

## SOME ASPECTS OF RESEARCH REACTOR NUCLEAR SAFETY REGULATION IN RUSSIA

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### Abstract

This paper presents general structure of regulatory documents on research reactor nuclear safety in Russia along with the main directions of further activities. General regulatory approach realizing in this structure takes into account peculiarities of nuclear research installations. The main peculiarities include neutronics and thermal power of NRI. Within the regulatory approach general requirements significant for all nuclear facilities (including nuclear power plants and fuel cycle facilities) are extended to NRI, and some specific requirements are developed. These general requirements are primarily associated with such general issues as radiation safety standards (e.g., exposure rates) for workers and publics, siting requirements, strength requirements, etc. Specialized safety regulatory documents relate to nuclear and radiation safety, emergency preparedness. Hierarchical approach is used for the specialized NRI safety documents. General safety rules are applied to all NRI, and nuclear safety regulations are developed for research reactors, pulsed research reactors, critical and subcritical assemblies. Specific regulations concern decommissioning issues, emergency preparedness and response, requirements to SAR and investigation of events also.

Structure of the nuclear safety regulatory document system in Russia is traditionally based on the hierarchical approach and include the following levels:

- International Conventions and Federal Laws,
- Presidential Decrees and Government Regulations,
- Federal Regulations,
- Safety Guides.

This structure is similar to the systems used in other countries. Documents of levels 1, 2 establish safety fundamentals and are applicable to all facilities and activities. Federal Regulations and Safety Guides can be focused on nuclear research installations (NRI) safety. It should be mentioned that requirements contained in Federal Regulations are mandatory, but Safety Guide contains recommendations. So, nuclear safety of NRI is under the following regulations [2]:

- General Federal Regulations for nuclear installations and activities applicable to the NRI;
- Specific Federal Regulations for NRI.

One of the factors determining availability of specific regulations is a large number of NRI. At the present time there are 74 NRIs in Russia, including research reactors, critical and subcritical facilities [1]. Distribution of NRI by types is given in Table 1.

General Federal Regulations (and Safety Guides) cover the following main issues in any way affecting the nuclear safety:

- Radiation waste management;
- Transportation of nuclear materials within the site;
- Single storages of nuclear materials;
- Nuclear materials control and accountability;

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- Security of nuclear materials;
- Seismic hazards and site evaluation;
- Lifetime extension.

TABLE 1. DISTRIBUTION OF NRI BY TYPES.

	Activity and license type		
	Construction	Operation (Including final shutdown)	Decommissioning
Research Reactors	2	24 (2)	6
Critical Facilities	0	27	3
Subcritical Facilities	1	11	0
Subtotal	3	62 (2)	9
Total	74		

Federal Regulations focused on NRI contain requirements specifically in the area of nuclear safety. In its turn the specific NRI Federal Regulations are divided into two groups: general regulations and regulations taking into account specific features of research reactor types.

The following general NRI Federal Regulations are available:

- General Provisions of Research Installations Safety;
- Requirements to NRI SAR Format and Content;
- Safety Regulations for NRI Decommissioning;
- Requirements to the Content of the Plan of Personnel Protection in Emergency Situations;
- Provisions on Investigation and Recording of Events at NRI.

Actually, regulations taking into account specific features of research reactor types (neutronics and thermal power, mainly) partially realize graded approach being developed now by IAEA experts. The following Federal Regulations are available:

- Criticality Safety Regulations for Research Reactors;
- Criticality Safety Regulations for Pulsed Reactors;
- Criticality Safety Regulations for Critical Facilities;
- Criticality Safety Regulations for Subcritical Facilities.

Now, accelerator driven subcritical facility is defined in General Provisions of Research Installations Safety as nuclear research reactor and there is a suggestion to develop criticality safety regulations to this type of research installations. This is explained by such reasons as large amount of fission products (as in a reactor of the same thermal power), transients caused by interaction between multiplying system and accelerator, complex control system combining accelerator and core control parameters, first wall problem, low subcriticality and change of core parameters under the neutron flux.

General Provisions of Research Installations Safety is the main document concerning nuclear safety. It includes the following sections:

- Purpose and scope;
- Objectives and basic principles of NRI safety;

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- Classification of NRI systems and components in view of purpose (systems of normal operation, safety systems); impact on safety (systems and components important to safety, systems and components no impact on safety); safety functions (protecting, containing, supporting, controlling);
- Requirements on design including general requirements, requirements to normal operation systems (core and reflector, primary loop, control systems), requirements to safety systems (protecting, containing, controlling, supporting), control board, experimental devices, radiation control and protection system;
- Construction and commissioning;
- Operation: start-up and operation at specified power level, temporary shutdown mode, extended shutdown mode, final shutdown mode;
- Preparedness and response for a nuclear or radiological emergency.

