DOI: 10.25283/2587-9707-2019-2-41-48 UDC 621.039.009

THE SAFE MANAGEMENT OF RADIOACTIVE WASTE: CONTEMPORARY IAEA ACTIVITIES

Sobolev A. I.

FSUE "RosRAO", Moscow, Russia

Article received on February 18, 2019

The IAEA Committee on safety standards for radioactive waste (WASSC) validates the safety criteria established to protect human and the environment from harmful effects of ionizing radiation at all stages of radioactive waste management. This article examines matters related to the arrangement of IAEA activities on the development of safety standards, document development workflow and analysis of WASSC activities in cycle of 2014-2017.

Keywords: *radioactive waste, safety standards, nuclear power facilities.*

Introduction

IAEA was established in 1957 in accordance with the UN decision of December 4, 1954 to implement the ambitious task of establishing a framework global forum for scientific and technical cooperation in the peaceful uses of nuclear technologies.

The Agency annually submits a report on its activities to the UN General Assembly and, if necessary, to the UN Security Council.

Initially, the USSR took the most active part in the establishment of the IAEA actively collaborating with other States in the development of the IAEA Statute and was among the first to ratify it.

The Agency's activities as an independent intergovernmental organization in the UN system stepped up significantly with the advent of the Treaty on the Non-Proliferation of Nuclear Weapons (approved by General Assembly resolution 2373 (XXII) of June 12, 1968). The work of the Agency has gained particular importance due to the obligation taken by each Member State to fullfill the requirement on concluding an agreement with the IAEA ensuring that no military research can take place.

The purpose of the Agency's activities in the Member States is to state that atomic energy is used exclusively for peaceful purposes.

The IAEA safeguards system does not involve any mechanisms preventing the transformation of nuclear material use from peaceful to military purposes, but only reveals the use of safeguarded material or facilities for prohibited purposes by initiating relevant review of such facts by the UN.

The activities of the IAEA are postulated by the following basic principles:

1. IAEA is considered exclusively as a technical body;
2. IAEA does not perform any political assessments of government performance;
3. IAEA does not have the right of modelling situations, but only works with facts revealed during its inspections.

The IAEA Safeguards Department, provides control over nuclear facilities and materials by analyzing relevant accounting records, verifying the operation of nuclear operators and conducting selective measurements in facility-specific modules.

To this end, inspector in-situ cueing practice has been widely applied.

IAEA Structure and Functions

1. Board of Governors gathers five times a year to review IAEA reporting, program and budget. It provides recommendations to the General Conference on these issues and also considers applications for IAEA membership. In addition, the Board of Governors approves safeguard agreements and the publication of IAEA safety standards.

2. General Conference is convened once a year with the representatives of all Member States to review the Board of Governors' report for the previous year, to approve the reporting, program and budget, the submitted applications for IAEA membership, as well as to review the pressing issues.

3. Secretariat is responsible for the implementation of programs approved by the decision-making bodies of the Agency.

The main functions of the Agency include:

- encouraging research and development on the peaceful uses of atomic energy;
- encouraging the exchange of scientific achievements and methods;
- formation and application of safeguards system;
- development, adoption and harmonization of safety standards.

IAEA Publications

In keeping with provisions of Articles III A and VIII C of the Statute, IAEA is authorized to promote the dissemination of scientific and technical information on the peaceful uses of atomic energy. Publications in the IAEA Series of Publications provide information on the nuclear fuel cycle, RW and SNF management systems, decommissioning of nuclear and radiation hazardous facilities, as well as on general safety issues relevant to all of the above areas.

The structure of IAEA Atomic Energy Series includes three levels:

1. Basic principles and goals (safety demonstration in atomic energy uses and explanation of goals that should be achieved in this area at different stages of relevant activities).

2. Guides (providing recommendations on the way these goals should be achieved).

3. Technical reports (additional detailed information on activities in various areas of atomic energy use).

Publications in the IAEA Atomic Energy Series are marked with the following codes:
NG — general issues;
NP — nuclear power;
NF — nuclear fuel;
NW — radioactive waste management and decommissioning.

IAEA Safety Standards

Considerable experience was accumulated serving a basis for the development of a complete set of IAEA safety standards for radioactive waste management.

The safety standards reflect the international consensus concerning the essence constituting to the high level of safety enabling to protect people and the environment from the harmful effects of ionizing radiation.

