Manager's point of view
Contribution from a research institute

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1. Summary

A nuclear research centre has some typical characteristics that make safety management in some way specific for these installations. This specificity relates to the research orientation of the installations and the people and to the nuclear nature of the facilities.

The management has to induce a living safety culture, including an adequate human resource management, a budgetary policy, allowing sufficient training, maintenance and provisions to cope with liabilities. An organization has to be set up stimulating self-assessment within a strict control by regulatory bodies and social partners. Last but not least, the management has an important impact on the internal and external communication policy and the management of emergencies. SCK•CEN is also performing research on some human aspects related to safety, as e.g. the internal communication of bad news and risk perception during emergencies.

2. Specific safety aspects of a nuclear research centre

2.1. The installations

As it is the case at most complex industrial facilities, nuclear research centres present a broad spectrum of risks: Fire hazards, mechanical hazards e.g. at the decommissioning workshop and due to the manipulation of heavy loads, chemical hazards at the laboratories and by the use of liquid metals, electrical hazards, since the use of heavy motors and heating elements, mining hazards in the underground research laboratory and, last but not least, the nuclear-related risks: irradiation or contamination of workers, release to the environment and nuclear excursions due to reactivity accidents.

Experiments are mostly set up for a rather short period within an ageing host facility that can accept a series of successive experiments over many years. Typical hosting facilities at SCK•CEN are research reactors (e.g. the BR2 high flux reactor) and the underground laboratory in clay Hades-Praclay.

This situation is rather specific from the point of view of safety: the experiments have often to cope with childhood diseases, while the host facility has to cope with ageing problems. Figure 1 shows the typical bathtub-curve of reliability versus age. For "young" experiments, the management has to decide whether the starting problems are indicative for the poor quality of the installations or whether the initial failure rate will quickly decrease to a normal level after the elimination of a few artefacts. For the hosting installations presenting an increasing rate of failures, a timely decision about a refurbishment or end-of-life with or without replacement has to be taken into account.

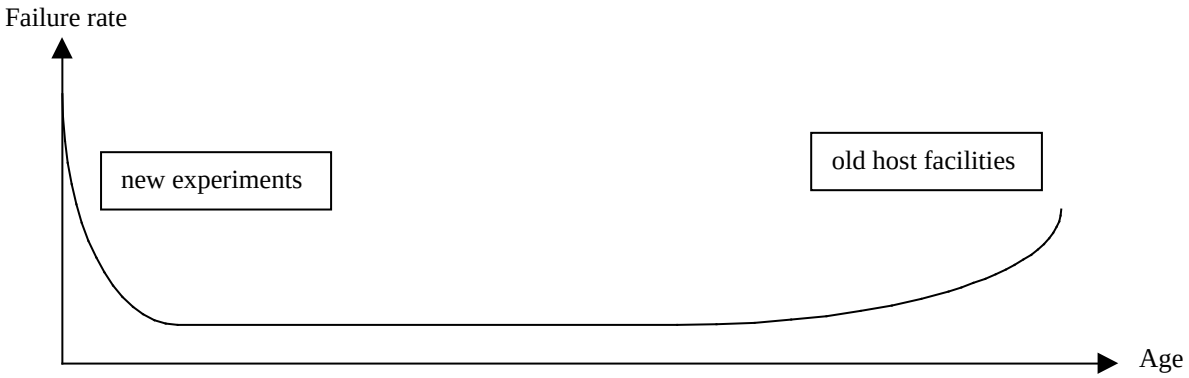

Figure 1: Research centres have to cope as well with childhood diseases as with ageing problems

Experiments require often transient phases presenting a higher risk than routine operations. Frequent modifications require continuous training and a great awareness to adapt the technical specifications, procedures and inspections to the up-to-date status of the installations.

Nevertheless, SCK•CEN has an excellent safety record, as can be illustrated by the working days lost per 1000 days. This severity index reveals to be about a factor 7 lower than the national average.