As an example, the content of Criticality Safety Regulations for Research Reactors is given below.

1. Terms and Definitions
2. General Provisions
3. Safety Requirements to the Research Reactor Design
  - 3.1. General Requirements
  - 3.2. Core and Normal Operation Systems Important to Safety
    - 3.2.1. Core and Its Components
    - 3.2.2. Experimental Devices
    - 3.2.3. Primary Loop
    - 3.2.4. Normal Operation Control System
  - 3.3. Safety Systems
    - 3.3.1. Safety System and other Systems Used to Shutdown Reactor
    - 3.3.2. Emergency Core Cooling
  - 3.4. Safety Control System
4. Nuclear Safety under Commissioning and Operation
  - 4.1. General Provisions
  - 4.2. Commissioning of Research Reactor
    - 4.2.1. Physical Start-up (Initial Criticality)
    - 4.2.2. Power Start-up
  - 4.3. Research reactor Operation
    - 4.3.1. Power Operation
    - 4.3.2. Temporary Shutdown Mode
    - 4.3.3. Extended Shutdown Mode
    - 4.3.4. Final Shutdown Mode
  - 4.4. Nuclear Material Handling
5. Supervision

Appendix 1 Recommended Operating Safety Documents at Research Reactor

Appendix 2 Recommended Format of Research Reactor Passport

The list of initiating events used in the analysis of design and beyond design basis accidents is given in the “Requirements to NRI SAR Format and Content” and includes such aspects as insertion of positive reactivity, cooling failure, pressure drop, secondary loop failure, failure of experimental devices, and external impacts. Operating organization should justify the choice of initiating event and accident sequences taking into account the specific design features of the NRI.

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In Russia, as well as around the world, there is a trend of research reactors aging. Most of research reactors were put into operation more than 30 years ago. Table 2 demonstrates years of start-up of research reactors.

TABLE 2. CRITICALITY YEARS OF RESEARCH REACTORS (EXCLUDING CRITICAL AND SUB-CRITICAL FACILITIES).

Criticality Years of Research Reactors	Number of Research Reactors
1941 - 1950	1
1951 - 1960	2
1961 - 1970	11
1971 - 1980	4
1981 - 1990	5
1991 - 2000	1
2001 - 2010	-

Aging of research reactors includes two main aspects: decommissioning and lifetime extension. Currently, decommissioning issues are covered by the Federal Regulation document entitled "Safety Regulations for NRI Decommissioning." In 2011 two new Safety Guides in this field were put in force: "Safety Guide on Structure and Content of Decommissioning Program" and "Safety Guide on Structure and Content of Decommissioning SAR." New Safety Guide on release of NRI sites from regulatory control is being developed now on the basis of the General Federal Regulations and IAEA recommendations [4] to cover all stages of NRI decommissioning.

As it was mentioned above, there is a general Federal Regulations on nuclear installations lifetime extension. This document provides a complex survey which results are used for assessment of reactor lifetime extension. Specific Safety Guide on structure and content of the program of the complex survey and structure and content of the report on the results of the survey is being developed now using IAEA recommendations [5] also. It is expected that next year this Safety Guides will be put in force.

The next direction of further activity is development of provisions for research reactor periodic safety review. It should be noted that currently there is a practice of licensing NRI operation for a period of five years. In accordance with this, safety documents of NRI are reviewed by operating organization itself and by independent experts every five years [6]. In addition, operating organization should annually submit a report to Rostekhnadzor entitled "Assessment of nuclear and radiation safety." In accordance with the Safety Guidance "Contents of the annual report of the operating organization on assessment of nuclear and radiation safety of NRI," this report presents information on current status of nuclear safety, technical condition of systems and components important to safety, personnel training and other aspects. Increase the term of the operation license requires the introduction of periodic safety review. Now, new Federal Regulations "Periodic Safety Review of NRI" is being developed.

Another important direction of further activity is understanding and application of lessons of Japan nuclear accident for research reactors. Some of directions of considerations are the following:

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- Impact of external factors (environmental and industrial) on research reactors,
- List and analysis of beyond design basis accidents,
- Emergency response under difficult conditions of natural disasters,
- Safety culture,
- International cooperation.

On the whole the NRI regulation system in Russia is constantly improved in response to the challenges and it is open to use recommendations of international organizations and experience of national regulators in other countries.

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