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LEARNING ORGANISATIONS FOR NUCLEAR SAFETY

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List of content:

ORGANISATIONAL DESCRIPTIONS

1 INTRODUCTION

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

The present report has been written as part of Workpackage 1 in order to establish a set of concepts that are useful when describing organisations. The report is intended to highlight descriptions of how nuclear power plants that are participating in the LearnSafe project organise their work. These descriptions will be used by the LearnSafe partners to foster a reasonable understanding of the organisations from which data has been collected. Due to the focus of the LearnSafe project an emphasis is placed on activities that are relevant to safety.

2 WAYS TO DESCRIBE ORGANISATIONS

An organisation can be defined as a well defined entity of people that are working towards a common goal. Organisational structure generally carries a line of command and reporting. There are many ways to organise thus it is important to describe the characteristics of a specific organisation to relate them to observed performance. It should however be noted that organisations are complex and dynamic therefore any description will provide only simplified illustrations of its characteristics at a particular point in time.

2.1 The organisational chart

An organisational chart is utilised in most organisations to define and communicate a structure of authority and responsibility. In many organisations, the *line organisation* is used to organise functions into divisions, departments, sections and groups. In this structure managers may have several subordinates, but everyone has one and only one superior. The line of command and reporting from the most senior manager to the shop floor can bridge several hierarchical levels.

The traditional line organisation is sometimes amended with a second line of authority and responsibility to form a so-called *matrix organisation.* This second line is sometimes connected to common functions within the organisation. For example work processes that bridge lines within the organisation and *process orientation* in activities. This arrangement is intended to ensure a smooth transfer of tasks over organisational borders. A third method of organisation is to manage tasks that are restricted in scope and time as *projects* within the organisation and to man them on a temporary basis.

The co-ordination of activities within an organisation relies, in addition to the defined lines of authority and responsibility, on various contact fora such as meetings, working groups and task forces. Sometimes these are given an institutional function for example to affirm certain decisions within the organisation. One of these is the *senior management group* whose members are employed to provide support to the most senior manager in the organisation.

2.2 Goals, priorities, plans, operation and follow up

One important management activity at each level in every organisation is to define goals, prioritise, devise plans, put them into operation and follow up achievements. This planning cycle usually follows the fiscal year as used by the organisation. However, for nuclear power plants planning cycles are also connected to the cycle of refuelling outages.

Some organisations have formalised their planning to a high extent by using standardised forms for the collection of input data and for the documentation of plans. The same documentation is then used to conduct a follow up of the activities. Most organisations make a distinction between operative and strategic planning, where strategic plans typically take an outlook for 3-5 years.

The follow up of the operative and strategic plans is typically used to initiate the next round of planning in a process where prior performances are evaluated definingnew goals and developing priorities. Most nuclear power plants report their performance using the so-called WANO indicators. While other plants have amended the WANO indicators with a set of their own indicators. Some nuclear power plants have introduced the *balanced score card* concept as a formalised method to set goals and to assess performance.

2.3 Work processes, activities and tasks

It is common practice to consider work processes as referring to larger entities which comprise of several people and organisational units. Work processes can also be subdivided into activities with such activities being further subdivided into tasks. The work processes, activities and tasks are documented accurately in *procedures* and *instructions* within the nuclear power plants.

Work processes can be modelled formally using the concepts of *inputs*, *outputs*, *control* and *resources* or more loosely considering only the flow of errands handled by different organisational units. There are several tools on the market at present which can be utilised for the formal modelling of work processes. Thus when there is a need for major restructuring of activities use of such tools provides a large benefit.

The resources allocated to work processes, activities and tasks influence the quality of the work. It is possible to discriminate between different classes of resources considering for instance time, money, materials, tools and personnel to be utilised. The information system is also an important resource, which is used both to access required input information for the activities and record output information on their completion. At many nuclear power plants today there has been a move towards computerised information systems.

2.4 Organisational factors

Currently there appears to be a consensus suggesting that organisational performance relies on more intangible factors than those that can be described in organisational charts and procedures. A number of studies have been carried out in a search for such organisational factors[1], but these studies reflect the variety of approaches rather than giving clear direction for how such factors should be assessed. Many studies have been descriptive in their account of how

[1] NEA (1999). Identification and assessment of organisational factors related to the safety of NPPs, Vol.1 & Vol.2, NEA/CSNI/R898)17.

organisations have structured work and the performance observed. Other studies however have been post hoc considering organisational failures and attempting to provide reasons for the problems observed. Very few studies have attempted to give normative guidance onhow to achieve good performance.

One approach utilised in many studies of organisational factors has involved the use of questionnaires with statements, which the respondents are asked to judge on a scale of agreement. The responses are then grouped using statistical methods to find a set of dimensions that characterise the collected data. Typical dimensions in these studies includethe degree of formality in the work, the focus on performance or processes, the success of activity integration, the extent of normative support for activities the organisation provides, etc.