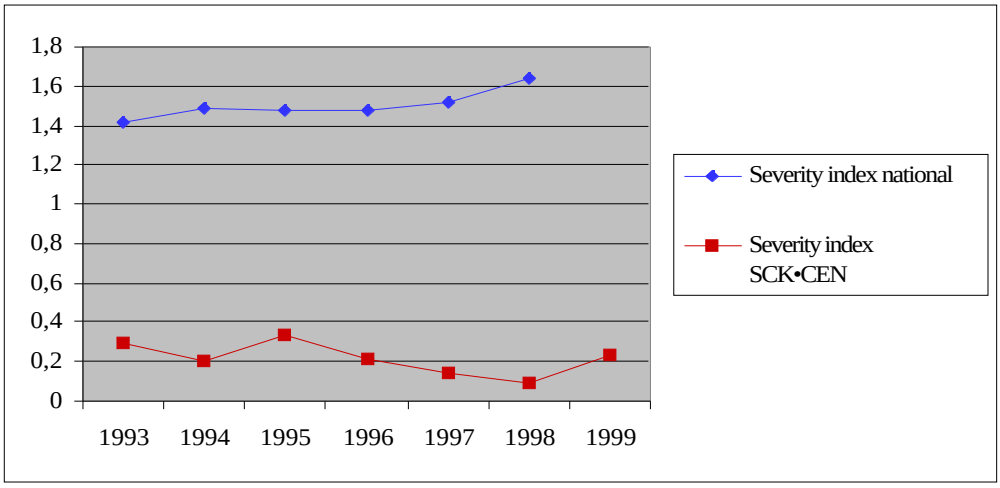

Figure 2: SCK•CEN shows an excellent safety record (severity index = working days lost per 1000 days)

Although our activities know their contractual constraints, the economic pressure is less important at a research facility than for an industrial production unit as e.g. a nuclear power plant. The conflict between safety and availability will often turn out in a victory of safety. This context also allows to avoid as much as possible maintenance during the operation, a situation that often leads to initiating events of notional incidents, such as the Three-Miles-Island accident.

2.2. The human factor

The middle management of a research centre is mostly scientifically oriented. This scientific spirit could lead to a risk taking attitude and a reluctance towards excessive regulations, procedures and external control. Since research budgets are always exhausted, there is also a real risk that preference is given to new investments and new scientists, reducing the technical manpower to a minimum. These kinds of risk are the most important for smaller experimental set-ups. Large facilities are organized and managed as common industrial installations.

2.3. The nuclear factor

Nuclear safety presents some specificities that have an impact on the attitude of the public, workers, authorities and ipso facto of the responsible management. The main specific issues are related to the non-familiarity with radiation, the non-zero risk of very low exposure, the possibility of severe accidents and the production of radioactive waste.

Although we are living daily with radiation coming from natural and medical sources, nuclear installations are often still considered as mysterious black boxes, where an untouchable elite is playing with the health of people. The non-familiar nature of radiation hazards increases the perceived risk. Since the complexity and inaccessibility of most installations, this black box concept could also be the image as seen by workers.

Since the exposure to ionizing radiation is assumed to present some risk without any threshold, it is difficult to define safe situations. Each exposure or release has to be assessed in the context of the optimization of protection. The residual risk cannot be considered as trivial. This makes the communication to the public and to the workers often difficult.

The possibility of severe accidents with a very low probability but entailing important health and economic consequences requires of course a permanent awareness by all actors and in particular by the management. Last

but not least, the production of radioactive waste has some specific impact on the management of nuclear installations. A strict policy of the physical control and inventarisation of waste is required, as well as a budgetary policy considering future, uncertain, costs.

