Solutions for Incubation and Building of Nuclear Safety Based on Regulatory Perspective

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Abstract. It is indicated about the requirements of China’s current nuclear and radiation safety regulations on nuclear safety culture and the status of regulation of nuclear safety culture by the National Nuclear Safety Administration (hereafter as the “NNSA”) in this paper. With this information summarized, the characteristics of regulation of nuclear safety culture are analysed, and corresponding solutions are proposed.

1. Introduction

“Nuclear Safety Law of People’s Republic of China” has been applied since January 1st, 2018. It is indicated in Clause 9 “The nation makes nuclear safety policy, and she strengthens nuclear safety culture construction. The nuclear safety regulatory body under the state council, the nuclear power industry department, and the energy department shall establish a mechanism to foster nuclear safety culture. The operating units of nuclear facilities and units who provide them with equipment, engineering, and services shall actively foster and build nuclear safety culture. They shall take it into all processes of production, operation, scientific research, and management.”

In order to implement the “Nuclear Safety Law of the People's Republic of China”, with nuclear industry safety management experience and based on special action of "Nuclear Safety Management Promotion Year", the National Development and Reform Commission, the National Energy Administration, Ministry of Ecological and Environment, State Administration of Science, Technology, and Industry for National Defence issued the "Management Guidance on Further Strengthening Safe Operation of Nuclear Power Industry" together in May 2018. In this document, the overall goal is proposed as to “Put forward the guidelines and the evaluation system for building nuclear safety culture. Relevant departments, together with relevant parties, shall study and compile guidelines for building nuclear safety culture to guide and to standardize enterprises with nuclear safety culture construction activities. The principles and attributes of nuclear safety culture shall be transferred into specific requirements, and to be further implemented into safety management of nuclear power plants. Research shall be done about qualitative and quantitative evaluation indicator...
system to realize the inspection, quantification, and evaluation of health status of nuclear safety culture. Nuclear power plants shall carry out regular self-assessment and peer-assessment activities of nuclear safety culture, to identify weakness timely, to learn from good practices, and to improve nuclear safety culture specifically.” So far, it becomes an important issue to be urgently solved for the NNSA to face about how to continue to promote building nuclear safety culture, and effectively carry out regulation of nuclear safety culture.

2. Status of Regulation of Nuclear Safety Culture
Since the NNSA’s inception, it has paid great attention to the nuclear safety culture. As stipulated in the “Safety Supervision for Nuclear Facilities (HAF001/02-1995)” issued as early as 1995, one of the duties of the on-site nuclear safety supervisors is to "publicize national nuclear safety policies and regulations to the operating units of nuclear facilities and related units and staff, and to supervise their implementation of laws and regulations, and the implementation of nuclear safety culture". In addition, in the regulations on nuclear and radiation safety issued by the NNSA, it is stated for design units of nuclear power plants, operating units, and individuals and organizations engaged in radioactive waste management about clear requirements on nuclear safety culture [1].

From August 2014 to August 2015, the NNSA held the “Special Action to Promote Nuclear Safety Culture”, which is the first special action with nuclear safety culture as the theme in the 60 years of the development of China's nuclear industry. The entire operation covers four areas: nuclear power plants and research reactors, nuclear safety equipment, nuclear fuel cycle, and nuclear technology utilization. Two goals of "full coverage" and "zero tolerance" are realized, which is to cover all licensed units and all key personnel, and zero tolerance for concealment and false report, and violative operations. This special operation has a long duration with wide coverage, and involves many units and staff. Taking the nuclear safety equipment field as an example, the special action covers all the licensed units: 187 licensed units for civil nuclear safety equipment nationwide, including 9 design institutes, 176 design and manufacturing units, 12 installation units, 4 non-destructive testing units, 14 welding testing centers, and 5 certification units for non-destructive testing. The special action also covers all licensed key personnel, mainly including nuclear welders and welding operators for licensed units, non-destructive testing personnel for nuclear level, with a total number of about 10,000. It covers all the personnel in key positions, including the major management, the nuclear quality assurance and quality testing personnel, the personnel of processing, design and verification, etc., with a total number of about 30,000[2,3].

