear power plant itself is the first to inform media of possible disturbances in operation.
– Encourage staff to inform outsiders about the pros and cons of nuclear power.
– Execute regular opinion polls in the local communities of the nuclear power plants.
– Establish various kinds of cooperation with the local communities.

2.8 Organizational climate and culture

Organizational climate and culture are among the most important preconditions for how people thrive in their jobs. If people find their jobs meaningful and interesting, they will be committed to the work they do. If the organizational climate is open and helpful, communication is easier. Honest and fair treatment of all will also create a good organizational climate. The organizational culture at nuclear power plants is also connected to the concept of safety culture, which has been identified as one of the most important precursors for operational excellence.

Good practices:

– Conduct systematic programmes to enhance motivation, ownership and commitment.
– Use performance appraisals as a channel to get feedback within the organization.
– Ensure open and honest communication, both vertically and horizontally.
– Ensure that managers are willing to spend time explaining, educating and training people within the group of their subordinates.
– Have regular safety culture seminars and courses. Include small working groups, where participants are asked to define what they understand about the concept of safety culture.
– Use regular surveys of the organizational climate. Give feedback to section heads and group leaders.
– Use regular performance appraisals.

3 FUNCTIONAL ACTIVITIES PROMOTING SAFETY

Safety management can be seen as a broad spectrum of activities that are important in maintaining continued safety of the nuclear power plants. There are no specific norms to what activities should be considered as a part of the safety management and the list below is therefore somewhat arbitrary.

3.1 Risk analysis

Identification of risks and their likelihood is a precondition for safe operation. Identified risks make it possible to act on them through methods of safety engineering. Deterministic risk analyses are used to design protective systems that are able to identify and react to certain combinations of events and failures. Probabilistic safety analyses (PSA) are similarly used to assess the likelihood of certain sequences of events that may pose a threat towards the safety of the plant.[7] The deterministic risk analyses are mainly adapted to the modelling and design of technical systems, whereas the PSA approach has some provisions for dealing with human errors.

[7] Björn Wahlström (2003). Risk Informed Approaches for Plant Life Management: Regulatory and Industry Perspectives, paper presented at "FISA 2003, EU research in reactor safety", 10-13 November 2003, Luxembourg.

Applied more generally, the risk analysis framework can—at least in principle—also be used to identify and act on threats with a human and organizational origin.

Good practices:

- Assess the depth and completeness of risk analysis efforts.
- Create realistic risk maps to include human errors and organizational deficiencies.
- In the case of large organizational change, try to identify the most important risks in advance. Carefully plan the change and review after the implementation of the change.[8] [9]

3.2 Design for safety

Design for safety includes known principles of safety engineering to build away identified threats, to confine the threats through protective devices and to mitigate the consequences of unwanted events. The application of these general principles has for the nuclear power plants led to the application of the defence-in-depth concept by which multiple barriers are erected to protect against errors and failures. Another corresponding concept is the single-failure criterion, which applies redundancy and diversity in the design of a system to ensure that no single error and failure will pose a threat to safety. The concept of a design-basis accident is used in the deterministic risk analyses to set down a threat scenario that the plant is designed to withstand. The concept of a grace time is used to ensure that plant operators have enough time for analysing and decision making in emergency conditions. These general design concepts can also be applied to protect against human errors and organizational deficiencies.

Good practices:

- Use a generalized defence-in-depth approach to identify and act on possible organizational deficiencies.
- Design the organization to have enough redundancy and diversity in vital safety functions to be able to withstand a set of postulated threats.
- Remember that people react to situations as they perceive them to be, not as they are.
- Define the boundaries of safety and non-safety as explicitly as possible.
- Use modern information technology in the development and use of methods and tools for risk assessments and design for safety.
- Ensure that there is enough slack in resources to cope with unexpected demands. If there are no margins, even a small unexpected workload may force the organization into a reactive mode of operation.

