SOME CULTURAL FLAVORS OF SAFETY CULTURE

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Abstract: Safety culture has got a wide acceptance in nuclear power operation. The concept is closely related to issues of management and organization. Safety culture is not a universal concept, but it has to be related to a national context and given anchoring in the specific environment of a nuclear power plant. In spite of its relativity it should still be possible for outsiders to assess manifestation of safety culture. The paper discusses aspects of safety culture with a special emphasis on the use of the concept as a management tool. Further development of the concept is also discussed. A conclusion of the paper is that safety culture needs further development and proper connections to management sciences and organizational theory.

1. INTRODUCTION

Safety culture is a concept that has got a wide acceptance in nuclear power operations. IAEA has been instrumental in developing the concept with detailed guidelines for international reviews of safety culture. Safety culture is thought to be expressed through a commitment to safety on all organizational levels. Individual commitment within nuclear organizations is a crucial issue of safety. Safety culture and its manifestations seem however more ambiguous. A generality of the guidelines should be a goal, but assessments should be adapted to the environment where they are to be applied. This adaption goes beyond simple translations of of questions and should also take stand on conformity of practices with local requirements.

The concept of safety culture got a social requisition in the Chernobyl accident[1]. Even a superfluous analysis makes it apparent that a deficient safety culture contributed to the accident. To what extent this insight can be used to prevent new disasters is another question. The inherent ambiguity of the concept tends to shift the difficulty of assessing safety practices to the problem of defining safety culture. A simplistic interpretation of the concept may propose the use of a technically oriented definition to which conformity can be checked. Reality is richer. Safety culture cannot be decoupled from its cultural anchoring in values, attitudes and practices and these may vary between plants. A simplistic application of the concept may even do more harm than good.

Even if it is assumed that safety culture can be assessed objectively, it is difficult to find means to improve it. An assessment of the level of safety culture within a specific organization is based on indicators. Improving the indicators without impact on safety is evidently not the intention. To achieve a permanent improvement can also be difficult[2]. An orientation towards continuous learning is an important component of safety culture[3]. To get the full benefit of assessing safety culture it is necessary to dig deeper into the concept and its causal precursors. Only then safety culture and therefore also nuclear safety can be influenced by conscious management efforts.

2. THE CONCEPT OF SAFETY CULTURE

Safety culture was introduced in the aftermaths of the Chernobyl accident[4]. The concept got an immediate interest and many people asked for additional clarifications. The work of IAEA:s International Nuclear Safety Advisory Group (INSAG) continued and a more thorough report was

Presented at the ANS - IAEA - OECD/NEA International Topical Meeting on Safety Culture in Nuclear Installations, Vienna, 24-28.4.1995.

written[5]. Work was carried on and IAEA is now offering missions for assessing safety culture by international teams (ASCOT). Lists of questions have been developed to support these missions[6]. Safety culture has got a good acceptance within the nuclear community. The success can be attributed to an implicit need that has been given an explicit anchor in the concept.

Safety culture is defined as "that assembly of characteristics and attitudes in organizations and individuals which establishes that, as an overriding priority, nuclear plant safety issues receive the attention warranted by their significance." Safety culture is further said to consist of "two components. The first is the necessary framework within an organization and is the responsibility of the management hierarchy. The second is the attitude of staff at all levels in responding and benefiting from the framework." The safety culture concept relies also on a definition of commitment to safety by all persons involved (Table 1).

Table 1.Safety culture defined as commitment of people.

policy level commitment
statement of safety policy
management structures
resources
self-regulation
managers commitment
definition of responsibilities
definition of control and safety practices
qualifications and training
rewards and sanctions
audit, review and comparison
individuals commitment
questioning attitude
rigorous and prudent approach
communication

Lessons from Chernobyl and other spectacular accidents (TMI[7], Challenger[8], Bhopal[9], Piper Alfa[10]) demonstrate that human errors and organizational deficiencies have a crucial influence on the sequence of events. The lessons learned show that accidents are caused by a combination of simple disturbances that are aggravated by numerous hidden deficiencies in the systems. An understanding of the course of events can be obtained only through an analysis within a technical, organizational and personnel perspective[11]. There have often been earlier warnings in incidents with similar initiating events as the accident.

