Role of Regulator in Promoting Safety Culture

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Abstract:
In order to operate a nuclear installation safely, it is not enough to have a technically safe system. For safe operation, it is also equally important that the operating personnel should have a proper attitude to safety and the management, as well as the workers must be committed to safety and must realize that safety has the highest priority above all. This is the concept of safety culture.In spite of all recent efforts there is still room for improvement in understanding the concept of safety culture and implementing it effectively worldwide in the management of all NPPs.The main goal of this paper is to discuss the role of regulatory body in determining the level of the safety culture and how to promoteand assess safety culture. Also, this paper sheds the light on concerned with defining the attributes of a good safety culture and describing how nuclear plant operators can develop those attributes.

1. Introduction

A key element of a nuclear power plant's safe operation - its nuclear safety culture - depends on every employee, from the board of directors, to the control room operator, to the field technician in the switchyard, to the security officers and to long term supplemental individuals on site [1].

The concept of *"Safety Culture"* for the first time was announced in 1986 while studying the causes and aftermaths of Chernobyl disaster performed by the International Agency of Atomic Energy (IAEA). It was recognized that it was the lack of safety culture that became one of the causes of the disaster. Using safety to modify culture implies that safety culture is a subset of a greater plant culture with respect to normal operation and power production [1]. Research community turned to the studying the parameters and attributes of safety culture in an effort to know how safety culture affects human performance.

An early definition was given in the INSAG-4 report in 1991:

"Safety Culture is 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. Thus, it is understood that safety culture refers to an organization's basic safety values, attitudes toward conservative operation, quality, professionalism, continuous learning and improvement processes as well as an environment in which workers are free to raise safety concerns without fear of retribution [2].

International advisory group in nuclear safety in team of IAEA director general suggests the following definition of the concept:

"**Safety Culture** is such parametric and specific of activity of organizations and separate persons' behavior that determines that nuclear power plant safety issues as those which have the highest priority are devoted the attention defined by their significance". Safety culture can be defined as a leader attitude that ensures a hazardous technology is managed ethically to ensure that individuals and the environment are harmed [1].

The experience of nuclear power plant operation demonstrates that causes of accidents and incidents origin in any events are connected with the behavior of people (human factor), notably, with their attitude to the safety issue. Therefore human resources, style and methods of management, physiological atmosphere inside of the employee's staff of the enterprise should be at the center of management.

Analyzing accident showed that lack of a safety culture can lead to operator behavior which breaches multiple barriers of the entire defense-in-depth safety fabric. That is, when the basic safety values, norms and attitudes of an entire organization are weak or missing, then one can have procedures ignored, operating limits exceeded and safety systems bypassed, no matter how well they have been designed and built [3].

Both all personnel and top management also are included into the process of safety culture forming. Currently-operating Committee in safety culture should be a collegiate body which coordinates nuclear power plant departments' activities as regards to maintenance and improvement of personnel safety culture works at NPP.

Special attention is devoted to formation of personal responsibility and adherence to safety culture of all those, whose activity influences NPP' safety. Owners of NPP policy aimed to make personnel, be critical regarding their actions and avoid showing mildness of temper in safety issues. NPP administration is intent to create conditions in which workers will not be afraid to report about their own faults. It will allow avoiding repeating them in future. It provides each worker with not only the right but also a practical possibility to participate in introducing proper operational order by recording comments and proposals to a central database. Safety culture mandatory requirements are also presented in the context of the management commitment, responsibilities of the management representative, scope of the management procedures, exchange of the information, requirements for contractors, management of changes, self-assessment, and reporting requirements [4].

Ideal safety culture is the engine that drives the system towards the goal of sustaining the maximum resistance towards its operational hazards, regardless of the leadership's personality or current commercial concerns [5].