3.3 Feedback of operational experience

Feedback of operational experience is an important function to ensure that lessons from operation and maintenance are properly reflected. All nuclear power plants around participate in a systematic collection, analysis and feedback of operational experience. This activity takes place at the plant and is typically organized by giving a specialized group of people the dual task to analyse and document their own operational experience and to analyse and act on operational experience from other plants around the world. A rapid and efficient screening of events—for example in regard to safety significance and urgency—is important to prevent the group being drowned in work. In this activity, it is important to screen the experience, to analyse specific sequences of events, to find relevant issues to act on and to implement the lessons in concrete

[8] Björn Wahlström, Carl Rollenhagen (2003). Merging of two organisational cultures, PLEM – LearnSafe – W005.
[9] Björn Wahlström, Carl Rollenhagen, Lennart Wallin, Edward Dunge (2003). The path to a new organisational structure, PLEM – LearnSafe – W006.

actions at their own plant. Only prudent and insightful work within this activity can ensure that recurrent failures are avoided.

Good practices:

- Be systematic in the collection of experience on development trends and deterioration mechanisms.
- The group of people given the task of collecting and analysing operational experience should include people with a good understanding of human and organizational factors.
- Ensure that operational experience is collected in a systematic way. Ensure that the screening criteria also include repetitions of simple events.
- Select a suitable set of their own and international incidents for in-depth analysis to be used in the continuing training of personnel.
- Create a willingness to share experience with other nuclear power plants and with international organizations.
- Ensure that recommendations from the analysis of experience reach persons that can do something about them.

3.4 Operational decision making

Operational decision-making at nuclear power plants is typically exercised according to a line of command and reporting from a responsible manager at the plant to the shift crew in the main control room. This line of command and reporting is established in organizational handbooks and in control room instructions.[10] This line of command and reporting should be defined, understood and adhered to. Operational decision-making falls into two general categories of which one is concerned with normal operation and the other with disturbed situations. In disturbed operational situations it is of paramount importance that the necessary guidance can be found in instructions and procedures.

Good practices:

- Create a clear line of command and reporting from the most senior manager of operations to the control room operators. Document this operational control properly and ensure that instructions are followed.
- Institute regular meetings, where all levels of operational decision-making personnel meet to discuss recent events and operational results. Ensure that other functions such as maintenance, technical support and safety analysis participate in the meetings.
- Create for all organizational levels clear and easily understood instructions that take all relevant plant states and configurations into consideration.
- Create a practice whereby instructions are followed with thought, because no instruction system can foresee all possible situations. Update the instructions regularly.
- Institute a system whereby important operational decisions are always re-examined afterwards on the next hierarchical level in the line of operational control.

3.5 Management and quality systems

Work activities at the nuclear power plants are typically governed by formal management and quality systems. Depending on local practices the control room instructions are considered either as a part of this system or as a separate system. The quality system is often handled

[10] Björn Wahlström, Olle Andersson, Olli-Pekka Luhta (2003). Quality activities, operations management and process orientation; experience from a benchmarking exercise, PLEM – LearnSafe – W004.

separately from the management system. These documents define organizational structure and yearly planning processes, which are used to set priorities and to allocate resources. One important related area is the plant design base in which requirements specifications, the final safety analysis report and the safety technical specifications are documented.

Good practices:

- Create a comprehensive management and quality system. Ensure that it is accessible, understood, accepted and used. Remember that instructions and handbooks have to be to the point to be used.
- Ensure that the plant design base is updated to reflect modifications and changes.
- Update organizational handbooks, management procedures and quality documents at regular intervals.
- Use regular audits and review to ensure that the management and quality system is followed. If there are deviations between actual and documented practices these should be removed.

3.6 Safety performance indicators

Control of performance implies that it can be measured and influenced.[11] This has introduced a search for safety performance indicators.[12] Safety performance is, however, more difficult to measure than, for instance, economic performance. This should never imply that more emphasis is placed on economic than on safety performance, because an unsafe plant can never be economic. Attempts have been undertaken to include the impact of management, organization and safety culture in a set of performance indicators, but it seems difficult to find a satisfactory set of such indicators.[13] At some nuclear power plants the so called balanced-score-card approach has been applied as a tool for planning and monitoring performance. These systems usually include performance indicators for issues connected to safety. The systems have shown to be valuable in stimulating internal discussions on components of safety.

