TOPICAL SESSION 2

SAFETY CULTURE OVERSIGHT

Papers submitted

PAPERS SUBMITTED FOR TOPICAL SESSIONS ON SAFETY CULTURE OVERSIGHT

SAFETY CULTURE ACTIVITIES OF RUSSIAN REGULATOR (ROSTECHNADZOR) TSOs

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Abstract

Federal Environmental, Industrial and Nuclear Supervision Service of Russian Federation (Rostechnadzor) is a federal state supervisory body in the field of atomic energy uses, a regulatory body under the Convention on Nuclear Safety and the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, as well as a competent body of the Russian Federation under the Amendment to the Convention on the Physical Protection of Nuclear Material. It's TSOs (FSUE VO "Safety" and FBU "SEC NRS") provide Rostechnadzor with scientific and technical support in the field of atomic energy uses, including safety culture aspects. In 2014 FSUE VO "Safety" was assigned by Rostechnadzor to develop a training course on safety culture in nuclear activities for Rostechnadzor's new entrant inspectors as well as for the staff of regulatory bodies and operators from countries embarking on a nuclear power program. When developing the training course special attention was being paid to the IAEA regulations, since the concept of safety culture was born within the walls of this international organization, and it has made a significant contribution to the development and promotion of safety culture worldwide. The paper presents short description of the course program as well as safety challenges identified during the development process.

1. INTRODUCTION

In November, 2013 the IAEA follow-up regulatory review mission was held in the Russian Federation. The Integrated Regulatory Review Service (IRRS) mission team said in its preliminary findings that the Russian Federation had made significant progress since an earlier review in 2009. It also identified good practices in the country's nuclear regulatory system. Acting Chairman of Rostechnadzor underlined that despite progress done by Rostechnadzor since the initial IRRS mission in 2009, there are areas for continuous improvement, and the IRRS follow-up findings indicated directions for this work.

One of these directions, according to the IRRS mission report, was promotion of safety culture.

Nuclear countries like Russia have experienced that one of the most difficult challenge for operating organizations is the formation and maintenance of a strong safety culture.

The INSAG-26 confirms that: *"the development of an appropriate safety culture should be seen as the foundation for everything that the new operator does"* [1].

In 2014 FSUE VO "Safety" was assigned by Rostechnadzor to develop a training course on safety culture in nuclear activities for Rostechnadzor's new entrant inspectors as well as for the staff of regulatory bodies and operators from countries embarking on a nuclear power programme. The program of the training course covers the following modules:

— Introduction to nuclear safety culture;
— Safety culture as the type of organizational culture;
— Root causes of accidents at nuclear facilities and human factors;
— Main stages of safety culture development in organizations;
— Role of leadership and management in the development and support of a strong safety culture;
— Staff attitudes and skills for safety culture;
— ITO concept and systemic approach to safety;
— Assessment and oversight of safety culture.

Some of the safety challenges that we encountered during development of the course are presented below.

2. NUCLEAR SAFETY CULTURE

The term '*nuclear safety culture*' was first used by experts of the International Nuclear Safety Advisory Group (INSAG) at the post-accident review meeting on the Chernobyl accident that took place in Vienna on 25-29 August 1986. The summary report of the meeting emphasised "a need for a 'nuclear safety culture' in all operating nuclear power plants" [2].

The definition of the concept was presented by INSAG five years later:

"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" [3].

Presently, it is accepted that the concept of safety culture applies not only to nuclear safety but also to conventional and personal safety.

However it is clear, that "the most harmful consequences arising from facilities and activities have come from the loss of control over a nuclear reactor core, nuclear chain reaction, radioactive source or other source of radiation" [4].

At the present time public anxiety over nuclear power remains high because people still consider it to be a high risk technology.

In our opinion the term ‘nuclear safety culture’ that was introduced straight after the Chernobyl accident has been unjustly forgotten.

The public should be aware that the nuclear community gives due attention to the issues of nuclear and radiation safety. This means that nuclear and radiation safety issues should be given higher priority than, say, occupational safety, taking account of negative public’s attitude toward radiation.

‘Nuclear safety culture’ implies that the highest priority is given to nuclear and radiation safety.

The definition of ‘nuclear safety culture’ can be simply adapted from the IAEA’s Glossary: “The assembly of characteristics and attitudes in organizations and individuals which establishes that, as an overriding priority, radiation protection and nuclear safety issues receive the attention warranted by their significance” [5].

3. LEADERSHIP, MANAGEMENT AND CULTURE FOR SAFETY

The concept of ‘defence in depth’ is being the primary means of preventing and mitigating the consequences of accidents in nuclear facilities. Among other things defence in depth is provided by “an effective management system with a strong management commitment to safety and a strong safety culture” [4].

The 3rd IAEA’s fundamental safety principle “Leadership and management for safety” [4] establishes, that the management system has to ensure the promotion of safety culture. Put simply, safety culture can be seen as the end result of the management system and the many other functions of an organization fitting together.

Senior and middle management in organizations should, through its leadership, promote and foster a culture of safety by developing shared safety values and work environment in which employees can become fully involved in achieving organizations’ objectives.

Leadership is generally viewed as the key determinant of organizational success in all its various endeavors. International Organization for Standardization (ISO) defines in Ref. [6] ‘Leadership’ as a fundamental management principle.

Bearing in mind the crucial role of safety culture in safety assurance of nuclear facilities the more accurate definition of the 3rd fundamental safety principle, from our point of view, would be “Leadership, management and culture for safety”.

4. CERTIFICATION OF SAFETY CULTURE

Nowadays, enterprises of the Rosatom State Nuclear Energy Corporation that provides products and services to foreign customers should rely on requirements to management systems established by the IAEA Standard GS-R-3 “The management system for facilities and activities” [7]. This results from the fact that in order to enter foreign markets, Russian suppliers have to meet foreign requirements related to quality assurance, protection of the environment, nuclear and radiation safety, etc. For instance, the Finnish customer "Fennovoima" requires full compliance of the management systems of the Russian companies involved in the construction of the Hanhikivi-1 NPP with the GS-R-3 Standard. And safety culture is not an exception.

ISO 9001 Standard "Quality Management Systems – Requirements" [8] is widely implemented in the nuclear industry enterprises in Russia. The assessment of compliance of the quality management systems with the established requirements is carried out by the certification bodies. The same relates to the environmental management systems that are implemented at the majority of nuclear facilities in Russia. But due to their uniqueness and associated significant risks, the nuclear industry enterprises have to meet current safety requirements and principles established in the IAEA Safety Standards, such as safety culture and risk management.

In GS-R-3, the IAEA uses the approach according to which safety culture is integrated in the management system, see Figure 1, i.e., the safety culture assessment should be carried out as a part of the management system assessment.

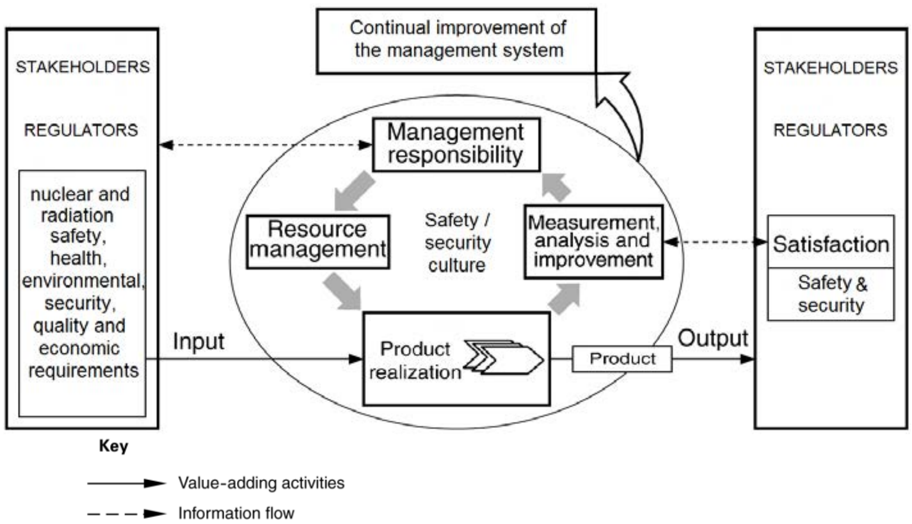

FIG. 1. Model of a process-based integrated management system of a nuclear facility (adapted from ISO 9001:2008 [8]).

Nuclear and radiation safety authorities (regulatory bodies) are entrusted by IAEA with the assessment of quality management systems compliance with the GS-R-3 Standard.

However, according to the ISO/IEC Standard [9], the compliance assessment of quality management systems with the established requirements should be carried out by the so called certification bodies whose functions differ from the functions of the regulatory bodies that are provided in IAEA's GSR Part 1 [10]. Regulatory bodies in many countries have neither resources, nor specialists for the compliance assessment of the supervised organizations.

New Standard ISO/AWI 19443 "Quality Management Systems. Specific requirements for the application of ISO 9001 and IAEA GS-R-3 requirements by organizations in the supply chain of the nuclear energy sector" is currently being developed. It is aimed at harmonisation of the requirements of ISO 9001 and GS-R-3. In comparison with ISO 9001, this Standard has some significant advantages, such as requirements on the safety culture and risk management, and in contrast with the GS-R-3 Standard, it has provisions for the management system certification of organizations in the supply chain of the nuclear energy sector. The main disadvantage is that the Standard does not cover management systems of nuclear facilities, e.g., NPPs.

We consider it reasonable to entrust the certification bodies that have relevant resources and experience with the assessment of nuclear industry enterprises management systems.

For instance, Bureau Veritas employs 66 500 staff in 1400 representative offices in 140 countries; Intertek (Moody International) employs 38 000 staff in 1000 locations in 100 countries.

The development of ISO Standard for the nuclear industry enterprises management systems is required. Implementation of this standard will make it possible to achieve efficiency of the nuclear industry enterprises management systems and, as a result, high safety culture.

5. SYSTEMIC APPROACH TO SAFETY

For a safety culture to be strong "there should be a knowledge and understanding of human behaviour mechanisms and established human factor principles should be applied to ensure the outcomes for safety of individuals–technology–organization interactions" [11].

According to the IAEA Report [12] the Fukushima Daiichi accident was a wake-up call for the nuclear community to recognize the complexity of safety and to respect the entire systems interaction of ITOs. The complexity of nuclear organizations is increasing, and different and more unique approaches are needed to ensure that safety is maintained. The Fukushima Daiichi accident was avoidable, according to the presentations of experts from Japan.

Taking into account the ongoing interaction between all the individual, technical and organizational (ITO) factors reveals the complexity and non-linearity of the operations at a nuclear power plant. It is necessary to better examine how the weaknesses and strengths of all these factors influence one another and to facilitate the proactive elimination of risks.

The IAEA International Experts Meeting participants [12] emphasized that an integrated approach to safety through consideration of the interaction of ITO systems is needed to complement the more traditional approach to safety. The concept of a systemic approach to safety represents a new way of thinking about safety for some Member States and even for some IAEA activities and services.

Several considerations were identified during the International Experts Meeting [12] for the development of an integrated approach to safety. In particular, the need to complement the traditional approach to safety with an ITO systemic approach was emphasized. The participants suggested that this approach might include the use of 'stress tests' for human and organizational factors (HOFs) and the further exploration of non-technical aspects of safety. Future analyses should include ITO considerations in an integrated way. Guidance and training materials for the integration of all elements of HOFs, safety culture, organizational culture, the management system and ITO factors in existing and new nuclear programmes should be developed to ensure that the systemic approach is developed and maintained.

According to Ref. [12], "the systemic approach to safety addresses the whole system by considering the dynamic interactions within and among all relevant factors of the system — individual factors (e.g. knowledge, thoughts, decisions, actions), technical factors (e.g. technology, tools, equipment), and organizational factors (e.g. management system, organizational structure, governance, resources)".

Unfortunately, the ITO systemic approach to safety doesn't consider external impacts (floods, cyclones, explosions or fire originating from off-site sources, etc.) on NPPs safety as well as NPPs impacts on the environment (e.g. radioactive discharges to the environment).

It should be reminded that the Fukushima Daiichi nuclear disaster was initiated primarily by the tsunami after the Tōhoku earthquake on 11 March 2011, i.e. by the external natural events.

According to Edgar Schein, "culture is best thought of as what an organization has learned throughout its history in solving its problems of external survival and internal integration" [13]. "Ultimately all organizations are socio-technical systems in which the manner of external adaptation and the solution of internal integration problems are interdependent and intertwined" [14].

From our point of view, the new approach to safety is needed – the ITOE paradigm with its emphasis on the interrelationships and interactions of the individual (human), technical, organizational and external factors, see Fig. 2.

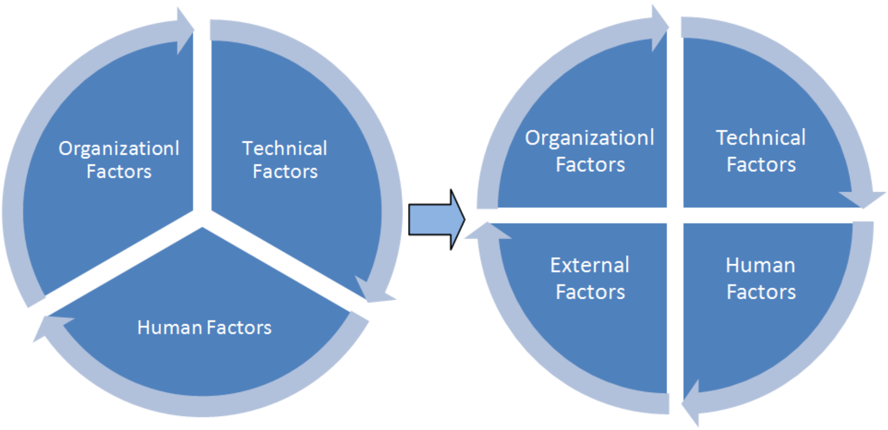

FIG. 2. Evolution of the systemic approach to nuclear safety.

We use the term “external factors” to mean natural and human induced external events in the region that have the potential to affect the safety and security of facilities and activities. This could include natural external events (such as extreme weather conditions, earthquakes and external flooding) and human induced events (such as aircraft crashes and hazards arising from transport and industrial activities, terrorist attacks).

6. SAFETY SCIENCE

The field of safety science has been evolving over time through different overlapping phases of safety concerns:

> “First was the technical phase. An example can be found in early aviation: In response to frequently occurring accidents, airplane builders continuously optimized the design and material of technical components, thus improving aviation safety.
> Second came the human error phase, when it became evident that erroneous human action often produced accidents in spite of technically solid machines. The selection of capable operators and training for their competencies was the preferred choice of combating human threats to safety.
> Third was the socio-technical phase: During the 1980s it was recognized that the complex and often poorly understood interaction of social (human) and technical features had to be taken as the roots of large-scale system failures” [15].

The mission to ensure safety of people and society in the context of scientific and technological progress and development of nuclear technologies is a complicated political, scientific and technical, social and economic challenge.

Scientists from around the world gradually come to a conclusion that the system of knowledge about protection of people and the environment from hazards of human activities should become a stand-alone theory.