2. Safety Culture Characteristics
All various definitions of SC indicate that SC can be characterized by five attributes as shown in Fig. 1. These attributes include the following core meaning is [6]:

- Prioritize safety as a shared value within an organization. In order to work with safety culture, organizations should spend sufficient time to reach a common understanding since the concept by its nature is difficult to explain in a few sentences.
- Safety culture does not exist in isolation and is influenced by the prevailing organizational climate or culture. It is important that the organization culture be supportive of safety and, particular, that it should encourage the appropriate behavior, attitudes and values on the part of the employees [5].
- Culture is a dynamic concept that encompasses everything that happens in an organization. It affects what we do, what we think, and what we make sense of – it is our collective understanding of reality. Therefore, to eliminate ambiguity, it is valuable for an organization to share perspectives about what safety culture encompasses in day to day work-related tasks.
- Perform an early assessment of national and local cultural attributes in relation tosafety awareness and attitudes toward risk. National and local cultures are the context within which safety culture must be developed. Efforts should be directed at strategies for countering attributes that would hinder the development of a strong safety culture.
- Assign leaders with an understanding of and commitment to developing a strong safety culture. Such leaders have the courage to promote organizational learning by questioning established practices, revitalizing complacent organizations, and helping those who are not familiar with best practices.
- Engage external expertise in the early phases, specifically in the areas of safety, safety culture, human performance, organizational design, management system design, and regulatory development
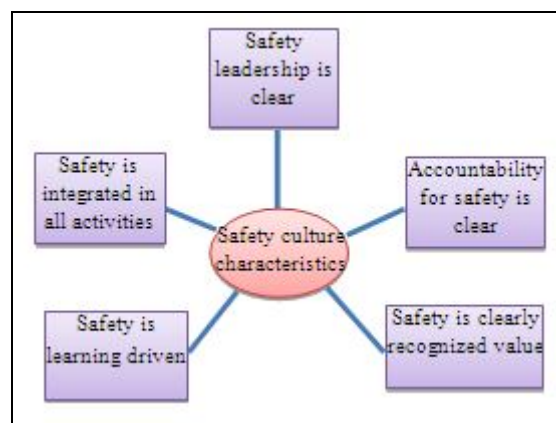

Figure 1: Safety Culture Characteristics

3 Modeling Safety Culture Approaches
Many recent attempts for modeling safety culture have approached safety culture from three perspectives: psychological, behavioral and structural. These three approaches are triangulated to provide a view of the prevailing safety culture, making use of existing measurement tools and methodologies: (a) safety management system audits, (b) safety climate surveys, and (c) behavioral safety scores. Implicitly or explicitly, most academic definitions of safety culture encompass these three perspectives [8]. Another approach for modeling safety culture based also on 'individual and group values and attitudes' refers to members perceptions about and attitudestowardssafetygoals;'patternsofbehavior'referstomembersday-to-daygoal-directed safety behavior; and, the 'style and proficiency of an organization'shealth and safety programs' indirectly refers to the presence and quality of organizationalsafety systems to supportgoal-directedsafetybehavior [7].

The many separate practices interact to give a much larger effect'. It becomes clear that this working definition of safety culture alludes to the reciprocal relationship between an organization's safety management system(s) (SMS), the prevailing safety climate (perceptions and attitudes), and daily goal-directed safety behavioras shown in Fig.2. Since each of these safety

culturecomponentscanbedirectlymeasuredintheirownright orincombination,itispossibleto quantify safety culture in a meaningful way at many different organizational levels, which hitherto hasbeensomewhatdifficult.
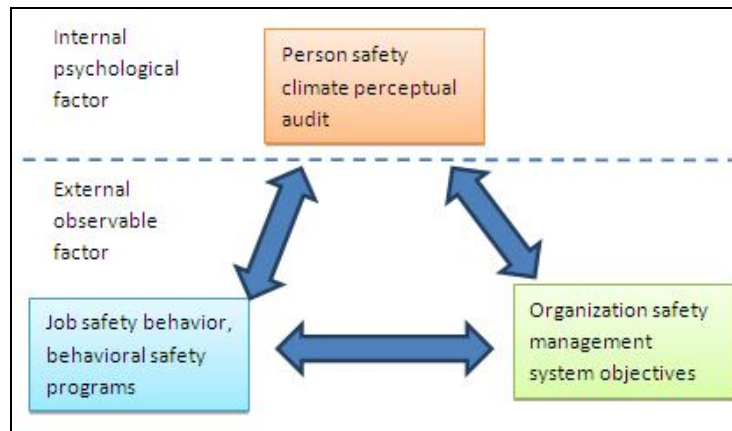

