Organisation de Coopération et de Développement Economiques
Organisation for Economic Co-operation and Development

NUCLEAR ENERGY AGENCY
COMMITTEE ON THE SAFETY OF NUCLEAR INSTALLATIONS

IDENTIFICATION AND ASSESSMENT OF ORGANISATIONAL FACTORS

RELATED TO THE SAFETY OF NPPs

State-of-the-Art Report

February 1999

74660

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

Pursuant to Article I of the Convention signed in Paris on 14th December 1960, and which came into force on 30th September 1961, the Organisation for Economic Co-operation and Development (OECD) shall promote policies designed:

- to achieve the highest sustainable economic growth and employment and a rising standard of living in Member countries, while maintaining financial stability, and thus to contribute to the development of the world economy;
- to contribute to sound economic expansion in Member as well as non-member countries in the process of economic development; and
- to contribute to the expansion of world trade on a multilateral. non-discriminatory basis in accordance with international obligations.

The original Member countries of the OECD are Austria, Belgium, Canada, Denmark, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. The following countries became Members subsequently through accession at the dates indicated hereafter: Japan (28th April 1964), Finland (28th January 1969), Australia (7th June 1971), New Zealand (29th May 1973), Mexico (18th May 1994), the Czech Republic (21st December 1995), Hungary (7th May 1996), Poland (22nd November 1996) and the Republic of Korea (12th December 1996). The Commission of the European Communities takes part in the work of the OECD (Article 13 of the OECD Convention).

NUCLEAR ENERGY AGENCY

The OECD Nuclear Energy Agency (NEA) was established on 1st February 1958 under the name of the OEEC European Nuclear Energy Agency. It received its present designation on 20th April 1972, when Japan became its first non-European full Member. NEA membership today consists of all OECD Member countries except New Zealand and Poland. The Commission of the European Communities takes part in the work of the Agency.

The primary objective of the NEA is to promote co-operation among the governments of its participating countries in furthering the development of nuclear power as a safe, environmentally acceptable and economic energy source.

This is achieved by:

- *encouraging harmonization of national regulatory policies and practices, with particular reference to the safety of nuclear installations, protection of man against ionising radiation and preservation of the environment, radioactive waste management, and nuclear third party liability and insurance;*
- *assessing the contribution of nuclear power to the overall energy supply by keeping under review the technical and economic aspects of nuclear power growth and forecasting demand and supply for the different phases of the nuclear fuel cycle;*
- *developing exchanges of scientific and technical information particularly through participation in common services;*
- *setting up international research and development programmes and joint undertakings.*

In these and related tasks, the NEA works in close collaboration with the International Atomic Energy Agency in Vienna, with which it has concluded a Co-operation Agreement, as well as with other international organisations in the nuclear field.

COMMITTEE ON THE SAFETY OF NUCLEAR INSTALLATIONS

The Committee on the Safety of Nuclear Installations (CSNI) of the OECD Nuclear Energy Agency (NEA) is an international committee made up of senior scientists and engineers. It was set up in 1973 to develop and co-ordinate the activities of the Nuclear Energy Agency concerning the technical aspects of the design, construction and operation of nuclear installations insofar as they affect the safety of such installations. The Committee's purpose is to foster international co-operation in nuclear safety among OECD Member countries.

The CSNI constitutes a forum for the exchange of technical information and for collaboration between organisations which can contribute, from their respective backgrounds in research, development, engineering or regulation, to these activities and to the definition of the programme of work. It also reviews the state of knowledge on selected topics on nuclear safety technology and safety assessment, including operating experience. It initiates and conducts programmes identified by these reviews and assessments in order to overcome discrepancies, develop improvements and reach international consensus on technical issues of common interest. It promotes the co-ordination of work in different Member countries including the establishment of co-operative research projects and assists in the feedback of the results to participating organisations. Full use is also made of traditional methods of co-operation, such as information exchanges, establishment of working groups, and organisation of conferences and specialist meetings.

The greater part of the CSNI's current programme is concerned with the technology of water reactors. The principal areas covered are operating experience and the human factor, reactor coolant system behaviour, various aspects of reactor component integrity, the phenomenology of radioactive releases in reactor accidents and their confinement, containment performance, risk assessment and severe accidents. The Committee also studies the safety of the nuclear fuel cycle, conducts periodic surveys of reactor safety research programmes and operates an international mechanism for exchanging reports on safety-related nuclear power plant accidents.

In implementing its programme, the CSNI establishes co-operative mechanisms with the NEA Committee on Nuclear Regulatory Activities (CNRA), responsible for the activities of the Agency concerning the regulation, licensing and inspection of nuclear installations with regard to safety. It also co-operates with the NEA Committee on Radiation Protection and Public Health and the NEA Radioactive Waste Management Committee on matters of common interest.

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The Expanded Task Force (ETF) on Human Factors members would like to express their thanks to all participants of the Boettstein Castle Workshop on Organisational Factors.

Organisation of the report

This report is divided in three volumes:

Volume I

Section I: "Introduction" provides background information on the development of the workshop and how the workshop was organized.

Section 2:   "Organisational Factors" provides a description of the twelve factors identified in the workshop.

Section 3:   "Assessment Approaches" discusses various methods for assessing organisational factors. (Details on Methods and frameworks used in different countries by utilities, regulators and researchers are presented in Volume II.)

Section 4:   "Future Needs" describes research needs to enhance understanding and knowledge of organisational factors and its contribution to human safety performance and risk.

Volume II

Methods and frameworks used in different countries by utilities, regulators and researchers.

Volume III

Appendix II: Papers contributed by the participants.

All bibliographical references appear in both Volume I and Volume II.

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EXECUTIVE SUMMARY

The initiation of this State-of-the-Art Report (SOAR) on Organisational Factors Identification and Assessment comes from operating experience associated with a number of major events world-wide which caused power plants to be shutdown for a significant period of time. Root cause assessments of these events identified weaknesses in organisational factors as contributing to these events. There is general recognition that organisational factors need to be evaluated for their contribution to plant safety performance and risk to prevent their recurrence in events.

A special recommendation to create a SOAR was presented in the NEA report on Research Strategies for Human Performance [NEA/CSNI/R(97)24]. Based on this recommendation the Principle Working Group 1 (PWG1) requested, as a top priority, that the Expanded Task Force (ETF) on Human Factors develop a SOAR for the September 1998 meeting.

The ETF members were aware that it was a challenging topic. The field of organisational behaviour is not yet fully developed for the nuclear organisation. There is a need to collect and analyse operational and event data from the nuclear environment to determine the safety and risk significance of organisational factors, to identify assessment methods for those factors, and to gain peer review of the results to ensure credibility and acceptability of these methods and possibly their measures.