2.5 Organisational culture

Organisational culture is a concept that has recently received considerable attention. Organisational culture is commonly associated to the deeply held assumptions and beliefs that prevail in an organisation. Organisational culture is thought to govern many of the activities that are found in an organisation on a deep unconscious level. Organisational culture is also thought to be influenced by national cultures as some recent best-selling books have attempted to prove.

Cox and Cheyne[2] (2000) developed an approach to assessing organisational culture, and in particular safety culture and climate in a joint industry and UK Health and Safety Executive research project. The Safety Climate Assessment Toolkit was based upon a systems approach to organisational culture. The toolkit combined a number of assessment methods such as questionnaires, focus groups, behavioural observations and situational audits to describe and explore the efficacy of health and safety management systems. The evidence produced by such methods are complimentary rather than alternatives and provide different views of organisational health and safety culture by tapping many aspects of the organisations structure, function and behaviour. The Safety Climate Assessment Toolkit therefore is able to build upon a holistic approach and provide a rich picture of the organisations overall safety climate.

3 SAFETY MANAGEMENT ACTIVITIES

Safety management can be viewed as a connective concept for many activities, which are important for safety. Many of the safety management activities are defined and prescribed in international or national regulation. Today a common view is that all activities, on some level, may have safety implications. Many nuclear power plants have a *safety committee* as a forum to oversee their safety management activities.

3.1 The quality system

The quality system is one of the corner stones of the safety management activities. On a basic level it may be said to contain defined quality requirements for work activities together with descriptions of ways to which that quality can be reached. The quality systems specify regular audits of important activities with the dual purpose to ensure that activities are carried out

[2] Cox, S.J. and Cheyne, A.J.T. (2000) Assessing safety culture in off-shore environments. Safety Science, Vol 34, page 111-129

according to requirements and to identify possible deficiencies in the quality requirements or work processes. The quality system also contains rules for keeping such requirements up-to-date. The quality system is often seen as an administrative barrier to prevent work of inferior quality.

Quality systems are today often integrated in the management system that is utilised at nuclear power plants. Within such organisations the management system is described in a comprehensive set of documents starting with the mission and the values of the organisation. Lower level documents then define directives and procedures for work processes, activities and tasks. While at the lowest level within the system more concrete instructions for operational manoeuvres and maintenance activities are found.

Within or connected to the quality system there are certain sets of documents that provide important reference for the safety activities. The *final safety analysis report* specifies norms and requirements according to which the plant has been built and it also contains a description of technical and administrative solutions and analyses, which demonstrate that the requirements are fulfilled. The *safety technical specification*s are the conditions and other administrative requirements that have to be present in the operation. The original versions of these documents are produced during the plant design and construction process and they are updated whenever plant modifications are made.

3.2 Safety analysis

Safety analysis is used as a tool to ensure that all safety requirements are met and that no undue risks are introduced at any time during plant operation. A distinction is usually made between deterministic and probabilistic methods. The safety analysis provides a valuable source of reference for the safety philosophy and for basic safety requirements of the plant. The safety analysis is used in the training of plant personnel to prepare them for various conditions that may be a potential threat to safety.

The deterministic safety analysis is carried out to ensure that safety systems have the required capacity to handle the demands they are designed for. In a deterministic analysis a scenario is developed which includes a failure that has triggered the need for an intervention. A computer code is then used to calculate the transition the plant will go through to ensure that all crucial design variables are within their safe operational envelopes. Research, especially in the field of severe accidents, has over the last few years initiated several plant modifications, which have improved the capabilities of nuclear power plants to cope with various accident scenarios.

The probabilistic safety analysis (PSA) is used to calculate the likelihood of certain unwanted situations based on a model of possible sequences of events leading to that state. At a number of plants the PSAs were carried out as a retrofit after the plants were in operation. The PSAs have been used as a tool to detect possible weaknesses in the design and to prioritise proposed safety improvements at many nuclear power plants.

3.3 Feedback of operational experience

The most important utilisation of operational feedback occurs as part of the normal goal setting and planning activities and thus affects all parts of the organisation. If a goal has not been achieved it is common practice to conduct a thorough analysis of reasons and possible

remedies. The regular audits as defined in the quality systems also give important feedback from activities.

Nuclear power plants are obliged to report all events of a certain seriousness to the regulatory authority. Such events are analysed using formal methods to determine their root causes. This experience is further shared with the whole nuclear community in the world through WANO. The aim of sharing information throughout the nuclear community is to reduce the likelihood of repetition of events as well as encouraging learning from the mistakes of others.