Figure 2: Safety Culture Modelling

4. Safety Culture Implementation and Development

Implementation of nuclear safety culture in an organization that is an amalgam of cultures and organizational experiences calls for an integrated, holistic approach as well as for the use of external standards and models. Such models could come in the form of really experienced people who will serve as an example and allow for gradual implementation of the safety culture within the organization [3]. It is hard to change the attitudes and beliefs of employees by direct methods of persuasion. But acting and doing, shaped by organizational controls, can lead to thinking and believing [5].

In this case there is a need for an in- depth analyses and knowledge to start to develop and implement a new culture which will create a basis for the strong safety culture with an appropriate education background, training and competencies as well as attitudes and behaviors of workers with a strong support of leadership leads to the nuclear safety and public trust for the future NPP operator

Based on the theory of safety culture and supported by the theory of human error, the idea of acceleration of the safety culture development and the work of human performance, which is characteristic of "promise-making and example-setting of managers, influence radiation and penetration of the main force, participation and contribution of staff. International safety idea characteristic of in-depth defense, initiative prevention, and conservative decision-making; safety management idea characteristic of localized practices [4]. Safety culture evolve gradually in response to local conditions, past events, the character of leadership and the mood of workforce [8].

5. Safety Culture and Regulatory Body

Safety is the primary purpose of the regulatory body. What is more difficult for the regulator is finding the right balance of firmness but fairness in dealing with the operator. In addition to enforcing safety regulations, the regulator should have a positive effect on the operator's safety culture.

The regulator can promote safety culture in the operator's organization just through the mere fact of placing it on the agenda at the highest organizational levels. The operator's priorities are influenced by those matters regarded as important by the regulatory body. Thus, the regulator can stimulate the development of a safety culture by providing positive reinforcement for good performance and high quality in plant work processes, by encouraging good safety practices, by promoting the examples of operators having a good safety culture, and by recognizing initiatives of industry organizations [6] [8].

As safety culture involves everyone, whose attitude may influence nuclear safety, not only the utility operators but also the regulatory body. The aim of this document is to focus on the dual role of the regulatory body in both (a) promoting safety culture, through its own example and through encouragement given to operators, and (b) evaluating the safety culture of licensees through performance or process based inspections and other methods [7].

Safety culture cannot be easily regulated and controlled taking into account the fact that it is based on the attitudes, beliefs and other psycho sociological features of the employees. These attributes cannot be strictly documented and measured. However, it probably can be regulated and controlled indirectly. Although safety culture is easy to speak about its importance for nuclear safety, it is very difficult to deal with safety culture itself, to measure, strengthen it or even to try to regulate it. The relation between safety culture at nuclear power plants and regulatory authority can be defined and discussed in terms of legal requirements, guidance, international standards, routine inspections, discussions, seminars and other measures as shown in Fig.3.