Safety culture, as it has been defined, is not explicitly concerned with organizational and management issues, although these are implicit in many questions. One early project on safety implications of organization and management in nuclear power was carried out 1982-85 within the Nordic Research Programme on Nuclear Safety[12]. IAEA has been involved in a few meetings on organization and management[13][14]. The importance to address cultural aspects of organizations was pointed out in a recent study[15]. Efforts have been spent to create a framework for including organizational factors in the probabilistic safety analyses (PSA)[16].

In spite of its success the concept of safety culture can be criticized. It does not seem well anchored to mainstream research of management science. The concept is inherently vague which makes it difficult to draw firm conclusion for actions of improvements. Is it possible to force all important aspects of safety into the concept or not? It is also difficult to specify the view to be taken in an assessment. Should it be the view of corporate management, plant management or regulators? If the concept is intended to identify weak signals of deteriorating performance, questions should be more specific. There is also a danger that international review teams will make an assessment too dependent on the assessors' own cultural frame. The safety culture concept seems to overemphasize nuclear safety without stress on a successful balance between conflicting requirements of safety and economy.

3. MANIFESTATIONS OF SAFETY CULTURE

A manifestation of safety culture should be apparent in all the work at a nuclear power plant. As has been argued earlier that safety precautions can be expressed in the simple model of Figure 1[17]. Safety goals and targets are fed to a safety analysis that is providing a predictive planning instrument. This is acting as a feed forward control path determining plant design and operational practices. The collection of operational experience provides a feedback path for assessing possible deviations from the predictions and thus places where actual practices and used prediction models should be improved.

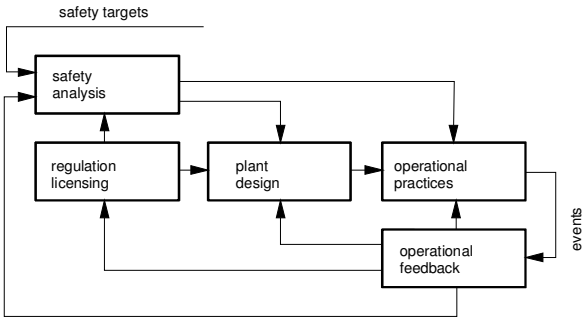

Figure 1.The model of safety precautions.

A regulatory agency plays an important role in the model above. It is assumed that safety requirements can be defined and demonstrated in the interactions between the regulator and the plant operator. The regulator can be seen as the representative for the public in ensuring that a plant is acceptably safe. Regulation is anchored in national legislation. Approaches in various countries are still very similar due to efficient international exchange of information. Relationships and interactions between the regulator and the nuclear utilities are very important for a continued safety. The nuclear utility should accept and support the regulatory efforts and the regulator should never get too close to operational decisions at the plant.

The level of safety culture has to be measured by indicators, because no direct measuring method exists. In assessing performance indicators it is important that they express appropriate characteristics (Table 2,[18]). In using performance indicators it is important also to understand that they may become ends in themselves. A too large emphasis should thus not be put on some specific performance indicator, because priorities may shift. In specifying a set of performance indicators it is important to be prepared to change them at regular intervals. This need is also connected to the need of performing regular reviews of operational practices.

Table 2.A set of ideal characteristics of performance indicators.

Close relationships to risks and/or safety,
Data readily available,
Quantitative (show range of performance),
Unambiguous,
Unlikely to cause undesirable actions,
Significance should be understood (objective and fair),
Industry wide applicability,
Not susceptible to manipulation,
Physical results,
Independent indicators essential,
Manageable set,
Worthy goal.

One important component in the manifestation of safety culture is a strive for excellence. Operational excellence is however not connected only to safety performance, but also to economic and technical performance. The definition of performance brings the need to find a proper balance between safety and economic performance. A good economic performance gives larger margins for plant improvements and will therefore have a positive influence on safety. Too large weights on economic performance may however jeopardize safety.