The collection and analysis of incidents are typically organised in specialised groups at the nuclear power plants, which have the responsibility on one hand to analyse their own events and on the other hand to place the experience from other nuclear power plants into the use at their own plants. Sometimes plants have, in addition to the formally required reporting activities, also set up a reporting system for the collection of minor incidents that can be used for improvements of normal day-to-day practices.

3.4 Analysis of events and deviations

The feedback of experience generates information on events both from their own plant and from other nuclear power plants aroundthe world. A thorough analysis of this information is a necessary step in the prevention of similar and recurrent events. The analysis has to be brought to a level where deviations from acceptable norms can be identified and reacted on. A forceful performance improvement program should be used to react on findings from the analysis.

Event analyses contribute to the organisational learning as lessons learned from events are fed back into the organisation. The primary goal of event investigation is to prevent recurrence. For an objective assessment of events and near misses an adequately structured event investigation methodology should be applied, which leads to the identification of all causes and contributing factors. Proceeding from this information relevant corrective actions can be established and the corresponding knowledge circulated within the organisation and the nuclear community through relevant channels. The methodology should cover the dynamic interaction between various technical, human and organisational subsystems and their contribution to events. Most events have multiple causes that should be pursued during event investigation and analysis.

Other activities such as quality system audits, self-assessments and external reviews also generate similar important experience that should be analysed in depth and reacted on. In the analysis effort it is important to recognise that several minor deviations may be the symptoms of more severe underlying problems.

3.5 Human resource management

The management of human resources including a definition of required competency and skills is an important activity related to safety. The nuclear power plants have, due to their special requirements, rather comprehensive internal training programmes. One important part of these activities is related to the promotion of sound and prudent approaches to safety through specialised training courses and information campaigns. WANO has been instrumental in promoting activities for a sound and prudent approach to safety management activities within their major programmes.

Human resource management has sometimes been associated with the concept of *safety culture*. The concept was introduced after the accident at Chernobyl and it received immediate attention and interest worldwide. IAEA was instrumental in defining the concept suggesting that 'the safety culture of an organisation is the product of individual and group values, attitudes, perceptions, competencies and patterns of behaviour that determine the commitment to and the style and proficiency of an organisations health and safety management.' The IAEA have also been involved in creating instruments for the assessment of an organisations safety culture. However, in spite of such efforts the safety culture concept is still unclear, but experience has shown that it has played an important role in discussions of necessary precursors for safety. One such example has been when multi-functional groups during training courses at the nuclear power plants have been asked to define what safety culture means to them.

3.6 Regulatory oversight

National safety requirements are similar due to an international exchange of experience, but there is diversity in the practices for regulatory oversight. In some countries the regulator has issued detailed requirements and guidance and in other countries the requirements are given on a more general level.

Regulatory oversight is usually carried out using methods of inspection, assessment and programme review. Standard regulatory policy involves assessment ofall activities that are important for safety at regular intervals. While a more thorough periodic safety review is typically carried out with an interval of about ten years.

A recent change in European regulatory requirements has resulted in the nuclear authorities in some countries introducing a requirement that involves a safety review being prepared whenever a major change in the organisation is carried out. This requirement seems reasonable in the light of problems that have occurred at some plants around the world. Experience has proven that in some circumstances it can be difficult to provide a convincing argument that a selected solution does not influence safety in a negative way.

4 DRIVERS OF CHANGE

Drivers of change in the environment of a nuclear power plant provide a key to an understanding of their situation. The drivers of change are relatively similar in each of the countries participating in the LearnSafe project, but they also differ in some respects. The section below gives a brief account of some novel demands that management of nuclear power plants haves been confronted with. Managers at the nuclear power plants are thus challenged to develop and introduce new organisational practices to ensure continued safety and economy in production.

4.1 Changes in the political and economic environment

Deregulation and the internationalisation of the energy market has induced everywhere the need to cut production cost in order to maintain competitiveness of the nuclear industry compared to other forms of primary energy use. The opening of the market for competition between plants and countries has brought the electricity price to levels where nuclear power plant operating costs often have been difficult to cover. Shareholder values impose short term planning horizons. Cost saving strategies are directed towards reduction of investments in

technological improvements and reduction of personnel. Early retirement schemes have been developed and implemented begetting the threat to lose of experience and competence. In some countries political changes and increasingly negative attitudes of the population have lead to nuclear exit policies which further push towards limited time horizons of management.

4.2 A changing work force

The average age of the work force within nuclear power plants is increasing. This is partly a consequence of demographic changes in the work force at large. However, the nuclear industry is faced with specific additional ageing characteristics of its employees: Younger qualified persons are becoming increasingly hesitant to seek employment in the nuclear industry. This reflects to some degree the change of attitudes in the wider public towards nuclear energy production. But many universities have cut down their training efforts of engineers qualified for work in the industry. Furthermore, in some countries it is clear that there is a genuine motivation crisis, which affects experienced personnel working in nuclear power plant. The reasons are sometimes the apparently limited time horizon of the industry due to nuclear exit strategies of governments. Such limited perspectives add to discourage young qualified persons to apply for work in nuclear power plants.