The first activity to help accomplish this task was a Workshop on Organisational Factors Identification and Assessment, hosted by the Swiss Regulatory Body, HSK. This SOAR reports on the results of the workshop. The workshop was held in Boettstein Castle, Switzerland, on 14-19 June 1998. Twenty-eight participants from twelve Member countries and Russia represented three different environments: nuclear utilities; regulatory bodies and inspectorates; and the research and academic community. The various approaches discussed in the SOAR reflect the perspective of these entities. It should be noted that the SOAR is a status report that provides an agreed-upon understanding of organisational factors important to safety from the perspective of the workshop participants and provides country-specific information on assessment methods and research. It does not reflect all the information in the field of organisational factors identification and assessment which would require more resources, time, and research to develop. It does, however, present a representative view of developments in this field. The task will continue with a broader charter until the end of 1999.

The SOAR addresses the following topics:

− identification of organisational factors;
− identification of methods for the evaluation of organisational factors;
− identification of methods for the evaluation of whole organisations;
− identification of gaps in knowledge and needed research to evaluate adequately the influence of organisation and management on safety and risk.

The workshop participants identified 12 organisational factors as important to assess in determining organisational safety performance. They are: external influences; goals and strategies; management

functions and overview; resource allocation; human resource management; training; co-ordination of work; organisational knowledge; proceduralisation; organisational culture; organisational learning; and communication.

Different cultural backgrounds of participants using their own terminology sometimes made it difficult to have a common definition for certain factors. Some factors could be defined by consensus; other factors such as organisational culture, organisational knowledge, and organisational learning have a slightly different interpretation and will need further discussions to reach a common definition. Although the definitions of these factors may differ slightly for each country, it is important to emphasize that they were all considered to have an influence on plant safety performance.

The SOAR also presents information about assessment approaches used in the three environments:

- Two utilities detail their self-assessment practices.
- The regulatory bodies assessment approaches, as presented in the report, include a description of the context and framework of their assessment methods or approaches, and in some cases, more detailed information on their methodology.
- The researcher information comes from two types of research: university-based research (as well as from public and private laboratories) and contractor-based research which may be sponsored by the regulatory body or the utility. This information is introduced by a brief background of current research trends.

The assessment methods can be distinguished between two applications. The first application of the assessment method results from detection of organisational weaknesses in events or inspections, or from continuing deteriorating performance. The assessment tries to find root causes and contributing causes of the identified weaknesses in the organisation. This application is considered "reactive". The references for this approach are requirements of the regulatory body or utility commitments, or the legal framework. The second application assesses the organisational factors as leading indicators of performance problems. This application is considered "proactive", integrating information on organisational factors in order to capture mechanisms which are very important for the reliability of the organisation. This could be the decision-making process, change process, coherence of the organisation with the policy, etc.

Lastly, the participants identified several research needs for the identification and assessment of organisational factors, including the importance of international co-operation:

- assessing the impact of organisational factors on human safety performance;
- transferring of knowledge and developing a common metric amongst Member countries for comparing methods and audit practices;
- establishing a common understanding of specific organisational mechanisms, features and patterns;
- exchanging operational performance data for analysing the risk significance of organisational factors;
- exchanging information in two to three years to discuss progress in concepts;
- establishing theories and methodology, identifying risk significance and quantifying organisational factors.

The Boettstein Castle workshop discussions and the iterative process of information exchange between participants in developing the SOAR allowed the attainment of the goals of the ETF mandate, including the identification of research needs for CSNI consideration.

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1. INTRODUCTION

During the past decade it has been widely recognized that different factors controlled by the organisation of a Nuclear Power Plant (NPP) have an important influence on the safety attitudes and the safe behaviour of individuals. Interest in these influences begun to increase with the development of the concepts of safety culture and quality management. The importance of organisational performance has been demonstrated when in several countries NPPs were shut down due to significant organisational problems. The increasing focus on organisational factors led to the consequence that event analyses more frequently identified organisational factors as root causes and contributing causes of events. The development of new root cause analysis methods such as Human Performance Enhancement System (HPES[1]), Human Performance Investigation Process (HPIP[2]) and Assessment of Safety Significant Event Team (ASSET[3]) have somewhat addressed this issue. The removal of an organisational problem is only the reactive part of the problem solving process. However, it is important for operators as well as for regulators to detect early signs of deteriorating safety performance in order to prevent the degradation of the safety of NPPs. In order to be proactive, the links between the organisational factors and the safe behaviour of individuals have to be identified, as well as the mechanisms which increase the reliability of the organisation to manage safety. To this end, a Workshop on "Organisational Factors Identification and Assessment" was initiated by the Expanded Task Force on Human Factors (ETF[4]). The objective of this workshop is to identify the organisational factors, their links to the individual and their influence on human performance, as well as the mechanisms important for organisational reliability.

The initiation of this task (TASK 7) of the ETF traces back to ETF's TASK 6 "Improved guidance for reporting of human and organisational factors". Task 6 proposed ways to improve the reporting and the coding of events reported to the Incident Reporting System Database (IRS). The main improvements identified were in the area of human errors which are now much more explicitly addressed and much more differentiated. In this context, it was recognized that organisational factors, as potential root causes of human errors, need to be identified and assessed in order to effectively prevent their recurrence.

The ETF prepared a task for the improvement of root cause analysis methods in the area of organisational factors. Similar activities were initiated by different organisations: The IAEA started a co-ordinated research program on Root Cause Analysis and the European Union (EU) developed a program for a "Concerted Action" in the area of organisational factors. This fact was taken into account in a NEA specialists meeting in August 1997 initiated by the Committee on the Safety of Nuclear Installation (NEA/CSNI). The results of the meeting are outlined in the report "Research Strategies for Human Performance" (NEA/CSNI/R(97)24, Feb. 98). This report includes recommendations on research issues, research co-ordination, and importantly, a recommendation to conduct a workshop on organisational

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[1] Developed by the Institute of Nuclear Power Operations (INPO)

[2] Developed by the US Nuclear Regulatory Commission (US NRC)

[3] Developed by the International Atomic Energy Agency (IAEA)

[4] ETF of the «Principal Working Group 1 on Experience Feedback and Human Factors» (OECD/NEA Nuclear Energy Agency)

issues in order to develop a State of the Art Report (SOAR). This SOAR would serve as a basis for CSNI's recommendations on future research activities.

The ETF discussed these recommendations during two regular meetings. ETF members recognized that different countries use different approaches for the evaluation of organisations and have different understandings of organisational factors. Furthermore, it was recognized that how much these factors influence human performance is not yet well demonstrated.

The ETF decided to focus on the following four topics:

1. Identification of organisational factors.
2. Identification of methods for the evaluation of organisational factors.
3. Identification of methods for the evaluation of whole organisations.
4. Identification of gaps in knowledge and needed research to adequately evaluate the influence of organisation and management on safety.

In its meeting in September 1997, the PWG1 approved the ETF's proposal to initiate TASK 7 with a workshop on these topics. The PWG1 strongly recommended that the time schedule for this phase of SOAR be reduced from two years to one year. This placed time constraints on the workshop organizers and on the possibility of covering all aspects of the topic. However, PWG1 members felt that it was important to have results available as soon as possible, acknowledging that there would be some lack in completeness.