In searching for manifestations of safety culture the ambiguity of the concept is important. The ambiguity may even be used to hide problems with safety implications. Available guidelines provide

support for a self-assessment of safety culture, but their literal use without understanding may direct attention in wrong directions.

4. SAFETY CULTURE IN VARIOUS CULTURAL SETTINGS

A major question is to what extent the concept safety culture can be applied to a large variety of organizations. The word culture stresses the connections with family, language and communication, religion, government and politics, education, transformations and technology, society, economic structures and activities[19]. Reluctance should therefore be present in transferring considerations from one country and one plant to another. Cross-cultural comparative studies have been carried out within management sciences[20]. A recent issue of the journal Management Science stressed the importance of transferring concepts and models between cultures[21].

Nuclear plant vendors are international companies with customers in many countries. Technologies and corresponding safety approaches are exported from one cultural setting to another. The adaption of the technologies has usually been made only with little consideration for cultural questions. Some countries have acquired plants from two or more vendors which have forced them to create safety concepts encompassing very different approaches. International exchange of experience has on the other hand tended to make these approaches to converge.

There is evidence that a disregard of cultural difference may introduce problems. Deficiencies leading to the Bhopal accident were at least partly caused by cultural differences not accounted for. Anecdotes from the offshore field in the North See also suggest the need for a reconsideration of cultural roots of operation when a technology is moved from environment to another. According to results from business organizations the most problematic situations emerge if there is an incongruence between underlying core values in two different cultural settings[22].

The Nordic model of managing nuclear power divides into Finnish and Swedish models. The development of these models has been supported by views of Danish and Norwegian experts through safety research funded by the Nordic Council of Ministers. The Finnish model has a further subdivision into BWR and PWR culture at the TVO and Loviisa plants. This is not to say that one model is better than another, but to stress that the cultural environments of the plants have to be considered. Only then it is possible to enter constructive talks on the transfer of good management principles. In admitting the cultural relativity of management theories, one should however not make the mistake to believe that everything is relative. Such a conclusion would actually assume that learning over cultural borders is impossible.

Cultural variety pose interesting questions in the transfer of nuclear technology from one country to another. What are the specific considerations that have to be changed? Will the cultural differences make it necessary to make changes also in the technical design, or is it enough that documentation is translated to the language of the host country. To what extent the nuclear technology presumes a certain culture and how could this be created in the receiving country? These questions have to be given far more consideration than has been done so far.

The proposed approach for assessing safety culture is to utilize international teams. This is certainly correct for an exchange of good operational practices. To what extent the experts should understand the cultural environment of their mission country is another question. Again it seems difficult to carry

out such missions disconnected from local culture. A certain humbleness in the assessments should always be present. Similarly it is necessary to be explicit enough in expressing concerns to make sure that important messages are crossing possible language and cultural barriers. Last it is always important to remember that even scientists have a cultural background that may introduce unconscious biases[23]. Culture brings in expectations for things to be and those expectations may color what we see.

5. SAFETY INDICATORS AS A MANAGEMENT TOOL

The ideal use of the safety culture concept is as a management tool. This means that managers should react on a bad safety culture. To select proper reactions can however be extremely difficult. Safety culture is assessed through a number of indicators, but it is not enough to improve just them. In selecting proper actions it is necessary to use the full spectrum of rethorics, collective pressure, praise, promotion and rewards to influence norms, beliefs, roles, attitudes and practices of the organization[24]. In selecting actions it is important to remember that people are extremely sensitive to genuineness in messages sent.

Any assessment should use both objective and subjective indicators. Subjective indicators can be based both on self-evaluation and evaluations by outsiders. Interviews and questionnaires can be used. Interviews are time-consuming, but can give more in-depth results. The assessments can be restricted to only a few key persons within the organization, or it can be a complete organizational review covering all organizational levels and most of the people. There are various reasons for entering an organizational review. If not for other reasons, organizational reviews should be carried out at regular intervals. One reason for initiating an organizational review is when some incidents give indications of problems. A review can also be connected to some outside activity providing a reason to measure the "temperature" of the organization.

