
KNOWLEDGE MANAGEMENT FOR IMPROVED OF EMERGENCY PREPAREDNESS AND RESPONSE AT NUCLEAR FACILITIES OF RUSSIA

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Abstract. At present in Russia the national project “Strengthening of emergency preparedness and response at nuclear research facilities” (RUS/9/005) is being realized in the framework of IAEA technical co-operation to improve interdepartmental informational system, conditions of emergency preparedness and response of research centers, skills and training of Rostechndzor staff. The experience of national project design may be used by IAEA to develop regional project for improvement of emergency preparedness and emergency response at nuclear installations.

1. Introduction

In result of prestige falling of professions and lack of young specialists who would like to get a job, in nuclear industry take place ageing and turnover of the personnel and cutting down of total number of experienced specialists at objects of the use of atomic energy, reducing of qualified experts in domains of nuclear safety, and researchers in nuclear centers and enterprises. Staff aging entails by loss of institutional knowledge, practical skills of personnel at nuclear objects and competence¹ of regulatory body [1]. Deficiency in knowledge and skills can be in the basis of personnel errors at nuclear facility.

Sustaining of knowledge management poses inseparable part of safety maintenance at a nuclear facilities and provision of competence of regulatory authority [2]. Enhancement of safety culture and its transmission to young newcomers shall be based on persistent studding of safety, lessons learned in the past and operational feedback.

Below, the key issues are considered to achieve the proper level of staff competence of operating organizations and the regulatory authority in domains of nuclear safety at Russian Nuclear Research Facilities (NRF)² on the basis of international fundamental principles of safety [3].

2. Legislative and normative framework of knowledge management in the sphere of atomic energy use in Russia

The principle of prime responsibility for safety was established at legislative level in Russia [4, 5]. The principle states that the prime responsibility for activities, which entail a risk of the use of atomic energy, lies with those who carry out these activities: responsibility of operator for the safety of objects, responsibility of consignor for the transport of nuclear materials, responsibility of employer for radiation protection of workers, responsibility of executive agency of the use of atomic energy for arrangement to ensure safety including preparedness of forces and means to response in case of abnormal situations and emergencies, also creation and implementation of programmes for disposal of radioactive wastes and utilization of spent nuclear fuel.

Federal environmental, industrial and nuclear supervision service of Russia (Rostechndzor) carries out major functions of the regulatory body of nuclear and radiation safety including development of regulations and guides, authorization, review and assessment of safety;

¹ Competencies are groups of knowledge, skills, and attitudes needed to perform a particular job [2].

² NRF - will be interpreted structures and complexes with civil research nuclear reactors, critical and subcritical nuclear assemblies, which have been designed for utilization of neutrons and ionizing radiation for research purposes.

inspections and enforcement measures. Moreover, Rostekhnadzor's competence includes arrangement to ensure functions of the state subsystem to oversee the emergency situation at objects of the use of atomic energy [6].

On the basis of modern approach to safety regulation of NRF the set of national standards and regulations (Federal Norms and Rules) including requirements to emergency preparedness and emergency response was developed in Russia as following:

- NP-033-01 General regulations for NRF safety, in force from June 01, 2002, by RF Gosatomnadzor³ decree from January 16, 2002, № 2;
- NP-042-02 Requirements for Quality Assurance Program of Nuclear Research Facilities, in force from September 01, 2003, by RF Gosatomnadzor decree from December 31, 2002, № 16;
- NP-049-03 Requirements to the Content of the Safety Analysis Report for Research Nuclear Facilities, in force from May 28, 2004, by RF Gosatomnadzor decree from December 31, 2003, № 10;
- NP-027-01 Provisions on Investigation and Reporting of the Operational Violations at Nuclear Research Facilities, in force from October 01, 2001, by RF Gosatomnadzor decree from 30.03.2001 №2;
- NP-075-06 Requirements to the Contents of Emergency Plan for Personnel of Nuclear Research Facility, in force from March 01, 2007, by Rostekhnadzor decree from December 19, 2006, № 10.

