INTERACTION OF INDIVIDUALS, TECHNOLOGY AND ORGANIZATION – A REGULATORY VIEW

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Introduction (1)

- In January 2013, the so-called Safety Requirements for Nuclear Power Plants have been issued in Germany which supersede several older documents including the Safety Criteria for Nuclear Power Plants.

- These Safety Requirements state in the fundamental principles that the basis of the safe operation of a nuclear power plant is the safety-oriented interaction of human, technical and organizational factors. The interconnection of these factors with the aim to act in a safety-oriented manner is also the basis for a highly developed safety culture. It is the licensee's task to maintain this safety culture and to enhance it continuously to ensure safety.
Moreover, these Safety Requirements state in the section on organizational requirements that an integrated management system (IMS) shall consider all objectives and requirements, such as safety, quality, ageing, staff safety, the environment, or profitability.

All objectives and requirements have to be balanced, weighted and clearly specified in a comprehensible and transparent manner, giving consideration to the priority of safety. In this context, the interaction of human, technological and organizational factors (man-technology-organization) has to be considered.

The interfaces between individuals, technology and organization shall be considered in the development of the IMS.
Introduction (3)

- In its supervision process, the nuclear regulatory authority takes a holistic approach, viewing the plant as an individual-technology-organization system.
- Safety technology, an effective organization and the safety-driven behaviour of qualified and motivated personnel form the basis of the safe operation of a nuclear facility. This is why requirements are imposed on individuals, technology and the organization to ensure safety.
- However, these three factors of the system are not mutually independent but rather influence each other.
- Each Federal State in Germany has some kind of supervision approach for this specific topic; however, the concept for regulatory supervision of nuclear power plants in Baden-Württemberg is described in the most detailed manner.
Basic requirements for individuals, technology and organization

Technology
- safety principles
- quality
- operation experience

Individuals/Personnel
- number and qualification
- reliability
- physical and psychological demands

Organization
- structural organization
- process organization
- written organizational rules, manuals
- safety policy
- safety management system
Interaction of individuals, technology and organization

**Individuals/Personnel**
Safety promoting operation of the personnel is influenced

*by the factor technology*
- operation equipment
- instrumentation
- ergonomics

*by the factor organization*
- work schedules
- education and training
- safety culture

**Technology**
Quality of the technology is influenced

*by the human factor*
- operation
- inspection
- maintenance

*by the organizational factor*
- quality management
- testing programme
- operation instructions

**Organization**
The mode of action of the organization is influenced

*by the technical factor*
- radiation protection
- occupational safety
- information and monitoring systems
- documentation

*by the human factor*
- superior behaviour
- team behaviour
- safety culture
- organizational learning
Impact of individuals and organization on technology

- Technology is influenced by human behaviour. At the interface between man and technology, factors such as the operation of the plant, inspections to be conducted and maintenance activities need to be considered.

- The organization with its written operating rules has to ensure that the plant is operated safely, minimizing the load on components, and that systematic and comprehensive inspections are performed. Such rules also serve to prevent human failure.

- The processes defined in the written operating rules which consist of the operating, testing, maintenance, quality assurance, documentation, crisis organization and emergency manuals are important organizational factors influencing technology. If these rules are appropriate and reasonable, the quality standard of the technical systems is ensured on a long-term basis.
Impact of technology and organization on individuals (1)

- At the interface with technology, human behaviour is mainly determined by the design of the workplace, instrumentation and computer-based information systems. In that context, ergonomic aspects play a special role.

- The organization influences human behaviour, e.g. through written instructions, job clearance procedures and work schedules. These must aim to support human performance and reliability; thus avoiding errors to the greatest extent possible.

- Nevertheless, events may occur in nuclear power plants which are caused by the suboptimal interaction of individuals, technology and organization.
Impact of technology and organization on individuals (2)

- In addition to the written operating rules, the effectiveness of unwritten social rules is of considerable importance. They determine the relationship between superiors and workers and the behaviour among colleagues. People’s basic beliefs and values make up the very core of the operator’s safety culture.