The IAEA Safety Standards Series includes three categories of documents:

1. Safety Fundamentals (containing fundamental safety objectives, principles of safety and protection, and also serving a basis for the development of Safety Requirements).

2. Safety requirements (establish requirements that should be met to protect people and the environment).

3. Safety Guides (contain recommendations and clarifications regarding the implementation of the Safety Requirements).

The key documents in the field of the safe radioactive waste management are as follows:

- IAEA Safety Standards No. GSR-5 "Pre-disposal Management of Radioactive Waste";
- IAEA Safety Standards No. SSR-5 "Radioactive Waste Disposal".

Development of IAEA Safety Standards

The following parties are involved in the development and review of the safety standards:

1. IAEA Secretariat

2. Safety Standards Committees:
NUSSC — Nuclear Safety,
RASSC — Radiation Safety,
WASSC — Radioactive Waste Safety,
TRANSSC — Transport Safety,
EPReSC — Emergency Preparedness and Response.

3. Safety Standards Commission

Commission on Safety Standards (CSS) coordinates and oversees the entire IAEA Safety Standards Program.

All IAEA Member States may nominate experts to IAEA Safety Standards Committees and submit comments on the draft standards.

CSS members are appointed by the IAEA Director General; CSS includes senior government officials responsible for setting national standards.

WASSC in the cycle 2014-2017

In 2014—2017, WASSC Committee brought together representatives from 51 State, namely: Algeria — Mr. A. Ghezal, Argentina — Ms. M. Medici, Australia — Mr. G. Williams (Committee Chairman), Austria — Mr. H. Fischer, Belgium — Mr. W. Blommaert, Bulgaria — Mr. A. Alexiev, Brazil — Mr. M. Leal, Burkina Faso — Mr. M. Tionou, United Kingdom — Ms. D. Varley, Hungary — Mr. I. Lazar, Germany — Mr. C. Goetz, Greece — Mr. D. Mitrakos, Denmark — Mr. D. Ulfbeck, Egypt — Mr. Y. Selim, Israel — Mr. R. Hakmon, India — Mr. C. Kaushik, Jordan — Mr. M. Hawwari, Iran —Mr. H. Sadeghloo, Spain — Ms. J. Higuera, Italy — Mr. M. Dionisi, Canada — Ms. P. Doughty, Kenya — Ms. W. Njiraini, Cyprus — Mr. A. Yiannaki, China — Mr. Guo'an Ye, Costa Rica — Mr. E. Villalobos, Lebanon — Ms. M. Assi, Libya — Mr. M. Albahi, Lithuania — Mr. V. Paulikas, Malaysia — Ms. T. Iyu Lin, Mexico — Mr. R. Alvarado, Namibia — Mr. A. Tibinyane, Netherlands — Mr. T. Louis, New Zealand — Mr. C. Ardouin, Norway — Mr. R. Lystad, Pakistan — Mr. N. Maqbul, Poland — Ms. B. Zielinska, Russian Federation — Mr. A. Sobolev, Romania — Ms. D. Dogaru, Slovakia — Mr. J. Homola, Slovenia — Mr. T. Zagar, USA — Mr. J. Tappert, Ukraine — Mr. V. Berkovskyy, Croatia — Mr. D. Skanata, Finland — Mr. J. Leino, France — Mr. C. Kasiotiot, Czech Republic — Mr. P. Lietava, Switzerland — Mr. O. Beffort, Sweden — Mr. B. Hedberg, South Africa — Ms. V. Maree, South Korea — Mr. H. Ki Shin, Japan — Mr. M. Uchida.

Member States in WASSC presented in Figure 1.

It seems interesting to compare this percentage with the data from the IAEA method used to rank the countries by the number of reactors that have reached criticality [1], presented in Figure 2. Comparison of the results for Europe 51.0 and 51.4%, Asia – 21.6 and 18.4%, America – 11.8 and 29.9% confirms the conclusion stating that the representation of States in WASSC Committee is stably correlated with the global nuclear power indicators.