4.3 Changing technology in plants

New information technology offers opportunities to change not only instrumentation and control systems, but also utilise integrated information systems in all work processes and activities. These may improve operating procedures, but pose particular challenges for nuclear power plant staff to the acceptance of these innovations and the requisite competence of handling them appropriately. Spare parts for older nuclear power plants are often no longer available from manufacturers, which may lead to ad hoc stop gap operations in order to maintain production. The number of companies offering equipment and services is also decreasing.

4.4 Changing organisations of nuclear power plant and utilities

Merger activities in response to economic challenges imply new authority lines within the organisation of utilities and induce new ways of operating which often are not found to be appropriate by staff, feeding back into a potential motivation crisis. The same can be noted in connection with new business strategies attempting to reduce investments and personnel by outsourcing certain functions, which hitherto were dealt with within nuclear power plants. The integration within Europe has also lead to the present situation where utility companies, which some years ago were national, now own nuclear electricity generation capacity in two or several countries.

5 CONCLUSIONS

There are many different factors that influence performance. A collection of methods to describe organisations provides a path towards an understanding of various precursors to performance. Of these there are things that management could influence on a short term and others that would need conscious efforts over many years. In addition there are many things that are important, but on which the management has little or no influence at all. In the

creation of organisational descriptions it would be important to trace the necessary conditions and precursors for safety to systematically correlate them with actual performance.

The Appendix contains a form that is intended to provide some background information from the nuclear power plants that are participating in the LearnSafe project to be shared with the other partners. This information is intended to give some understanding of organisational structure and how activities are carried out.

APPENDIX. BACKGROUND INFORMATION FROM THE PLANTS

It is the intent to assemble a restricted set of background information on the nuclear power plants (NPP) participating in the LearnSafe project. This is intended to give a reference for the partners to understand main characteristics of the participating organisations. It is assumed that most of this information is publicly available in various places such as annual reports, data bases, web-sites, etc. The collection of the background information should not be seen as a burden, but rather as an opportunity to share information on your plant and on how you have organised your work with your colleagues and to receive the same information from them.

Site etc.

LearnSafe Partner and the site from which the data is given	
Legal status of NPP	
Number of reactors at site, their types, vendors, power and start-up years	
Major recent changes at the plants and the years for them	plant modernisation's reorganisations change in plant ownership other

Staff

Staff at the NPP	total staff % persons with a higher academic degree % persons with a lower academic degree % persons with vocational training % other staff
Age distribution of own staff (approxi-mate percentages)	≤ 29 30-39 40-49 50-59 ≥60
Typical number of people on site	during normal operations day-time own contractors during normal operations night-time own contractors during refuelling outages own contractors

Organisation (please provide a copy of your organisational chart)

Composition of senior management group	
Organisational levels	How many organisational levels are there in your organisation including the most senior manager and persons on the shop floor?
Organisational type	How would you characterise the type of your organisation? typical line organisation line organisation and functional responsibility matrix organisation

Planning activities and follow up

Planning cycles	Fiscal year for economic planning and follow up Typical interval between refuelling outages Time of the year for your refuelling outages Is there a larger cycle between long and short outages? The outlook in your strategic plans
Use of performance indicators	Are you using performance indicators (e.g. WANO, balanced score card) to assess your performance? Please give a brief overview of indicators you are using together with your achievements using these indicators during the last few years.

Recent reviews carried out at your plant

Periodic safety reviews	Unit Year
Peer reviews	IAEA WANO other
Upcoming reviews	type of review scheduled time

Procedures and instruction

Quality system	Please describe briefly the structure, content and position of your quality system.
Procedures and instructions	Approximate number of control room procedures Approximate number of other instructions

Work processes at the plant

Safety and risk analysis activities	Do you carry out your safety/risk analysis activities yourself or do you use consultants for a major part of the work? How many persons of you own staff is involved in these activities?
Analysis of events	Do you have a section or group responsible for this function

and feedback of experience	within your own organisation? Where is the group located and how large is it? Describe in a few word how the work is done and what inputs are used and what kind of outputs are generated.
Change management processes	Please describe briefly your procedures for the management of change (plant modifications, organisational changes).
Personnel resource management	Please describe briefly your procedures for managing knowledge and skills in your own organisation. Is this activity centralised or is it the responsibility of each department? Have you done an inventory of the resources you need in terms of competency and skills?
Analysis of work processes	Have you carried out a process-oriented analysis of your work processes? If you have, which processes have you analysed?

Additional information

The Internet site of your plant	http://www.
Internet sites where additional infor-mation may be found	national regulator IAEA Safety Convention report reactor vendor other