The Swiss Federal Nuclear Safety Inspectorate (HSK) agreed to be the Task-Leader for TASK 7 and organizer of the workshop. The ETF members identified potential participants in their countries and communication between the organizers of the workshop and the participants was established. The organizers requested that each country respond to four questions prior to the workshop. The questions were:

1. "What are you doing with your method/approach?"
2. "Why are you doing this?"
3. "How are you doing this evaluation?"
4. "What is your experience (expectation)?"

The responses to these questions were distributed to all workshop participants prior to the workshop.

The workshop was held in Boettstein Castle, Switzerland, during the week 14 - 19 June, 1998.

Twenty-eight participants from twelve countries attended the workshop. The participants came from regulatory bodies, utilities and research institutes. The workshop was not organized in a classical way, i.e., it did not have individual presentations by the participants followed by discussions. Since all participants were provided with information contributed by each country in advance of the workshop, it began with discussions in three working groups.

This report summarizes the results of the workshop:

- Knowledge of organisational factors impacting safety, their identification and methods for their assessment.
- Organisational factors research in different countries.
- Identification of research questions.

This report should be seen as a representative overview of the topics based on the workshop participants' knowledge and experience. However, this report does not address the full body of knowledge and expertise that exists regarding organisational factors and human performance relative to safety and risk.

This report was prepared by the HSK in collaboration with the "Institut de Protection et de Sûreté Nucléaire" (IPSN) in Paris with contributions of the "University of Technology" (UTC) at Compiègne. A specialist on Work and Organisational Psychology did the compilation and structured the material from the notes taken at the workshop. The report was reviewed by the participants of the workshop and their comments have been reflected in the final report.

2.   ORGANISATIONAL FACTORS

Organisational factors have been defined in the area of organisational and behavioural sciences and they are listed in many publications. They were subject of research but the results are not widely known outside the research community. Furthermore only a few research results were translated into assessment methods.

This chapter presents an overview of the organisational factors regarded as important to safety by the specialists at the workshop. The different cultural backgrounds represented by the participants, using their own terminology and understanding of the factors, made it difficult to have a common definition for certain factors. Some factors are well known and could be defined by a consensus, other factors, such as "organisational culture", "organisational knowledge", "organisational learning" have slightly different interpretations and will need further discussions to reach a common definition. The workshop participants reached a consensus on twelve major factors. The order of the factors does not reflect their level of importance. The twelve factors are:

1.   External Influences (from outside the boundary of an organisation),
2.   Goals and Strategies,
3.   Management Functions and Overview
4.   Resource Allocation,
5.   Human Resources Management,
6.   Training,
7.   Co-ordination of Work,
8.   Organisational Knowledge,
9.   Proceduralization,
10. Organisational Culture,
11. Organisational Learning,
12. Communication.

An organisational factor may be a process, representing an aspect of the dynamic part of the organisation, or the outcome of a process. For example in the "Human Resources Management" factor, the process requires that personnel are selected according to certain requirements, roles and responsibilities are assigned, and are periodically evaluated. All those processes can lead to the outcome that the right people are working in the right position, and further, this may reduce the risk in operation. There are some factors which can be seen both as process and outcome. For example "Communication" is on one hand a "process" with the outcome that personnel are receiving the information they need (vertically and horizontally) to perform their job effectively and safely. On the other hand, "Communication" is the "outcome" of managerial processes, such as the development and implementation of strategies and policies for the dissemination of information within the organisation.

Definitions of Organisational Factors

The goal of the workshop was to have a comprehensive list of factors which draws attention to the most important aspects of an organisation which can influence safety. There are interdependencies and overlays amongst the factors as they are in the organisational environment.

For each of the factors a "definition" is provided. "Aspects of this factor" characterizes the factor. "Further Clarification" of the factor provides additional information.

2.1 External Influences

Definition

"External Influences" are factors outside the boundaries of the corporate and operating organisations, which may impact the organisations' culture and performance.

Aspects of this factor

- Political situation.
- Legal system.
- Economic system (e.g. deregularization).
- Cultural aspects.
- Social and educational status of the work force.
- Other institutions and organisations (e.g. unions).
- Regulatory authorities.
- Public opinion and perception.
- Media reports.
- Employees' perception of their job status.

Further clarification

The mechanisms by which the organisation adapts to these "External Influences" are coping strategies which contribute to the organisation's culture. In many cases these influences can be introduced into the organisation by its own members. External Influences can be identified, observed and reacted to, but cannot be directly controlled or significantly changed by the organisation. Nevertheless these factors clearly influence the way an organisation meets its objectives. For example, it is particularly important for the regulatory body to understand and take into consideration the impact of its procedures, programs, policies, and regulations on the NPP's organisational culture and performance. However, "External Influences" are only mentioned briefly here and not discussed further because it is difficult to assess their influences on the organisation, and they are very country-specific.

2.2 Goals and Strategies

Definition

The top level organisational objectives that set priorities, allocate resources, promote safety, and establish long-range planning. Department and individual objectives should be tied to these goals and strategies.

Aspects of this factor

- Management policy and strategic planning in support of the mission of the organisation.
- Business planning process.
- Definition, prioritisation, and communication of goals and objectives.
- Development and implementation of higher-level plans.
- Definition of organisational structure, accountabilities, and authorities.
- Long term follow-up and control mechanisms, problem identification and resolution.

Further clarification

The "Goals and Strategies" factor appears to overlap with many other organisational factors in that other factors include establishing goals and objectives as one of their functions. However, as used here, "Goals and Strategies" is a function at the very top level of an organisation where long-term strategic planning takes place, which nevertheless, affects day-to-day work. This provides a framework in which all other planning and managing activities are established, prioritised and evaluated.

2.3   Management Functions and Overview

Definition

Arrangements of the upper management to organise, plan, control and monitor processes and activities supporting goals and strategies.

Aspects of this factor

- Identification, development and support of managers in order to allow them to carry out their functions as required. This may include identification of good managers with leadership skills and allocation of appropriate resources to support leaders.
- Empowerment, to enable managers to act on their authority.
- Promotion, and reinforcement of safety practices.
- Definition and establishment of goals and standards.
- Establishment of a framework for a reliable, traceable and efficient decision-making process.
- Establishment of an information management process to identify, acquire, distribute, store and operationalize necessary information in a precise and timely manner.
- Collection, tracking, trending and analyzing of safety and other performance information.
- Promotion of an organisational learning process to identify problems and to learn from past experiences and improve performance.
- Identification and resolution of problems (gather information to assess the situation, find solutions, evaluate different alternatives, implement decisions taking into account appropriate information and personnel, supervise execution, and monitor the results).
- Detection and management of possible internal conflicts between safety and economical benefit.
- Management of technical and organisational change.
- Planning and scheduling of the work processes including workload management.

- Establishment of an effective communication process with other interest groups, including the regulatory body, contractors, local public, media, trade unions, etc.
- Monitoring the resource allocation process which ensures that the right people are in the right position with the appropriate support.
- Establishment and monitoring of good work practices and processes (enforced by e.g. walk throughs, walk around, housekeeping standards, material conditions, etc.).