The full list of legal and normative documents that Rostekhnadzor used for state safety regulation of the use of atomic energy are given in reference [7].

Analysis of efficiency of normative basis for safety regulation of Russian NRF in compliance with international requirements in particular to requirements of the Code of Conduct on the Safety of Research Reactors (2004) is being carried out permanently in view of fact that the improvement of safety is a never-ending process. According to Federal law «On Technical Regulation» from 27.12.2002 №184-FZ and programme that has been approved by governmental order №1889-r from 08.11.2005 the development of technical regulations has been laid down including «General Technical Regulations on Nuclear and Radiation Safety» and «Specific Technical Regulations on Nuclear and Radiation Safety of Objects, Buildings and Sites with Nuclear Reactors». At present preliminary work and debate are hold to develop new standards and regulations on following objectives:

Construction NRF

- Criteria to select site for construction of NRF.

Operation of NRF

- Technological regulations of NRF in operation of (limits and conditions of safe operation).
- Methodology of evaluation of severe accidents at RR.
- Review of efficiency of emergency preparedness and emergency response at NRF.

³ RF Gosatomnadzor – Federal Nuclear & Radiation Safety Authority of Russia (1991-2004)

Decommissioning of NRF

- Structure and contents of report of comprehensive engineering characterization and radiation monitoring for decommissioning of NRF.
- Structure and contents of safety assessment report of NRF decommissioning.
- Criteria to exclude the site of NRF from sphere of state regulatory control after termination of nuclear activity.

Following research works are planned:

- Creation of data bank of neutron- physical experiments.
- Basic methodology for probabilistic safety analysis (PSA) of NRF.

In current practice operating organization fulfils knowledge management of personal including training, retraining, and provision of qualification skill. Accordance to Federal law "The Use of Atomic Energy Use" [5] and on the basis of governmental order [8] defining the list of worker positions at plants who should obtain the regulatory body's permits, Rostechnadzor issues permits conferring the right to carry out activities in the sphere of the use of atomic energy. The qualifying requirements to NRF employees to be granted with permits shall be determined by «Qualification Directories» which have to be agreed by regulatory authority and ministry of health and social development of the Russian Federation (earlier, the ministry of trade and social development). These Qualification Directories are under development and not approved by Rostechnadzor yet.

Examination Commissions in the Headquarters (HQ) and in Interregional Territorial Offices on Nuclear and Radiation Supervision (Regional Offices - RO) of Rostechnadzor were organized to examine administrative and operating personnel of Operating Organizations. Commissions of HQ examine knowledge of legislative framework on nuclear and radiation safety of top-level personnel. Commissions of RO participate in procedure of personnel skill testing at nuclear facility and examine knowledge of legislative framework on nuclear and radiation safety of operating personnel.

In result of examination HQ and RO of Rostechnadzor issue permits for personnel of operating organizations. Granted permit includes obligatory conditions that define responsibility of permit holder in domains of nuclear and radiation safety.

Effectiveness of state supervision depends on qualification and skill of employees of the regulatory body. On the basis of Federal law «On Public Service in Russian Federation» [9] the Examination Commission was organized in HQ to examine skill level of headquarters' employees of Rostechnadzor. In RO Examination Commissions were formed as well.

State employee's skill has to be improved as necessary but not less once per three years. However, at present there is not developed yet comprehensive system for staff skills in all domains of regulation of nuclear and radiation safety. Thereupon creation of training courses in sphere of NRF safety regulation is essential objective for development of Rostechnadzor's manpower training system as a whole.

3. Key issues of knowledge management for operated NRF

Knowledge management for competence of nuclear and radiation safety of NRF covers different groups of specialists: personnel of operating organizations, employees of regulatory bodies, experts of technical support organizations, researchers and engineers of research establishments and design institutes. The scope of necessary knowledge includes issues of

legislation, safety regulation, safety of nuclear facilities, radiation protection and monitoring, information technologies and communication, public relations, psychology and other areas of knowledge.