Good practices:

- Discuss safety performance indicators within the cycles of strategic and yearly planning.
- Senior management should be sensitive to weak signals of problems emerging from the shop floor.
- Define indicators of good safety performance and monitor them. Be aware of the fact that actual safety performance may not be accurately read from the indicators.

3.7 Surveys of organizational climate

Surveys of organizational climate are used regularly at many nuclear power plants. Organizational surveys are efficient tools to get a general feeling of how people view the organization. Organizational surveys also have the benefit of reaching everyone in the organization and very high response rates are typically cited from the nuclear power plants. Some of the organizational surveys have been used in a relatively unchanged form at regular intervals, which make it possible to follow trends. Other organizational surveys have been used by a large number of industries and can therefore provide material for comparisons.

Good practices:

[11] Björn Wahlström, Carl Rollenhagen (2004). Organisational controllability, PLEM – LearnSafe – W011.
[12] IAEA (2000). Operational Safety Performance Indicators for Nuclear Power Plants, TECDOC-1141.
[13] Björn Wahlström (2002). Safety performance indicators for nuclear power plants, PLEM – LearnSafe – X003.

– Select and implement a survey instrument for organizational climate. Ensure in pilot applications that the questions are understood. The use of a web-based survey instrument can help in carrying out the surveys and analysing the results.
– Try to relate the survey results to other performance data collected from the plants.
– Use organizational surveys at regular intervals. When results are broken down into individual sections and groups within the organization, there is a possibility to go beyond average figures as obtained for the whole organization.

3.8 Self-assessments

Self-assessments are an important tool to evaluate organizational performance.[14] Methods for self-assessment fall basically into two categories. Firstly, self-assessments can be used against a certain norm of behaviour and, secondly, self-assessments can be carried out as a kind of peer-review.[15] In both cases however, there is at least an implicit norm of what is expected, from which deviations are recorded. Self-assessments typically use some form of semi-structured interview technique. Self-assessments can be initiated at regular intervals or at some event, which triggers a suspicion that improvements in work practices or organizational structure may be necessary.

Good practices:

– Create criteria for good performance that can be used for self-assessments.
– Invite groups, sections and departments to carry out regular self-assessments.
– A discussion of behavioural norms to be used in the self-assessments can help in clarifying important aspects of safety.

3.9 Safety committees

A common practice at the nuclear power plants is to have a safety committee with regular meetings. The composition of the committee and the frequency of the meetings vary, but it usually gets a kind of independence and long-term view in taking a stand on various issues connected to safety. At some plants the safety committee is seen as a forum that gradually, through its decisions, creates precedence on issues connected to safety.

Good practices:

– Establish a high-level safety committee that takes a stand on various issues connected to safety.
– Use the safety committee to give regular safety reports to the board level in the utility company.
– Select a senior manager with integrity status as the chairman of the safety committee.

3.10 Organizational structure

The organizational structure is typically defined in the organizational handbook in which authorities and responsibilities are defined. The organizational structures typically used at the nuclear power plants are hierarchical line organizations, where each person has one, and only one, superior. Some plants have introduced organizational structures that have components of matrix

[14] Carl Rollenhagen, Björn Wahlström (2004). Methods and tools for organisational self-assessments, PLEM – LearnSafe – W204.
[15] Björn Wahlström, Bernhard Wilpert, Carl Rollenhagen (2003). Reflections on the WANO peer review process, PLEM – LearnSafe – W003.

organizations. Several nuclear power plants have used outsourcing as a mean to save costs and to help managers to concentrate on core activities.

Good practices:

- Ensure that there is an understanding of the safety requirements on all levels in the organization.
- Ensure that the organizational structure is clear and understood.
- Ensure that delegation of authority and responsibility is transparent and understood.
- Have one senior manager who is explicitly responsible to look after safety in the broadest sense.
- Use empowerment and delegation as means to increase individual motivation and commitment.
- Ensure that managers give frequent feedback to their subordinates, both good and bad.
- Use outsourcing with caution, because indirect and hidden costs can be unexpectedly large.
- Evaluate carefully the pros and cons of hiring in consultants or outsourcing activities as compared with carrying out the activities with in-house personnel.