3. The role of the manager

3.1. Well-informed, responsible decision makers

The role of the manager and of each hierarchical level between the operator and the highest level is to take decisions that cannot be taken by the lower level, due to their global impact, the need to co-ordinate multiple resources, or the information needed to make the right choices. Each level has to take decisions respecting the corporate values, to create a climate enhancing the probability that those decisions will be executed, by supplying the required means, by motivating people and by ensuring a feedback of experience, allowing quick and controlled reactions in case of an anomaly. The management of safety is in this way similar to the other challenges for the hierarchy. Subsequent comments relate to the practice at SCK•CEN.

3.2. The quality of installations

The residual risk of a hazardous installation is always a result of some cost-benefit decisions. At SCK•CEN, common rules of good engineering practice are applied. In general, nuclear installations meet the "single failure criterion". This means that one single failure or human error may never lead to a significant unwanted consequence. The residual risk and cost are compared in a qualitative way with what seems reasonable for the kind of installation. When the cost of the safety features of an installation reveals to be excessive, some protection measures can be shifted to the individual protection of workers. Safety should be intrinsic and may not require a continuous effort by the workers.

The management has to intervene when the decisions become difficult, i.e. when the balance between the goal of the activity (e.g. the scientific value), the risks and the costs are not obvious. It is important to empower the design engineer to a self-assessment of all the factors involved. The project leader has to be trained to make a full analysis of safety aspects, together with the scientific justification and the cost-assessment. For each reactor experiment and for other larger experiments, these operational and safety-related issues have to be evaluated by a group of internal stakeholders, including the safety services. In case of special interventions or activities with a rather important dose burden, also the representatives of the trade unions may participate in the evaluation process. This procedure foresees three steps: the feasibility analysis, the detailed design analysis and the examination of procedures, technical specifications and inspection requirements. The inspection of hard- and software is a very important step. In case of the detection of anomalies, the management has often to decide whether some risks can be taken awaiting some modifications. It is also a task of the management to insist on periodical re-qualifications during the lifetime of an installation and on preventive maintenance programmes. For ageing installations, the end-of-life or refurbishment have to be scheduled in due time, in order to avoid risk-taking decisions under the pressure of operational needs.

3.3. The quality of the operators

The operators have to be trained in order to become capable not only to perform the anticipated actions, but also to understand the risks. The analysis of past accidents or quasi-accidents is very useful for all levels. SCK•CEN has an important training programme. 5 % of the working hours of supervisors and 2,5 % of those of operators have to be spent on training. The training programme of the reactor operators has to be approved by the internal and external safety authorities, as well as their eventual qualification.

SCK•CEN tries to reduce the risks related to the learning process of hazardous operations by digital and physical simulations. Important human interventions in a hostile environment are optimized and trained in virtual reality (computer simulation) and by cold tests (training on physical mock-up). This allows to improve the experience of the operators, the suitability and user's friendliness of tools and the quality of the protection. This procedure can of course not be applied for a multitude of smaller experiments.

3.4. The feedback of experience

It is important that the management remains well informed about the anomalies that happened on the workfloor. This allows to detect precursors of dangerous situations, due to a negative trend of the safety culture or a lack of maintenance or to find out unforeseen accident scenarios.

This feedback is realized by formal internal reporting systems, by informal bypasses of hierarchical levels and by the daily follow-up by supervisors walking around in the workplaces. As for other managerial challenges, an open communication has to be stimulated. A lack of communication does not only lead to a loss of the benefits of the feedback of experience, but can also trigger accidents when operators want to hide errors by corrective actions that are not evaluated by the appropriate level (e.g. the Chernobyl accident). An open attitude of the operators requires some tolerance by the management with respect to human errors. The handling of collected information has to be optimized by installing periodical reviews by safety committees, translating the experience into practical actions.

3.5. The control system

The safety of SCK•CEN is controlled by three parallel systems:

- the legal safety structures:
- the social survey system;
- the management survey system.

Those systems are not independent. It is obvious that all hierarchical levels and the legal internal safety services play an important role in each of those.

