EXPERIENCE OF IPEN-CNEN/SP IN THE EXECUTION OF THE FIRST PHASE OF SAFETY CULTURE ENHANCEMENT

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Abstract. This work describes the experience gained in the execution of the first phase of the Safety Culture Enhancement Programme being carried out in the IEA-R1 Research Reactor, at IPEN-CNEN/SP. This phase covered a period from September 2002 to September 2007. The methodology applied and the main results achieved in the implementation of the first phase of the safety culture enhancement programme are presented. The methodology consisted of the following steps: a) safety culture assessment, using three different approaches; b) elaboration of an action plan; c) implementation of the action plan aiming at the enhancement of safety culture in the organization.

1. INTRODUCTION

During the whole 19th century and most of the 20th century, the safety improvement of technological processes was almost obtained exclusively through the improvement of technical aspects of engineering systems. During most of this period this approach revealed a good result to guarantee a gradual and continuous decrease in the rates of accidents, especially in industries which presented critical aspects of safety. However, in the last decades of the 20th century, it was verified that this approach was not good enough to guarantee the safety of these processes because human factors, management systems and safety culture turned out to be more important [1]. Examples of accidents that were caused by deficiencies in these aspects were: Chernobyl (1986), London King's Cross Underground Station fire (1987), passenger train crash at Clapham Junction (1988), Piper-Alpha oil platform in the North Sea (1988), Tokaimura Criticality Accident (1999), Spaceshuttle Columbia (2003), among others.

More recently, two significant incidents were reported in the nuclear industry: a) Davis Besse Nuclear Power Station Incident (2002) and b) Paks Fuel Damage Incident (2003). Both were caused by inconsistent and incomplete company policies on safety, inadequate organizational commitment to safety and inadequate share of safety information. Fortunately, they were identified sufficiently early to prevent their escalation to a major accident [2].

In this way, the focus of the efforts in safety improvement changed gradually from the technological systems to human factors and organizational administration.

This perception was mentioned in the report elaborated by the International Atomic Energy Agency (IAEA, 1986) after the occurrence of the nuclear disaster of Chernobyl [3], when the term “safety culture” was used for the first time, attributing weakness of the safety culture of the organization as the main cause this accident. Some years later, in 1991, the concept "Safety Culture" was detailed by the Nuclear International Safety Advisory Group in INSAG-4, published by the International Atomic Energy Agency [4]. In this document 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."

A number of definitions have been developed aiming the improvement of the definition proposed by IAEA. One of the most widely used is that developed by the Advisory Committee on the Safety of Nuclear Installations (ACSNI) [5]. ACSNI's definition is given below:

"*The safety culture of an organization is the product of individual and group values, attitudes, perceptions, competencies and patterns of behavior that determine the commitment to, and the style and proficiency of, an organization's health and safety management.*

Organizations with a positive safety culture are characterized by communications founded on mutual trust, by shared perceptions of the importance of safe and by confidence in the efficacy of preventive measures".

This definition is based on the interpretative view that culture cannot be considered as a simple thing that can be bolted on to an organization.

Since 1986 the International Atomic Energy Agency has been publishing guides with the objective to improve safety culture of nuclear facilities, namely the Safety Series No. 75-INSAG-4, "Safety Culture" [4]; IAEA-TECDOC-1321, "Self-assessment of safety culture in nuclear installations" [6]; IAEA-TECDOC-1329, "Safety culture in nuclear installations" [7], and others. Although these documents focus mainly nuclear power reactors, basic guidelines for implementation in research reactors are presented and have been used in the safety culture enhancement programme at the High Flux Reactor (HFR) Petten, NL [8].

2. SCOPE OF THE WORK

This work describes the experience gained in the execution of the first phase of the Safety Culture Enhancement Programme being implanted in the IEA-R1 Research Reactor and covers the period from September 2002 to September 2007. The main results of the study are presented.

