ON THE 20TH ANNIVERSARY OF THE JOINT CONVENTION ON THE SAFETY OF SPENT FUEL MANAGEMENT AND ON THE SAFETY OF RADIOACTIVE WASTE MANAGEMENT

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The article evaluates the efforts implemented by the Russian Federation on fulfilling the obligations arising from the Joint Convention undertaken since its ratification and their main results. It overviews the drivers that prompted the development of the Joint Convention, its goals and scope. The article also provides some suggestions seeking to improve the effectiveness of mechanisms for the selection of a best practice recently proposed under the Joint Convention.

Keywords: *Joint Convention, safety, spent nuclear fuel, radioactive waste, Meeting of Contracting Parties, National Report.*

Introduction

For decades, the Russian Federation has been implementing the mechanisms geared to the international cooperation in nuclear and radiation protection and providing for various formats of relations. Russia has been actively engaged in the development of harmonized approaches and requirements to the safe peaceful use of atomic energy based on bilateral and multilateral international agreements involving treaties, agreements, memorandums, government initiatives, including: Convention on the Establishment of a Security Control in the Field of Nuclear Energy (1957) ratified by Russia in 2005; Convention on the Physical Protection of Nuclear Material (1980) ratified in 1987; Convention on Early Notification of a Nuclear Accident (1986) ratified in 1986; Convention on Assistance in the Case of a Nuclear Accident or Radiation Emergency (1986) ratified in 1986; Vienna Convention on Civil Liability for Nuclear Damage (1977) ratified in 2005.

Rosatom State Corporation and Rostekhnadzor pay especially careful and systematic attention to the international cooperation under the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (hereinafter referred to as the Joint Convention, the Convention) and the Convention on Nuclear Safety developed under the auspices of the IAEA.

Over the past two decades under the Joint Convention, the IAEA has been putting forth the efforts to achieve and maintain a high level of safety and compliance with the international standards associated with spent nuclear fuel (SNF) and radioactive waste (RW) management [1]. The 20th anniversary of its adoption was marked under the 61st session of the IAEA General Conference. At the meeting, the Contracting Parties shared their experience emphasizing the role of the Joint Convention as a

global instrument for nuclear and radiation safety. IAEA Deputy Director General J. C. Lentijo noted that "the Convention has contributed globally to the improvement of the safety level in the field of radioactive waste and spent nuclear fuel management, and this work will continue in the future."

This article presents the key takeaways from the analysis evaluating the activities of the Russian Federation implemented to fulfill the obligations assumed under the Joint Convention since its ratification.

It overviews the motivational aspects standing behind its establishment, its objectives and scope. The paper also provides some suggestions on how to improve the effectiveness of the mechanisms for the best practice selection recently introduced by the Joint Convention.

Historical background and prerequisites for the Joint Convention development

Prior to the Joint Convention, some international agreements were effective in the field of atomic energy use regulating nuclear and radiation safety. However, they did not regulate the management of spent nuclear fuel and radioactive waste, but were mainly related to the safety of nuclear installations.

Hazardous waste management was regulated by the 1989 Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal (hereinafter referred to as the Basel Convention) [2], which did not cover RW.

The management of radioactive materials was neither regulated by the 1994 Nuclear Safety Convention [3].

Thus, under international agreements, no systematic regulation was in place in this field.

In September 1994, to eliminate such a considerable safety gap, the IAEA General Conference decided to initiate the development of a convention on the safety of radioactive waste management. In March 1995, the IAEA Board of Governors declared the establishment of an expert group to deal with this issue and adopted the Principles of Radioactive Waste Management Safety Fundamentals [4].

The Diplomatic Conference convened by the IAEA in Vienna on September 1—5, 1997 engaged representatives from 84 states and four international organizations. All articles of the Convention and their provisions developed by the expert group were agreed upon with neither any objections expressed nor even any further discussions with the exception of three provisions with no consensus reached on relevant legal and political issues.

However, the vote was not unanimous: two country representatives from the total of 67 states presented at the Conference and entitled to vote, namely, New Zealand and Pakistan, voted against the Convention, three abstained. Nevertheless, the overwhelming majority voted in favor. The final act of the Diplomatic Conference was signed on September 5, 1997 by 65 states, three states did not sign it.