An organizational review should be tailored to specific needs. It should be restricted with respect to used resources and time. Despite its scope it should assess all major variables that are important for safety. Table 3 gives a proposal for a list of important variables to be checked. Definition, communication and checking of goals are a part of the strategic planning process that is important for systematic operation. The orientation variable measures approaches to work and used problem solving strategies. Contradicting goals are present in any activity and the variable would measure the extent these contradictions have been resolved and communicated. Operational planning refers to a variable characterizing the degree of systematics in the operational work. The final variable organization structure carries an assessment of the coverage of organizational design and the efficiency in handling emerging informal practices.

Table 3.Five major variables to be assessed in organizational reviews.

goals, definition and communication of goals, commitment to goals, checking achievements of goals
orientation, approaches towards work, typical problem solving strategies, spectrum of used actions
resolving contradictions, contradictory requirements, resolution of contradictions, instructions and procedures
operational planning, planning systems, communication and implementation of plans, changes in plans, follow up systems
organizational structure, task division, cooperation, communication, formal and informal organizations, reporting

The variables above are covered at least to some extent in most questionnaires. The orientation and contradictions' variables are perhaps not as well documented and may therefore need some clarifications. Orientation was originally used as a variable in a study on flexible manufacturing systems[25]. The concept was further elaborated in [26] and used in a study of maintenance personnel at a nuclear power plant[27]. In that study individual orientations where typed according to Table 4. An organization is assumed to carry better abilities for a continued improvement with orientations of individual initiative and systematic development. The routine orientation may in this formulation not seem to stress compliance to instructions, but a slavish unthoughtful following of instructions does not comply to a good safety culture.

Table 4.Four basic orientation types.

Withdrawal. If a problem is conceived as a threat the person withdraws, or expresses reluctancy to make a decision.

Routine. Problems are tackled using instructions and a situation without instructions may be felt as a threat.

Individual initiative. Implicit expansions of tasks are taken and the possibilities to improve task execution are made overt.

Systematic development. Further expansion of regular tasks are taken to search for better ways of establishing organizational structures.

Orientation is also connected to span of control. A systematic development orientation implies that persons use their whole span of actions for achieving defined goals. The plant manager should for instance understand and make operational the operative, tactic and strategic dimensions of his/her decisions[28]. Operative decisions have typical reaction times of 1-3 years and include definition of ambitions, outage planning, technology utilization, transient management, housekeeping, etc. Tactical considerations may include approaches to safety, involvement as architect-engineer, creation of favorable motivational climate, maintaining international information channels, careful analysis of operating disturbances, honesty in communication, maintaining the right to make errors, good training and licensing system, continuous plant improvements and practical QA system. Some strategic concerns may be outside the immediate influence of the management such as educational systems, technological traditions, status of power engineering, communication between main actors, union cooperation, public acceptance, competent suppliers and solid utility economy.

The need for addressing contradictory requirements has been brought forward in several [2930]studies. Popular bestsellers have made the observation that successful business organizations can simultaneously manage apparent ambiguity and paradox[31]. Nuclear power is similarly bound to resolve contradictory goals and allow them to coexist. The most important of these contradictory requirements is the need to balance between economy and safety. On a lower level the contradictions of Table 5 should be understood, resolved and communicated.

Table 5.Contradictory requirements within a high-reliability organization.

A healthy self-esteem	accept outside advice
Formal	informal rules for assuring safety
Accept errors	require errorless performance
Centralized	distributed decision making
Managing details	maintaining the overview
Search for information	avoid information overload
High specialization	generality of roles
Cooperation	competition for resources and power
Monitoring and reporting	confidence and trust
Move from past strategies	enforcement of roots

The will to improve has to come from the inside the organization. Outside pressure may initiate a process of change, but actual improvements have to originate from the organization itself. One can actually say that the organization should have a proactive orientation towards improvements. This

implies listening to weak signals of emerging problems. By an analogy these can be heard only if the listener is tuned to the problems. This is another way of saying that any review should, to some of its parts, be tailored to situational needs as felt by the management. It is also necessary that the review is decided at a level having the highest authority for the part of the organization where the review is carried out. There is a benefit of using a combination of outsiders and insiders for the reviews. It is also beneficial to combine both technical and human factors experience among the interviewers. The review should as far as possible be treated as an internal affair of the reviewed organization.