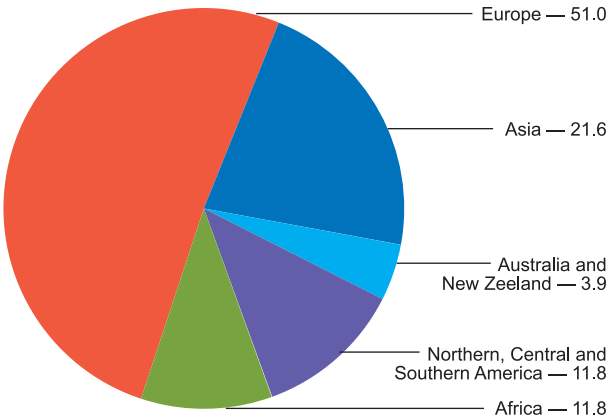

Figure 1. Member States in WASSC (%)

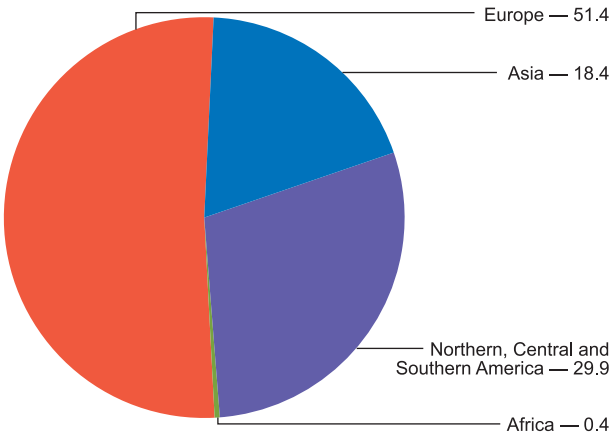

Figure 2. Distribution of nuclear reactors that have reached criticality (%)

Traditionally and on a regular basis, representatives of international organizations are engaged in meetings of the WASSC Committee, the list of which is given in Table 1.

Table 1. International organizations in WASSC

UN Scientific Committee on the Effects of Atomic Radiation	UNSCEAR
International Commission on Radiological Protection	ICRP
World Health Organization	WHO
European Nuclear Installations Safety Standards Initiative	ENISS
European Commission	EC
United Nations Environment Programme	UNEP
World Nuclear Association	WNA
Organisation for Economic Co-operation and Development / Nuclear Energy Agency	OECD/ NEA
International Organization for Standardization	ISO
International Source Suppliers and Producers Association	ISSPA
International Radiation Protection Association	IRPA

RW amounts: problem scale

Activities associated with arranging meetings of the contracting parties on the fulfillment of obligations arising from the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management can be certainly considered as a main activity of the WASSC Committee. Meetings of the IAEA contracting parties take place once in three years starting from November 2003. Afterwards these were traditionally held in May (in 2006, 2009, 2012, 2015 and 2018), gathering over 650 representatives from each Contracting Party of the Joint Convention.

National Reports developed by each Contracting Party of the Joint Convention serve a basis for the data evaluation on various characteristics of radioactive waste and the forecasts regarding waste generation. Analysis of the information presented in these reports is carried out based on a unified approach involving the compilation of tables providing data on spent fuel and radioactive waste inventory, as well as recommendations enabling to convert the indicators given in national classification systems into the GSG-1 classification [2]. Each Joint Convention National Report contains a list of enterprises engaged in activities associated with spent fuel and radioactive waste management, as well as data on the amounts of spent fuel and radioactive waste.

Table 2 presents the data on the amount of stored solid radioactive waste that can be found in various regions of the globe with Table 3 providing relevant information on the waste held in disposal facilities [3].

Table 2. Amounts of stored SRW, thousand m³

Region	VLLW	LLW	ILW	HLW
Africa	7	20	1	0
Europe	239	2,834	370	13
America	2,105	285	84	8
Middle and Far East, Southern Asia	5	334	4	0
Southeast Asia and Pacific region	0	5	1	0
Total	2,356	3,478	460	21

Table 3. Amounts of SRW held in disposal facilities, thousand m³

Region	VLLW	LLW	ILW	HLW
Africa	0	14	0	0
Europe	278	2,901	15	0
America	7,176	17,468	91	0
Middle and Far East, Southern Asia	1	64	0	0
Southeast Asia and Pacific region	452	4	0	0
Total	7,907	20,451	106	0

Figure 3 presents the list of main SRW generation sources for the waste held in storage facilities with relevant data concerning SRW disposal facilities given in Figure 4.