Defining and establishing an effective safety culture and recognizing related trends is still a recent initiative, undergoing development and review within operator organizations and regulatory bodies. As more studies are performed and experience is gained in this area, the role of the regulator in promoting and evaluating safety culture will continue to evolve and mature [7].
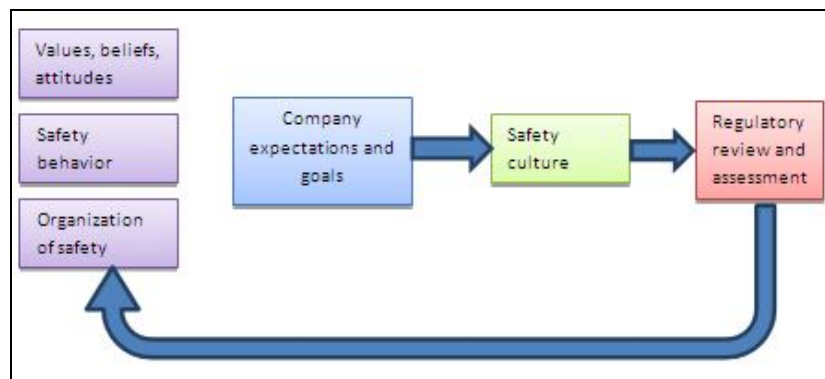
Figure 3: Safety Culture Adaptation

Regulation and control of safety culture is quite a complicated task to fulfill this task competently, it depends on many factors; the most important one is the safety culture of the regulatory authority itself. Safety culture related regulatory requirements can be defined in a number of mandatory requirements such as:

- The management system shall enhance safety culture of the organization. In this regard the organization shall:
    - Ensure proper understanding of safety culture issues;
    - Provide necessary resources and measures to the employees
    - Promote training in all levels of the organization;
    - Systematically evaluate and promote the safety culture.
- Management shall evaluate safety culture based on the employee surveys, monitoring, self-assessment results and effectiveness of the management system. NPP operating organization shall organize the employee surveys at least once per 3 years.
- Safety culture monitoring criteria and evaluation methodology shall be prepared by licensee and agreed with regulatory authority.

The following tools, applicable for assessment of these safety culture related issues, were described in the document [6]:

- Audit;
- Employee surveys, interviews;
- Employee surveys, questionnaires;
- Incident reporting and evaluation;
- Safety performance indicators;
- Involvement of employees in safety planning;
- Personnel statistics;
- External peer reviews;
- Periodic reporting.

6. Regulating Safety Culture

One of the most difficult challenges in assessing the safety performance at a nuclear power plant is to recognize the early signs of declining safety performance, before conditions become so serious that regulatory sanctions must be imposed or, worse, a serious incident or accident occurs [7]. Safety culture, probably, cannot be regulated directly, especially if we speak about psycho sociological features of the employees. However, it definitely can be influenced indirectly through the safety culture related issues. When we speak about influence to the safety culture of the licensee, it should be understood that safety culture can be influenced positively or even affected negatively. And in this context competence of the regulatory authority is crucial [6].

The Nuclear Safety Law of a country should include statement regarding the safety culture. It should declare that nuclear facilities operating organizations and other licensees shall ensure high level of safety culture within the organization and its employees. The statement provides a legal basis to describe this understanding in a more detailed way and enables the regulatory authority to control the safety culture related activities [6].

So based on the national legislation, cultural aspects and existing experience in a specific country, safety culture can be regulated in different ways. General requirements can be presented in the top level legislation. More detailed requirements can be presented in the mandatory regulatory documents. And much more detailed safety culture related aspects can be regulated through the non-mandatory guidance type documents. The IAEA standards can be used also as reference requirements or guidance.

7. Safety Culture of Regulatory Body

Regulation and control of the safety culture related issues cannot be separated from the safety culture of the regulatory authority itself. It should be difficult to understand proper regulation of the safety culture issues if the regulatory authority is not in the position to

ensure that the existing regulatory and control practice is based on the proper application of the safety culture understandings. The following issues in this respect can be highlighted [6]:

- Competency of the regulatory staff. This is a basis for all activities of the regulatory authority.
- Properly developed internal management system. Properly developed internal management system essentially contributes to the effectiveness of the regulatory authority and efficiency of its employees.
- Clear, consistent regulatory documents. The quality of the regulatory documents has two important aspects for:
  - The licensee can clearly understand and act based on the explicit regulatory norms,
  - The employees of the control institution can understand and be capable to properly apply the regulatory norms during the safety evaluation and inspection activities.
- Properly oriented regulatory control, no space should be left for any corruption or private interest elements of inspectors. It can totally destroy the basis for safety culture.
- Clear and consistent requirements. There are more realistic and frequent problems in this area related to the possible misinterpretation of the regulatory requirements during the inspection or safety evaluation activities.
  - It is difficult to produce perfect regulatory requirements (especially for small countries). Some of the requirements are not explicit enough,
  - Some of the regulations do not cover all necessary safety related issues,
  - And some of the regulations can be simply out-of-date.
- Proper and fair regulator decision, it happens that inspector can identify that the licensee has violated a regulatory requirement which, actually, do not create any additional value to the safety assurance. The regulatory decisions shall not disorientate the licensee from activities important to safety towards activities important for escape from possible sanctions.

The above mentioned points can be abbreviated in the following milestonesto providethe basis for proper safety culture regulatory environment [9]:

- Safety culture of the regulatory authority itself;
- Proper identification, regulation and supervision of the licensee's safety culture related issues; and
- Enhancement of the safety culture regulatory and control activities through the possibilities provided by and duties derived from the international cooperation.

The nature of the relationship between the regulator and the operator can influence the operator's safety culture at a plant either positively or negatively. In promoting safety culture, a regulatory body should set a good example in its own performance. This means, for example, the regulatory body should be technically competent, set high safety standards for itself, conduct its dealings with operators in a professional manner and show good judgment in its regulatory decisions. Some of the attributes of a good regulatory safety culture are the following [7]:

- a clear organizational commitment to priority of safety matters;
- clear lines of responsibility within the regulatory body;
- a program of initial and continuing training to maintain regulatorystaff competence;
- a personal commitment to safety from every staff member;
- good communication and co-ordination between organizational units of the regulatory body;
- clear guidelines for conducting safety reviews;
- clear guidelines for conducting safety inspections;
- clear regulatory acceptance criteria;
- a commitment to timely regulatory decisions;
- a commitment to regulatory intervention that is proportionate tothe safety circumstances; and
- The use of risk insights in decision-making.

8 Safety Culture Assessments

There is no composite measure for safety culture. The changing nature of safety culture makes it unlikely that such a measure will ever be found [9]. So assessing progress in the development of safety culture should be based on identifying the range of indicators that reflect the individual sub-components of safety culture. Such component includes observable behavior, conscious attitudes and perceptions or beliefs. IAEA safety reports series No.11 [10] gave examples of methods that had been applied to measure these key components as shown in Fig. 4.
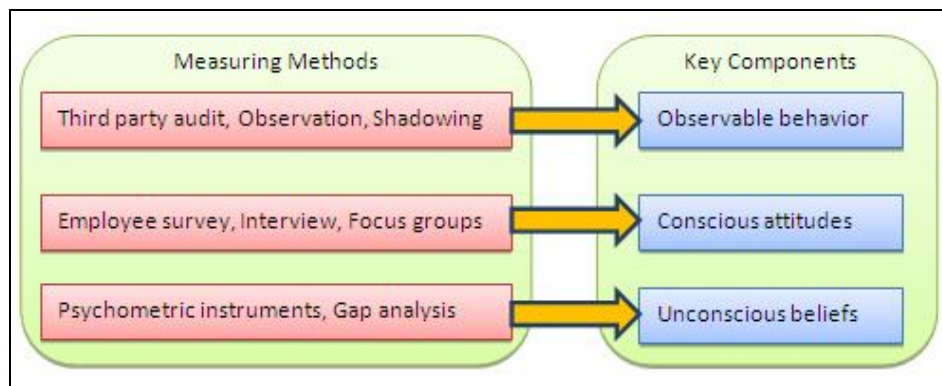
Figure 4: Measuring Methods for Safety Culture Components

To facilitate the recognition of declining plant processes and performance, the regulator may perform periodic safety assessments of a facility [7]. This should be a systematic assessment of performance based on coordinated discussions and reviews by the regulatory staff. The assessment may include the following:

- Observations by site inspectors and specialist inspectors;
- Reviews by regulatory safety specialists;
- Reviews of trends in event reports;
- Review of the effectiveness of operator's controls to identify, correct and prevent problems. These controls include: safety review committees, root cause analysis programs, corrective action programs, and self-assessment programs;
- Review of work backlog and delays in implementing prescribed actions;
- Assessment of day-to-day incidents, which can reveal both organizational weaknesses and inadequate response by individuals; and
- Review of operating events to look carefully for safety significant events or conditions that may be precursors to serious accidents.