Further clarification

The "Management Functions and Overview" factor is a significant factor on its own and also overlaps with other organisational factors. Most of the other factors are managed at the middle, or even on a lower level in the hierarchy. Management Functions and Overview ensures, through controlling and monitoring, that all the crucial middle and lower management functions are accomplished. A manager on this upper level has the responsibility for monitoring whether all the crucial activities are carried out properly at all levels of the organisation.

2.4   Resource Allocation

Definition

Allocate, distribute and monitor financial, human, time and technical resources, to support activities required by goals and strategies.

Aspects of this factor

- Identification, acquisition and development of necessary know-how and technical resources.
- Balance between economic pressure, safety requirements and timetables.
- Prioritisation of goals.
- Organisational structure for resource allocation decision making process (degree of centralization).
- Control and monitoring process for human and technical resources.
- Logistics.
- Assignment of organisational (social) support.
- Involvement of Human Factors and other appropriate personnel in work design.
- Support of business planing.
- System support to operational functions.

Further clarification

The "Resource Allocation" factor is linked to the following three factors: Human Resources Management, Training, and Co-ordination of Work. Resource Allocation should ensure that resources are distributed in the direction of supporting safety. If resource allocation is inadequate, safety will be undermined. The Resource Allocation factor is particularly important during periods of reduced budgets and downsizing where there could be an emphasis on economic operation at the expense of safe operation. This factor is also addressed in the section about Organisational Culture.

2.5   Human Resources Management

Definition

Specify roles, responsibilities and accountabilities to meet organisational requirements and select, assign, develop and evaluate personnel (including contractor personnel) to meet those requirements.

Aspects of this factor

- Recruitment and selection of personnel based on predetermined qualifications including experience, education, and training.
- Attention to the psychological and psycho-physiological condition of available manpower.
- Assignment of personnel to roles, responsibilities and accountabilities as described in position descriptions and standards.
- Shift organisation rules.
- Working hours and overtime policies.
- Staffing policies and procedures.
- Adaptation of the organisation to changes in technology.
- Use and evaluation of contractors.
- Management of job rotation and promotion.
- Evaluation of motivation, performance and professional competence through formal appraisal process.
- Professional evolution, career development.
- Tracking reasons for staff turnover.
- Job security issues.
- Succession planning to anticipate and fill vacancies.
- Reward and recognition system.
- Appropriate support of personnel to do their jobs.
- Monitoring morale and attitude relative to a safety culture.

Further clarification

The "Human Resources Management" factor includes recruitment and assignment of personnel based on selection criteria, adequate definition of roles and responsibilities, training as required, evaluation of personnel on pre-established performance standards ensuring the right people in the right position and long-term development of personnel for continuous improvement in human resources.

Human Resource Management is linked with the two other factors Training and Co-ordination of Work and there is an overlap with the Organisational Knowledge factor as well. Human Resources Management needs to be aware of how organisational knowledge influences how employees do their work in practice versus how it may be prescribed.

2.6 Training

Definition

The process of identifying functions and tasks, and identifying the knowledge, skills and abilities required to accomplish those tasks in a safe and efficient manner, and the provision of appropriate training.

Aspects of this factor

- Organisation of the training process to ensure a continuous improvement in knowledge, skills and abilities to meet job requirements and organisational goals and strategies.
- Establishment and evaluation of different types of training, e.g. initial training, refresher training, remedial training and determine different strategies for training, e.g. class room, on-the-job, distance, self-paced, simulator, etc.
- Implementing training methods and developing training materials with consideration of the development of training media and psychological aspects of learning.
- Individualization of training.
- Implementation of a QA process for training.
- Continuous evaluation of training programs.
- Training according to actual needs
- Allocation of resources needed for training including the appropriate selection of instructors.
- Periodic training for career development.
- Monitoring the adequacy of instructors and materials.
- Training on new technologies as needed.
- Professional educational support.

Further clarification

Training is an important link to many of the other organisational factors and is especially important to meet organisational safety objectives. Human Resources Management helps determine training needs derived from long-term planning in accord with Goals and Strategies as well as the introduction of new or changing technologies and the availability of qualified personnel. Furthermore the content of training is dependent on certain task requirements defined in the Co-ordination of Work factor as well as the level of Proceduralization. In addition operational experience as described in the Organisational Learning factor should be addressed in training programs.

2.7 Co-ordination of Work

Definition

Process of planning, scheduling, integrating, allocating and implementing resources and responsibilities for co-ordinated work activities.

Aspects of this factor

- Organisation of inter-related work activities.
- Identification of roles, responsibilities and delegation of responsibilities.

- Shift work, shift turnover and team composition.
- Inter- and intra-organisational communication and co-ordination.
- Prioritization, planning and scheduling of work activities.
- Planning of work to allow an appropriate workload distribution.
- Logistics, assistance and support.
- Management of personal workload and work-flow.
- Traceability of work activities.
- Coordination of contractors with licensee employees.

Further clarification

The "Co-ordination of Work" factor defines in a formal way how work is to be carried out, taking into consideration the allocation of technical, financial and time resources. It sets the framework for the assignment of personnel to required tasks and the interactions between different positions. It defines the interdependencies of work activities and consequently their interfaces, and makes the interrelations between work activities explicit and traceable. This results in a common understanding of how things are done and how they relate to each other, i.e. Organisational Knowledge.

2.8   Organisational Knowledge

Definition

The understanding personnel have regarding the organisation's formal and informal processes, procedures, and practices, and the way in which work is actually accomplished in the organisation.

Aspects of this factor

- Understanding of the structure of the organisation and the different interfaces between organisational units.
- Knowledge about formal and informal communication channels and the interrelationships between an organisation's sub-systems.
- Individual awareness of roles and responsibilities and one's own place in the hierarchy of the organisation in the organisation.
- Implicit knowledge about work practices.
- Corporate memory of past experiences and organisational knowledge represented by the employees.
- Management of the communication of the organisational knowledge.

Further clarification

Organisational Knowledge was seen to represent two types of knowledge. The first type encompasses the views of the members of an organisation on the work reality, i.e., on how the organisation actually functions, which they gain by being part of the everyday working environment. This includes their knowledge of:

- the mission of the organisation,
- how budgets, time and technologies are distributed

- how people are assigned to their jobs
- when, how and why people attend training and educational programs
- the way work activities should be carried out formally
- attitude toward procedure adherence
- how the work practices are actually accomplished (which may be formal or informal).

The second understanding of Organisational Knowledge maybe characterised as "hidden knowledge" present in the memories of employees which is not captured unless it is made explicit and documented. Employees accumulate experiences and become more expert in their fields by doing their job day to day and this expert knowledge is only available to them because it is their stored knowledge. Organisational Knowledge or "Corporate Memory" often plays a more crucial role than documented procedures in official work practices.

2.9   Proceduralization

Definition

The process of identification, development, verification, validation, and implementation of rules, procedures and methods, based on standards for work activities and often on an analysis of functions and tasks.