The classic approach to the development of a new theory consists of a sequence of steps: collecting experimental data; defining regularities among the data; formulation of an empirical law; building a system of hypotheses. Such reactive way to develop the theory of safety seems to be too long. From one accident to another empirically humanity takes too short steps towards safety.

Until the accident at Three Mile Island (1979), little attention was being paid to the critical role of human factors in the operation and maintenance of nuclear power plants. The Chernobyl accident (1986) highlighted the importance of safety culture and the impact of human and organizational factors on safety performance.

After the Fukushima Daiichi nuclear accident (2011) the concept of systemic approach to safety that establishes interconnections among individuals, technology and organization (ITO) is being actively developed.

It should be mentioned that the Fukushima Daiichi nuclear accident was initiated primarily by the tsunami of the Tohoku earthquake, i.e., from natural external effects. Unfortunately, the ITO concept doesn't consider the impact of external effects on a nuclear facility as well the impact of a nuclear facility on the environment.

Thirty years following the Chernobyl accident have given rise to a clear understanding that complicated set of various safety-related issues is the subject of interdisciplinary research.

The aim of in-depth interdisciplinary studies should be not only to obtain a comprehensive and coordinated vision of the full scope of safety issues, but eventually to develop reliable methodological tools applied for the analysis of more specific issues.

In other words, today we need to have a kind of "safety philosophy" or science about safety.

We suggest using the term "asphology" or "asphaleology" which means "science about safety". The new term comes from Greek word ασφάλεια - "aspháleia" that literally means "safety, protection" [16].

One may already state that the new science should emerge at the intersection of already existing natural, social and technical sciences.

Asphology should not be understood in a narrow practical way as a methodology of scientific research related to the study of standards and regulations, laws and tools, but should be regarded in a wider sense as a worldview, scientific ideology, a kind of philosophy regulating integrated scientific cognition.

7. CONCLUSIONS

One of the fundamental principles of safety culture is continuous learning and safety training. Training in safety culture can help new employees recognize the importance of human and organizational factors in safety assurance of nuclear facilities.

Recently FSUE VO "Safety" has developed an intensive training course on safety culture in nuclear activities for Rostechnadzor's new entrant inspectors as well as for the staff of regulatory bodies and operators of countries embarking on a nuclear power programme.

Some of the safety challenges that we encountered during development of the course are presented below:

(a) The term 'nuclear safety culture' was first introduced by INSAG in 1986. We think that the term 'nuclear safety culture' has been unjustly forgotten. The public should be aware that the nuclear community gives utmost attention to nuclear and radiation safety issues in nuclear facilities and activities.

(b) Culture is best thought of as what an organization has learned throughout its history in solving its problems of external survival and internal integration. The Fukushima Daiichi nuclear disaster was initiated primarily by the tsunami after the Tōhoku earthquake, i.e. by the external natural events. External factors that may affect safety performance of nuclear facilities should be taken into account in the individuals, technology and organization (ITO) systemic approach to safety leading to an ITOE concept.

(c) Safety culture is seen as the end result of the management system and the many other functions of an organization fitting together. The IAEA's 3rd fundamental safety principle "Leadership and management for safety" establishes that an organization's safety culture should be fostered by leaders and promoted by management systems. Bearing in mind the crucial role of 'culture of safety' in safety assurance of nuclear facilities more accurate definition of the 3rd fundamental safety principle would be "Leadership, management and culture for safety".

(d) IAEA safety standards provide nuclear industry with dozens of requirements and recommendations on safety culture and safety management. An important point is that IAEA safety standards are advisory rather than mandatory. Moreover they apply only to nuclear facilities and activities. Other hazardous industries may not have any safety culture requirements. Consequently a hazardous industrial enterprise entering the international market cannot prove compliance of its safety culture with international requirements in the eyes of foreign customers. From our point of view, the development of new all-industries ISO Standard is required that would contain safety culture and safety management aspects.

Implementation of this standard will make it possible to achieve safety on a global scale.

(e) Thirty years following the Chernobyl accident have given rise to a clear understanding that a complicated set of various safety-related issues is the subject of interdisciplinary research. The aim of in-depth interdisciplinary studies should be not only to obtain a comprehensive and coordinated vision of the full scope of safety issues, but eventually to develop reliable methodological tools applied for the analysis of more specific issues. In other words, today we need to have a kind of ‘safety philosophy’ or science about safety that we suggest to call “asphology”.

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INSIGHT AND LESSONS LEARNED ON SAFETY CUTLURE FROM ANALYSIS OF INSPECTION FINDINGS AND EVENTS

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Abstract

The paper introduces, as an effort of regulatory side, recent changes in the role of regulators in safety culture, safety culture components with regulatory expectations to achieve desired status of licensee's safety culture. Also, human error-related events and inspection finding with these safety culture components were analysed, respectively. Comparison of the analysed results between human error-related events and inspection finding was performed. And lessons learned and insight from perspectives of organizational factors and safety culture were derived. From the results for analysis of human error-related events and inspection findings, safety culture components were analysed that should be improved to enhance licensee's safety culture in Republic of Korea. The results and insights obtained from this study will provide inputs and lay foundations in regulatory infrastructure and system for plant oversight, which are based on operating experiences and lessons learned on the aspects of human, organizational factors and safety culture.

1. INTRODUCTION

Safety culture has been a main subject of scrutiny in major accidents of modern complex technologies. The Fukushima accident also plausibly has its root cause deep into weak safety culture. After the Fukushima accident in Japan 2011, many critics have searched for cultural factors that caused the unacceptable negligence pervaded in Japan's nuclear society. Renewed emphasis has also been placed on rebuilding strong safety culture by operators, regulators, and relevant institutions worldwide. Significant progress has been made in approach to safety culture and this led to a new perspective different from the existing normative assessment method both in operators and regulatory side. Regulatory expectations and oversight of them are based on such a new holistic concept for human, organizational and cultural elements to maintain and strengthen the integrity of defense in depth and consequently nuclear safety.

In Republic of Korea, a change in regulatory position about safety culture oversight was made before and after an event of station black out cover-up in Kori unit 1 occurred in early 2012. The oversight of licensee's safety culture becomes an important issue that attracts great public and political concerns recently in Republic of Korea. Beginning from the intended violation of rules and regulations, a series of corruptions, documents forgery and disclosure of wrong-doings made the Korean public think that the whole mindset of nuclear workers has been inadequate. Thus, they are demanding that safety culture should be improved and that regulatory body shall play more roles and responsibilities for improving safety culture and conducting oversights of it. After the event, Korea regulator concluded that safety culture aspects were not properly managed by licensee and therefore minimum requirements should be imposed on. Based on the implications and lessons learned from the events, Korean regulatory authority announced the initiative of regulatory oversight and launched pilot inspection program and research project to develop oversight system and methodology.

This paper introduces, as an effort of regulatory side, recent changes in the role of regulators in safety culture, safety culture components with regulatory expectations to achieve desired status of licensee's safety culture. Also, human error-related events and inspection findings with these safety culture components were analysed, respectively. Comparison of the analysed results between human error-related events and inspection findings was performed. And lessons learned and insight from perspectives of human, organizational factors and safety culture were derived.

2. SAFETY CUTLURE OVERSIGHT MODEL AND SAFETY CULTURE COMPONENT

Safety culture is defined that assembly of behavioural patterns, core values and back beliefs shared by individuals in organization about the importance of safety. The safety culture oversight model is developed to focus on the organizational capabilities to maintain, improve and recover the integrity of key elements which play a major role in implementing the concept of defense-in-depth. Figure 1 explains the concept and approach for the development of the safety culture oversight model.

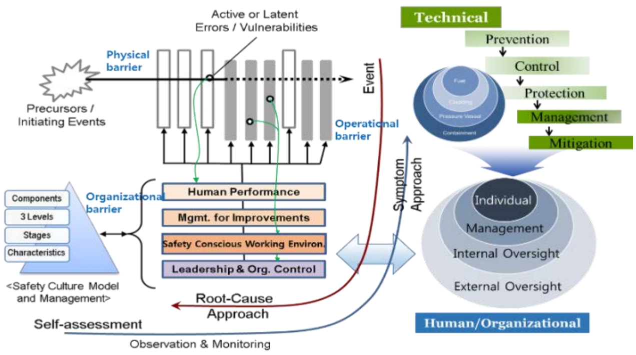


FIG. 1. Concept and Approach for SC oversight model development.

The safety culture oversight model, which is shown in Figure 2, assumes that safety culture is composed of 13 traits stems from 4 organizational barriers that describe areas important to keep healthy safety culture and licensee's safety culture management system.

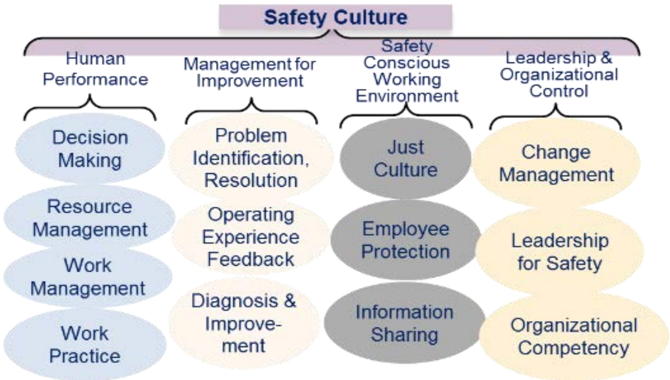


FIG. 2. Overall structure of safety culture oversight model.

For each safety culture component, characteristics which represent regulatory expectations and reference standards are developed. The characteristics of each safety culture component are as follows:

— Human Performance
  - (Decision Making) Rigorous and systematic assessment of safety-related design change, operation, work activities, and response to abnormal situation
  - (Resource Management) Management for human resources, documents, equipment, and work environment related to major works to be maintained appropriately
  - (Work Management) Management for safety-related works to be performed as planned, confirmed, and cooperated systemically
  - (Work Practice) Environment for continuous improvements to prevent human errors by individuals of plant and subcontractor during operation, surveillance and test, and work activities

— Management for Improvement
  - (Problem Identification and Resolution) Identification, evaluation and resolution of all the potential problems that may impact on safety in a systematic way and promptly
  - (Operating Experience Feedback) Systematic collection, evaluation, implementation, and dissemination of internal and external operating experience in a timely and effective manner

- (Diagnosis and Improvements) Proactive diagnoses and improvements of program, system and practice that may have common cause weaknesses through continuous observation and comprehensive assessment

— Safety Conscious Working Environment
  - (Just Culture) Establishment of policy and system for rewards or sanctions according to justice principles to assess individuals who are related to accidents, failures, or errors
  - (Employee Protection) Establishment of policy and system for employees' rights and duties to freely raise safety concerns and management for preventing discriminations and chilling effects
  - (Information Sharing) Establishment and implementation of alternative channel for raising safety concerns independently of normal reporting line and ensuring confidentiality with regular assessment of effectiveness

— Leadership & Organizational Control
  - (Change Management) Classification and management of changes in environment, organization, system and procedures that can affect safety
  - (Leadership for Safety) Leaders' behaviour and oversight encouraging employees to keep safety first principles in all the work activities and leaders' ensuring human and financial resources for safety
  - (Organizational Competency) System for continuous learning, personnel evaluation and selection, and plant performance evaluation emphasizing safety competencies and performance.

3. ANALYSIS OF HUMAN ERROR-RELATED EVENTS

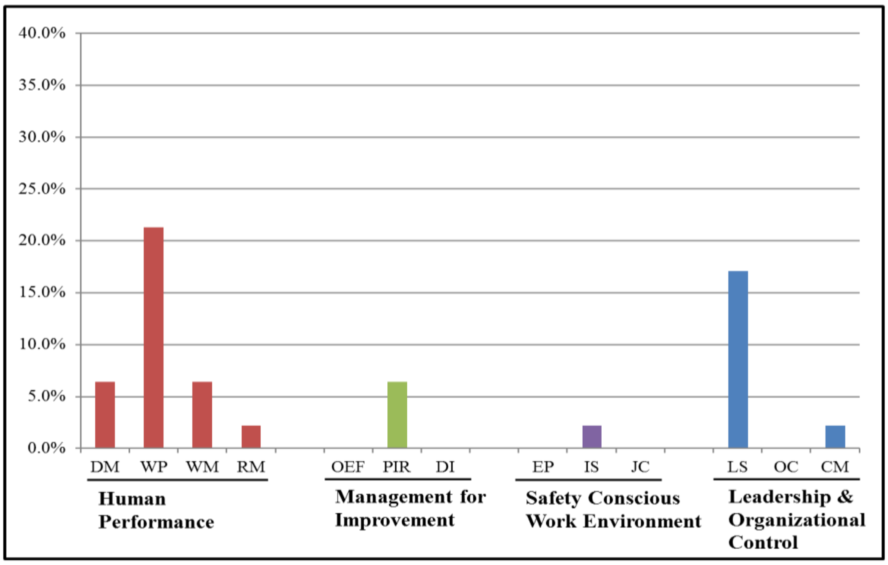
Event investigation is one of the key means of enhancing nuclear safety deriving effective measures and preventing recurrences. However it is difficult to analyse organizational factors and safety culture so that this paper tries to review human error-related events from perspectives of organizational factors and safety culture, and to derive insights and lessons learned in developing the regulatory infrastructure of plant oversight on safety culture.

The targets for analysis among the reported events to the regulatory body in Republic of Korea were selected in accordance with more than INES level 1, relativeness with organizational factors and safety culture, and significance and severity of events by experts' judgments. Among 203 events since 2002, 7 human error-related events were selected and analysed as follows.

(1) Spurious safety injection during Reactor Coolant System (RCS) heat-up (INES level: 1)

(2) Entering into sub-criticality due to fail-opening of the pressurizer spray valve and inappropriate defeat of automatic safety injection during RCS depressurization (INES level: 1)
(3) Loss of offsite power and Standby Diesel Generator (SDG) start-up due to opening of switchyard breaker (INES level: 1)
(4) Inadvertent containment spray of reactor coolant (INES level: 2)
(5) Loss of voltage on the safety bus and Emergency Diesel Generator (EDG) start-up due to human error during annual overhaul (INES level: 1)
(6) Station blackout due to loss of offsite power and fail to start EDG (INES level: 2)
(7) Inadequate safety injection during overhaul outage (INES level: 1)

The causes for 7 human error-related events were analysed to identify the relevance of organizational factors and safety culture in accordance with the safety culture components. From the analysis it was again confirmed that an event can occur if several causal factors, at least three in this study, are combined. This multiple-cause of event is widely recognized in other researches which imply that multiple barriers can collapse unless they are carefully maintained. The problem is to find how to maintain the integrity of such barriers in the environment of interactions among technology, human, and organizational system.



DM: Decision Making, **WP**: Work Practice, **WM**: Work Management, **RM**: Resource Management, **OEF**: Operating Experience Feedback, **PIR**: Problem Identification and Resolution, **DI**: Diagnosis and Improvement, **EP**: Employee Protection, **IS**: Information Sharing, **JS**: Just Culture, **LS**: Leadership for Safety, **OC**: Organizational Competency, **CM**: Change Management

FIG. 3. Analysis results for human error-related events.