- A high safety culture exists when special attention is given to safety issues. To strive for continuous improvement is part of a high safety culture. In order to maintain a high safety culture it is necessary to take effective long-term measures to promote this safety culture and to perform regular reviews in the form of self-assessments.
In a nuclear power plant safety concerns are addressed at all hierarchical levels as well as in different areas and contexts. Important elements of safety culture can be found in

- corporate management,
- the provision of resources,
- internal organization,
- personnel,
- activities,
- communication, and
- striving for improvement.
Impact of technology and organization on individuals (4)

- In keeping with a holistic approach of the individuals, technology and organization to the supervision, the regulatory body should not review the safety culture separately, using a specific reviewing method.

- Rather, it should look at the various elements and aspects of a safety culture in the context of the operating process and review them by applying pertinent methods and procedures.
Impact of individuals and technology on the organization

- At the interface with the human factor it becomes obvious that human behaviour has a strong influence on the organization. This applies in particular to safety culture.

- The question of how the organization can successfully learn from experience is of essential importance for its optimization. This so-called organizational learning process has to be designed in such a way that it is not blocked by an attitude of apportioning blame (‘failure culture’).

- Organizational learning means that processes, events etc. are checked for weak spots and improvements are proposed and implemented.

- Technology as a sub-system influences the organization by determining which rules are necessary. These include radiation protection, occupational safety measures and technical documentation requirements.
Monitoring and safety management by the operator

- The safety of a nuclear power plant is first and foremost subject to monitoring by the operator.

- The control activities of the operator directly address the nuclear facility as a system, while regulatory supervision, as defined in the Atomic Energy Act, is the next step after control by the operator which it follows and monitors.

- Accordingly, regulatory supervision is, above all, a control of the operator’s compliance with his duty of monitoring.
Environment and influences on the ITO-system

Corporate company  \[\rightarrow\]  Electricity
Supplier  \[\rightarrow\]  Safety performance
Contractors staff  \[\rightarrow\]  Safety culture
Regulatory authority  \[\rightarrow\]  
Politics / Society  \[\rightarrow\]  

Individuals / Personnel  \[\text{Technology}\]  \[\text{Organization}\]
Impact of the environment on the plant (1)

- Nuclear supervision must be well aware of its own influence on the system and must subject its own impact on the plant’s safety level to a constant critical review. The regulatory authority’s behaviour should contribute to promoting the plant’s safety management and safety culture and ensure that they are not weakened.

- It is the objective of the regulatory authority to employ those types of action that have the greatest effect on plant safety.

- Past experience has shown that extensive back fitting and adjustment of the plants to comply with the state of the art can be achieved on the basis of a critical, yet constructive dialogue and associated co-operative action.
Impact of the environment on the plant (2)

- However, the responsibilities of nuclear supervision are not restricted to a critical and constructive dialogue, but can be divided into three different categories.
  - Category 1: control of compliance with legal rules and regulations,
  - Category 2: control of activities aimed at averting danger,
  - Category 3: more extensive control.
Concluding remarks (1)

- Regulatory supervision process encompasses the interaction between individual, organization and technology to ensure that such interactions exist in operating organization for safe handling situations during abnormal and accident conditions.

- In its supervision process, the nuclear regulatory authority takes a holistic approach, viewing the plant as an individual-technology-organization system even if still the words man--technology-organization system are used.

- Regulatory supervision still is a control of the operator’s compliance with his duty of monitoring.
Concluding remarks (2)

- The general process for the entire individual-technology-organization system has become difficult for those German nuclear power plants which had to be permanently shutdown in August 2011.

- Another important aspect is that it is also necessary to develop and improve a safety culture framework for the regulatory body.

- Moreover, the regulator should be aware that also his activities influence the individual-technology-organization system of the plant operator.