3. Solutions for Incubation and Building of Nuclear Safety Culture
In 2017, the NNSA issued “Nuclear Safety Culture Traits”, which includes 36 attributes and 153 examples based on the “8 traits” from the “Nuclear Safety Culture Policy Statement”. This document is another milestone for China to take further actions on regulation of nuclear safety culture. However, nuclear safety culture is a complex and developing context. It is necessary to establish a regular mechanism for regulation of nuclear safety culture, focusing on the current situation of regulation of nuclear safety culture in China. Solutions are as follows.

3.1. Integrate Regulation of Nuclear Safety Culture with Existing Model of Regulation
The investigation on degradation of the dome of the pressure vessel at the Davis-Besse nuclear power plant in 2002 showed that the weak safety culture was a fundamental cause of the incident. The U.S. Nuclear Regulatory Commission (U.S NRC) has taken measures to improve the plant’s abilities which were found as potential weakening of nuclear safety culture during the inspections and performance reviews in the process of revising the Reactor Oversight Procedures (ROP). However, the NNSA has not officially included regulation of nuclear safety culture into the regulation guidelines yet. There are only few regional nuclear and safety regulatory stations who initiated pioneering work on nuclear safety culture regulation for licensed units.
The regulatory activities for nuclear safety culture can continuously and effectively verify and detect the trend of characteristics of nuclear safety culture at nuclear power plants, and provide references and evidence for nuclear safety culture evaluation. Therefore, when implementing inspections on nuclear facilities according to the guidelines at the stage, the NNSA should inspect and record the characteristics of nuclear safety culture of nuclear facilities related organizations and individuals through the methods of document review, behavior observation, etc. The NNSA should also integrate nuclear safety culture regulation with existing model of regulation through adding relative contents of nuclear safety culture into the processes including quality assurance inspection, experience feedback inspections, or establish special inspections on nuclear safety culture. The key of nuclear safety regulation is the units’ compliance and implementation of laws and regulations. However, it is not enough to implement strict procedures mechanically and for good practices. The regulation of nuclear safety culture just makes up for the deficiencies mentioned above. In order to build a stronger guarantee for nuclear safety, it is needed to connect things that "seem to have nothing relevant".

3.2. Implement Research on Connection of Nuclear Safety Culture and Safe Operation Performance

The investigation on degradation of the dome of the pressure vessel at the Davis-Besse nuclear power plant in 2002 showed that the long-term good performance of nuclear power plants cannot prove that the nuclear power plants are safety. On the contrary, the performance sometimes would become a cover for serious accidents. Only carrying out the nuclear safety culture evaluation regularly can avoid over-confidence of the management effectively, and improve their awareness to safety. At the same time, the incident also further revealed that nuclear safety issues are always reflected by some abnormal states and indicators. At present, many countries in the world have incorporated nuclear safety culture into the management of safety operation performance. For example, based on the lessons learned from the experience of Davis-Besse nuclear power plant incident, the U.S. NRC has incorporated safety culture into the regulatory framework. Among them, the characteristics and attributes of safety culture are categorized by the U.S. NRC in three overlapping areas: personnel performance, problem identification and solutions, and stressing on safe work environment. Also, the U.S. NRC connects the plant performance in these three areas associated with seven security cornerstones, so as to establish the safety culture and reactors safety, radiation safety and facilities safety, which integrates "invisible" and "hard to be quantitated" safety culture with safety operation performance. The safety status of nuclear power plant will be clearly reflected by yellow, white, green, and red.