Aspects of this factor

- Appropriate standardisation and formalization of recurring and critical work activities taking into consideration personnel experience and knowledge.
- Clear information of potential risks during activities.
- Presentation of procedures based on human factors and ergonomic principles and taking into account past errors.
- Participation of end users (i.e. operators) in the development, design and modification of procedures.
- Administrative aids.
- Administrative control, ensuring the quality of procedures in accordance with work practices and of the procedure modification process
- Good balance between the strict proceduralization and standardization of work activities and the skills and experience of the personnel.
- Influence of quality management systems on proceduralization.

Further clarification

The word Proceduralization is a neologism created to emphasize the process involved in developing and maintaining internal standards for work activities. Proceduralization is not only limited to control room procedures but also includes formalization and standardization of all work activities on all organisational levels (as for example quality assurance standards). Proceduralization includes identifying the functions and tasks in work processes, developing rules and procedures, verifying and implementing them, and finally evaluating and modifying them, if recognized as necessary. The Proceduralization process incorporates learning from past experiences, ensures participation of end users and Human Factors

specialists and appropriate inclusion in training programs. This factor is linked to the Co-ordination of Work, Communication, and Training factors.

2.10   Organisational Culture

Definition

Refers to the shared assumptions, norms, values, attitudes and perceptions of the members of an organisation.

Aspects of this factor

- Safety culture as an aspect of the organisational culture where safety is a critical factor in the norms, values and attitudes of every employee throughout the organisation.
- Basic (shared) assumptions about how work has to be done in normal operations and in emergency situations.
- Safety awareness of individuals.
- Organisational support for employee socialization, i.e., important informal activities.
- Reward and recognition system reinforcing safety work performance.
- Attitude towards and interaction with the regulatory body.
- Awareness of implicitly sanctioning certain behaviours and disapproving other behaviours.
- Supervisors and peer employees acting as role models (i.e. showing acceptable behaviour).
- Psycho-social competence of.
- Open communication lines.

Further clarification

Every employee enters the organisation with a set of values and attitudes toward different aspects of work (of which one is safety). The personal values and attitudes of each employee is influenced by the oganisational culture, i.e., the commonly held assumptions, norms, values and attitudes about the work environment. The mission of an organisation reflects the organisational culture and is communicated throughout the organisation so that the employees follow the same objectives. The way management promotes safety and how safety is prioritized influences all levels of the organisation. Official work regulations as well as work practices and individual behaviour contribute to the employees' perception of the organisational culture. This perception subtly influences behaviour and contributes to the perpetuation of the existing organisational culture. Hence, the organisational culture factor is both process and outcome.

This important factor is not always tangible but nevertheless influences safety relevant behaviour in everyday situations.

2.11   Organisational Learning

Definition

A process by which organisations identify problems and learn from past experience and experience from other utilities in order to improve their future performance.

Aspects of this factor

- Feedback of operational experience and its utilisation.
- Proactive instead of a reactive behaviour.
- Transformation of individual tacit knowledge into explicit organisational knowledge.
- Questioning attitude.
- Promotion of common understanding of processes and responsibilities.
- Learning from generic issues.
- Identification, ownership and resolution of problems.
- Recurrent self assessment.
- Capacity and readiness to learn.
- Continuous improvement.

Further clarification

Organisational Learning is both process and outcome and occurs throughout the organisation. There are organisations that have recognised the importance of monitoring the process of Organisational Learning to enhance safety and which designate personnel with the task of promoting it. However, its main expression is through the organisation and all its members. Organisational Learning is related to the Management Functions and Overview factor, specifically to problem identification and problem solving, trending, monitoring and promotion of learning. It also involves Human Resources Management and Co-ordination of Work where feedback loops (one form of Organisational Learning) should promote a common understanding of roles and responsibilities with respect to work practices and processes. Furthermore it is associated with Training, where organisational experience and generic organisational issues can be addressed, and with Organisational Knowledge, where tacit knowledge coming from past experiences may be transformed into explicit knowledge[5]. An outcome or a sign of Organisational Learning is a questioning attitude by each individual in the organisation which also characterises the Organisational Culture.

2.12   Communication

Definition

Process by which information is exchanged, both formally and informally, written and verbal, within and across organisational boundaries.

Aspects of this factor

- Information flow between the organisation and other entities (e.g. the regulator and contractors).
- Information flow between different layers of the organisation, both vertical (between different level of management and employees) and horizontal (between different departments or projects).
- Intra-organisational communication i.e. within groups, between group members.

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[5]   Some people use the terms of Organisational Knowledge and Organisational Learning interchangeably to express the same objective: To learn from past knowledge (experiences) to improve future performance.

- Appropriate use of different means to convey information.
- Transfer of information in appropriate time.
- Awareness and effective application of the contents of message.
- Openness from top to bottom and vice versa.
- Formalization of the communication processes.
- Quality of the document management process.
- Tools and concepts to code and submit information.
- Informal and unofficial communication practices.
- Redundancy of messages.
- Managerial supervision of the communication process.
- Visual behaviour, written words, face-to-face communication.

Further clarification

The Communication factor is the strongest factor with the characteristic of being both process and outcome. Furthermore it is an aspect of all the other factors in that effective information flow is needed by them and the quality of communication within each factor will influence the quality of their function.

Communication is a component of all the other factors that can directly support or undermine safety, and it is, therefore, important to continuously monitor and analyse the quality of the communication process.

The safe operation of a nuclear facility is dependent upon effective communication processes.

3. ASSESSMENT APPROACHES

This chapter discusses first the methodological aspects of assessing organisational factors which may includes techniques, methods, models and frameworks. Then, a brief background will attempt to map the current research trends

3.1 Methodological aspects

Models or *frameworks* provide a structure for data collection, and uses the information gathered to present a picture about the interplay of different factors. It embodies the expected relationships between the various factors and certain outcome variables. Consequently it defines, what kind of data has to be collected, but it does not necessarily prescribe, what sort of method has to be used to get them.

A *technique* or a *method* is a structured way of gathering information or collecting data about organisational factors. Some examples are, document reviews, check lists, observations, interview protocols.

Analytical methods may be used to gather information, to analyse information, or they may be sources of information. Some examples are[6]:

- Human Reliability Analysis (HRA),
- Probabilistic Safety Assessment (PSA)
- Probabilistic Risk Assessment (PRA)
- Event and Barrier Function Model (EBFM)
- Function Analysis (FA) and Task Analysis (TA)
- Discrete Event Analysis (DE)
- Management Oversight and Risk Tree (MORT)
- A Technique for Human Error ANAlysis (ATHEANA)
- Professional Graphical Analysis (PGA)

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[6] Analytical methods are described in detail in the «System Safety Analysis Handbook» (1993), chapter 3 «Analysis Methods and Techniques»

Different perspectives

The participants of the workshop were representatives of three different environments; nuclear utilities, regulatory bodies and inspectorates, and the academic research community. The various approaches reflect the perspective of these entities.

The following section describes methodologies used by the three environments depending on their needs.