In late 2001, the Joint Convention came into force with 25 countries viewed as its Contracting Parties. Today, out of 173 IAEA member states, 88 are seen as its Contracting Parties.

The Russian Federation ratified the Joint Convention in 2005.

Structure, objectives, scope and obligations of the Joint Convention

The Joint Convention, its structure and provisions largely reflect the fact that by the time of its development, the Convention on Nuclear Safety had already been adopted and ratified by most countries. The logical structure and a few approaches of the latter were effectively implemented in the Joint Convention.

It consists of the following chapters:

Chapter 1 presents its Objectives, Definitions and Scope of Application.

Chapters 2 and 3 discuss the requirements on the Safety of Spent Fuel Management and the Safety of Radioactive Waste Management, including existing facilities, siting of proposed facilities, their design and construction, safety assessment, operation, spent fuel disposal (for SNF management), institutional measures after closure (for RW management).

Chapter 4 contains the General Safety Provisions on SNF and RW management, including relevant legislative and regulatory framework, the responsibility of the license holder, requirements to the coordinating body, human and financial resources, quality assurance, operational radiation protection, emergency preparedness and decommissioning.

Chapter 5 Miscellaneous Provisions covers the transboundary movement of SNF and RW and legal obligations for the disused sealed sources.

Chapter 6 Meetings of the Contracting Parties elaborates on the procedure for the preparatory meetings held for reports review and the extraordinary meetings, the reporting and attendance issues, summary reports, languages and confidentiality.

Finally, Chapter 7 Final Clauses and Other Provisions again provides a comprehensive discussion of SNF and RW management issues in terms of disagreement resolution, signature, ratification, acceptance, approval, amendments to the Convention, depository, authentic texts.

The National Report of each Contracting Party should present its policy and practice in the field of SNF and RW management; criteria used to define

and categorize the waste; lists of waste management facilities, information about their location, design purpose and most important characteristics; SNF inventory; a list of nuclear facilities undergoing decommissioning and their state-of-art.

As mentioned above, Chapter 1 summarizes the objectives of the Joint Convention:

1. To achieve and maintain a high level of safety worldwide in spent fuel and radioactive waste management, through the enhancement of national measures and international co-operation, including where appropriate, safety-related technical co-operation.

2. To ensure that during all stages of spent fuel and radioactive waste management there are effective defenses against potential hazards so that individuals, society and the environment are protected from harmful effects of ionizing radiation, now and in the future, in such a way that the needs and aspirations of the present generation are met without compromising the ability of future generations to meet their needs and aspirations.

3. To prevent accidents with radiological consequences and to mitigate their consequences should they occur during any stage of spent fuel or radioactive waste management.

The Scope of Application is defined in the third Article of the Convention saying that the Convention shall apply to the safety of spent fuel management and the safety of radioactive waste management when these result from civilian applications. It shall not apply to the safety of spent fuel or radioactive waste management within military or defense programmes. Nevertheless, its preamble acknowledges that in the latter cases these should be managed in accordance with the objectives stated in this Convention.

Spent fuel held at reprocessing facilities as part of a reprocessing activity is not covered in the scope of the Convention unless the Contracting Party declares reprocessing to be a part of spent fuel management. It shall not apply to waste that contains only naturally occurring radioactive materials and that does not originate from the nuclear fuel cycle, unless it constitutes a disused sealed source or it is declared as radioactive waste for the purposes of the Convention by a Contracting Party. The Convention shall also apply to releases/discharges to the environment.

Implementation of obligations by the Russian Federation under the scope of the Joint Convention

Ratification of the Joint Convention, a new program for nuclear power development in Russia, the concept and the Federal Target Program Nuclear and Radiation Safety in 2008—2015 [5] developed and approved marked a fundamental change in the status of the RW management challenge in Russia enabling a transition to a systematic approach to safety assurance and addressing the large-scale nuclear legacy challenges.