China's nuclear safety regulatory body has established a set of performance indicator system of nuclear power plant operation safety in line with China's regulatory requirements and characteristics. However, based on the performance indicators of "operation", the "human" factor has not been fully taken into account. Combined with the experience feedback from Davis-Besse nuclear power plant incident of degradation of dome of pressure vessel and international advanced experience, it is necessary for us to carry out the research on connection of nuclear safety culture and safe operation performance. It shall be combined for the eight traits of nuclear safety culture, 36 attributes with performance indicators of the nuclear power plant in China, so as to realize function of identifying insecurities and problems under the situation of good performance of nuclear power enterprises.

3.3. Regular Inspection Mechanism of Nuclear Safety Culture Evaluation Effectiveness for Licensed Units

At present, China's three major nuclear power groups have established their own nuclear safety culture evaluation mechanism, and compiled nuclear safety culture evaluation guidelines for their own use. They established their own nuclear safety culture evaluation team, and regularly carried out various forms of nuclear safety culture evaluation activities, which greatly promoted building nuclear safety culture of the licensed units. However, this status brought problems as follows.
1) Due to the uneven levels of evaluation staff, different evaluation conclusions were issued for the same nuclear power plant.

2) Due to the deficient control over the evaluation process, whether the evaluation conclusion reveals the most urgent safety problems and hidden dangers that nuclear power plants need to solve remains to be confirmed.

3) As companies adopt their own evaluation guidelines, and lack a common understanding and consensus on nuclear safety culture, the effectiveness of nuclear safety culture experience exchange and feedback is greatly weakened.

4) The problems reflected in the nuclear safety culture evaluation are currently only for internal feedback and rectification within the enterprise which are not included in the inspection activities by the NNSA. This has caused the waste of personnel and resources to a certain extent.

Based on the situation above, it is recommended to establish a regular inspection mechanism of nuclear safety culture evaluation effectiveness for licensed units. The main contents are as follows.

1) The quality of nuclear safety culture evaluation shall be ensured through the qualification review of nuclear safety culture evaluation staff of licensed units.

2) Based on the “Nuclear Safety Culture Policy Statement” and “Nuclear Safety Culture Traits” issued by the NNSA, the understanding of the nuclear safety culture by the licensed units shall be unified to build foundation and to construct a platform for effective exchange of experience.

3) Through the effectiveness review for nuclear safety culture evaluation for the licensed units for every 2 years, problems in the nuclear safety culture evaluation process shall be timely found and to be solved to promote the process.

4) The licensed units shall report the relevant problems found in the nuclear safety culture evaluation activities to the NNSA. The NNSA shall include them in the follow-up regulation activities as appropriate.

3.4. Include the Nuclear Safety Culture Training into Nuclear Safety Regulator Training System

The regulation of the nuclear safety culture is completely consistent with the nuclear safety regulation. However, due to the specialty and uniqueness of the “culture”, for the application and focus of the specific methods, it is different with methods for nuclear safety culture regulation that we commonly use and the method of nuclear safety regulation. Although China has her own nuclear safety regulator training system, the current nuclear safety culture courses have not been systematically incorporated into relevant training courses. The training for regulators is about the primary theory of the origin and development of nuclear safety culture, training on regulators' interviewing skills, observation capabilities, and data collection and analysis capabilities used in conducting nuclear safety culture regulation is not sufficient. Therefore, it is necessary to draw on international advanced experience to form a comprehensive series of nuclear safety culture training courses for nuclear safety regulators, so that regulators can have the ability to summarize regulation conclusions which support the nuclear safety culture while conducting on-site regulation.

4. Conclusion

Nuclear safety culture regulation is a proactive approach to regulation, which can be used as a useful supplement to compliant regulation based on regulatory requirements and permit conditions. Although the nuclear safety culture of the licensed unit is the result of long-term and continuous incubation, it is impossible to completely control this process. However, based on the international advanced practices, through strengthening nuclear safety culture regulation, scientific and effective nuclear safety culture evaluation is carried, and improve nuclear safety culture training for supervisors and evaluators, and strengthen the regulatory body's own nuclear safety culture construction to implement the nuclear safety culture related requirements in the Nuclear Safety Law. This will have a positive impact on the nuclear safety culture of the entire industry.
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