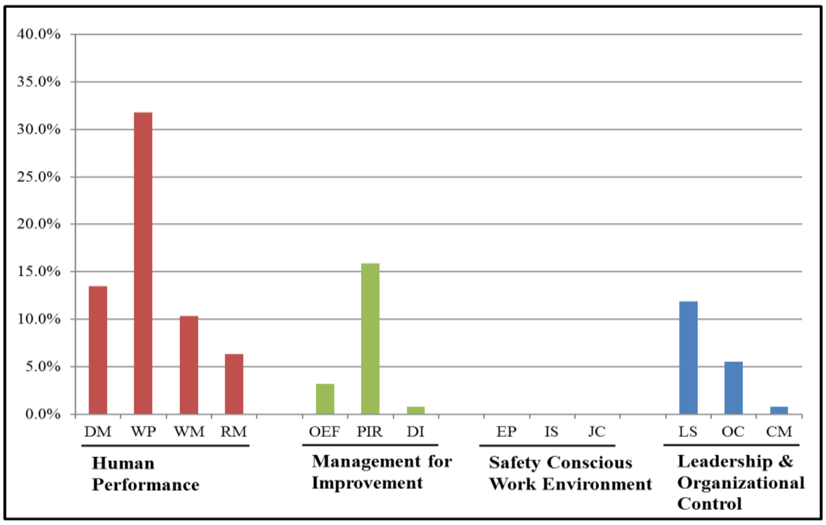
Figure 3 is an analysis result of the safety culture components for human error-related events by portion. The result shows that "Work practice" in "Human Performance" has the highest portion among the components, nearly 21%, and "Leadership for safety," "Decision making," "Work management," and "Problem identification and resolution" also have high portion compared to others. All components in "Human Performance" have high portion and this means main contributors of safety culture for human error-related events. From the results, it can be inferred that environment for human performance, process of problem identification of resolution, assessment for decision making, and leadership for safety need to be improved to enhance safety culture of licensee.

4. ANALYSIS OF INSEPCTION FINDINGS

The type of inspection findings in Republic of Korea has been distinguished according to specific categories of design, repair, procedure, test, function, etc. There are no detailed categories to distinguish the type of inspection findings related to safety culture. Previous inspection findings from periodic inspections for operating NPPs and quality assurance inspections for operating and constructing NPPs from 2009 to 2013 in Republic of Korea were reviewed to select the target analysis of inspection findings related to the safety culture mainly focusing on performance deficiencies. Thus, 91 inspection findings (12.9%) among 720 inspection findings were selected as shown in table 1.

TABLE 1. NUMBER OF INSPECTION FINDINGS SELECTED FOR THIS STUDY

	2009	2010	2011	2012	2013	Total
Total No. of inspection finding	183	183	152	118	84	720
No. of inspection findings for the analysis	23 (12.6%)	23 (12.6%)	13 (8.6%)	22 (18.6%)	10 (11.9%)	91 (12.6%)



DM: Decision Making, **WP**: Work Practice, **WM**: Work Management, **RM**: Resource Management, **OEF**: Operating Experience Feedback, **PIR**: Problem Identification and Resolution, **DI**: Diagnosis and Improvement, **EP**: Employee Protection, **IS**: Information Sharing, **JS**: Just Culture, **LS**: Leadership for Safety, **OC**: Organizational Competency, **CM**: Change Management

FIG. 4. Analysis results for inspection findings.

Figure 4 is an analysis result of a portion of the safety culture components for 91 inspection findings. The result shows that “Work practice” in “Human Performance” has the highest portion among the components, nearly 32%, and “Problem identification and resolution,” “Decision making,” and “Leadership for safety” also have high portion compared to others. All components in “Human Performance” have high portion and this means main contributors of safety culture for inspection findings. From the results, it can be inferred that environment for human performance, process of problem identification of resolution, assessment for decision making, and leadership for safety need to be improved to enhance safety culture of licensee.

5. INSIGHT AND LESSONS LEARNED FROM THE RESULTS –EVENTS AND INSPECTION FINDINGS

Figure 5 shows comparison from the analysis results both human error-related events and inspection findings. It can be inferred that the results shows similar trends. The major safety culture components that have high portion from the analysis were studied in-depth analysis to find common characteristics that can affect to licensee’s safety culture.

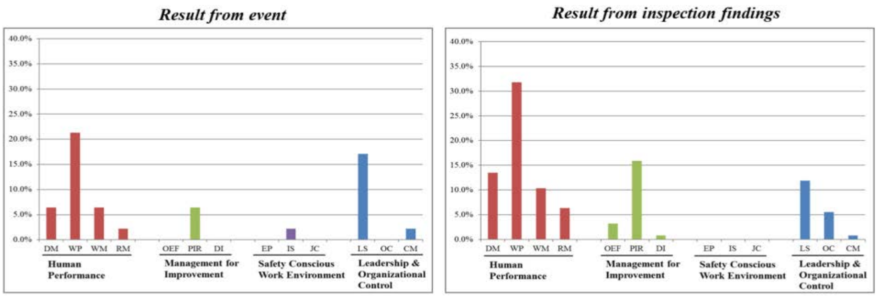


FIG. 5. Comparison of analysis results; events and inspection findings.

Common characteristics were identified from in-depth analysis. In “Work practice” of “Human Performance” licensee often tends to omit the confirmation of initial conditions, to pan a test inadequately, and to cooperate inappropriately. In “Problem identification and resolution” of “Management for Improve” licensee often tends to identify the equipment status insufficiently and to fail monitoring the operational parameters. In “Leadership for safety” of “Leadership and Organization Control” licensee often tends to fail management of human and financial resources for safety and to fail identification of the changes in environment, organization, system and procedures for safe operation.

Based on the results, the safety culture components, which have high portion, need to be reviewed to find whether the reason of weakness of those components lies in systematic, organizational or cultural ground. Then, actions to strengthen them and to prevent recurrences of similar events or degradation of human performance can be identified and implemented. Also, efforts in both regulatory and licensee side need to improve the consciousness for safety culture of licensee.

6. CONCLUSIONS

After the Fukushima accident in Japan 2011, many critics have searched for cultural factors that caused the unacceptable negligence pervaded in Japan’s nuclear society. Renewed emphasis has also been placed on rebuilding strong safety culture by operators, regulators, and relevant institutions worldwide. Significant progress has been made in approach to safety culture and this led to a new perspective different from the existing normative assessment method both in operators and regulatory side. Regulatory expectations and oversight of them are based on such a new holistic concept for human, organizational and cultural elements to maintain and strengthen the integrity of defense in depth and consequently nuclear safety.

Recent changes of regulator’s role in safety culture, safety culture components with regulator expectations, and analysis both human error-related events and inspection findings were introduced in this paper. From the results, safety culture components were analysed that should be improved to enhance safety culture of licensee in Republic of Korea. Actions to strengthen them and to prevent recurrences of similar events or degradation of human performance can be identified and implemented. Also, efforts both regulatory and licensee side need to improve the consciousness for safety culture of licensee. To ensure continuously improving nuclear safety and to prevent further deterioration in nuclear workers mindset, it is needed to build strong safety culture and to sustain long-term commitment to it. Every individual should keep in mind continuous learning attitude and leadership for safety.

The results and insights obtained from this study will provide inputs and lay foundations in regulatory infrastructure and system for plant oversight, which are based on operating experiences and lessons learned on the aspects of human, organizational factors and safety culture.

ACKNOWLEDGEMENTS

This work was supported by the Nuclear Safety Research Program through the Korea Nuclear Safety Foundation (KORSAFe), granted financial resource form the Nuclear Safety and Security Commission (NSSC), Republic of Korea (No. 1303019).

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THE REGULATORY APPROACH FOR THE ASSESSMENT OF SAFETY CULTURE IN GERMANY
A tool recommended for practical use for inspections

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Abstract

The tool presented in the paper is recommended to support regulatory oversight of the safety culture in German nuclear power plants taking into account the particular challenges of the post-Fukushima decision to phase out civil nuclear energy production. The tool is based on empirical research findings on how observable actions and measures of leadership (e.g. clear instructions regarding the priority of safety) influence directly unobservable psychological drivers of human action (e.g. personnel's motivation to act safely) and personnel's observable safe performance which depends on these drivers. These empirical research findings thus capture how this kind of observable leadership activities will foster unobservable and observable aspects of safety culture and safety-directed human action. The tool supports inspectors' collection, processing, and evaluation of information about this kind of observable leadership activities at the licensee's. In total, 17 activities are considered which cover the entire range of leadership. The evaluation of collected information with the tool shows to which extent leadership fosters safety culture in the licensee organization and its members and, consequently, to which extent the safety culture of the licensee is a strong one. The tool is designed in such a way that it supports information collection during any kind of inspection on site and by inspectors after the familiarization which is necessary in order to use the tool ("en-passant approach"). Since many inspections are carried out in the course of time, the en-passant tool application can provide regulatory authorities with a steady flow of up-to date information which can comprise early indications of degradations in the area of safety culture. The tool does also support in-depth investigations and evaluations of licensee's safety culture by inspector teams which comprise experts in the area of safety culture. For both en-passant approach and in-depth analyses, the tool provides proper guidance.

1. INTRODUCTION

This paper presents a practical tool for assessing licensees' safety culture in the process of regulatory oversight of German nuclear power plants. It was developed by GRS on behalf of the German Federal Ministry for the Environment, Nature Conservation, Building, and Nuclear Safety (BMUB), the federal regulatory authority in Germany. Two reports in German are available which document this tool (including guidance for proper tool application) and the scientific basis of tool development ([1], [2]).

The tool is recommended to be used for regulatory oversight of safety culture. Any decision regarding its use rests with these authorities. Application by other users is possible. In particular, licensees are free to apply this tool in the course of safety-culture self-assessments.

The paper is structured as follows: The next chapter provides an overview of relevant German rules and regulations, the current practices of safety-culture oversight in Germany, and the challenges to safety culture after Germany's decision to phase out civil nuclear energy production by 2022. The tool was designed to capture possible effects of these challenges. The third chapter of this paper presents the tool. Subsections will address development objectives, focus, process of application, and validation aspects of the tool. The last chapter will be focused on conclusions regarding the future development of safety-culture assessment methods.

2. REGULATORY OVERSIGHT OF SAFETY CULTURE IN GERMAN NUCLEAR POWER PLANTS

2.1. Relevant rules and regulations

In the regulatory framework of Germany safety culture is "determined by a safety-oriented attitude, responsibility, and conduct of all staff required for ensuring the safety of the plant. For this purpose, safety culture comprises the assembly of characteristics and attitudes in a company and of individuals which establishes that, as an overriding priority, nuclear safety receives the attention required by their significance. Safety culture concerns both the organization and the individual." ([3], p. 27). This definition is aligned in its second sentence with the definition of the IAEA. The focus of the regulatory approach on safety culture in Germany lies on the management system and its influence on safety culture. In the German regulatory framework, a management system is understood as a process-orientated management system, which integrates all the different objectives and requirements of the organization which give safety its due priority. One of its main functions is to foster a strong safety culture.

The central piece of the German regulatory framework is the Atomic Energy Act. It establishes that the responsibility for nuclear safety lies with the licensee. The revision in December 2010 ([4]) places an obligation on the licensee to implement a management system which gives priority to nuclear safety. Another requirement is the responsibility of the licensee to secure financial and personnel resources and provide adequate training to ensure and develop the personnel´s know-how.

Subordinate to the Atomic Energy Act, the BMUB released the new “Safety Requirements for Nuclear Power Plants” in November 2012 and revised them in March 2015. Within the German regulatory framework these requirements have the level of a legal provision. One of the fundamental principles of these requirements is the statement that the safety-oriented interaction of human, technical and organizational factors is the basis for the safe operation and for a highly developed safety culture of a nuclear power plant. The maintenance and continuous development of this safety culture is the task of the licensee ([3], p. 1). The top management and the leadership are inter alia required to:

(a) implement and continually improve a process-oriented management system, which integrates all objectives and relevant requirements such as safety, environmental protection, staff safety, quality and finances. This Integrated Management System`s (IMS) prime objectives are to guarantee and continually improve safety and to promote safety culture. ([3] p. 2;)
(b) implement a safety policy;
(c) provide appropriate resources and organizational structures;
(d) assure the internal and external feedback of experience and of changes in the state of the art in science and technology to be registered, evaluated and implemented by a process of the IMS:
(e) guarantee the necessary competences and training of the personnel (3], p. 2.)

Another relevant document of the regulatory framework in the context of safety culture is the Nuclear Safety Standard KTA 1402 – “Integrated Management System for the Safe Operation of Nuclear Power Plants” which was published in November 2012 by the Nuclear Safety Standard Commission (KTA, [5]). The requirements of the afore-mentioned higher-ranking documents of the regulatory framework are defined therein in more detail, such as the responsibility of the leadership and requirements for the IMS and its impact on the safety culture. The IMS shall be process-oriented and continuously improved using the Plan-Do-Check-Act Cycle ([5], p. 2-3). One of the main objectives of the IMS ([5], p. 1) is to support and foster safety culture inter alia by:

(a) supporting a common understanding of the key aspect of safety culture inside the corporation;
(b) strengthening the basic attitude of learning and questioning on all levels;
(c) providing the resources for the organization to continuously develop and improve its safety culture.

Moreover, the safety standard places an obligation on the top management and the leadership to foster a high safety culture through exemplary function as executives and to identify possible improvements to work behavior and safety culture by means of process-independent assessment of the IMS based on e.g. walk-throughs and observations ([5], p. 4 / p. 16).

2.2. Current practices

The governmental structure of Germany as a federal republic and its institutions is reflected in the structure of the nuclear regulatory oversight. The oversight over the nuclear power plants is a shared task. The federal authority BMUB is responsible for the exchange on the international level and generic aspects e.g. regulation and guidelines, which are legally binding for all licensees in Germany. The direct oversight of the nuclear power plants lies with the authorities of the individual federal states. These are responsible inter alia for the licensing aspects and the surveillance of the safe operation of the nuclear power plants. The federal regulatory provisions for the oversight of safety culture are generic in order to leave a range of possible approaches to the respective authorities in their individual oversight of safety culture. The approaches to assessing safety culture therefore depend on the federal-state authorities. The tool presented in chapter 3 offers guidance to further develop these approaches and is recommended to be taken into account by the federal-state authorities.

One of the federal-state approaches is well documented and published and will therefore be presented in the following as an illustrate example. This approach is called KOMFORT. KOMFORT is a German acronym which can be translated as follows: “Catalog for Capturing Organizational and Human Factors during on-site Inspections” ([6]). KOMFORT was developed by the regulatory authority of the federal state of Baden-Wuerttemberg in order to support the assessment of safety culture during on-site inspections. It is based on practical experiences of the inspectors of the regulatory authority of Baden-Wuerttemberg. The development was supported by HTO-experts. KOMFORT is based on the culture model of Schein ([7]), which describes culture by referring to three interrelated levels: artefacts, espoused values and basic assumptions. As the level of basic assumptions is difficult or impossible to observe directly, KOMFORT focuses on a set of observable indicators related to the artefact level. These indicators are:

(a) quality of written documents;
(b) compliance with provisions;
(c) knowledge and competence;
(d) training courses;
(e) workload;
(f) exercise of managerial functions;
(g) housekeeping;

(h) dealing with the authority;
(i) working climate.