Over these two decades elapsed since the Joint Convention was enacted, unprecedented infrastructural, engineering, regulatory and managerial measures have been implemented under the Federal Target Program Nuclear and Radiation Safety in 2008—2015 [5] and Nuclear and Radiation Safety in 2016—2035 [6], as well as a few departmental projects seeking to enhance the safety level, namely, under the obligations undertaken to comply with the provisions of Art. 4 para. iii and Art. 12 para. ii of the Convention, particularly concerning "the results of past practices." Substantial research, design development and practical efforts deployed within the key segments of the final nuclear fuel cycle stage, i. e., SNF, RW management and nuclear decommissioning paved the way for the nuclear organizations to achieve an earnest progress both as regards the nuclear legacy challenges that had been previously put on hold and the development of a somewhat solid foundation providing robust safety in the future. Table 1 presents a brief summary of the most important conceptions on the scope of methods implemented to comply with the obligations taken under the Joint Convention to improve the safety level [7—9].

The following tasks are going to remain in the focus of the Russian Federation within the next 5—10 years:

- establishment of a SNF management system — its reprocessing rate should exceed the one of its generation; 100 % of the federal RBMK SNF inventory should be transferred to safe long-term *dry* storage; SNF reprocessing plant of a new generation should be commissioned; 100 % of the federal SNF inventory subject to reprocessing should be reprocessed; transition to nuclear material recycling in thermal and fast reactors should be implemented;
- isolation of LRW surface storage facilities at SCC, PA Mayak, MCC sites;
- dismantlement of ships and floating maintenance bases pertaining to the nuclear icebreaker fleet;
- cleanup of contaminated areas;
- further development of the near-surface RW disposal system;
- establishment and operation of an underground research facility (URF);
- improvement of the regulatory and legal framework in the field of atomic energy use and scientific and methodological support of SNF and RW management activities;
- decommissioning of nuclear legacy facilities.

Table 1. Risk mitigation and safety level enhancement through activities covered under the framework of the Joint Convention

Measures implemented under the obligations arising from the Joint Convention	Risk mitigation and safety enhancement measures in SNF and RW management
SNF management	
Construction of a dry SNF storage facility complex for RBMK-1000 and VVER-1000 SNF at the MCC site with a capacity of over 30,000 SNF tons in 2004–2015 [9]	Risk mitigation in relation to the SNF held in the wet storage facility
Large-scale infrastructure, research and engineering efforts launched in 2012–2015 to reduce the excess filling degree of SNF cooling pools at NPP with RBMK reactor units [9] Commercial shipment of RBMK-1000 SNF from the Leningrad, Smolensk and Kursk NPP	Elimination of NPP shutdown risks due to exhausted cooling pool capacities
Shipment of the entire highly-enriched SNF (and unirradiated fuel) inventory from the Russian-designed research reactors abroad for reprocessing to Russia in 2004–2017	Elimination of risks associated with possible reactor fuel use by terrorists
Commissioning of the first start-up SNF reprocessing unit at the Pilot Demonstration Center operated by MCC. Completed construction of a Pilot Demonstration Center (PDC) for SNF reprocessing at the MCC site. Development of an advanced reprocessing method geared to the basic types of the accumulated SNF inventory [9]	Mitigating risks associated with the management of the arising RW inventory due to future elimination of liquid radioactive waste (LRW) streams
RW management and legal framework improvement	
The Federal Law of July 11, 2011 № 190-FZ On Radioactive Waste Management… introduced the mandatory RW disposal principle; managerial transformations addressing safety regulation: Rostechnadzor previously supervised by the Russian Ministry of Natural Resources got under direct supervision of the Russian Government; the National RW Management Operator has been established; waste acceptance criteria for disposal have been adopted; RW disposal tariffs have been set; federal ownership over legacy RW has been established; primary registration campaign has been launched all across the country to inventory the RW and RW sites in 2013–2014 [10]; Construction of near-surface disposal facilities (NSDF) and RW Class 3 and 4 disposal efforts were launched in the Novouralsk region in 2016	Mitigating long-term RW storage risks, impetus for RW transfer for disposal, state funding of federal RW disposal
Completion of isolation operations at LRW storage reservoirs: V-9 at the PA Mayak site, B-1, B-2, B-25 at the SCC site. Reservoir №345a at the MCC site has been upgraded [9]	Eliminated risks of environmental contamination due to natural and technogenic emergencies (wind-driven entrainment, tornadoes)
Safety enhancement activities at the Techa Cascade of Water Reservoirs (TCR) (dam strengthening, construction of a combined sewerage system, development of LRW treatment and cementing capacities); development of a strategic master plan addressing the TCR challenges at the PA Mayak site [11]	Eliminated risks of the TCR reservoir overflow with its long-term safety provided based on approved strategies and a master plan governing their implementation and control
Strategy for the development of a deep geological repository for RW (DGR) in the Nizhnekansk rock mass (the Krasnoyarsk region) [12] and a strategic master plan supporting the long-term safety assessment of DGR designed for RW Class 1 and 2 disposal in the Nizhnekansk rock mass [13] have been developed and approved by the State Corporation Rosatom; construction of an underground research facility (URF) designed for R&D on the RW disposal safety was launched in 2019	Risk elimination and the long-term safety provided for the accumulated and generated high-level waste management
Implementation of a work program developed to adhere to the recommendations of the IAEA peer review mission on the deep well LRW injection practice [14]	Evaluation of additional measures seeking to provide the long-term safety of the deep well LRW injection practice and their implementation
Nuclear decommissioning	
In 2006-2021, decommissioning efforts were implemented at over 100 facilities, including 7 shutdown reactor units and 2 reactor units undergoing decommissioning (Novovoronezh NPP, 1st and 2nd units), production uranium-graphite reactor (PUGR) EI-2 at the SCC site, building B at the VNIINM site located within the urban area of the Moscow city, building 804 at the AECC site, several buildings and structures constituting to PUGR SFA production at the NCCP site, research reactor units RBT-10/1 and AST at the RIIAR site, research reactor units MR and RTF at the Kurchatov Institute site, floating maintenance bases Lepse and Volodarsk operated by Atomflot; two pilot-demonstration centers for uranium-graphite reactor and VVER-reactor type NPP decommissioning have been established	Elimination of environmental risks associated with aged engineered safety barriers (EBS) constituting to the structures of shutdown nuclear facilities and RW releases into groundwater, mitigated risks of radiation accidents in densely populated areas