The IEA-R1 is a 5 MW pool-type reactor, cooled and moderated by light water, and uses graphite and beryllium as reflectors. First criticality was achieved on 16 September 1957 and the reactor has been operating regularly and safely for almost 50 years. The reactor building is located within the premises of the Nuclear and energy Research Institute, inside the campus of the University of São Paulo, Brazil.

The safety culture enhancement programme started when the general manager of Research Reactor Centre instituted a Safety Culture Enhancement Working Group, with the objective to formulate and implement the first phase of the Safety Culture Enhancement Programme. The group included senior professionals representing diverse areas such as radiation protection, quality management, probabilistic safety assessment, managers of reactor operation and services and the general manager of the Research Reactor Centre. The group meetings were held every week to discuss different issues involved in the programme.

3. METHODOLOGY

The first task of the working group was to acquire knowledge about the state of the art in safety culture. This task was accomplished through seminars given by invited speakers and panel sessions where the participants made presentations based on literature studies in this area. The relevant literature studies consisted of guidelines and reports published by the International Atomic Energy Agency (IAEA), the U.S. Nuclear Regulatory Commission (NRC), Health and Safety Executive (HSE), DuPont and Brazilian nuclear organizations (Eletronuclear, INB, IEN and CNEN), among others.

After the completion of literature survey and the detailed analysis of different approaches which could possibly be used in our context, the working group developed a proper methodology to be used in the first phase of the Safety Culture Enhancement Programme at IEA-R1 Research Reactor consisting of the following steps:

a) Identification and assessment of safety culture at IEA-R1 reactor;

b) Elaboration of an action plan aiming at the enhancement of safety culture in the organization;

c) Implementation of the action plan.

3.1. Safety Culture Assessment

As highlighted by Glendon et al. [9], the safety culture exists at different levels and crosses several dimensions, a range of measures is required for its assessment. Thus, triangulation is an important research principle, which maintains that multiple sources should be used to focus upon a particular problem or issue, ideally using both quantitative and qualitative techniques. In this way, limitations of various individual methodologies can be counterbalanced for a more robust analysis of the issues and greater general applicability of results. The working group decided to carry out the identification and evaluation of safety culture at IEA-R1 reactor considering three different forms:

a) safety perception survey;

b) safety culture self assessment;

c) safety culture assessment based on the Three Level model.

3.1.1. Safety perception survey [10]

The safety perception survey evaluated the main aspects of safety culture based on the reactor employee's attitude, opinion and perception. The survey method used was a quantitative written questionnaire composed of 42 questions. These questions were divided into 14 aspects that presented different safety culture dimensions. The questionnaire was answered by 34 people involving only part of the staff of Research Reactor Centre, more specifically those who work at the reactor Operation and Maintenance Division, the Irradiation Service Division as well as the technicians of the Radiation Protection. The data were compiled, statistically analyzed, documented in a technical report, and the main conclusions were presented to the employees in the form of a seminar.

Based on the opinions of IEA-R1 reactor employees, eight safety aspects were considered inadequate (satisfaction level less than 65 %) for the accomplishment of the activities in the installation. Table 1 highlights the main results of the survey following an ascending order of satisfaction level.

It was observed that the main aspects considered inadequate, from the employees' point of view, were those related to leadership. In fact, the satisfaction level attributed to safety management was particularly bad (38,2 %), and this called the attention of the top manager of IEA-R1 reactor. Up to this moment, there was not an official safety management system being used in the organization but only a quality management system was set.

Presently, an integrated management system is being developed for IEA-R1 reactor, in which the safety elements of a safety management system will be incorporated.

Concerning commitment to safety, there has been an effort by the top managers towards demonstrating their commitment to safety throughout all of the areas of the organisation through scheduled safety tours, meetings, statements and newsletters.