Traditional methods of international co-operation in research programmes as well as up-to-date information technologies, which use Internet, are applicable for knowledge management. In the context of collaboration with US Department of Energy and European Commission Rostechnadzor has set up the system of staff training to provide knowledge of supervision for accounting, control, and physical protection of nuclear materials radioactive substances and radioactive wastes. Russia supports a few research programmes in framework of international co-operation to share knowledge and experience of safety activity at NRF. Among them are as following:

- Reduced Enrichment for Research and Test Reactors (RERTR);
- Decommissioning NRF;
- IRSRR and RRs database;
- Utilization of redundant weapon plutonium and other.

Problem of emergency preparedness and emergency response are fundamental importance for facilities in operation and includes all listed above specific knowledge. Since Chernobyl catastrophe (1986) the problems of emergency preparedness and response have been developed not only for Nuclear Power Plants (NPP) but for other objects of the use of atomic energy. Problems were posed to classify radiation incidents and emergencies, to evaluate consequences of accidents, to develop decision-making procedures in result of assessment of conditions at the emergency object, to realize monitoring of environment, to organize interaction between local administration and executive bodies.

Research reactors (RR) having small capacity in comparison with units of NPP represent relatively less potential radiation hazard for population. Nevertheless, majority of RR is located in cities or near to settlements within all territory of Russia. Defined risk of dangerous radiation consequences and economical losses exists due to frequent changes of their physical parameters and experimental works that characterized by a wide variety of experimental devices and facilities related to safety, also fuel of high enrichment is used. Sensitive of each site of RR to internal and external impacts and personnel errors is differ.

In Russia the estimations of radiological consequences for design basis accidents (DBA) and for beyond design basis accidents (BDBA) have been calculated for all operated RRs. On the basis of national standards and regulations the Operating Organizations elaborated necessary documents for safety justification: Safety Assessment Reports (SAR), Quality Assurance Programmes (QA), Emergency Plans and other. Accordance to Federal law "The Use of Atomic Energy Use" (1995) and on the basis of «Provision on Licensing of Activities in Sphere of the Use of Atomic Energy» (1997) the licensing procedures and procedures for issuing of permits to personnel were developed and realized.

However, cumulative experience of licensing of NRF and results of carried out inspections at NRF of Russia show that some operating organizations have not full scope of emergency evaluations, also use for safety calculation computer codes, which were not validated or became out of date. The experts' remarks concern the following subjects of improvement emergency preparedness and emergency response at NRF:

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- Engineering design, conditions of the principle physical barriers to release of radioactive material and radiation in environment, state of the engineering and organizational measures for protection of the these barriers and supporting their efficiency;
 - Operational limits and conditions;
 - On-site and off-site doses consequence analysis from DBA releases;
 - Preventive measures;
 - Definition of facility exclusion zones,
 - Emergency planning;
 - Incident investigation, analysis and reporting system;
 - Decision-making and emergency response;
 - Emergency skills and training;
 - Knowledge of potential accident severity (INES);
 - Security measures.

In this connection the problem was initiated to revise calculations, which have been carried out long time ago with purpose to assess radiological consequences in result of potential severe accidents at NRF. More precise and reliable estimation have to be done on the basis of modern methods and certificated computer codes [10].

To develop probabilistic approach of safety evaluation the following quantitative values of likelihood were included in national standards NP-033-01:

- Unavailability factor for safety control system to realize emergency scram - not more than 10^{-5} (probability of damage of the reactor core);
- Probability of extreme radioactive release to environment that needs taking-decision of emergency population defense - not more than 10^{-7} per year on one RR.

At present 26 RRs and 30 Critical Assemblies (CA) are operate in Russia by various Operating Organizations (OO), which belong to different Federal Ministries and State Departments and other Establishments. This OO have different human and financial recourses to provide and enhance safety at NRF.