Proposals on further improvement of the review meeting process

Since 2014, along with the declarative reporting principle, the Review Meetings on the implementation of two international conventions, namely, the Convention on Nuclear Safety and the Joint Convention, have been actively discussing the principle of competition. In particular, first steps have been taken to test it as referred to the definition of *a good practice* adopted in 2014 at the Second Extraordinary Meeting of the Joint Convention [15]. Nevertheless, these efforts have yielded no noticeable results yet, probably due to the somewhat vague applicability scope.

At the same time, we believe that higher efficiency of the inspired competitiveness principle can be attained through some quantification of the basic criteria constituting to the definition of the *good practice* enabling either their comparison or transformation with a higher degree of detail achieved.

A key concept in this definition is the one of a *significant contribution to the safety*. Discussions held at the Fifth and Sixth Review Meetings (Figures 1—3) showed that the cases proposed by the Contracting Parties were referred to *good practices* based on the expert judgement method without any quantitative assessment that would demonstrate the degree of such a *significant contribution to the safety*. Given the heterogeneity of the cases considered, it seems quite difficult to judge them in an unbiased manner. Meanwhile, to select a *good practice*, it can be compared not with various and mostly heterogeneous cases proposed by the Contracting Parties, but with some related alternative option. Such options may involve, for example, open or closed nuclear fuel cycles, pre-disposal decay storage of radioactive waste to reduce its activity or the *immediate* disposal option, etc. Of particular importance is the fact that a choice in favor of a particular option can be made based on a quantitative criterion rather than on a qualitative expert judgement, for example, the collective dose of personnel or public exposure.

The second subjective approach is to test a *good practice:* in this case the predicted (estimated) contribution to safety can be evaluated based on the avoided hypothetical exposure doses.

Another similar non-quantitative criterion is associated with the concept of *a new or revised practice, policy or program*. If the wording *new practice* remains in the definition only, it renders the definition itself considerably more specific.