During each inspection, a small range of these nine indicators is observed and rated by the inspectors on a four-level scale. The findings of each plant visit are collected in a database and represent mere “snapshots”. Accumulated over a longer period of time, these “snapshots” can show trends, which can be used as an early warning system for signs of a declining safety culture. Once a year all collected findings are evaluated for the individual nuclear power plants and conclusions regarding licensee’s safety culture (strengths, weaknesses, needs of fostering safety culture by the licensee etc.) can be drawn. The oversight approach to safety culture of the regulatory authority of Baden-Württemberg consists of four main elements:

(a) aggregation of the conclusions from the usage of KOMFORT;
(b) evaluating the self-assessment of the IMS of the licensee;
(c) fostering ownership and therefore the development of the safety culture of the licensee through the oversight approach of the regulatory authority;
(d) communication of the findings and impressions of the regulatory authority regarding weaknesses and possible fields of improvement to the senior management of the licensee in the so-called annual safety management system meeting.

A key point for the oversight of safety culture is the regulator´s awareness of his influence on the safety culture of the licensee. It is essential that the licensee remains fully responsible for the decisions about the measures be taken in response to the regulator´s findings and issues concerning licensee’s safety culture. The regulatory authority thus has to void any steps which might compromise the licensee´s responsibility for his safety culture.

2.3. Challenges of nuclear phase-out

The decision to finally phase out civil nuclear energy production until 2022 was taken by the German Federal Government after the accident at the nuclear power plant in Fukushima-Daiichi in 2011. This decision changed the parameters for the whole nuclear field in Germany. As a result, the last three Pressurized Water Reactors (PWRs) of Konvoi-type will end their operation in 2022. The phase-out decision increased the risk of losing know-how due to employees leaving the industry because of the limited career perspectives, and of a decrease in motivation, which could lead to a decline in safety-oriented behavior and safety culture. The plants which were already shut down are also under a rising pressure to cut costs, which is amplifying the challenges. Empirical experiences of other industries ([8], [9]) show that working and therefore safety-oriented behavior depends on the kind of the phase out process (e.g. with or without lay off of personnel, good or bad communication).

Maintaining the current high level of know-how, keeping up the motivation of the personnel in the nuclear sector, and fostering a strong safety culture under these conditions remains a significant challenge and is seen as priority in keeping a high nuclear safety level. The Reactor Safety Commission as advisory body of the BMUB is currently working on a statement addressing these issues. A R&D project was completed recently, which had the goal to develop the tool presented in the following section as an instrument for the assessment of nuclear safety culture by the regulator. Moreover, a R&D project is currently ongoing with the objective to develop a systematic process for influencing and improving safety culture considering the current situation in Germany and its resulting challenges. The project is conducted by GRS on behalf of the BMUB and is in its final phase.

3. A PRACTICAL TOOL RECOMMENDED FOR SAFETY CULTURE OVERSIGHT BY INSPECTORS

3.1. Objectives and principal lines of tool development

The development of the tool was driven by the following objectives:

(a). The essential features of safety culture have to be captured by the tool.
(b). Application of the tool shall provide results within a short period of time.
(c). Challenges of Germany’s decision to phase out civil nuclear energy production have to be addressed.
(d). The tool has to be concise and easy to use.

These objectives were realized as follows (details will be presented in the subsequent sections):

(a) Results of empirical research show, that management and leadership play a key role in promoting both the culture of a company and personnel’s striving for the goals of the company ([1], Appendix A) . These findings cover safety culture and safety goals. The development of the tool was therefore based on applicable knowledge about the managerial and leadership activities which can be expected to promote safe plant operation and safety-related performance of personnel. These activities form an integral part of safety culture, since, according to IAEA, leadership for safety is one characteristic of a strong safety culture ([10]).
(b) The objective of providing results within short periods of time was reached by developing two approaches. The first one is called “en-passant approach”, the second one “self-contained approach”. In the following, a brief description of both approaches will be given (more details about the

two approaches and their possible combination will be presented in section 3.3).

(i) In the "en-passant" approach, regulatory authorities prepare, motivate, and support inspectors to collect information on safety culture during their inspections in particular on site. It is not required, that the main goal of these inspections is safety culture oversight. En-passant-information about safety culture is so to speak a by-product of e.g. technical inspections during which inspectors have the opportunity to observe e.g. compliance with procedures or personnel's workload. Since many inspections are carried out all the year round and in different parts of a licensee's company, this approach can provide a steady flow of up-to date information about safety culture. This information can be processed and evaluated as soon as it is available to the regulatory authority. Due to quick availability of information and evaluation, the regulatory authority can rapidly react to degradations of the aspects of safety culture which are captured by the "en-passant" information (e.g. repeated non-compliance with procedures by several teams of licensee personnel during a period of a few weeks).

(ii) The "self-contained approach" was designed as a means of supporting safety culture oversight by an investigation aiming at the collection, processing, and evaluation of safety culture-relevant information which is as exhaustive as possible. Such investigations provide huge amounts of information. The processing and analysis of this information will be quite time-consuming. Results will therefore be available with correspondingly long delays, but they will, as far as possible, cover licensee's safety culture as a whole.

(c) Analysis and evaluation of nuclear phase-out challenges to safety culture were explicitly considered in the development of the tool.

(d) In order to facilitate practical application, the users' guide to the tool was kept as short and simple as possible.

3.2. Focus on leadership for safety and safety culture

Many findings of empirical research show that personnel's and, more generally, human performance systematically depends on leadership activities which can be divided into two major classes:

(a) Personal interaction with subordinates (instructing, directing and monitoring subordinates' task performance, corrective actions in case of need, fostering good relations to and between subordinates, settling conflicts between them, etc.);

(b) Planning and implementation of conditions which shape or influence task performance (e.g. training, ergonomic design of work-aids, workplaces etc., sufficient manpower and resources to perform tasks without time-pressure, etc.).

More precisely, these leadership activities influence human attitudes, motivation, confidence, commitment, qualification, stress, fitness, health, well-being etc. which, in turn, are key drivers of human performance also with respect to safety ([1], p. 13ff, [2], p. 158ff.). Based on these findings, it is possible to establish "causal chains" between observable leadership activities, unobservable psychological effects of these activities on subordinates, and subordinates' observable behavior, performance, errors, injuries, health status, etc. which are due to these psychological effects. We use the term "causal chain", because it is easy to understand, but we do not intend to convey the idea of a deterministic relation of cause to effect which characterizes classical natural laws. For convenience, the notion "leadership" will be used as an abbreviation of "leadership for safety and safety culture" throughout the rest of this paper. We will use the term "leader" in the following broad sense: Leaders are all members of a company in charge of leadership tasks. Leader may thus be people belonging to all levels of the hierarchy from top management (e.g. CEO, board of directors) down to personnel being only temporarily in charge of leadership tasks. For convenience, the term "manager" will not be used, but subsumed under "leader".

The before-mentioned "causal chains" are highly relevant to safety culture oversight: Proper inspection of leadership activities at a licensee's company will reveal the extent, to which

(a) Observed leadership activities correspond to those activities which, according to empirical evidence, will promote subordinates' safety-conscious and safety-related performance;
(b) Observed subordinates' task performance and observed conditions of task performance, which are "good" or "bad" with respect to safety, depend on leadership activities, which are in line or at variance with good practices of leadership for safety.

Evaluations can be based on empirical findings on positive or negative effects of particular leadership activities on subordinates' performance and on the achievement of the goals of a company. Users of this empirical findings can easily identify the issues which require corrective actions or, more generally, particular promotion by the licensee.

3.3. Tool development

The development of the tool used this empirical evidence on leadership and its positive or negative effects on personnel and performance as input. Use of this input comprised the following steps:

(a) Systematic review of the evidence presented in scientific publications ([1], p. 130ff.);
(b) Clearly structured classification of leadership activities (see below);
(c) Analysis, to which extent essential features of safety culture are captured by this classification ([2], p. 32ff.);
(d) Clear, user-friendly wording of the leadership activities.

3.3.1. Review and classification of leadership activities

Readers are referred to the sources indicated above, if they want to learn more about the literature review.

The classification of leadership activities is a hierarchical one with two levels. The higher level comprises five tasks, the lower level presents for each task several more concrete activities (in total: 17). Tasks and activities were defined is such a way that the entire range of tasks (activities) is covered without creating much redundancy ([1], p. 13ff.).

The five tasks are the following ones: Leaders have to

(a) Create best possible prerequisites of task performance;
(b) Coach, direct, and supervise personnel effectively;
(c) Build a powerful learning organization;
(d) Duly reward and recognize safety-culturally correct behavior, sanction safety culturally incorrect behavior;
(e) Foster trustworthy relationships to and within team.

The following lists present the more concrete activities:

Regarding best possible prerequisites of task performance, leaders have to

(a) Provide clear explanations of policy and goals of the company, of plant policy and plant goals, of standing orders, and of the significance of these goals, policies, and standing orders for safety;
(b) See to best possible conditions of safe and reliable task performance with respect to man, technology, and organization;
(c) Evaluate subordinates’ qualification, behavior, and performance objectively and provide adequate possibilities of personnel’s development.

Regarding effective coaching etc. of personnel, leaders have to

(a) Make clear decisions, give clear instructions, and provide clear information in particular with respect to safety and reliability;
(b) Be good role models by their own safety-related behavior;
(c) Encourage and support subordinates to ask questions and to rise concerns about work, safety, and reliability without delay and without self-censorship;
(d) Answer questions and resolve concerns about work, safety, and reliability professionally and prior to subordinates' performance of the tasks concerned;
(e) Monitor task performance by subordinates at the workplace, provide support, and perform necessary corrective actions.

Regarding the building of a powerful learning organization, leaders have to

(a) Encourage and support subordinates to be alert to actions, near-misses, and any factor compromising safety, to perform corrective actions as far as possible, and to report any issue objectively without delay or reserve;
(b) Take on clear responsibility for their own actions and errors;
(c) Investigate errors and issues in need of improvement as quickly as possible, to determine causes as precisely as possible, and to arrange for improvements in time;
(d) Encourage and support subordinates to freely suggest improvements of safety and reliability;
(e) Use any source of information (subordinates, operating experience, own observations, regulatory authorities, etc.) For developing improvements with respect to safety and reliability and without inopportune delays.

Regarding rewards, recognition, and sanctions, leaders have to

(a) Recognize subordinates' performance promptly, justly, and in a way which strengthens safety and reliability;
(b) Sanction behavior, which requires sanction for good reasons, in an adequate way.

Regarding trustworthy relationships to and within teams, leaders have to

(a) Foster good relations to and between subordinates in such a way, that these relations support safe and reliable actions;
(b) Be reliable as far as their announcements and promises are concerned.

The review of the empirical evidence does not support the conclusion that these activities are of unequal importance. It is thus not possible to identify a subset of these leadership activities which are more important than the remaining ones. Consequences of this conclusion for the tool will be presented below.

3.3.2. Relationship between leadership activities and essential safety-culture features

The tool development included the analysis, if these leadership activities capture the essential features of safety culture. The attributes of safety culture according to IAEA were used as a reference for "essential features". A deeper analysis reveals that the entire set of 37 attributes of a good safety culture according to IAEA can be mapped on the leadership activities listed above or on the psychological effects of these activities on subordinates' attitudes, competences, and confidence ([2], p. 50). The leadership activities are in general defined on a more abstract level than the attributes defined by IAEA. Since the attributes defined by IAEA correspond to the leadership activities or their psychological effects on personnel, it can be concluded, that the essential features of a good safety culture are captured by these leadership activities.

The tool uses the 17 activities listed above as the frame of reference for assessing leadership and its contribution to safety, safety-culture, and performance related to safety. Each activity is expressed as a requirement, i.e. as actions and measures people in charge of leadership tasks have to perform. According to the underlying empirical research findings, these leadership activities have positive effects on subordinates' health, psyche (emotions, knowledge, motivation, attitudes, commitment etc.), and performance. Section 3.3 will show how this frame of reference is recommended to be used for regulatory oversight.

3.3.3. User friendliness of the tool

Documentation of the tool and users' guidance were formulated in such a way, that inspectors can familiarize themselves easily with the tool and its application.

3.4. Collection, processing, evaluation, and use of relevant information

The tool supports two approaches to safety culture oversight ([1], p. 31ff.). Regulatory authorities can apply the two approaches in the following way: it is recommended to implement the en-passant approach, and to additionally apply the self-contained approach, if the regulatory authority wants to obtain more detailed and in-depth information about licensee's safety culture. This implementation strategy has the advantage of providing evaluations in the area of safety culture within a short period of time and of supplementing such quick evaluations by in-depth analyses. Regulatory authorities are free to supplement information obtained with the approaches by using other suitable methods for the analysis and assessment of safety culture or safety performance: The first approach is called "en-passant-approach", the second one "self-contained approach". Approaches of both types have been in use in different countries. They are characterized by the following general features (more detailed information about the approaches will be presented after this general characterization):

3.4.1. En-passant approach

The en-passant approach supports the analysis and evaluation of leadership activities during all kinds of inspection. Even if the primary goal of the oversight activities (e.g. technical inspections) is not the collection of information about leadership, such inspections can also provide insights into the promotion of safety culture by licensee's personnel in charge of leadership tasks. Observation of e.g. a periodic test will offer inspectors the opportunity to watch personnel's use of written procedures, response of team leaders to questions by personnel, presence of higher management on the shop-floor, support by equipment etc. Inspections can also provide opportunities to ask personnel about how and why they are doing what they are doing in order to perform their task (culture is often characterized as "ways of doing things"). Continuous application of this approach will provide lots of individual pieces of information about leadership for safety culture which are up to date and which can be processed and evaluated within a short period of time after the individual inspections.

3.4.2. Self-contained approach

The second or "self-contained" approach supports the analysis and evaluation of leadership in the context of an investigation which is focused on leadership and safety culture. Such investigations can take place within a period of e.g. several days or a few weeks. They will address leadership and safety culture in a more extensive and systematic way than observations and interviews during individual inspections, and they will provide a more or less huge amount of detailed information which represents a kind of snapshot of leadership activities at the time of the investigation. Due to the amount of resources needed, time intervals between successive investigations can be quite large.

3.4.3. Similarities and differences of both approaches

Both approaches share the following features:

It is recommended that inspectors familiarize themselves with the activities leaders have to perform in order to promote safety culture and to use this knowledge as guidance in the following sense: Inspectors should become alert to facts and communications which are related to leadership activities. They should try to get more and more detailed information about these leadership activities by asking (as far as possible) leaders as well as leaders' colleagues, superiors, and subordinates and (or) by observing additional relevant facts. Information should thus be obtained from multiple sources, because leaders' and e.g. subordinates' views, opinions etc. can be quite different. Ideally, inspectors will find out what, why, and with which effects leaders are doing what they are doing.

Very probably, inspectors will not get this kind of rich information, if they simply check off leaders' activities without "digging deeper" or if they distribute questionnaires about the leadership activities listed in section 3.2. Questionnaires should not be used, because leader and other personnel may answer the questions in a more or less biased way. Therefore, the tool should not be used as a questionnaire, but as guidance to observations and discussion as described above. The tool contains open lists of concrete topics of observation of prerequisites of task performance and discussion with personnel as well as guidance on how to ask questions and on how to perform observations.

Inspectors should also collect information about leadership activities which are in line with those required by the tool. Proper collection, processing, and evaluation of this "positive" information will show, how widely spread observed leadership activities are (in particular those which are at variance with the required leadership activities).