3.11 Work practices

There are many specific work practices that are highly safety relevant although they are not regularly included in the concept of safety management. One example is maintenance activities, where one important control parameter is the division of efforts between corrective and preventive maintenance. Another important example is plant modifications, which—in addition to technical modifications—may include modifications in procedures, instructions and other documents. One common characteristic of those activities is that they should involve extensive inspections and reviews to ensure that all tasks have been carried out correctly. These inspections and reviews by necessity involve a large group of different competencies to ensure that all possible concerns have been given consideration.

Good practices:

- Use regular reviews with the aim of improving work practices.
- Search for the best available practices within different work activities.
- Inform and engage employees when there is a need for changes in work practices.
- Use process orientation as a tool to restructure important work activities. Remember that the largest benefit often comes from a better understanding of the work processes.
- Ensure sufficient independence between activities of design and construction on the one hand and activities that are involved in inspections and review on the other.

4 FACILITATORS AND HINDRANCES OF ORGANIZATIONAL LEARNING

Organizational learning has been identified as one important characteristic for safety.[16] In the literature there are several references to theories and models that can be applied to organizational learning.[17] The LearnSafe project has collected a large data set on facilitators and hindrances for organizational learning. This material gives valuable hints for good practices and some guidance for specific actions. This chapter has been structured into sections according to

[16] IAEA (2002) Key practical issues in strengthening safety culture, INSAG-15.
[17] Bethan Jones (2002). Theoretical approaches to organisational learning. PLEM – LearnSafe – P002.

the eleven clusters that were used identified in the analysis of the statements on hindrances and facilitators for organizational learning.[18]

4.1 Objectives, priorities and resources

In this cluster lack of time was the most commonly mentioned hindrance to organizational learning. According to one of the statements "Time pressures are caused by an uneven loading on people and difficulties to prioritise". This interpretation implies that the definition of objectives and priorities as well as the allocation of resources in a realistic way are important preconditions for organizational learning. In defining objectives, it is important to have a long-term outlook from which goals and policies are defined. It is also important that these goals and policies are communicated, understood and accepted. Finally, sound activity planning and preparation of work should be in place.

Good practices:

- Make objectives and priorities explicit and communicate them clearly within the organization.
- Have regular discussions at each level in the organization on objectives and priorities in the workplace. Ensure that activities are given the resources and the time they need.
- Avoid time pressures by appropriate prioritisation of activities and by finding smarter ways to work.
- Give organizational learning a high priority and ensure that people can devote time to it.

4.2 Formal systems and practices

Systems and practices that govern work activities are some of the most important factors of organizational performance. There are both formal and informal practices within work activities, but due to stringent safety requirements, systems and procedures at the nuclear power plants are quite formal. Formality may, however, stifle creativity and innovation, and people should therefore be encouraged to bring forward new ideas. This may also support the creation of a questioning attitude that has been identified as important for safety. A search for efficient practices can be supported by systematic benchmarking activities both within and outside the nuclear field. Feedback of experience is one important part of a continuous development of systems and routines.

Good practices:

- Ensure that people understand the reasons behind and benefit of the formal systems.
- Stress the need for formal routines to ensure traceability and consistency, but encourage creativity and innovation.
- Try to simplify systems and procedures. Explain their intent and their basic building blocks. Document the systems and procedures in a pedagogical way.
- Circulate people between functions in the organization.
- Ensure separation between meetings searching for solutions, meetings selecting the best solution from given alternatives and meetings giving a decision for a selected solution.
- Perform regular reviews of work activities. Benchmark work activities with other actors.

[18] Jari Kettunen, Teemu Reiman, Björn Wahlström (2004). Statements on organisational learning; draft analysis report (MetaFuzz approach), PLEM – LearnSafe – W501.