- *Utilities* are responsible for establishing the functions that are addressed by organisational factors. Utilities may evaluate or monitor organisational functions on a regular basis or through special self-assessments. These self-assessments may be initiated by the organisation itself or by the direction of the regulator. They may be conducted by the utility or by a consultant to the utility.
- *Regulatory bodies and inspectorates* are interested in three different kind of assessments. Reactive assessments following an event or continuing problems, proactive assessment of licensees to identify early signs of deteriorating performance, and regular inspections to assess licensees corrective actions
- The *research community* investigates organisations primarily from a theoretical basis Data is collected to develop certain assumptions and to test hypotheses. Following validation, research results may be used to develop measures for evaluating organisational factors and to improve assessment approaches. In addition, research results should contribute to understanding of the risk significance of these factors.

Methods and Techniques

There is a set of methods and techniques which are commonly believed to be useful in gathering data about organisational factors. As they can be found in the literature, a detailed presentation is not provided in this report. Some of the common methods and techniques are summarized below:

- Behavioural Observations: The investigator is present at the site and observes organisational behaviour, work practices through e.g., meetings, shift turnovers, etc.
- Checklists: This tool is used for walking through an organisation and focusing on certain issues.
- Structured interview: Individuals or groups are interviewed using a pre-developed protocol or questionnaire.
- Simulation: Individuals simulate an occurred or anticipated event.
- Rating scale: Verbal statements (sometimes anchored by behaviour descriptions) are rated by workers or experts based on their own perceptions.
- Document analysis: Provides information on history, present work processes and procedures depending on the focus of the investigation.
- Event review: Following an event investigators collect different types of information about the event help to determine the contributing and root causes of the event.
- Survey, questionnaire: Standardized method for gathering information.
- Focus group: Representatives from the same, or different, parts of an organisation come together in a group to discuss a specific issue or topic in a formal, facilitated situation.
- Trend analysis: Performance data is gathered over time and analyzed to determine trends.

Finally it is important to point to certain prerequisites which should be considered before using any of these methods:

– Determine the accessibility and sources of data.

– The techniques should be used with a model or framework to ensure that the collected data will be appropriately analyzed

– The users of the method should be trained in the use of the method.

– The method should be validated.

– The organisation under investigation should have a clear understanding of the methods used.

3.2   A brief background of current research trends: a tentative mapping

In parallel to the industry and regulatory efforts towards a better understanding and evaluation of organisational factors affecting safety performance, the research community has also been involved in different projects and programs. Increasing, and systematically developing knowledge on high-risk organisations and their coping strategies with uncertainties is a priority for many researchers. Many of these programs have been developed with the support and/or in close co-operation with utilities or regulatory bodies (there are a few exceptions also). Some have also been developed within other industries (airlines, flight deck operations, chemical plants, off-shore platforms, transportation systems ... Gordon Rachael P.E (1998), Nivolianitou Z.S. & Papazoglou I.A (1998), Bea, R.G. (1998).). It should also be noted that the majority of these research projects are based on extensive field-work, combining various methods to collect and validate data (surveys, interviews, observations, task analysis and their subsequent methods of examination). Psychologists, sociologists, management specialists, human factors specialists and also anthropologists, economists and political scientists are contributing to the research efforts in this area.

The organisations that this report examines are known as **"High Reliability Organisations"**, a notion first developed by La Porte, Rochlin, Roberts and Schulman (1987). The concept of **reliability** includes both safety concerns and availability requirements. The organisations in this category have the following characteristics : they provide important public services which include operating for periods of very high peak demands; failure of their task/production/ technology coupling can be catastrophic; trial and error learning in some areas are risky; social acceptance must be guaranteed. These organisations have received increasing attention over the last 10 years. And as result, they constitute one of the most dynamic research areas in organisational science (for an interesting review see Short and Clarke, 1992). Some of these research projects are presented briefly in this report, specifically projects represented at the workshop.

This section presents the research programs and projects that were communicated at the workshop . It is not our objective to review here all the research activities and projects in this area[7] but rather to give an overview of some of the promising and emerging research in this field: *Understanding the fundamentals of the social construction of organisational reliability.*

Organisational failure

Research on organisational reliability and on organisational factors influencing safety was initially framed mostly in terms of *organisational failure*. High-risk industries have been studied chiefly when they have failed rather than when they have succeeded, perhaps because their failure can hardly go unnoticed. The

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[7]   For a more detailed presentation see Sola, Vaquero and Garcès (1998), a literature review prepared by CIEMAT for CSN (Consejo de Seguridad Nuclear) .

leader of this type of research is Charles Perrow, who's book *Normal Accidents* (1984) has greatly contributed to placing organisational aspects of complex socio-technical systems in the foreground of public concern and on the research agenda. Perrow claimed that for technological and organisational reasons, high-risk industries cannot escape a "normal accident" (i.e an endogenously produced failure). In this view, there is no point in speaking about organisational reliability. As a notion it has been neglected in favour of organisational failure. However this perspective has serious limitations especially because high-risk industries do not fail so often. This raises the question of how their organisational strategies sustain such high levels of performance.

Organisational reliability

This is the perspective taken by the High Reliability Organisations' (H.R.O.) group based in Berkeley (California). HRO scholars (La Porte, Rochlin, Roberts, Schulman and to a lesser extend Wildavsky and Weick) are not so much interested in the fact that these organisations are doomed to fail sooner or later**, but rather in the conditions that allow them to fail so rarely**. They identified a set of selective criteria that according to them make HROs capable of sustaining such a high level of reliability. According to HRO theorists an HRO display four characteristics:

- Members of the organisation totally agree on its goals and objectives
- One can observe the use of redundant decision channels and use of redundant controls and supervision between staff
- Comprehensive training programs help employees develop their expertise in new domains
- The power to make decisions is both highly centralised and highly decentralised, meaning that anybody (even from the lowest rank of the hierarchy) can stop any kind of activity if he or she judges that installations or employees are at risk (See Rochlin, 1988 and also Perrow, 1977)

For HRO scholars these four criteria identify the capacity of an organisation to sustain a high level of reliable functioning.

Safety Culture and organisational Culture

Following the establishment of the INSAG 4 document (IAEA 1991) and the discussions that took place at that time (1990-1991) a couple of research programs have been developed in order to understand patterns of "safety culture", exploring the links between the organisation's culture and the safety performance.

For example, Weick (1987; with Roberts, 1993) and Rochlin (1988; with Von Meier, 1994) have extended the HRO research agenda with regards to the influence of organisational culture on reliability. For example, Weick (1987) has been able to identify a "story telling effect", reflecting the importance of developing an organisational culture allowing for plant personnel freely exchanging information about work-experiences (the bad ones as well as the good ones). Aldrich, and Pfeffer, (1976). Have focused on the organisation*s and their environments*.

Also, belonging to this research perspective is the program directed by Norbert Semmer, [SITASC] a member of the workshop, whose research will be presented in the Volume II (Semmer & Regenass, in press).