In various Scientific Centers and Enterprises, which operate NRF, conditions are different in current state and quality of operational documentation, means of communications, and facilities of emergency response. Informational-Analytical Centre of Rostechnadzor is not provided with necessary program-technical equipment for activity in the mode of emergency at NRF. At present the state of interdepartmental informational interaction, conditions of incident reporting at NRF, and fulfillment of normative regulations' requirements on emergency preparedness do not fully provide proper level in scientific centers [11, 12].

The procedures of emergency preparedness and response require storage and maintenance of voluminous set of textual and graphical information like safety assessments, engineering drawings, operational and emergency instructions, operational reports and records that have to be logical systemized for effective access and analysis in case of an incident or emergency at NRF. All this information contained in reference documents needs to be properly stored and retrieved for authorized end-users if needed. Advanced information technology has to be

implemented to provide proper quality of documents and effective access to necessary references supporting the emergency procedures.

The national project “Strengthening of emergency preparedness and response at nuclear research facilities” (RUS/9/005) in the framework of IAEA technical co-operation has been prepared by Rosatomnadzor, agreed by IAEA and now is being realized to improve interdepartmental communication system, conditions of emergency preparedness and response of research centers, skills and training of Rostekhnadzor staff. Pilot project develops interaction between three organizations and includes three facilities, namely: HQ and Interregional Territorial Department for Information and Protection of Information of Rostekhnadzor; State Scientific Centre of the Russian Federation “Research Institute of Atomic Reactors” (SSC RF RIAR, Dimitrovgrad, facilities: MIR.M1, 100 MWt; BOR-60, 60 MWt); Russian Research Centre “Kurchatov Institute” (RRC KI, Moscow, facility IR-8, 8 MWt).

Plan of works of pilot project includes arrangement for creation of information system to support emergency preparedness and emergency response at NRF, creation of mobile inspector’s office on the basis of wireless communication technology to provide access to necessary documentation and information about current conditions at facility and site, also development of effective knowledge management strategies and programmes (experts mission, training courses, workshops), improvement of incident reporting system at NRF, and interdepartmental interaction.

Concerning the state of incident reporting system of NRF the following subjects are needed to be improved:

- Mechanism for classification and analysis of operational information, determining of main point and priority of lessons to be learned and distribution of these lessons learned in form convenient for end users;
- Analysis and information exchange on events of «nearly happened accidents», deficiencies of design, and events of low level to specify ways to avoid incidents and accidents;
- Procedures and formats to inform public about a risk at objects of the use of atomic energy, transparency of activity to enhance safety and prevent hazards.

The methodical documents of educational programme for NRF personnel and Rostekhnadzor staff in sphere of safety and crisis response at NRF is planned to develop on the basis of two scientific centers: Training Centre of the SSC RF RIAR (Dimitrovgrad) and Educational and Research Centre of RRC KI (Moscow). Draft of educational programme includes four Training Courses:

1. Course of basic theoretical training of fundamental problems of NRF designing and their safety operation.
2. Course of specific training at NRF.
3. Course of practical skills.
4. Advanced training of emergency response at NRF.

Implementation of the pilot project RUS/9/005 that covers only three RRs - MIR.M1, BOR-60, IR-8, lets to develop methodology of large national data base of Russian nuclear centers for purpose of improvement of emergency response procedures, training and skills of NRF personnel and Rostekhnadzor’s staff.

4. Summary

1. For objects of the use of atomic energy Rostekhnadzor keeps on forming and development of regulatory staff competence in sphere of nuclear and radiation safety that have been started by former RF Gosatomnadzor.
2. Programme of National Project is aimed to enhancement of safety of Russian NRF in operation and efficiency of knowledge management of Operating Organizations' personnel and Rostekhnadzor's staff.
3. Implementation of National Project will promote efficiency of experience feedback at Russian NRF and reporting to IRSRR IAEA.
4. Experience of National Project design may be used by IAEA to develop Regional Project for strengthening of emergency preparedness and emergency response at nuclear installations.

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