Figure 1. O. V. Kryukov — presentation of the Fifth National Report of the Russian Federation on behalf of the State Corporation Rosatom (2018, IAEA, Vienna, Austria)

Figure 2. A. V. Ferapontov — presentation of the Sixth National Report of the Russian Federation (2022, IAEA, Vienna, Austria)

Figure 3. A. N. Dorofeev — presentation of the Sixth National Report on behalf of the State Corporation Rosatom (2022, IAEA, Vienna, Austria)

Figure 4. Contracting Parties to the Joint Convention attend the Seventh Meeting, 27 June—8 July 2022 (IAEA, Vienna, Austria)

The improvements proposed in [16] are believed to open up some new opportunities and precise the mechanisms that should be followed to apply the definition of a *good practice* in real life.

Moreover, application of this concept is challenged by another possibly even more overriding issue, which is the heterogeneity of the facilities proposed by the Contracting Parties, when one has to compare processes and facilities associated with atomic energy use being different in their scale. Nevertheless, even within the existing provisions of the Joint Convention, one can find the approaches set out in [17], which, on the one hand, would enable a uniform application of the wording *good practice* in all country groups and, on the other hand, avoid making the process extremely complicated so that it could be considered a feasible method.

The approaches can be mainly based on facility breakdown by areas of activity associated with SNF and RW management with the definition itself applied to the selected elements. Given the nature of the process, it seems quite obvious to consider relevant management stages.

As it comes to SNF management, possible gradation in terms of the SNF volumes involved can be omitted since relevant activities are going to be compared for countries with nuclear installations. Therefore, two elements can be kept in the definition — SNF storage and its processing.

As it comes to RW management, two main stages can be considered: pre-disposal treatment and disposal. Obviously, if *good practices* are compared, one should specify the elements characterizing the scale of the practical activities involved. Therefore, two elements can be proposed: availability or unavailability of nuclear installations.

As it comes to nuclear decommissioning, it is referred to the decommissioning of nuclear facilities and other facilities in the field of atomic energy use.

Insufficient awareness of the countries with highly developed nuclear power (USA, France, Russia, China, Great Britain, Japan, etc.) on the challenges faced by those with less developed nuclear power (and especially vice versa) turned out to be another feature of the Review Meeting process due to which it was almost insuperably difficult to select the best cases of *good practices* and not much contributing to the work progress since it did not provide opportunities for an unbiased and *consensual* decision-making on the facilities or processes. A more reliable approach could be the selection of *good practices* among the countries with comparable nuclear power development levels, for example, through an additional pre-screening process.

Furthermore, the discussions held under the Joint Convention should entirely exclude any political background and issues not related to the objectives and scope of its application.

Conclusion

To conclude, it seems worth noting that the Joint Convention is a fundamental platform promoting international cooperation in the field of safe spent nuclear fuel and radioactive waste management, an important binding instrument contributing to the development of national waste management methods and technologies.

For many years Russia has been engaged in this process and therefore is eligible to express its proposals on considerable expansion of information and cognitive potential as regards the safety of nuclear facilities through the mechanisms summarized below:

1. To get acquainted with and apply the findings of independent external reviews focused on the activities of a Contracting Party provided for under the application scope of the Convention.

2. To use the best practices reported by the Contracting Parties in their National Reports in the interests of the international nuclear community.

3. To get answers from countries to questions considered of interest to other Contracting Parties engaged in similar (or different) activities.

4. To participate directly in the discussions on the presentation of one's own and other National Reports at the Review Meetings of the Contracting Parties.

At the same time, it's worth noting that the guideline documents of the Joint Convention can be seen as a dynamically evolving and live mechanism providing flexible reporting opportunities within the established requirements. Basic feedback with relevant proposals on the comprehensive structuring and upgrading of data presented in the Russian National Report were discussed in [18].

Despite the current complicated geopolitical situation, the Russian Federation still adheres to the general obligations assumed under the Joint Convention since its ratification on appropriate legislative, regulatory and administrative measures being implemented to regulate the SNF and RW management safety and provide adequate protection of individuals, society and the environment from radiological and other hazards, as well as to comply with the reporting and the peer review mechanism, primarily by reporting relevant information in its National Reports.

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