Often it requires an analysis using Probabilistic Safety Assessment (PSA) methodology to fully understand the safety significance of a complex event. When the outcome of a safety assessment suggests the onset of declining performance, the regulator may decide upon a special surveillance program for the plant. This could include regulator meetings with plant management and staff to discuss the assessment findings and to better.

Lack of a safety culture can lead to operator behavior which breaches multiple barriers of the entire defence-in-depth safety fabric. That is, when the basic safety values, norms and attitudes of an entire organization are weak or missing, then one can have procedures ignored, operating limits exceeded and safety systems bypassed as shown in Fig 5., no matter how well they have been designed and built. A conclusion can be driven [4], "an accident comes from a minor deviation and a consequent result comes from a minor error and the tolerance of the minor error".

Figure 5: Effect of Weak Safety Culture on Safety

8.1. Methods of Assessing Safety Culture
Various activities can be used to assess an organization's safety culture. These include direct observations, assessments, Causal Factors or Root Cause Analysis, surveys, interviews, review of key safety culture related processes, performance indicator monitoring and trending, and Voluntary Protection Program VPP type assessments [2] [11] [12].

- **Direct observations of work place behavior** may provide objective information regarding the effectiveness of training, management effectiveness, accountability, and behavior expectations. Observed management behaviors may indicate whether a supervisor is receptive to concerns and supports and rewards employees for raising concerns.
  Direct observation of employees in the work environment can provide valuable insights into the employees' buy-in to the ISMS and their questioning attitude and willingness to challenge perceived unsafe behavior. One advantage of these direct observations is that you can watch the culture as it enacts itself, thus it is possible for the observer to confirm results obtained from interviews and/or surveys. Observations provide new information on cultural phenomena, but they cannot be quantified and used for statistical purposes. Be careful as there is the risk of over-generalization from too few observations.

- **Causal Factors Analyses or Root Cause Analyses** are useful tools to evaluate an organization's safety culture because they start with façade of a strong safety culture being stripped away because obviously a serious incident or accident is being investigated as result of a significant organizational failure.
- **Surveys** can be useful tools and complement other tools used to assess safety culture. The extent of such surveys will vary depending on the size and organizational structure. Survey results can indicate employee beliefs, attitudes, and satisfaction with key attributes and suggests ways to strengthen the safety culture. Pre-survey communications can be a very important aspect of such tools.
- **Face-to-face interviews** have a significant role to play in assessment of culture. They are commonly used as a means of providing data that will assist survey design or to explore qualitatively the issues emerging from the written survey. An advantage of the interview is that the respondent can use his or her own words and expressions. It also allows for a greater flexibility in questioning, with the possibility for follow-up questions, making it easier to get to the deeper meanings and to clarify ambiguities in meaning. They are also relatively time consuming, usually based on only a limited sample. This can make it difficult to generalize results for the whole organization. Interviews can provide more depth than normally available using a survey.
- **Review of key safety culture related processes** such as:
    - Those used for fixing problems (e.g., the corrective action program)
    - Alternative processes for raising concerns (e.g., employee concerns program, ombudsman)
    - Human resources for work environment concerns, disciplinary action, etc.
    - Legal cases for Department of Labor cases, etc.
    - Assessment findings or observations
    - Lessons learned processes including use of both internal and external operating experience
    - Whether or not employees feel free to identify issues using the various processes available to them, whether or not these processes are viewed as effective, and why or why not.
    - Effectiveness of the root cause analyses for significant issues and the effectiveness of associated corrective actions.
- **Performance indicators** provide regular feedback on the health of an organization's safety culture as opposed to assessments which represents a snapshot in time. The complexity and number of useful performance indicators depend on the size and organizational structure of the organization. Although no single indicator is sufficient in itself to identify the state of the safety culture, monitoring trends in various safety culture performance indicators as a function of time may provide insights into strengths and weaknesses.
- **Voluntary Protection Program VPP assessments** may be a source of information regarding the culture of an organization. The assessments generally include a high level of worker participation which can provide a different perspective than typical assessments. VPP assessment criteria include certain cultural aspects related to the team focus areas such as employee involvement which could provide valuable insights into organizational safety culture.
- **Stream analysis** is a tool used by the commercial nuclear industry contractors as a means of understanding the organizational drivers related to safety culture. For complex organizations, the tool is useful in helping the management team tounderstand the dysfunction within their organizations [11].
- **Self-Assessment** may provide insight into an organizations culture. The organization should be open to problem finding and facing. Also an important component of a sound safety culture is clear roles and responsibilities in an organization management [12].