Since in both approaches the information obtained consists of more or less numerous and heterogeneous individual pieces, a synthesis has to be produced by which the pieces will be coherently put together. In particular, the following questions have to be answered during this synthesis: Are the individual pieces of information correct or do they contain errors (e.g. an inspector may commit an error regarding the correct designation of a component)? Do correct pieces of information reveal a systematic, more or less wide-spread phenomenon or trend or are they "outliers" (i.e. nothing that is valid for other people, situations, processes in the organization, buildings, equipment etc.)? How wide-spread are the phenomena, which are no outliers, do these phenomena reveal something which characterizes the entire company or subcultures within the company? The synthesis shall address causes, consequences, and interactions between leadership activities. It is recommended that these steps be performed by critical group discussions of inspectors in order to achieve best-possible objectivity of the syntheses. According to the state of the art, no rigorously formalized method for performing these steps is provided by the tool.

In both approaches, it is in principle possible to produce syntheses with a few pieces of information. Regulatory authorities thus can react quickly, if these pieces of information provide enough evidence on degradations in the areas of safety, safety culture, and related leadership activities. In the limiting case, even a single piece of information can be sufficient to trigger regulatory authorities' reactions. This possibility is given in self-contained approach, because there is no need to wait for the complete results of an investigation, if insights about licensee's safety culture, which require quick reaction by regulatory authorities, are discovered in the course of the collection, processing, and evaluation of information).

In both approaches, evaluations are based on the same criterion. Each leadership activity has to be evaluated individually. Inspectors can evaluate observed leadership activities with three categories:

(a) "Leadership activity in question requires promotion because of inacceptable discrepancies from the leadership activity that should be practiced";
(b) "Leadership activity in question requires more promotion because without additional promotion inacceptable discrepancy from leadership that should be practiced have to be expected";
(c) "No such discrepancies were found, leadership activity in question has to be promoted with at least the same effort which was invested until now".

Each negatively evaluated leadership activity has to be considered as an issue which requires improvement by the licensee. According to the tool, it is therefore not possible to balance deficits with respect to particular leadership activities, and other leadership activities which did not reveal unacceptable discrepancies or a need of increased promotion. Users must not evaluate the safety culture of a licensee as a good one, because the number of leadership activities which were evaluated according to category (c) is higher than the number of the leadership activities with a category-(a) or category-(b) evaluation. The underlying reason is the following one: If the licensee tolerates degradations in a particular area of safety culture, personnel and leaders may feel free or even encouraged to neglect adequate promotion of safety culture not only in this, but in more and more other areas. Tolerance of degradations in one area means, that the licensee does not promote safety culture as a whole and has to be triggered to develop proper measures of promotion.

If licensee's personnel do not provide adequate support to inspectors' collection of information, the first evaluation category is applied to all leadership activities concerned. The background of this evaluation is the requirement that the licensee's organization has to be a learning one and to use any source of information which can promote learning. Evaluation and feedback by regulatory authorities is one of these sources. Lack of adequate support of safety culture oversight is thus a sign of a safety culture which needs improvement in order to become a true learning organization.

Regarding the use of syntheses and evaluations, regulatory authorities may either continue the collection and processing of information without providing feedback to the licensee. Alternatively, the regulatory authority may feedback the synthesis and the evaluation to the licensee, evaluate licensee's response and explanations, and trigger necessary planning and implementation of corrective measures by the licensee. Due to licensee's responsibility for safety and safety culture, regulatory authorities will only indicate the need of corrective measures. It is up to the licensee to define and apply appropriate measures on his own responsibility.

In both approaches, information, syntheses, and evaluations can and should be aggregated and trended in order to provide insights regarding the development of licensee's safety culture.

En-passant and self-contained approaches differ in the following respects:

The en-passant approach ideally supports a steady flow of smaller information packages from different inspections, whereas the self-contained approach will provide bigger and more comprehensive information packages which arrive within a short interval of time. If self-contained approaches are repeated, the intervals between successive investigations may be longer or shorter, depending e.g. on the resources of the regulatory authority.

In the en-passant approach, inspectors need not to be experts in the area of safety culture or human and organizational factors. They should "only" be made familiar with the tool and its application. Teams performing investigations in the self-contained approach should have members who are experts in the afore-mentioned areas. In order to facilitate the en-passant approach, a short and simpler list of leadership activities is provided by the tool (see appendix). This short list can also be used in the self-contained approach, if the regulatory authority comes to the conclusion that the shorter list is better adapted to the authorities' resources (e.g. number of inspectors who are safety-culture experts etc.). But use of the short list in the self-contained approach implies losses of details which can only be captured with the original list of leadership activities (see section 3.2).

The en-passant-approach in particular is not only a means of information collection. It will become an integral part of the safety culture oversight, if collection and processing of information as well as communication of evaluation results to the licensee are performed extensively, continuously, and with minimal delays. Ideally, licensees will promptly and even proactively promote safety culture. This "mobilization" effect will be weaker, if only a self-contained approach is pursued, because inspectors who are investigating safety culture, asking questions, and drawing licensee's attention to relevant issues will be less frequently on site. As already pointed out, licensee remain fully responsible for safety culture and of measures to be taken in response to these discussions.

Decisions about the infrastructure, such as use of data banks, support by external safety-culture experts etc., rest with the regulatory authorities.

3.5. Tool validation

In science, methods are required to be objective, reliable, and valid, i.e. they have provide results which, ideally, are unbiased, reproducible, and meaningful. In pure science, appropriate tests have to show that a method fulfills these requirements. The development of the tool did not include such tests, rather the pragmatic example of other methods of safety culture oversight was followed: In order to decrease biases and to enhance reliability, the tool recommends that inspectors collect as many pieces of information by using as many sources as possible, to critically discuss, synthesize, and evaluate their observations as a team, and to use licensees' feedback in a critical and objective manner. Licensees' feedback as well as support by safety culture experts will also support tool validity.

In addition to these measures, a prior version of the tool was discussed with experts of the regulatory authority of the German federal state of Baden-Wuerttemberg. This group of experts is in charge of topics related to the system of Human-Technology-Organization and it has acquired deep expert knowledge in the oversight of safety management and safety culture. Their very positive feedback on the tool was used to improve its final version.

4. DISCUSSION

The development of the tool presented in section 3 of this paper was driven by two basic ideas:

(a) Information used as input to processing, analysis and evaluation has to be observable by inspectors;
(b) Conclusions about safety culture which are based on this information have to be supported by relevant findings of empirical research.

Both ideas were realized by identifying and systematizing observable leadership measures and actions which, according to results of empirical research, promote personnel's safe and reliable performance. It was verified, that these leadership activities are in line with the attributes of a strong safety culture according to IAEA. The identified leadership activities thus capture essential aspects of safety culture as defined by IAEA.

Since one major goal of the tool was to support analyses and evaluations of essential aspects of safety culture within a small period of time, two approaches were developed. In the "en-passant" approach, any kind of inspection can be used as a source of information about safety culture. Proper processing and evaluation of this information immediately after the inspection will support rapid reactions of regulatory authorities to possible degradations of safety culture, which are revealed by this information from inspections. This approach is particularly important in situations in which licensees undergo profound changes such as the definitive shutdown of a plant or deep organizational changes due to e.g. privatization or fusion of companies. The tool does support comprehensive and in-depth assessments of safety culture by a second approach (self-contained approach). Combination of both approaches will further strengthen safety culture oversight, because in-depth understanding of licensee's safety culture and rapid reaction to changes will go hand in hand.

We consider that these features (information available to inspectors, empirically founded conclusions regarding performance, being up to date about licensee's safety culture, and good understanding of licensee's safety culture) are essential for effective safety culture oversight. The tool is therefore recommended to be used by regulatory authorities in Germany. Dissemination of information about the tool is in progress. Final decisions regarding tool application rest with the regulatory authorities.

Since the tool has not been used in practice so far, we were not able to present practical experience regarding tool application. Feedback from practice will certainly trigger or even require further developments of this tool. But, based on our experience during tool development, we would like to suggest, that the further development of practical safety culture oversight methods, tools or approaches in general should draw on the basic ideas of using information which is easily and rapidly available to regulatory authorities and of taking systematic advantage of empirical findings which show how safer and reliable human performance depends on measures which are accessible to direct observation by regulatory authorities.

ACKNOWLEDGEMENTS

Many thanks are given to the members of the MTO-group (German abbreviation of "Human-Technology-Organization") of the regulatory authority of Baden-Wuerttemberg) who possess, due to the development and application of the KOMFORT-tool, a large amount of expert knowledge in the oversight of safety management and safety culture. This group provided highly valuable and encouraging feedback on the last-but one version of the tool.

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APPENDIX

In order to support inspectors who are (beyond training and familiarization with the tool) not necessarily safety-culture experts in the en-passant approach, the following requirements regarding leadership activities are available.

Leaders on all levels of the hierarchy have to

(a) Propagate the priority of the safety goal with respect to other goals unambiguously, frequently, and emphatically;
(b) Decide and act in a way which clearly demonstrates the priority of safety;
(c) Create best possible conditions of safe and reliable task performance;
(d) Make clear decisions, give clear instructions, and provide clear information;
(e) Be open to other people's hints, questions, concerns, and criticisms, clarify whatever has to be clarified in a professional, benevolent way, and to improve whatever needs improvement;
(f) Be present on the shop-floor level with sufficient frequency in order to get first-hand information and to support correct task performance;
(g) Foster open reporting of errors, near-misses, error potentials, and weak points, investigate causes and (possible) consequences objectively, and take on responsibility for their own actions and errors;
(h) Use insights obtained in order to develop and implement effective precautions and improvements;
(i) Recognize subordinates' performance adequately and in such a way that the priority of safety is clearly stressed;
(j) Sanction actions which truly require sanctions promptly and duly;
(k) Be reliable with respect to announcements and promises, treat others respectfully, and contribute to the respectful interactions between other people;
(l) Use all their possibilities to maintain qualified staff in sufficient number.

Correspondences with the original 17 activities are explained in the tool documentation ([1], p.46-47).

LESSONS LEARNED FROM A FIVE-YEAR EVALUATION OF THE BELGIAN SAFETY CULTURE OVERSIGHT PROCESS

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Abstract

The Belgian Regulatory Body[1] has implemented a safety culture oversight process since 2010. In a nutshell, this process is based on field observations provided by inspectors or safety analysts during any contact with a licensee (inspections, meetings, phone calls…). These observations are recorded within an observation (excel) sheet – aiming at describing factual and contextual elements – and are linked to IAEA Safety Culture attributes. The process is now fully operational. A self-assessment has been recently performed in order to learn from experience. The aim of the paper is to present the main strengths and limits of this kind of tool for safety culture oversight. Based on a five-year evaluation of the Belgian "Safety Culture Observations" (SCO) process, the paper intends to take stock of the main findings. More specifically, some issues will be highlighted such as the efficiency and the effectiveness of a SCO process, the way to improve the input of the process, the integration level of the process within the overall oversight process and the impact of the SCO process on the licensees safety culture.

1. INTRODUCTION

The purpose of the paper is to explore the feasibility of safety culture oversight, in particular in the nuclear field. Many research projects have already been conducted on safety culture within nuclear installations [1-10]. To assess safety culture, various methods are used: surveys, in-depth interviews, ethnographic assessments, case studies, focus-group or accident investigations [11-16].

Despite this large amount of studies, few of them focused on regulatory bodies' methodology needs [17-20]. Outlining a model of "Safety Culture Observation" (SCO) within the Belgian regulatory body, we argue that what is at stake for a regulatory body is nothing less than the development of new oversight capabilities [20]. Safety culture assessments intend to enable a systemic view of safety and to give the opportunity to better identify critical safety issues in Human and Organisational Factors (HOF). If safety culture cannot be directly regulated, it can be observed in order to develop a cross-cutting perspective of HOF domains

[1] The Belgian Regulatory Body is composed of the FANC (Federal Agency for Nuclear Control) and its technical subsidiary Bel V. The Safety Culture Observations process presented in this paper have been jointly developed by Bel V and FANC.

and, consequently, to engage a licensee in the deeper understanding of the cultural dimension of safety.

2. OVERVIEW OF A PROCESS

Regulators can require licensees to show proof of their efforts to establish and maintain a high level of safety culture. As presented in this paper, a regulatory body could also develop a system of data gathering and analysis aiming at a better understanding of a licensee safety culture. In a nutshell, the "Safety Culture Observations" (SCO) process, implemented since 2010 within the Belgian regulatory body, is based on field observations provided by inspectors or safety analysts during any contact with a licensee (inspections, meetings, phone calls…). The process has been revised in 2012 in order to renew the list of attributes and to give a better support to inspectors in terms of training, coaching and guidance.

Safety Culture Observations are recorded within an observation sheet (excel) aimed at describing factual and contextual elements[2]. These observations are then linked to safety culture attributes based on IAEA safety standard guidance (see table 1)[3][4].

[2] The observation sheet gives a homogenous framework to introduce information about the facility, the type of intervention during which the observations have been made (inspection, meeting, etc), the topic (subject of inspection/discussion) or the date of observation and possibly the reference report. More fundamentally, a safety culture observation also implies the description of the facts and context, the identification of safety culture attributes, an appreciation (positive or negative) and an argumentation developing the reasons why the observed fact is linked to safety culture.

[3] This table lists the attributes used in the process. Similar examples of attributes structure can be found in the guidelines established by the Bulgarian (2011) and the Romanian (2010) regulatory bodies [19].

[4] *Editor's note: This is an adapted version of the IAEA framework describing safety culture characteristics and attributes, found in Safety Guides GS-G-3.1 and GS-G-3.5. This edited version is not endorsed by the IAEA.*

TABLE 1. SAFETY CULTURE CHARACTERISTICS AND ATTRIBUTES

SAFETY CULTURE CHARACTERISTIC	ATTRIBUTE
A. Safety is a clearly recognized value	A1. The high priority given to safety is demonstrated in communication and decision making and reflected in documentation
	A2. A proactive and long term approach to safety issues is shown in decision making
	A3. Safety conscious behaviour is socially accepted and supported
	A4. Safety is a primary consideration in the allocation of resources
B. Leadership for safety is clear	B1. Commitment to safety is evident at all levels of management including corporate management
	B2. There is visible leadership showing the involvement of management in safety related activities
	B3. Management seeks the active involvement of individuals in improving safety
	B4. Relationships between management and individuals are built on trust
C. Accountability for safety is clear	C1. Roles, responsibilities and accountability for safety are well defined and clearly understood
	C2. There is a high level of compliance with rules and procedures
	C3. Ownership for safety is evident for all individuals and reflected in work environment and plant conditions
	C4. An appropriate relationship with the regulator ensures that the accountability for safety remains with the licensee
D. Safety is integrated into all activities	D1. Consideration of all types of safety including nuclear, radiological, industrial, environmental and physical safety is evident
	D2. Processes from implementation to review ensure that an adequate level of safety is maintained
	D3. Safe working conditions exist with regard to time pressures, workload and stress
	D4. Cooperation and teamwork ensure that an adequate level of safety is maintained
	D5. Factors affecting human performance are considered
E. Safety is learning driven	E1. A questioning attitude prevails at all organizational levels
	E2. Open reporting of deviations and errors is established and supported
	E3. Operating experience (both internal and external to the facility) contributes to continuous improvement
	E4. Internal and external assessments, including self-assessments contribute to continuous improvement
	E5. Safety performance indicators are tracked, trended, evaluated and acted upon
	E.6 There is systematic development of individual competences including leadership

However, it should be emphasized that the purpose of the process is not to give a comprehensive view of a licensee's safety culture but to address findings that require attention or action on the part of a licensee. In other words, gathering safety culture observations aims at identifying cultural, organisational or behavioural issues in order to feed a regulatory response to potential problems. Safety culture observations are then fully integrated in routine inspection activities and must be seen as input of the overall oversight process.