Learning Organisation, Self-Correcting Organisation, Self-Designing Organisation, Self-Adaptive Organisation

Influenced by the contribution made by the "Situated Cognition" approach (Norman, Hutchins) and the related "Shared cognition" approach, concepts such as Learning Organisation, Self-Correcting, Self Adaptive, Self-Designing-Organisation have been developed to draw attention to elements of organisational design as well as organisational culture patterns capable of fostering and facilitating an organisation's strive to safety. From this perspective, a Self-Designing (Weick, 1977; Rochlin et al. 1987), or a Self-Correcting Organisation (Landau, 1973) or a Self-Adaptive socio-technical system (Rasmussen, 1994), can be described as an organisation which empowers its employees with explicit authority and resources to adjust rules and procedures in order to cope adequately with unplanned situations (Bourrier, in press).

Organisational factors in PSA/PRA

A new breed of PRA techniques are also taking up the challenge of answering puzzling questions about the influence of organisational factors on safety. Integrating organisational aspects into classic PRAs seem difficult. As Hollnagel (1998) explained in the workshop:

"At present we are therefore faced with the challenge to account for how an overall account of the factors that affect event occurrence and development can be included in the established methods of safety and risk assessment, in particular of how management and organisation factors can be treated in PRA".

Moreover, taking into account organisational factors require more than the usual cosmetic fixes that PRAs tend to affectionate. Again as Hollnagel claims:

"It seems rather doubtful whether the challenge to account for the influence of a wider set of factors can be addressed by extending the set of performance shaping factors one more time. Instead, one should consider whether the basic approach of PRA should be revised, i.e., developing a PRA+ ("PRA plus") approach. In the current understanding, all events take place in and are shaped by a context".

Most of the probabilistic approaches and studies focus mainly on human actions and performance during incidents or accidents and only few studies put the emphasis on pre-accidental errors or pre-initiator conditions (Mosneron-Dupin F (1992), Baumont, Ménage & Bigor, 1997). New PRAs like SHERPA (Embrey), IMAS (Embrey), SAM (Paté-Cornell) or WPAM (Davoudian, Wu, Apostolakis), or CREAM (Hollagel) and ATHEANA (NRC), MERMOS (EDF) are trying to take up the challenge.

Human Reliability Analysis used for PSA and PRA is based on past studies focusing on a single human behaviour and performance. New research is focusing on "errors of commission", more generally cognitive errors which lead to "inappropriate action" in respect to a determined framework or formal procedure. Yet, they appear perfectly rational and understandable given the context. This type of context is called an "error forcing context" (Hollnagel, 1996, 1998; Dougherty, 1998; Le Bot, Bieder, Cara & Bonnet, 1998).

In general, the different operating crew factors and their organisational environment are not often considered as Performance Shaping Factors. In addition, the organisational factors listed above are seldom taken into account to quantify their influences on systems availability and initiator occurrence.

A quantification using the number of occurrences collected in operational experience feedback systems (Martz & Picard, 1998) is mostly preferred (because easier) to the detriment of a quantification taking into account all the organisational factors which could contribute to the failure.

4.   FUTURE NEEDS

On the last day of the workshop participants discussed future needs in the area of identification and assessment of organisational factors. Members of the workshop identified concerns and pending questions to include in the report. There was general agreement that although work in this area has begun in many countries and institutions, many questions remain and this issue needs further research efforts and resource allocation.

The research needs identified by the workshop participants have been broken down into four broad categories, as follows :

Category 1: Understanding specific organisational mechanisms, features and patterns

Workshop participants were also concerned about the impact of specific organisational mechanisms, on which they would like to have more understanding in order to better assess them. For example: how organisations are dealing with their institutional environment? On which assumptions do people react when confronted with uncertainties, difficulties, events? How does an organisation change?

This first category deals with the following questions:

1. **How does an organisation manage change?**
2. **What kind of strategies does the organisation use to cope with external factors?**
3. **What impact does the organisational environment have on?**
4. **What specific influences have management functions and strategies on safety and risk?**
5. **Based on which assumptions are people acting with uncertainty in their decision-making processes and what is the impact of conflicting goals on their behaviour ?.**
6. **What is the framework for addressing the main organisational issues to conducting a wide ranging assessment (for example for large-scale projects).**
7. **What are the tasks and the characteristics of the jobs of managers in nuclear organisations?**

Category 2: Understanding and assessing the impact of organisational factors on human safety performance

This category deals with the **initial question of the workshop**: i.e how to better understand the impact of organisational factors on human safety performance. Moreover, the identification of precursors (early warning signs) in organisational factors related to safety.

This category includes the following questions:

1. **What are the direct and indirect relationships between organisations and safety and between organisational factors and human performance? And what are the main mechanisms through which organisational factors should be used in order to decrease risk and improve safety performance.**

2. **What are the pre-cursors (early warning signs of deteriorating performance) in organisational factors related to safety?**

Category 3: Transfer of knowledge and development of common metric for comparisons

Transfer of knowledge concerns include several levels:

− A lack of knowledge transfer between the research community and the interested parties (utilities and regulators).

− A lack of a common metric in order to compare methods coming from various countries and various communities and institutions.

− A lack of transfer from other assessment methods, such as quality Assurance, Event analysis, and other performances indicators.

This category includes the following questions:

1. **How do we move from the theoretical models and techniques to the practical application of assessing a specific organisation?**

2. **How do we validate the research methods and how do we find a common metric to use all these methods?**

3. **How can assessment methods used in other areas be applied to organisational factors?**

4. **How to assess and evaluate organisational learning ?**

Category 4: Improvement of assessments conditions for plants

This last category deals with specific questions related to methods implementation. It echoes two series of concerns:
1) members of the workshop noted that a lot of audits are performed to assess safety, security, quality, and so on. These audits have some common points on management, policies, organisations, however they differ on performance indicators. In order to reduce the load on utilities, some common framework addressing the various modules should be developed.;
2) The audit activities have also to be evaluated in order to ensure their benefit to enhance human safety performance.

This category includes the following questions:

1. **How can methods and performance indicators, etc. appear in a common framework?**

2. **How can assessments be evaluated to determine if they lead to improvement in human safety performance.**

5.   CONCLUSIONS

Organisational changes in NPPs are highly predictable in the near future, due to the deregulation of the energy market. They have to be managed carefully in order to maintain the safety level of the existing NPPs. Therefore, instruments for assessing the safety performance of nuclear organisations are first a need for utilities, and then for regulatory bodies. Indeed, deterioration in safety performance of organisations, even with small impact on the environment, are perceived by the public as a failure to ensure the safe functioning of nuclear activities and a lack of concern for the potential risks of nuclear energy. This perception reduces the level of credibility of the nuclear industry world-wide.

Understanding the reliability mechanisms of a nuclear organisation and identifying of the main organisational factors influencing safety will contribute to improving assessment methods. These objectives have to be pursued in order to give the organisations of nuclear installations valid instruments for assessing of their actual safety performance, and especially for evaluating of the consequences of planned organisational changes.

It is necessary for the utilities to detect early signs of degradation in the safety performance of their organisation in order to take remedial actions. This would prevent the accumulation of performance deficiencies which could lead to an intervention of the regulatory body with increased inspections, special requirements or even a shutdown of the plant. This proactive behaviour has not only a positive impact on safety, but also a long-term influence on the economy of the utility. Consequently, methods to identify these early signs of deteriorating safety performance have to be developed, shared and periodically evaluated, in the light of new research results from the fields of organisational behaviour and sociology.