8.2. Indicators of Progressive Safety Culture
Safety culture does not exist in isolation and is influenced by the prevailing organizational climate or culture. It is important that the organizational culture be supportive of safety and, particularly, that it should encourage the appropriate behavior, attitudes and values on the part of employees. Table 1 gives an example of two organizations with different safety cultures[6][8][9]. Some organizational indicators of progressive safety culture are:
- Widespread employee commitment to good safety performance, including visible leadership by top management;
- Good safety performance, considered to be a goal in itself that is important tothe organization, and not merely intended to comply with regulatory requirements;
- Investigation of the fundamental causes of events or near misses to learn lessons rather than to allocate blame;
- Effective communication of safety information including safety performance trends;
- No blame attached to employees who voluntarily report mistakes;
- Commitment to continuous evaluation and improvement of safety performance;
- Co-ordinated and regular audit program;
- Managerial awareness of safety culture issues;
- Employee involvement in safety improvement activities;
- Primary organizational goals include safety and are not focused on cost or financial targets only;
- Adequate allocation of financial and other resources to support safety;
- Positive efforts made to learn from safety performance of external organizations;

- Safety performance measures include measurement of the effectiveness of activities on processes that affect safety, and not just measurement of the results of these activities or processes.

Organization A	Organization B
• Well trained staff • Plant specific simulator • Staff rigorously follows procedures • Fully staffed • Very little overtime • Good nuclear work ethic • Professional document in control room • Scram extremely rare • Diligent, probing porc • Good preventive maintenance • Shutdown to fix safety systems • Low maintenance backlog • Equipment repairing immediately • clean plant • system engineering onsite	• Poorly trained staff • No plant specific simulator • Staff does not use procedures • Many management and staff vacancies • Routine use of high overtime • Fossil plant culture • Noisy, undisciplined control room • Frequent scrams • Ineffective, pro forma porc • Run equipment until it breaks • Routinely operate in loc action statement • High maintenance back log • Equipment out of service for long periods • Many high radiation areas • No engineering site presence

Table 1: Example of Strong and Weak Safety Culture

9. Conclusion

A good safety culture has a positive impact upon anorganization's quality, reliability, competitiveness and profitability. So evaluation of the organization behavior and safety culture, at the time of planning, construction, and operation has important contribution that an effectivesafety culture can make to the control of their ongoing operational costs and the efficiency of theirongoing operations. This paper presented a detailed discussion about safety culture from many different point of views, such as characteristics and requirements of strong safety culture. Also modelling, implementation, and development of safety culture. As regulator, a special focus is given to relation between regulatory body and the NPPs owner organization. The impact of regulatory body safety culture on the organization culture on strengthening and promoting the organization's safety culture is explained. A regulator should keep a good and balanced relation with the operator to promote not to preclude safety. Both regulator and operator should unify their efforts towards one and only one target, keep and promoting safety.

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