Operationally speaking, a “Safety Culture Coordinator” (SCC) is in charge of the observation analyses and reporting. Safety culture observations are assessed through four key safety dimensions: *i.e.* management system, leadership, human performance and learning. For each of these dimensions, observed safety culture strengths and weaknesses are yearly discussed with licensees. For instance, driven by the SCO, findings concerning the ability of field managers to establish an open communication or the questioning attitude of operators could be drawn out. These findings constitute potential direct and operational messages to be taken into account by a licensee.

In case of a significant safety (culture) problem, direct reporting to the licensee is considered. On a regular basis, the SCC provides a series of reports (see table 2). These reports aim at identifying early signs of safety problems and recording recurrent observations. As a result of this, it could be decided to analyse a licensee performance more in detail in order to understand the underlying causes of a problem or to focus inspections on specific aspects. On an annual basis, a detailed report is released and a synthesis is inserted within the yearly safety evaluation report transmitted to the concerned licensee. The content of this yearly safety evaluation report is discussed with the licensee in order to be sure that the regulatory concerns are understood.

From a methodological perspective, observations focus on facts – *i.e.* information based on real occurrences: behaviour, statements, discrepancies… – and take into account the context. The first objective is therefore to answer the “What happened?” question. An observable fact could be either organizational (a resource mismatch, a backlog, a staffing problem…) or behavioural (an observation concerning cooperation or communication, a lack of verification or communication, a relevant decision, a disregard for rules…). Secondly, an observation should also be enhanced by answering some other generic questions (who, where, when…) in order to describe the workplace situation as thoroughly as possible: the operation or activity, the persons involved (function, department, organisation…), the problem to be solved, the document actually used or not, the role of management, the communicational context (one way communication, participation…), work conditions (stress, workload…), etc.

However, observing safety culture is not a natural approach for engineers. Guidance and coaching are needed to provide them with an appropriate framework.

TABLE 2. SCO PROCESS MAP

	Inspectors / Safety Analysts	SC coordinator	Aims	Impacts on oversight process
Each month	OBSERVATIONS	Observations analysis	• Improve observation (description and classification)	• Possible direct reporting to the licensee
Each quarter		Synthetic report	• Identify early sign of SC issues • Presentation to the monthly FANC-BelV meeting	• In depth analysis • Focus inspections on specific dimensions
Each Year		Detailed report	• Global analysis of SCO on yearly basis • Discussion with the licensee	• Input for annual Management inspection • Feeding annual inspections programme • Follow-up of licensee actions
Pluri-annual		Trend report	• Identify deep-seated SC issues • Discussion with the licensee	

3. OPEN UP INSPECTION PRACTICES

Standards and guidelines in the field developed different lists of key attributes indicating what a good safety culture consists of. Many elements as a questioning attitude, mutual trust between management and operators or cross-functional teamwork are attributes commonly considered as characteristics of a strong safety culture. Conversely, warning signs of a weak safety culture could be identified, such as a lack of systematic approach, insufficient reporting practices or resource mismatch.

Using the iceberg metaphor, culture has visible and invisible sides. Firstly, “Artefacts” are manifestations that include behaviours, rituals, dress code or the manner in which people interact. Secondly, “Espoused values” are defined as values adopted and supported by an organisation through general statements – such as “Safety first” or concerning teamwork, decision-making or reporting. Thirdly, according to the Schein model [21], the deepest layer of culture consists of the underlying assumptions, i.e. the taken-for-granted and unconscious beliefs that determine perceptions and behaviours. These shared assumptions are implicitly understood within an organisation, often unquestioned and deeply grounded on practices that resulted from a learning process. Therefore, what is at stake is to understand the interrelations of behaviours (what people do), values (what is said) and basic assumptions (what people think or believe). A representation of Schein’s layered model is described below (see figure 3).

However, what is a good or a bad safety culture is not so clear-cut on the workplace. For instance, a finding such as lack of “compliance with regulations, rules and procedures” is obviously significant but, adopting a safety culture point of view, it is more important to understand why people did not follow the rule: are we facing a bad behaviour or a bad rule issue? If we go further, a question could arise as to why operators did not comply: does it mean that we are facing an understanding problem (lack of training, knowledge of work process…) or a procedure fitness problem (appropriateness of the procedure for a specific task)? Relating to the group level we can raise issues concerning the legitimized level of compliance within a group (department, team, plant…). In terms of management, the questions could be oriented towards the commitment of management or towards a failure in the documentation reviewing process as well.

In this line of thinking, providing an observation is not only establishing a link between a finding and a dedicated attribute. The important point is to try to describe what is behind the link and to seek shedding light on the underlying reasons as to why the rules were ignored. That means that observations are not context-free: what is at stake is a deep understanding of the workplace situation [22]. As a challenge, observing safety culture contributes to diversify the classical inspection approach.

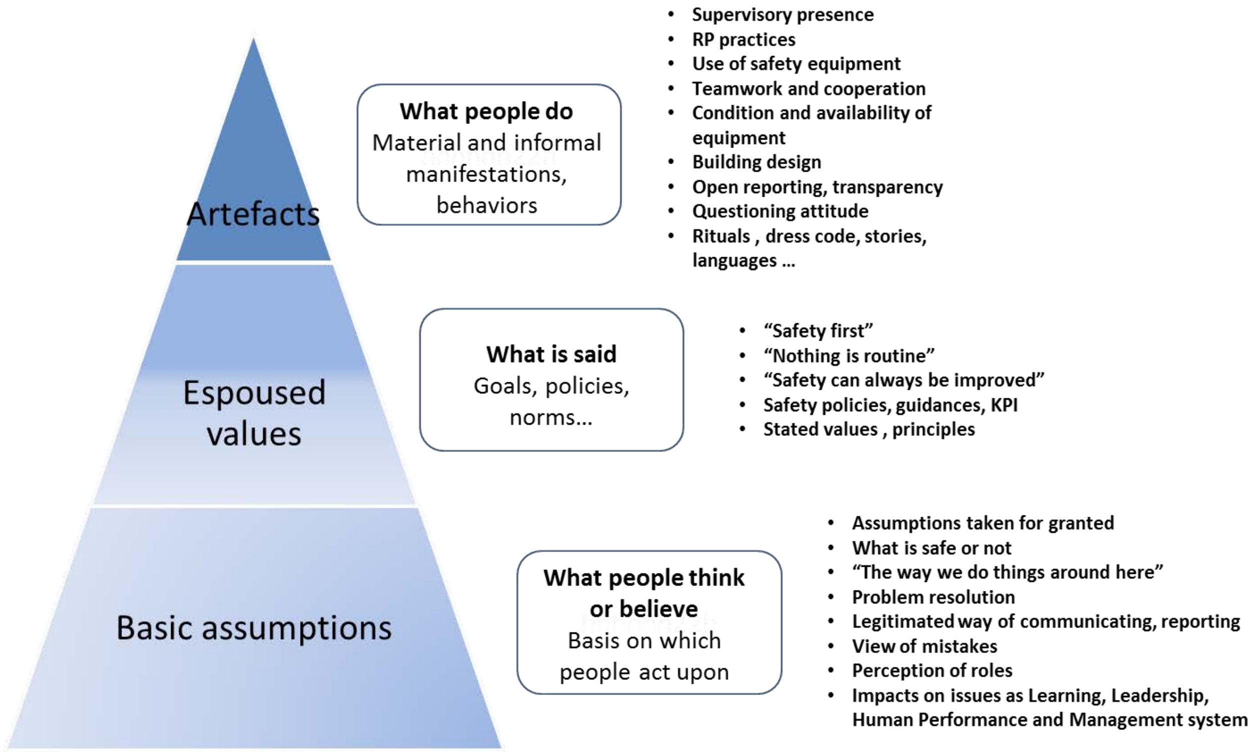
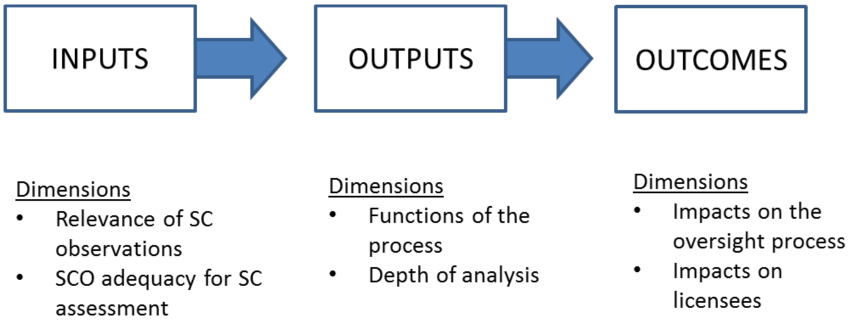


FIG.3. Adapted depiction of Schein's (1985) layered model.

4. A THREE-PHASE ASSESSMENT

In order to obtain a comprehensive view of the implemented tool, the assessment of the SCO process is broken down into three main phases as shown in table 3: the inputs (how the process is fed), outputs (what is produced) and outcomes (which impacts).

TABLE 3. PHASES AND DIMENSIONS ASSESSED



1. Input phase

4.1.1. Main achievements

— Safety Culture Observations (SCO) are mainly based on field observations (plant walk-down, meetings…) but are also gathered from review of event analysis reports. Therefore the SCO process is essentially fed by field inspectors (Bel V and FANC). Since September 2014, SCOs are also potentially provided by each Bel V safety analyst (belonging to the Safety Assessment Department).

— This implies that all these experts have been trained to apply the SCO tool (theory and practice sessions). Training is also regularly organised for newcomers. In addition, individual field coaching for inspectors is organised in order to develop their observation capabilities.

— It is important to mention that the Safety Culture Coordinator checks the inspection reports in order to identify additional potential SCOs. In that case, the coordinator and the inspector discuss the opportunity to record an observation.

— For instance, approximatively 70 SCOs (positive and negative) are provided yearly at the scale of a NPP site.

4.1.2. Assessment dimensions

— Relevance of Safety Culture Observations performed by inspectors:
  - Since the review of the process in 2012, the quality of SCO shows an improving trend. SCOs now reach a good quality level in terms of description (facts and context) and in terms of attribute selection.
  - The system in place enables to cover a larger scope of safety culture attributes.

— Adequacy of SCOs for safety culture analysis:
  - As mentioned, SCOs are exploitable data in order to develop a safety culture chapter within the yearly safety evaluation dedicated to each nuclear installation.
  - Nevertheless, from a quantitative perspective, it is important to note that the process needs to be fed by a minimal amount of observations. Actually, the more observations are recorded, the deeper is the analysis. What is at stake here is to obtain a sufficient number of SCOs in order to make a robust analysis.
  - This implies that inspectors' observation capabilities ("What to observe?") should be continuously reinforced through a systematic coaching in the field.

2. Output phase

4.2.1. Main achievements

— SCOs are analysed on a yearly basis and the findings related to an installation are reported and discussed with the licensee. These analyses constitute the main output of the process. In addition, a 3-year safety culture analysis of Belgian NPPs (SCO from 2013 to 2015) has been recently performed.

4.2.2. Assessment dimensions

— Functions of the process:
  - The SCO process is considered as appropriate for recording safety culture "discrepancies or good practices", analysing the observations and, once a year, for reporting the results to licensees. Regarding a specific negative observation, it is also noteworthy that an opportunity exists to react rapidly and inform a licensee of significant safety culture findings.
  - Nevertheless, it is important to note that the process is not relevant for real-time monitoring. The process actually needs time to gather information and, as said, the analysis method requires a sufficient amount of observations to identify relevant conclusions.

— Depth of analysis:
  - The process enables drawing attention to human and organizational issues to be followed or further investigated. In other words, the tool captures blind spots and signs of safety culture issues, in particular regarding dimensions as management system, leadership, human performance and learning.
  - However, until now, SCOs analysis remains at the site level of an installation. A larger amount of SCOs is needed to perform safety culture analyses at the units' or departments' levels. As a next step, analyses could go deeper into the knowledge of specific cultural characteristics of units, departments or occupational groups of a nuclear installation.

3. Outcome phase

4.3.1. Main achievements

— Prior to its actual start, the safety culture oversight process has been introduced to the licensees during a "Stakeholders meeting" *(i.e.* a one-day meeting, gathering all the licensees and the regulatory body).

— On the basis of the yearly safety evaluation report (including a safety culture chapter), the conclusions of the analysis of SCO are discussed face to face with the top level management of an installation.

4.3.2. Assessment dimensions

— Impacts on the oversight process:
  - The process was developed in order to feed the overall oversight process (see table 2). This implies that results of safety culture analyses should be use for setting licensee actions to be achieved by the licensees or for developing the next year's inspection program.

— Impacts on licensees:
  - Promoting licensees' safety culture was considered as an indirect objective. Actually, in parallel of the regulatory body SCO process, some licensees developed their own safety culture oversight process and asked to be advised by the regulatory body on that matter.

5. CONCLUSIONS: KEY DRIVERS TO SUCCESS

— Regarding the input and output phases, it seems that the SCO process is now fully operational. After a 5-year period dedicated to the development of the tool, the training of experts and the practical implementation of the process (including safety culture analysis and reporting to licensees), the time is ripe to deeper integrate the SCO process within the overall oversight process.
— According to these findings we can argue that this kind of process is relevant for capturing and analysing safety culture issues. This also implies adopting a “Learning by doing” approach and seeking for a continuous improvement of internal capabilities. In other words, this kind of process cannot be a “turn-key project” but necessarily is “home-made”.
— Qualitative and quantitative sides are equally relevant in order to enable a robust analysis. This implies continuously providing training and, most importantly, organising field coaching for inspectors.
— The nomination of a safety culture coordinator or officer is therefore a critical point in order to develop and manage the process. In that regard, as said, we can lay the emphasis on the coaching and managing functions of the safety culture coordinator.
— As a main advantage of the process, it is also important to mention that implementing a SCO process also constitutes a knowledge development process in itself. Observing safety culture attributes clearly was a new practice for most of the inspectors of the Belgian Regulatory body. The development of the process has been an opportunity to open up new safety issues and to reinforce inspectors’ capabilities in HOF oversight.