4.3 People's attitudes and orientation

Nuclear power plants depend on the attitudes and orientation of their staff. Financial pressures on electric power utilities make it necessary to manage with a workforce that is not excessively large. This implies that nuclear power plants have to engage their own personnel to a larger extent than within traditional purely hierarchical organizations.[19] Psychological evidence also points to higher performance among motivated and committed personnel. There is empirical evidence to claim that the span between the highest- and lowest-performing individual in a team can be quite large.

Good practices:

- Get people to cooperate and to feel that they are participating in something important. Train people to share knowledge.
- Assess and develop motivation, commitment and safety awareness within the personnel. Use empowerment to support motivation and commitment.
- Considerable changes in organizational structure should be followed up with a visible programme for communicating needs and goals for the change. Large groups of people should be engaged in searching for better ways of carrying out work.
- Complacency, apathy and self-conceit should be combated, for example with regular internal seminars and training courses.

4.4 Corporate culture and traditions

Individual motivation and commitment build on the social climate in the organization. A tradition of cooperation and knowledge sharing can support trustful communication. A willingness to speak up and act in response to seen or perceived problems is important in preventing them from growing to unmanageable levels. An open communication atmosphere will support organizational learning. A tradition of communication over organizational boundaries is valuable for any organization. It is sometimes important to understand group think as a phenomenon and avoid it.

Good practices:

- Encourage people to speak up on problems they see and feel.
- Be aware that it may take a long time before the cultures of two organizations are harmonized after a merger. This may decrease the actual benefits of a merger as compared to calculations.
- Do regular surveys of the organizational climate. Bring the results down to a group level for actions.

4.5 Communication, guidance and appraisals

Nuclear power plants rely on cooperation of people with many different skills. Cooperation is possible only if people have a fairly good understanding of what their colleagues do. A functioning vertical communication in the organization is important. People at various levels should be aware of, understand and accept expressed company goals. People should be able to find guidance in the task they do both from their superiors and from instructions and procedures. Organizational lines of command and reporting should be adhered to. The management

[19] Björn Wahlström, Carl Rollenhagen (2003). Reflections on organisational structures in nuclear power plants, PLEM – LearnSafe – P003.

approach should be proactive. Messages from the management should be clear and easy to understand. A consensus in the organization helps in establishing efficient communication.

Good practices:

- Ensure efficient communication both vertically and horizontally.
- Ensure personal guidance and support in critical tasks.
- Use performance appraisals as means to collect views on organizational performance and improvement possibilities.
- Maintain a high level of face-to-face communication.

4.6 Maintaining touch and focus

Touch and focus have to do with both doing the right things and doing things right. This implies that there is realism in the initiatives taken and the outcomes expected. It also implies that decisions are taken when they are needed and there is also a loyalty to decisions taken. There is a willingness to see company benefits in activities and it is possible to try new things. When touch and focus are maintained, people have time for reflection.

Good practices:

- When new initiatives are implemented, ensure that there is a realistic expectation on the resources needed and the benefits gained.
- Allow small explorative activities in different areas to create an understanding of development potential.
- Create a willingness to learn.

4.7 Openness and trust

Openness and trust between members in the organization are important for many reasons. When people trust each other, delicate issues can be brought to the table and solved. Openness and trust can facilitate team spirit. Openness and trust can also facilitate a willingness to challenge and change old practices. Sometimes there is a need to ask "silly" questions to open up cases of group think. There should be a widespread understanding in the organization that small things may also be important.

Good practices:

- Create a kind of ethical code regarding safety and person-to-person interactions.
- Build up an open communication climate.
- Encourage honesty and fairness on all levels in the organization.

4.8 Work community

A well-functioning work community is an asset for any organization. Basically, it means that people have a clear understanding of the tasks they do and how they fit into the mission of the company. It also implies that there are shared values in the organization that govern interactions between people and work activities. Visibility of managers at all levels within the organization is an important precondition in the creation of an effective work community. An effective work community is characterized by commitment, motivation and perseverance. Prestige is not an important issue in an efficient work community.