During the Boettstein Castle workshop, there was a general agreement that the discussions were helpful for going beyond the assumption that it was possible to define "a" good organisation. It seems that the characteristics of reliable organisations differ from one country to another. These reliable organisations, in harmony with the country's culture, may have weaknesses or dysfunctions which in turn may be reduced by redundant mechanisms within the system.

To recall the atmosphere which characterised the workshop, people with different profiles (i.e organisational behaviour and sociology researchers, utility representatives, regulators or their technical support representatives, coming from 12 countries) searched to identify effective methods for determining reliability in organisations, in a predictive or proactive manner. The exchange of information between participants from these different environments led to an appreciation of how conceptual approaches must consider realistic concerns, how theories must be judged against pragmatic requirements, and for researchers, how to be responsive to the identified needs. The participants discussed experiences, identified common elements in approaches and addressed difficulties encountered in this field.

The current needs identified by these in-depth discussions concerned fundamental research questions, criteria for the development and validation of methods, and the standardisation of existing tools.

General remarks

The following are general remarks from the exchanges during the meeting:

- On the one hand, the vocabulary used in different countries can be very different for the same concept (e.g organisational learning) and on the other hand, the use of the same word can have different meanings (e.g. responsibility). Therefore, international collaboration in this field requires particular attention to the definition and explanation of concepts in order to foster mutual understanding.

- Each country has developed a particular system to control and audit safety based on the culture of the country (a framework, legal reference, academic background and knowledge of behavioural or human sciences, criteria for safety). Consequently, the introduction of a foreign method in a country must ensure that the method is discussed and appropriately integrated into the new field of application. The objective is to improve safety by enhancing methods while respecting each country's method of working.

- Defence-in-depth based on organisational reliability can benefit from co-operation between countries because each has developed an understanding of a particular mechanism which adds to the general knowledge base.

Comparison of methods

As regards methods of assessment, the main remarks were the following:

- The methods used in each environment (regulatory, utility self-assessment, research) are diverse.

- The common methods most of ten used are based on document reviews, interviews and observations. These techniques require some training to be used effectively.

- Two types of representation of the influence of organisational factors on safety sustain implicitly the assessment methods. One claims that organisational reliability is embedded in the whole organisation design and intricacies; others believe that specific characteristics of safety organisation can be disentangled from the whole organisation in order to be the main focus of organisational assessment. This difference in the representation influences the nature of the view to organisational deficiencies. In the first case, insufficient planning and scheduling or resource allocation, dissent, compartmentalisation, power struggles and goal displacement are considered as influencing safety problems. In this first case, the organisation is considered as a whole, what has to be explained is its very functioning with a systemic approach. In the second case, the organisation deficiencies have to be described explicitly in connection with technical safety issues or pre-defined organisational factors. In this case organisational factors are often treated like technical aspects. The organisation is only seen through the prism of specific functions in a deterministic way.

- The assessment methods can be characterised either as reactive or proactive. A reactive assessment results from the detection of organisational weaknesses in events, or through a series of inspections. This assessment approach attempts to identify root, or contributing causes, of the organisational weaknesses. It may be based on requirements of the regulatory body or on utility commitments, or on a legal framework. The proactive approach assesses the organisational factors as leading indicators of performance problems. Hence, this application integrates information on organisational factors in order to capture mechanisms or processes which are very important for the reliability of the organisation. This could be the decision-making process, change process, the coherence of the organisation with the policy, etc.

- The field of organisational factors is not an exact science. It is still in development. Therefore, gathering objective data, analysing the data and peer reviews of the results are required to ensure the credibility of the results.

Organisation reliability

- Organisational safety depends strongly on the effectiveness of the decision-making and problem-solving process and therefore on the knowledge and the behaviour of the managers of the organisation.
- To make effective use of organisational performance data coming from operational experience and events as valid input for research and the development of improved methods, the elements important for organisational reliability should be identified and taught during management training. This raises managers' awareness of the significance of organisational factors for the reliability of an organisation.
- Organisational safety depends very much on the ability of an organisation to learn from experience. Therefore, the way an organisation deals with unforeseen events, especially those with minor consequences, indicates the performance of the organisational learning process.

Future objectives for research and collaboration

The participants identified several research needs for the identification and assessment of organisational factors, as discussed in detail in Chapter 4. In addition to research needs, the need for strong international collaboration in this field was identified. The result of this collaboration should not be a common toolbox for the evaluation of organisational factors – a common instrument covering all cultural aspects and all countries seems unrealistic – but the international collaboration should result in a common pool of knowledge, accessible for interested experts in this field. This pool of knowledge may be used for information transfer, benchmarking purposes, the identification of specific common topics for research or further investigation, etc. In order to achieve this, the group came up with the following general recommendations:

- foster international co-operation in this field;
- transfer knowledge and develop a common metric amongst Member countries for comparising methods and audit practices;
- develop a common understanding of specific organisational mechanisms, features and patterns;
- exchange operational performance data for analysing the risk significance associated with organisational factors;
- exchange information in two to three years in order to share the progress of knowledge and to co-ordinate further collaboration in this field;
- undertake collaborative research on theories, methodologies, the identification and possibly the quantification of risk significance of organisational factors, and the impact of organisational factors on human safety performance.

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7. APPENDIX 1

7.1 Acronyms and Organisations

ASCOT	Assessment of Safety Culture of Organisations Team (IAEA)
ATHEANA	A Technique for Human Error Analysis (US NRC)
BARS	Behaviour Anchored Rating Scale
BPR	Business Process Reengineering
CIEMAT	Spanish Research Centre on Energy, Technology and Environment (depending on the Spanish Ministry of Industry)
EDF	Electricité de France - Operator of the french NPPs.
FA	Function Analysis
FRAMATOME	French Vendor of NPPs
HFIS	Human Factors Information System
HPES	Human Performance Enhancement System developed by INPO (Johnson, 1980).
HPIP	Human Performance Investigation Process developed by US NRC
HRA	Human Reliability Analysis
HSE	Health and Safety Executive (UK)
INPO	Institute of Nuclear Power Operations (USA)
MBWA	Management by Walking Around
MORT	Management Oversight and Risk Tree (Knox & Eicher, 1992).
MTO	Man-Technology-Organisation
OSART	Operational Safety Review Team (IAEA)
PGA	Professional Graphic Analysis (Abramova, 1997)
PIF	Performance Influencing Factors
PROGNOZ	Obninsk Scientific Centre (Russia)
PSA	Probabilistic Safety Assessment
PSF	Performance Shaping Factor
PRA	Probabilistic Reliability Analysis
RCA	Root Cause Analysis
SAM	Systems, Actions, Management
SALP	Systematic Assessment of Licensee Performance (US NRC)
SLIM-MAUD	Success Likelihood Index Methodology Using Multi Attribute Utility Decomposition
STUK	Finnish Radiation and Nuclear Safety Authority
VTT Automation	Finnish R&D organisation (technical and technico-economic work for the industry and government agencies)
WPAM	Work Process Analysis Model

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