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IMPROVEMENTS OF THE REGULATORY FRAMEWORK FOR NUCLEAR INSTALLATIONS IN THE AREAS OF HUMAN AND ORGANIZATIONAL FACTORS AND SAFETY CULTURE

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Abstract

The paper presents the development of regulatory requirements in the area of human and organizational factors taking account of the lessons learned from major accidents in the nuclear industry and in particular of the factors that contributed to the Fukushima Daiichi accident and the improvement of the regulatory oversight of nuclear safety culture. New requirements have been elaborated by the National Commission for Nuclear Activities Control (CNCAN) on the nuclear safety policy of licensees for nuclear installations, on independent nuclear safety oversight, on safety conscious work environment and on the assessment of nuclear safety culture. The regulatory process for the oversight of nuclear safety culture within licensees' organizations operating nuclear installations is presented, together its associated procedure and guidelines. CNCAN uses the 37 IAEA attributes for a strong safety culture, grouped into 5 areas corresponding to safety culture characteristics, as the basis for its regulatory guidelines providing support to the reviewers and inspectors, in their routine activities, for recognizing and gathering information relevant to safety culture. Starting with July 2014, Romania has a National Strategy for Nuclear Safety and Security, which includes strategic objectives, associated directions for action and concrete actions for promoting nuclear safety culture in all the organizations in the nuclear sector. The progress with the implementation of this strategy with regard to nuclear safety culture is described in the paper. CNCAN started to define its own organizational culture model and identifying the elements that promote and support safety culture. The experience with the development and improvement of the regulatory framework, regulatory oversight process and safety culture in the regulatory organization are all described in the paper and may prove useful for regulatory authorities of other countries.

1. INTRODUCTION

Following the Fukushima Daiichi accident, CNCAN (the National Commission for Nuclear Activities Control – the nuclear regulatory authority of Romania) has focused initially on the technical reviews of the protection of the plant against extreme external events and of beyond design basis accident analysis, severe accident management and emergency response. After more information became available on the organizational factors that have contributed to the accident, CNCAN has used the lessons learned to improve the national regulatory framework, its practices for regulatory oversight of licensees' safety culture and its own safety culture.

Lessons learned from the Fukushima Daiichi accident with regard to human and organizational factors cover a wide range of aspects, from human factors influencing the accident management and the emergency preparedness and response, to organizational factors related to the independence and technical competence of a nuclear regulatory authority and to shared assumptions about the credibility of beyond design basis accidents and the need for preparing for the unexpected.

The paper presents an overview of the regulatory requirements issued by CNCAN in the area of human and organizational factors, the process implemented for the regulatory oversight of nuclear safety culture and its strategic objective and efforts for improving nuclear safety culture in all organizations in the nuclear sector, including in its own organization.

2. NEW REGULATORY REQUIREMENTS ON HUMAN AND ORGANIZATIONAL FACTORS

Acting upon the lessons learned from the Fukushima Daiichi accident and from the safety reviews performed, CNCAN issued the regulation "Nuclear safety requirements on the response to transients, accidents and emergency situations at nuclear power plants". The regulation was published in January 2014 and came into force in April 2014. The new regulation on accident management and on-site emergency preparedness and response provides requirements on:

- objectives, principles and factors to be taken into account for the response to transients, accidents and emergency situations on-site;
- transient and accident scenarios to be addressed in / covered by the EOPs (Emergency Operating Procedures);
- severe accident scenarios to be covered by the SAMGs (Severe Accident Management Guidelines);
- emergency situations to be covered by the on-site emergency response plan and emergency response procedures;
- establishment of the minimum number of staff with necessary qualifications to manage all scenarios required by the regulation (including combinations of events and scenarios in which multiple units on site are affected by accidents initiated by extreme external events beyond the design basis of the plants);
- facilities and equipment to be available for accident management and on-site emergency response, including in situations caused by extreme external events;

- habitability analyses to demonstrate de feasibility of human actions for severe accident management;
- development, validation and documentation of the technical basis for the procedures, taking into account human factors;
- configuration management in relation to the procedures and systems credited for accident management and emergency response;
- training programs and exercises;
- use of operational experience for the improvement of accident management and emergency response and records from exercises and from real events.

Since accident management and on-site emergency response are intrinsically coupled, it was decided that both should be addressed in the same regulation. It is expected that this approach would contribute to a better correlation between activities pertaining to the development of EOPs, SAMGs and emergency response procedures and plans as well as to the effectiveness of regulatory review and inspection activities. Cernavoda NPP has already taken actions to comply with the new regulatory requirements. Review and inspection activities for assessing compliance with the new regulation are still ongoing. As actions resulting from the enforcement of this regulation, so far, we can mention the re-assessment of the minimum shift complement and the review and improvement of the EOPs addressing events occurring during shutdown states. The development of SAMGs to cover shutdown states had already been committed as part of the post-Fukushima action plan.

Although nuclear safety culture cannot be regulated as such, the organizational and human factors that support a healthy nuclear safety culture are subject to regulatory requirements. Formalizing the requirements on some of the artifacts that influence nuclear safety culture, CNCAN issued a new regulation, “Requirements on the nuclear safety policy and on the independent nuclear safety oversight”. It applies to all licensees and applicants for a license for the phases of construction, commissioning and operation of nuclear installations (including nuclear power plants). The regulation was published and came into force in September 2015 and the licensees have 1 year to ensure compliance with it.

The first part of the regulation establishes requirements on the nuclear safety policy, covering all the current WENRA safety reference levels in Issue A [1]. The second part of the regulation establishes requirements on the independent nuclear safety oversight. The requirements on independent nuclear safety oversight have been established by CNCAN taking account of the international experience available in this area, including the information from various countries that have a long tradition in this practice (e.g. UK, France, Belgium, etc.), the conclusions in the Summary Report of the 6th Review Meeting of the Contracting Parties to the Convention on Nuclear Safety [2] and the publication „Independent Oversight - A Nuclear Industry Good Practice Guide” [3].

The requirements are aimed at establishing an organizational unit, inside each licensee's organization, having as an exclusive and full-time job the independent oversight of nuclear safety. The organizational unit responsible for the independent nuclear safety oversight shall be separated from the organizational units responsible for design, engineering, construction, commissioning, operation, for development, maintenance and continual improvement of the management system, as well as from the organizational unit responsible for the performance of the current / routine nuclear safety evaluations. This function of internal independent nuclear safety oversight is different / separate from the independent audit of the management system (which is nevertheless recognized as a form of internal independent oversight). It cannot be considered fulfilled by external independent oversight units / organizations (such as Nuclear Safety Review Boards) and external review missions.

The intent of the regulatory requirements is that the independent nuclear safety oversight function is performed on a continuous basis. In other jurisdictions, this function is referred to informally as an "internal regulator" function. The independent nuclear safety oversight is expected to identify the processes and activities that are not effective in preventing problems with impact on nuclear safety

The regulation establishes requirements on the competences and qualifications of the personnel responsible for the independent nuclear safety oversight, on their authority and duties. The personnel assigned to perform independent nuclear safety oversight functions will be licensed by CNCAN based on exams and interviews that include observations of inspection activities performed by the candidates in the respective nuclear installations.

The implementation of the new requirements on independent nuclear safety oversight is not aimed to decrease the regulatory oversight effort but to provide additional assurance to the regulator that the licensee is taking all the reasonably practicable measures to find and correct any safety significant issues in a timely manner, taking account of the best practices in this area at international level.

3. REGULATORY OVERSIGHT OF LICENSEE'S NUCLEAR SAFETY CULTURE

The regulatory process for the oversight of nuclear safety culture within licensees' organizations operating nuclear installations and the associated procedure and guidelines, based on the IAEA Safety Standards, have been developed in 2010-2011. CNCAN has used the 37 IAEA attributes for a strong safety culture, grouped into 5 areas corresponding to safety culture characteristics (GS-G-3.1) [4], as the basis for its regulatory guidelines providing support to the reviewers and inspectors, in their routine activities, for recognizing and gathering information relevant to safety culture. The safety culture oversight process, procedure and guidelines have been reviewed and revised in 2015 to improve their effectiveness and to align with the current international practices, using lessons learned from the Fukushima Daiichi accident.

The SCOP guidelines have been designed to enable data gathering for the assessment of each safety culture attribute and include, as applicable:

— regulatory expectations relevant to the attribute;
— documentation to be reviewed;
— questions to be asked;
— observations to be made;
— elements necessary for considering an attribute fulfilled;
— warning flags.

A few examples of generic data sources for regulatory assessment of safety culture, which are applicable regardless of the technical area of inspection, are provided below:

— policy documents emphasizing priority to safety;
— procedures that describe safety-related processes and activities;
— self-assessment guidelines;
— self-assessment reports and safety performance indicators for various processes (e.g. training, maintenance, etc.);
— results of (quality) management system audits and reviews, reports from external reviews;
— previous inspection reports;
— records of past events and corrective actions implemented;
— interviews with licensee's staff at various levels (managers, supervisors, workers) during the inspections; observations during common meetings;
— observation of activities in the field (e.g. corrective maintenance work, preventive maintenance work, chemistry activities - sampling/analyses; surveillance/testing; nuclear plant operator rounds; new fuel receipt and inspection; shift turnover; control room and simulator evolutions; system/component clearance activities; hold point activities; training – initial / refreshment; maintenance planning meetings; outage planning meetings, etc.).

The implementation of the SCOP proved that all the routine regulatory reviews and inspections reveal aspects that are of certain relevance to safety culture. Interactions with plant staff during the various inspection activities and meetings, as well as the daily observation by the resident inspectors, provide all the necessary elements for having an overall picture of the safety culture of the licensee. Systematic planning of regulatory inspections to cover all areas important to safety should ensure that safety culture aspects are timely observed. However, significant regulatory resources and a large number of review and inspection activities are required, over a relatively long period of time, to gather sufficient data in order to make a judgement on the safety culture of an organization as a whole. Training of the reviewers and inspectors is considered essential for achieving consistency in the regulatory approach to safety culture oversight.

4. NATIONAL STRATEGY FOR NUCLEAR SAFETY AND SECURITY

Starting with July 2014, Romania has a National Strategy for Nuclear Safety and Security, which was officially approved by the Government and by the Supreme Council of National Defense. The strategy includes a policy statement with nuclear safety and security principles, including the ten fundamental safety principles outlined in the IAEA SF-1 Publication [5]. The strategy includes objectives, associated directions for action and concrete actions for promoting nuclear safety culture in all the organizations in the nuclear sector.

The progress with the implementation of this strategy with regard to nuclear safety culture so far consists of:

- new regulatory requirements on human and organizational factors and improved regulatory oversight of safety culture, as mentioned in the previous sections;
- promotion of the principles and attributes of a healthy nuclear safety culture;
- training activities for improving awareness and understanding of nuclear safety culture and of the factors of organizational culture that support or undermine safety culture;
- development of a safety culture model for the regulators' organization.

5. NUCLEAR SAFETY CULTURE OF THE REGULATOR

CNCAN started to define its own organizational culture model and identifying the elements that promote and support safety culture. The model has been developed using the organizational culture model developed by Edgar Schein [6]. This action has been taken based upon a recommendation received from the 6th Review Meeting of the Contracting Parties to the Convention on Nuclear Safety, to have assessments of the safety culture of the regulatory authority, acknowledging that the culture of the regulator may have an influence on the safety culture of the licensees. A limited exercise for a safety climate survey has been implemented for CNCAN staff involved in the regulatory review and inspection activities for nuclear installations. The same 37 attributes of a strong safety culture promoted by the IAEA have been used, in a slightly adapted form, also for the safety climate survey for CNCAN staff. Several training activities for the staff in the area of organizational culture and nuclear safety culture have been implemented and others are planned for 2016.

6. FURTHER WORK

CNCAN is committed to continue to keep itself informed of any further lessons learned from operational and regulatory experience and bring this to the attention of all national organizations in the nuclear sector. Work will continue on the implementation of the regulatory oversight of the licensees' nuclear safety culture, as well as on the development and self-assessment of the nuclear safety culture of the regulator.

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U.S. NUCLEAR REGULATORY COMMISSION
Safety Culture Oversight

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Abstract

The NRC recognizes that it is important for all organizations performing or overseeing regulated activities to establish and maintain a positive safety culture commensurate with the safety and security significance of their activities and the nature and complexity of their organizations and functions. The NRC's approach to safety culture is based on the premise that licensees bear the primary responsibility for safety. The NRC provides oversight of safety culture through expectations detailed in policy statements, safety culture assessor training for NRC inspectors, the oversight processes, and the Allegations and Enforcement Programs.

1. INTRODUCTION

Beginning in 1989, the NRC published three policy statements about safety culture at nuclear power plants. One described the Commission's expectations for the conduct of operations in control rooms; the second established the Commission's expectation for maintaining a safety-conscious work environment (SCWE), in which workers are able to raise nuclear safety concerns without fear of retaliation. In 2011, the NRC published a Safety Culture Policy Statement (SCPS) to establish the Commission's expectations for licensees to maintain a strong safety culture. The SCPS has informed the NRC's oversight process through the common language initiative.

The NRC provides training to inspectors to become qualified as Safety Culture Assessors for general safety culture assessments or IP 95003 inspections. This qualification requires a firm understanding of both safety culture and inspection skills, and is an essential part of the NRC's oversight of safety culture.

The Reactor Oversight Process (ROP) is the NRC's program for assessing the performance of operating commercial nuclear power reactors. In 2004, the NRC took steps within the ROP to strengthen the agency's ability to detect potential safety culture weaknesses during inspections and performance assessments. In 2006, guidance and procedures for inspecting and assessing aspects of licensees' safety culture were included in the ROP. In 2014, revisions were made to the ROP based on the common language initiative. The Construction Oversight Process (cROP) for new reactors, and the Fuel Cycles Oversight Process (FCOP) were modeled after the ROP.

In addition to the oversight processes, the NRC's Allegation and Enforcement Programs address safety culture through the use of Chilling Effect Letters (CEL) and Confirmatory Orders (CO). CELs are issued when the NRC has concluded that the work environment is "chilled," (i.e., workers perceive that the licensee is suppressing or discouraging the raising of safety concerns or is not addressing such concerns when they are raised). The number and nature of allegations received at the NRC, including allegations related to discrimination for raising safety related concerns help inform the NRC's decision to send a CEL. COs are issued by the NRC to document agreements on specific corrective actions made by the licensee in response to inspection findings.

The information referenced below, including the SCPS, Inspection Manual Chapters (IMC), Inspection Procedures (IP), and NUREGs, can be found in the NRC's Agency-wide Documents Access & Management System (ADAMS), or at specific websites noted within the sections below.

2. SAFETY CULTURE POLICY STATEMENT

The SCPS sets forth the Commission's expectation that individuals and organizations establish and maintain a positive safety culture commensurate with the safety and security significance of their activities and the nature and complexity of their organizations and functions. The SCPS is not a regulation. It applies to all licensees, certificate holders, permit holders, authorization holders, holders of quality assurance program approvals, vendors and suppliers of safety-related components, and applicants for a license, certificate, permit, authorization, or quality assurance program approval, subject to NRC authority. In addition, the Commission encourages the Agreement States (States that assume regulatory authority over their own use of certain nuclear materials), their licensees, and other organizations interested in nuclear safety to support the development and maintenance of a positive safety culture within their regulated communities. More information on the Agreement States can be found on the NRC's Web page [1].

The SCPS addresses both safety and security. Organizations should ensure that personnel in the safety and security sectors have an appreciation for the importance of each, emphasizing the need for integration and balance to achieve both safety and security in their activities. Safety and security activities are closely intertwined. While many safety and security activities complement each other, there may be instances in which safety and security interests create competing goals. It is important that consideration of these activities be integrated so as not to diminish or adversely affect either; thus, mechanisms should be established to identify and resolve these differences. A safety culture that accomplishes this would include all nuclear safety and security issues associated with NRC regulated activities.