Good practices:

– Be aware that organizational change carries a risk of destroying efficient work communities.
– Ensure that everybody has a chance to be involved in important activities.
– Encourage people look at arguments from both sides.
– Encourage people to think in functions and systems.

4.9 Encouragement and rewards

Encouragement and rewards are important motivators in all organizations. Several nuclear power plants use bonus systems to increase motivation. If the systems are defined as sharing the benefits of good results, they are usually well accepted. However, systems that promote one group of people before the others may have disrupting effects on cooperation. People at nuclear power plants often see the work itself as rewarding, if they are given challenging tasks to work with. Simple encouragement from superiors can in some cases be very rewarding.

Good practices:

– Pay fair salaries.
– Ensure that change initiatives are not allowed to fade away.
– Encourage fresh ideas and ensure that they are brought forward in the organization.
– Recognise good achievements.
– Make it clear that just doing nothing is not an acceptable action alternative.
– Award initiators of change. Award organizational learning.

4.10 Adequacy of means and methods

Adequate means and methods are important for any organization. One important need is to understand interactions between technical and organizational issues. Unfortunately, means and methods for this specific purpose are not well developed. Some help could be found if people with extensive experience from nuclear power plants can be engaged in preparing courses and documentation that explain important issues and interactions in a pedagogical way. A special requirement in this regard is the plant design base, which contains safety requirements and descriptions of solutions selected to meet these requirements. An understanding of these requirements is important, especially when modifications are implemented either in the technical systems or in the organizational structure.

Good practices:

– Ensure that new initiatives are kept under control and are reviewed in detail before their implementation.
– Ensure that there is a transparency in activities and tasks.
– Carry out a thorough debriefing when some large task has been completed.
– Ensure that organizational learning is an ongoing activity and does not take place only after some event.

4.11 Networking and cooperation

Networking and cooperation on a broad basis are a prerequisite for efficient operation. Networking should be extended to all important stakeholders such as other nuclear power plants, vendors, contractors, research organizations, universities and international organizations. Information should reach the right people in the right form and at the right time. One trend is that people are forced to seek information for themselves when needed. Information overload can

thus be avoided, but a large amount of time may be used to find what is looked for. Efficient and fast networking can also help in reaching right people for certain tasks.

Good practices:

- Establish contact networks to various stakeholders. Such networks can be very valuable when there is a need to rapidly find important information.
- Network with research organizations and universities, not only for the purpose of finding new information, but also for finding new staff.
- Remember that direct contacts are more efficient than going through some intermediate person or organization.
- Ensure that provision of e-mail and web services is available for everyone.
- Invest in document management systems and efficient search processes for information.
- Establish forums for information exchange and learning that stretch over several organizations.

5 CONCLUSIONS

It is difficult to condense good practices into simple advice, because too simplistic statements will be considered trivial and too long explanations will never be read. Perhaps the simplest recommendation that can be given is to continuously strive for excellence in all aspects of plant operation.[20]

Simply listing good practices in short statements can never reproduce the richness of a theory that is grounded in an empirical material. Unfortunately such a theory is still to be constructed. On the other hand most of the statements collected in the LearnSafe project that have a relationship to good practices are almost directly lifted from the collected data material.

In an attempt to summarise the good practices in just a few statements, the first is perhaps to ensure that key people have a good understanding of the requirements set on the nuclear industry and the implications they carry. The second is that the senior managers should select a proactive strategy in operating the plants. Finally a systemic view should be applied whenever activities are managed, which means that it is important to understand how different issues interact and sometimes in unexpected ways.

Perhaps the most important lesson in collecting this report on good practise comes from the insight that there is no gimmick nor philosophers stone to be found in the pursuit of nuclear safety. Good results can be achieved only with hard work that is based on a good understanding of all the issues involved.

The present report should be seen as the first attempt to collect good practices out of a very rich empirical material. It is hoped that further projects can continue to lift useful lessons out of the collected material of the LearnSafe project.

[20] IAEA (1999). Safe Management of the Operating Lifetimes of Nuclear Power Plants, INSAG-14.