Table 1. Main results of the safety perception survey

ASPECTS	SATISFACTION LEVEL
1. Safety management	38,2 %
2. Assessment of the safety level in the organization	58,8 %
3. Top management commitment to safety	61,8 %
4. Quality and adequacy of documentation and procedures	61,8 %
5. Openness and communications	61,8 %
6. Training	61,8 %
7. Priority to safety/importance given to safety related issues	64,7 %
8. Compliance with regulations and procedures	64,7 %
9. Working conditions regarding safety	67,6 %
10. "Absence of safety versus production" conflict	67,6 %
11. Employee's commitment and responsibility	76.5 %
12. Employee's attitude towards safety	79,4 %
13. Notions of risk prevention	85,3 %
14. Motivation and job satisfaction	88,2 %

3.1.2. Safety culture self assessment

The aim of this assessment was to evaluate the safety culture at the reactor objectively. For this purpose, the working group used the self assessment questionnaire proposed in the document Safety Series No. 75-INSAG-4 published by the IAEA [4]. This questionnaire is composed of 13 parts, each one representing a dimension to be evaluated. Each question was accurately analyzed, discussed and compared to evidences before being answered in a consensual way by the group. The appraised dimensions were:

- Corporate level safety policy
- Safety practices at corporate level
- Definition of responsibility
- Training
- Selection of managers
- Review of safety performance
- Highlighting safety
- Work-load
- Relations between plant management and regulators
- Attitudes of managers
- Attitudes of individuals
- Local practices
- Field supervision by management

Important improvement opportunities in the safety of the reactor were identified in all these appraised aspects. It is worth mentioning two examples: a) the safety policy of the organization must be rewritten in a clearer and complete format; b) training programme of the reactor performance must be focused on safety issues. The results of the self assessment task as well as an outline of improvement actions were documented in a technical report which was placed at the disposal of the staff of the IEA-R1 reactor.

3.1.3 Safety culture assessment based on Three Level model

An assessment based on Three Level model of safety proposed by Edgar Schein will be initiated in November 2007 with the participation of the whole staff of IEA-R1 reactor. This assessment will be developed during a workshop in which the main concepts of the book "*Organizational Culture and Leadership"* [11] and the guidelines IAEA-TECDOC-1329, "*Safety culture in nuclear installations*" [7], will also be presented and the knowledge gained through the lectures delivered during the workshop will be applied to the identification and evaluation of safety culture at IEA-R1 reactor.

3.2. Elaboration of an action plan

The elaboration of an action plan will take place after the accomplishment of the safety culture assessment step described above. This action plan will be made by the working group in charge of the safety culture enhancement programme in conjunction with representatives of IEA-R1 reactor operation staff. The action plan will be based mainly on the conclusions and recommendations of the safety culture assessment obtained by the previous tasks developed, which were still not implemented.

3.3. Implementation of the action plan

The implementation of the actions established in the action plan should be held in a short period of time and the schedule of these activities should be communicated to the reactor personnel.

After the completion of this task, Phase 1 of the Safety Culture Enhancement Programme will be concluded at IEA-R1 research reactor.

4. FUTURE DEVELOPMENTS

The second phase of the Safety Culture Enhancement Programme at the IEA-R1 Research Reactor will be started after the implementation of the action plan. This phase will repeat the evaluations of safety culture carried out in phase 1, so that the evolution of the performance can be checked. Besides, further methodologies will be used, such as:

a) Social capital theory of safety culture (SCT) [12]. The application of SCT of safety culture to IEA-R1 Reactor will be used in the identification of the number of social dimensions of the organizational environment that impact on worker behaviour and perceptions of the safety work environment.
b) Reciprocal safety culture model [13]. This model highlights the dynamic nature of safety culture as it emphasizes the interactive relationships between person (safety climate), situation (safety management system) and behaviour (safety-related behaviour).

The use of these methodologies supports the triangulated approach to measure the safety culture.

5. CONCLUSIONS

The experience gained with the Safety Culture Enhancement Programme helped in the identification of tacit problems related to safety and the planning of corrective actions. In addition, safety began to be treated in a more systematic and effective way. Finally, the important profits obtained with the programme of enhancement of safety culture at IEA-R1 reactor stimulated the management of IPEN/MB-01 reactor, which is another research reactor located in the IPEN-CNEN/SP, to start a similar programme.

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