Evaluation of the data presented above allows us to conclude that a "delay effect" associated with the introduction of modern complexes ensuring

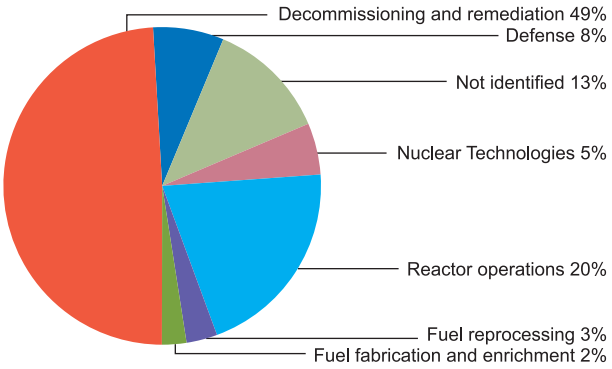

Figure 3. Generation sources for SRW held in storage facilities

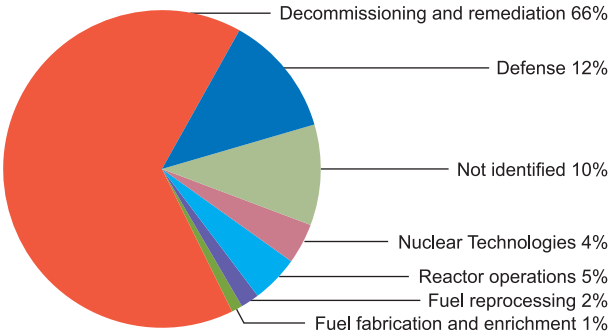

Figure 4. Generation sources for SRW held in disposal facilities

the safe disposal of solid radioactive waste as compared with the storage option can be observed. Probably the effect is primarily associated with the improvement of regulatory requirements, as well as intensification of nuclear decommissioning and remediation efforts at territories with radioactive contamination.

IAEA Safety Standards Development Procedure

Figure 5 presents the general chart showing the interactions between the Secretariat, the Commission and the Safety Standards Committees with the IAEA Member States under the process associated with the development of new safety standards and the review of the existing ones.

Table 4 provides a detailed list of steps enabling the development of new safety standards or the review of the existing ones, starting from the development of the terms of reference and up to the document publication.

Safety Standards Development Program

During the 2014—2017 cycle, the RW Safety Standards Committee reviewed and approved 14 draft terms of reference and safety guides from DS403 Decommissioning of Medical, Industrial and Research

Table 4. List of steps undertaken under the process of safety standards development

Step	Contents
1	Compilation of the terms of reference (TR) for the developed standard
2	TR examination by IAEA experts
3	TR examination at Committee Meeting
4	TR approval by Safety Standards Commission
5	Development of a draft safety standard
6	Preliminary review of the draft safety standard by IAEA experts
7	Preliminary review of the draft safety standard at the Committee meeting
8	Submission of the draft document to the Member states of the Committee
9	Evaluation of the comments, remarks and proposals
10	Second review of the draft safety standard by IAEA experts
11	Second review of the draft safety standard at the Committee meeting
12	Review of the draft standard by Safety Standards Commission
13	Approval of the document entitled as an IAEA safety standard
14	Publication of the IAEA safety standard

Facilities to DS512 Borehole Disposal Facilities for Radioactive Waste. A detailed list of the documents being under consideration indicating the status of the development process step, as well as WASSC meetings timeline is presented in Table 5.

When discussing the draft Safety Guide DS442 Regulatory Control of Radioactive Discharges into the Environment, based on the consensus of the Committee members, a decision was made on mandatory consideration of tritium and carbon-14 in a separate section of the document. Another controversial issue that invoked a heated discussion was associated with the "decommissioning" type of activity. It has been postulated that decommissioning cannot be attributed to operational activities, but should be considered as a type of a new activity involving the establishment of some specific monitored parameters. Discussion of the draft DS468 Safety Guide Remediation Process for Areas Affected by Past Activities and Accidents seems of an interest as it comes to the following issue: why such activities as decommissioning are excluded from the scope of issues covered by this document as remediation activities may be required to be performed at nuclear legacy sites. As a result of the discussion, the Committee has reached a consensus suggesting that dismantling activities may indeed