The legal safety structure foresees three levels:

- the internal safety services (industrial safety, physical protection against the risks of ionizing radiation and medical survey); Those services report directly to the general manager, they have to authorize specific installations and interventions, they survey hazardous operations in real time, they check the quality of protection features and monitoring, they are in charge of the safety training and have to organize the emergency management. The three services are integrated and concertation between individual experts is stimulated.
- the regulatory body: an external independent office that has to authorize specific installations and interventions, and has the duty to survey the quality of the internal safety services. Representatives of the regulator have free access to the installations and may discuss safety issues with the operators.
- the safety authorities: prepare the licences for the competent minister and are to be informed about doses, releases and in case of legally specified anomalies. They have the right to suspend the licence or to impose specific working or reporting conditions.

The social survey system is based on the daily control by representatives of the trade unions. They are often used as bypass of the hierarchy and have an easy access to the highest level of the management. As legally required, a safety review meeting with elected representatives of the trade unions, the safety services and the management is organized on a monthly basis. This committee agrees annually on a generic action plan and can enforce constraints below the legal limits, as it is e.g. the case for the individual dose burden.

The management survey system is based on a quality assurance system, implying a set of procedures and instructions that are often related to safety. The most important is the ALARA-procedure, requiring a risk assessment and a prediction of consequences (e.g. individual and collective doses) before each hazardous operation. The depth of the analysis and the review procedure depend on the perceived severity of the operation. The procedure foresees also a formal feedback, comparing the predictions with the observed consequences. The most important cases are discussed within the ALARA-committee, composed by members of the hierarchy, independent experts and members of the safety services. Specific committees are created to review the experiments in the BR2-reactor and in the underground laboratory. Each committee is reporting to the general manager, who can be invited to specific meetings.

The management is also informed by the evolution of safety by a keyboard of safety indices, resuming on a monthly basis, the distribution of individual doses, the collective doses, the atmospheric releases, the amounts of

radioactive waste produced and evacuated, the number of accidents, the working days lost and the number of real and false fire alarms. This keyboard is a useful tool to guide the safety culture of our facilities.

At nuclear installations, the accumulation of radioactive waste could become a significant threat for the quality of working conditions. The management has to imply a strict system to collect, inventorize and evacuate the waste production. Adequate monetary provisions have to be constituted to handle the waste coming from the future dismantling of today's installations and experiments.

3.6. Emergency management and external communications

The highest management level has to guarantee the quality of the emergency facilities, procedures and know how. The general manager is called to co-ordinate the emergency plan in case of an accident. This requires a personal comprehensive insight in the risks of the installations, allowing an efficient concertation with technical and safety experts in case of a crisis.

The external communication is an important aspect of the emergency management. The management has to survey the communication with the safety authorities and with the press media in order to facilitate the protection of workers and members of the public.

The care for external communication is however not restricted to accidental situations. SCK•CEN signed a convention with the safety authorities to report anomalies at a far less level of severity than for which reporting is legally required. Each event from level 1 on the International Nuclear Event Scale (INES) of IAEA has to be made public by a press release. This means that each loss of a single barrier in the defence-in-depth system has to be reported.

3.7. Research on human sciences

SCK•CEN started a research programme on the human science related aspects of nuclear activities. Collaborations are set up with academic researchers to analyze the human thinking in several situations. Today, issues as the communication barriers due to cognitive dissonance (the bad news is not heard) and the perception of risks during emergencies are studied. By this research, we will get more insight in the sociological and psychological aspects related to nuclear safety.

4. Conclusions

SCK•CEN is a nuclear research centre. The nature of the facilities, the economic situation and the characteristics of the personnel have a specific impact on safety issue. The management has to keep a real safety culture alive. This requires a formal organization of proactive risk assessments, quality control of installations, quality assurance of procedures and training at each level.

It is important to create a spirit of open communication to allow an efficient feedback of problems. Safety control has to be redundant in a way the bad news reaches always the management level. A specific care is needed for emergency preparedness and external communication.

In a nutshell: the manager has to take the difficult decisions, has to detect the top of the iceberg and to enforce some less popular procedures. This requires safety-minded managers.