The SCPS defines nuclear safety culture as the core values and behavior resulting from a collective commitment by leaders and individuals to emphasize safety over competing goals to ensure protection of people and the environment.

The SCPS includes a list of nine traits further defining a positive safety culture. These traits describe patterns of thinking, feeling, and behaving that emphasize safety, particularly in goal conflict situations, such as when safety goals conflict with production, schedule or cost goals. The traits listed Fig. 1 below are not all-inclusive. Some organizations may find that one or more of the traits are particularly relevant to their activities. There may also be traits not included in the SCPS that are important in a positive safety culture. More information on the SCPS can be found on the NRC's Web page [2].

Leadership Safety Values and Actions	**Problem Identification and Resolution**	**Personal Accountability**
Leaders demonstrate a commitment to safety in their decisions and behaviors.	Issues potentially impacting safety are promptly identified, fully evaluated, and promptly addressed and corrected commensurate with their significance.	All individuals take personal responsibility for safety.
Work Processes	**Continuous Learning**	**Environment for Raising Concerns**
The process of planning and controlling work activities is implemented so that safety is maintained.	Opportunities to learn about ways to ensure safety are sought out and implemented.	A safety conscious work environment is maintained where personnel feel free to raise safety concerns without fear of retaliation, intimidation, harassment or discrimination.
Effective Safety Communications	**Respectful Work Environment**	**Questioning Attitude**
Communications maintain a focus on safety.	Trust and respect permeate the organization.	Individuals avoid complacency and continually challenge existing conditions and activities in order to identify discrepancies that might result in error or inappropriate action.

FIG. 1. Safety culture traits and definitions.

3. SAFETY CULTURE COMMON LANGUAGE

Before work began on the 2011 SCPS, the nuclear power industry approached the NRC about starting an effort to develop a shared set of terms to describe safety culture. With insights gained during the development of the SCPS, the Office of Nuclear Reactor Regulation (NRR), along with Institute of Nuclear Power Operations (INPO) and Nuclear Energy Institute (NEI), hosted a series of public workshops beginning in December 2011 to discuss the idea of a safety culture common language. The intent of this initiative, as requested by the industry, was to align terminology between the NRC's inspection and assessment processes within the ROP and the industry's assessment process. This initiative was within the Commission-directed framework for enhancing the ROP treatment of crosscutting areas to more fully address safety culture.

NUREG-2165, "Safety Culture Common Language," documents the outcomes of the public workshops to develop a common language to describe safety culture in the nuclear industry. These workshops included panelists from the NRC, the nuclear power industry, and the public. NUREG-2165 outlines a suggested common language for classifying and grouping traits and attributes of a healthy nuclear safety culture. The results of the common language initiative were 10 traits of a healthy safety culture (the nine traits from the SPCS plus a 10th trait, decision-making), 40 aspects nested under those traits, and numerous examples for each aspect. These common language traits and aspects have been incorporated under the three cross-cutting areas of the ROP. NUREG-2165 can be found on the NRC’s Web page [3].

4. SAFETY CULTURE ASSESSOR TRAINING

Qualification as a Safety Culture Assessor requires the completion of a variety of activities, each of which is designed to help gather information or practice a skill that may be important during inspections. When qualified, the Assessor will have demonstrated the following competencies:

- Understand the legal basis for and the regulatory processes used to achieve the NRC’s regulatory objectives.
- Master the techniques and skills needed to collect, analyze, and integrate information using a safety culture focus to develop a supportable regulatory conclusion.
- Demonstrate the personal and interpersonal skills needed to carry out assigned regulatory activities, either individually or as part of a team.

All inspectors are required to complete an inspector qualification interview to evaluate how well an individual can integrate and apply inspector competencies to field situations. Additional information on IMC 1245, Appendix C-12, “Safety

Culture Assessor Training and Qualification Journal" can be found on the NRC's Web page [4].

5. OVERSIGHT PROCESSES

Reactor Oversight Process (ROP): The NRC's approach to safety culture is based on the premise that licensees bear the primary responsibility for safety. The ROP is the NRC's program for assessing the performance of operating commercial nuclear power reactors. The ROP uses inputs from performance indicators and inspection findings to develop conclusions about a licensee's safety performance. Performance is evaluated systematically and on a continuous basis through planned inspections, and mid-year and end of year assessment meetings.

The ROP stems from the NRC's mission to three strategic performance areas, and seven cornerstones, as in Fig. 2 below. Each cornerstone has corresponding performance indicators and inspection procedures to assess licensee performance. Safety culture is considered within three cross-cutting areas of Human Performance, Safety Conscious Work Environment, and Problem Identification and Evaluation.

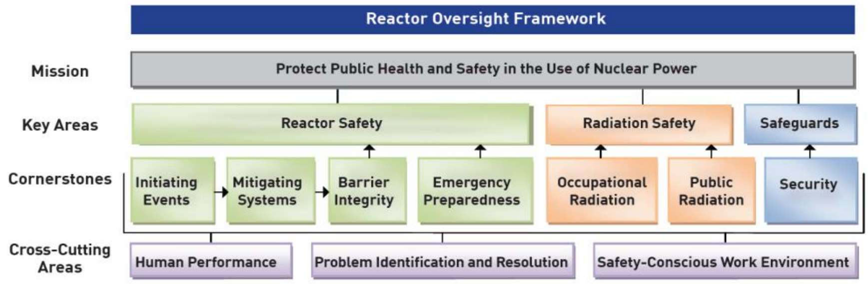

FIG. 2. Reactor oversight framework.

Based on the NRC's assessment of safety performance, licensees are assigned to a column in the ROP Action Matrix, and that placement in the Action Matrix determines the level of NRC oversight for that particular licensee. The NRC's approach to safety culture assessment is a graded process, see Fig. 3. The extent and complexity of a safety culture assessment is generally based on a licensee's placement in the ROP Action Matrix. The scope and complexity increases with increased oversight and the focus of the assessment may be tailored based on the original performance deficiency. An assessment may focus more heavily on one part of the plant, or on one area of safety culture, such as safety-conscious work environment.

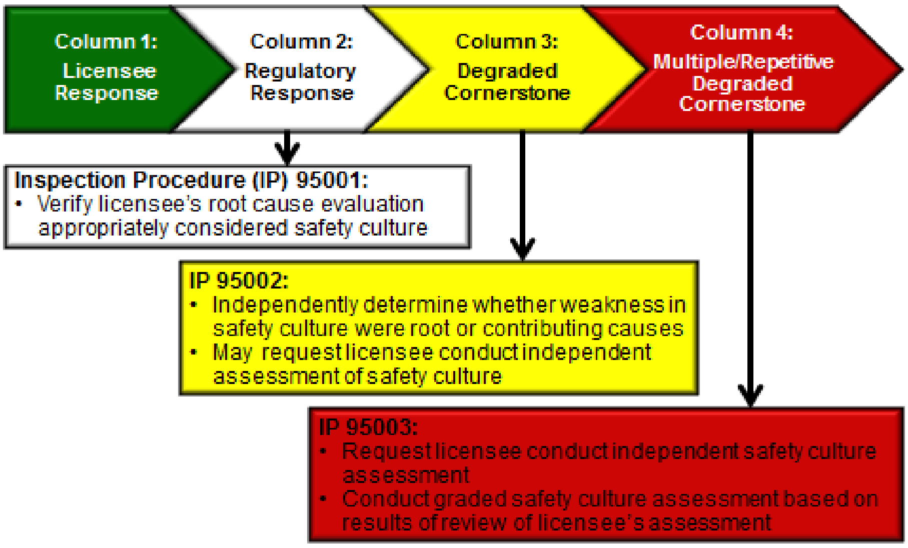

FIG. 3. Reactor oversight process.

The NRC's ROP Action Matrix, with the four columns of increasing oversight, is based on performance deficiencies. Licensees in column 1 are subject to NRC's baseline inspection program. As licensees move to columns 2, 3, or 4 they are subject to addition oversight in the form of supplemental inspections.

In column 2, as part of IP 95001, inspectors verify that the licensee's root cause analysis appropriately considered safety culture. IP 95001 can be found on the NRC's Web page [5].

In column 3, as part of IP 95002, the NRC independently determines whether safety culture weaknesses were root or contributing causes and may request that the licensee conduct an independent safety culture assessment. IP 95002 can be found on the NRC's Web page [6].

In column 4, as part of IP 95003, the NRC will request an independent assessment and will perform its own assessment of safety culture. IP 95003 can be found on the NRC's Web page [7].

Qualified NRC safety culture assessors evaluate the licensee's third party safety culture assessment, and then determine the scope of the NRC assessment based on that evaluation. The NRC assessors conduct the assessment on site, and identify and document safety culture themes in the inspection report. The assessors also review the licensee's planned and completed corrective actions to evaluate whether they address the identified safety culture themes, and whether the licensee needs to develop follow-up actions to address any remaining concerns. A detailed description of the ROP can be found on the NRC's Web page [8]. NUREG 1649, "Reactor Oversight Process," can be found on the NRC's Web page [9].

Construction Oversight Process (cROP): The Office of New Reactors (NR) staff completed a revision to cROP based on the ROP assessment program methodology, including the use of safety culture traits and cross-cutting issues, and completed a pilot of the revised cROP in December 2012.

Based on the results of the pilot program, NRO revised the construction oversight process, including the oversight of safety culture as described in IMC 0613, "Documenting 10 CFR Part 52 Construction Inspections," and IMC 2505, "Periodic Assessment of Construction Inspection Program Results," to provide guidance to assess the safety culture of a construction site. IMC 0613 was revised to provide a listing of cross-cutting aspects that can be assigned to inspection findings. Assigned cross-cutting aspects, which are generally associated with the root causes of performance deficiencies, are evaluated to identify cross-cutting themes which are assessed as outlined in IMC 2505. IMC 2505 also includes references to the supplemental inspection procedures, which are used when there is a decline in safety performance at a construction site. These procedures provide NRC inspectors with guidance on how to assess the safety culture at a construction site with escalating levels of efforts commensurate with the significance of a site's performance decline. The supplemental inspection procedures also provide NRC inspectors with the tools to communicate safety culture issues to stakeholders. IMC 0613 and IMC 2505 can be found on the NRC's Web page [10]. Additional information on the cROP can be found on the NRC's Web page [11].

Fuel Cycles Oversight Process (FCOP): In 2010, the Commission directed the staff on near-term activities related to revising the FCOP. In 2011, the staff described its development of safety cornerstones for fuel cycle facilities, its considerations for a fuel cycle significance determination process (FCSDP), and its work to provide licensees with incentives to maintain an effective corrective action program. The staff developed an FCOP with cornerstones, an FCSDP, a performance assessment process based on the FCDSP, a fuel cycle action matrix, and the cross-cutting areas used in the ROP and informed by the SCPS. The FCOP, as directed by the Commission, provides the tools for inspecting and assessing licensee performance in a more risk-informed, objective, predictable, and transparent way. Additionally, this FCOP provides a systematic way to adjust the inspection program based on licensee performance. Additional information on the FCOP can be found on the NRC's Web page [12].

6. ALLEGATIONS AND ENFORCEMENT PROGRAMS

The NRC's Allegations and Enforcement Programs address discrimination against licensee employees for raising safety related concerns, and the potential resulting chilling effect on the employee or coworkers.

Safety Conscious Work Environment (SCWE): The Commission describes a safety conscious work environment (SCWE) as a work environment where employees are encouraged to raise safety concerns and where concerns are promptly reviewed, given the proper priority based on their potential safety significance, and appropriately resolved with timely feedback to the originator of the concerns and to other employees as appropriate. Fostering an environment for raising concerns continues is an important attribute of a positive nuclear safety culture, and is incorporated as one of the traits of a positive safety culture in the NRC's SCPS, as “Environment for Raising Concerns.” Additional information on Safety Conscious Work Environment can be found on the NRC’s Web page [13].

The NRC places a high value on nuclear industry employees being free to raise potential safety concerns to both licensee management and the NRC, regardless of the merits of the concern. Unlawful adverse actions taken against employees for raising safety concerns may create a "chilling effect" on the employee or other workers who may wish to raise concerns. That is, the employees may not feel that they are free to raise concerns without fear of retaliation. When the chilling effect is not isolated (e.g., multiple individuals, functional groups, shift crews, or levels of workers within the organization are affected) the NRC refer to the situation as a chilled work environment.

If the NRC suspects there is a chilled work environment in the organization, the licensee may be asked for more information or the NRC will investigate through follow-up inspections. If the NRC is concerned about the licensee’s awareness of, or efforts to address a known chilled work environment, a Chilling Effect Letter (CEL) may be issued. A CEL is a public way for the NRC to communicate with the licensee, the public, and the licensee’s employees. The intent of such action is, in part, to prompt the licensee to take actions to mitigate the chilling effect that the discriminatory act or other event has caused. The NRC’s Allegations Program includes guidance on the NRC’s Safety Conscious Work Environment Policy and CELs, and can be found on the NRC’s Web page [14].

In addition to the Allegation Program, the NRC's Enforcement Policy ensures, through appropriate enforcement action against a licensee or licensee contractor (and when warranted, against the individual personally responsible for the act of discrimination), that adverse employment actions taken against licensee or contractor employees for raising safety concerns do not have a chilling effect on the individual or others who may wish to report safety concerns. The NRC vigorously pursues actions against licensees or licensee contractors who discriminate against their employees for raising nuclear safety concerns. Acts of discrimination include discharge and other adverse actions that relate to an employee's compensation, terms, conditions, or privileges of employment. The NRC’s Enforcement Program includes information on sanctions for discrimination against employees who raise safety concerns, and can be found on the NRC’s Web page [15].

Safety Culture Corrective Actions: Through the identification of cross-cutting issues, safety culture assessments in supplemental inspections, or findings of discrimination or chilling effect, the NRC publicly documents the concerns, and the licensee responds to the concerns with planned corrective actions. The NRC may also use its post-investigation alternative dispute resolution (ADR) program to resolve discrimination cases or other wrongdoing through mediation rather than through the NRC's traditional enforcement processes. The ADR program documents agreements between the NRC and the licensee on the licensee's planned actions, which then becomes the basis for Confirmatory Orders (CO). The CO is legally binding, becomes part of the licensing basis for that particular plant, and identifies actions that must be closed out before a licensee can move back to column 1 in the ROP Action Matrix and the baseline inspection program. The NRC conducts follow-up reviews or inspections to close the concerns or verify implementation of the actions. More information on these enforcement actions can be found on the NRC's Web page [16]. More information on the NRC's post-investigation ADR program can be found on the NRC's Web page [17].

7. CONCLUSIONS

The NRC communicates safety culture expectations through the SCPS, which applies to all organizations overseeing nuclear materials, including licensees, vendors and suppliers and Agreement States. The NRC qualifies inspectors to be safety culture assessors to facilitate the oversight of safety culture. In addition, safety culture oversight is achieved through the ROP, cROP and FCOP. Finally, the NRC's Allegation and Enforcement Programs ensure that employees are free to raise safety concerns without fear of retaliation and can issue CELs and COs for SCWE and SC corrective actions.

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