6. SUGGESTIONS FOR THE FUTURE

Safety culture is an important concept, but it should be blended with ideas from management science and organizational theory. The cultural component of safety culture, i.e., the extent to which it is influenced by local and national cultures should be investigated. The concept of safety culture should be merged into a theory of safety oriented or high-reliability organizations. Evidently management practices in a safety oriented organizations are different from business organizations and governmental bureaucracies, but the difference may not be that large. There are other safety oriented organizations such as civil aviation, chemical industry and offshore production, with which nuclear industry could exchange experience on safety matters. This kind of technology transfer does not seem to have been very efficient in the past[32].

The close consideration of human factors issues and organizational deficiency has brought still one additional requirement onto the management of nuclear power plants. It is apparently not enough to have technical skills, but they should be combined with managerial skills. Managers should in addition be able to understand subtle issues of behavioral science. Obviously adding more requirements will narrow down the possibilities to find and train individuals for managerial positions at the nuclear power plants. If research can come up with methodologies and systems for supporting managers as well as their selection and training processes important work has been done.

There is an evident benefit of an efficient exchange of international experience. It is not only regular conferences and meetings that should be supported, but also exchange and missions that are exposing managers to other practices and ways of thinking. The OSART, ASSET and lately the ASCOT missions of IAEA provide to this kind of exchange. Only by using the operational experience of all reactor-years, it will be possible to maintain a continuing safety of the nuclear power plants in the world. In that intensified exchange of information there is however still a need for assuring a plurality in approaches.

The largest single threat towards nuclear safety seems to be the defacto moratorium on nuclear power. The industry has been forced to cut down in personnel and spending and have been concentrating on a strategy of survival. This strategy may not be successful if no new openings can be ensured. Nuclear industry seems to have entered a vicious circle where an absence of public confidence and trust makes it harder to maintain a level of safety warranting this confidence and trust.

It seems necessary to ceate an international research agenda addressing safety oriented organizations. Such research would address also some remaining problems. One is the handling of a crisis period that typically causes changes of decision locus where decisions migrate between hierarchical levels within the organization[33]. Another problem is connected to the inclusion of organizational factors in the PSA:s[34]. This research should be directed to survey cultural components of safety. An unbiased

comparative study of good operational experience is likely to provide important answers. It may not be optimal to involve the international organization directly in this work, because they are sometimes hampered in their actions due to political reasons. The most attractive possibility is to involve academia in a truly international project. The necessary funding for such an endeavor may however be difficult to find.

7. CONCLUSIONS

Safety culture is an important concept. The ambiguity of the concept has both pros and cons. It is easy to adapt to various cultural environments, because everyone will read their own fads into the concept. It is more difficult to use as a norm for developing methods for assessing and improving the level of safety culture. The use of the word culture contains an implicit relativity that never should be forgotten. Safety culture has an important anchor in organization and management that should be supported. Research results from management science and organizational design should be used in this process. Results should be adapted to practical needs of safety oriented organizations.

Theories and research instruments to assess cultural influences are less universal than we would like to believe[35]. This applies also to the concept of safety culture. It has been argued that scholars in organizational theory should extend their research to incorporate a cultural context in their research. In that cross-national comparisons would provide a new basis for collaborative efforts[36]. This conclusion is most appropriate also for nuclear power.

One of the most difficult questions managers at a nuclear power plant are faced with is the allocation of resources for safety improvements. Good economics of the plant makes it easier to agree on sufficient investments in safety. One tool for supporting these decisions is plant specific living PSA:s. This tool should however be better tuned also to questions concerned with organization and management.

A question on an international level is to how support plants where improvements are necessary, but the economic situation make improvements difficult. Nuclear is a really international technology where "An accident anywhere, is an accident everywhere". Because the whole industry is judged by its worst performers, it is in the interest of everybody to ensure that all plants can be operated safely. How this can be achieved in an increasingly competitive climate is another question.

19.1.1995

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