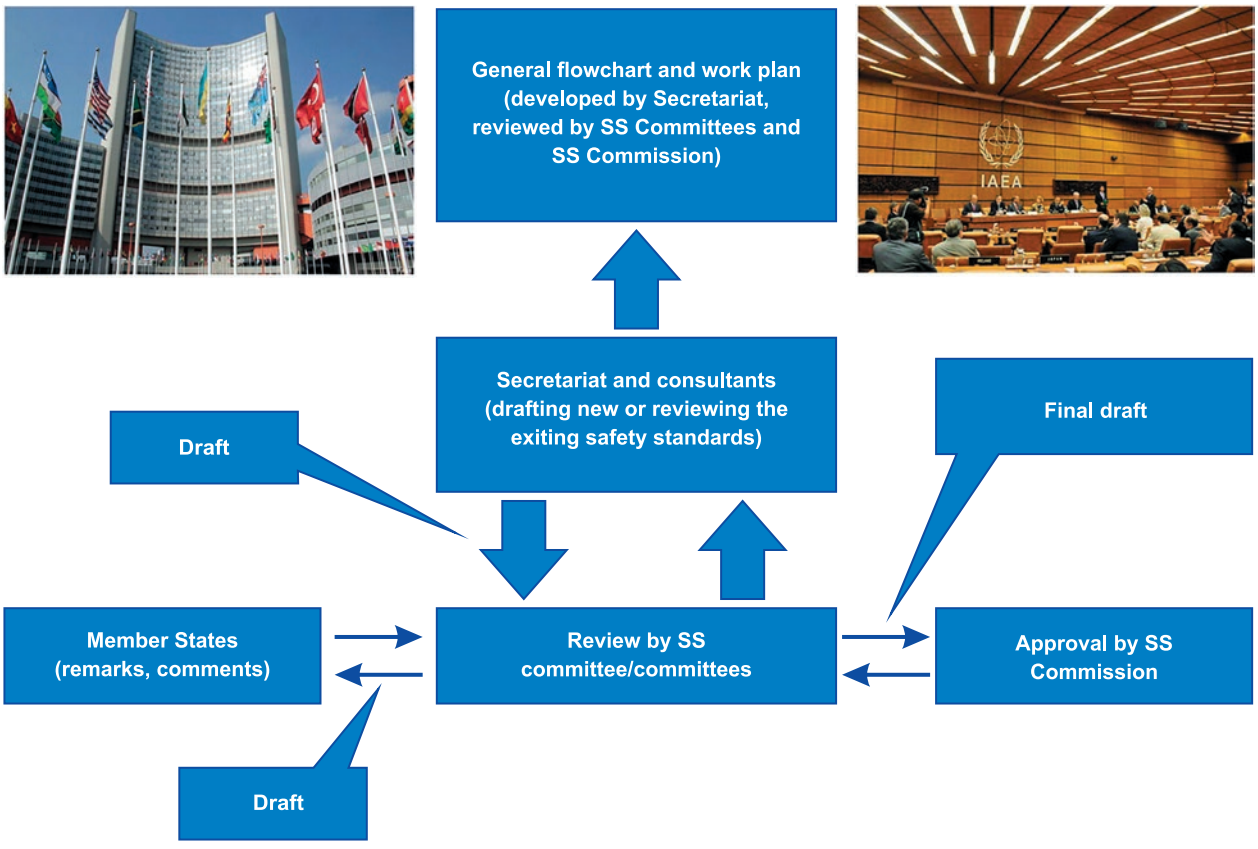

Figure 5. Flowchart representing IAEA safety standards development process

Table 5. WASSC activity program under 2014–2017 cycle

Name of the Safety Guide	2014		2015		2016		2017	
	W37	W38	W39	W40	W41	W42	W43	W44
D5403 Decommissioning of Medical, Industrial and Research Facilities			Step 7				Step 11	
D5427 Prospective Radiological Environmental Impact Assessment for Facilities and Activities		Step 7		Step 11				
D5442 Regulatory Control of Radioactive Discharges to the Environment		Step 7		Step 11				
D5447 Predisposal Management of Radioactive Waste from Nuclear Fuel Cycle Facilities		Step 11						
D5448 Predisposal Management of Radioactive Waste from Nuclear Power Plants and Research Reactors		Step 11						
D5452 Decommissioning of Nuclear Power Plants, Research Reactors and Other Nuclear Fuel Cycle Facilities		Step 7		Step 11				
D5454 Predisposal Management of Radioactive Waste from the Use of Radioactive Material in Medicine, Industry, Agriculture, Research and Education	Step 7			Step 11				
D5459 Management of radioactive substances from mining and other activities on the management of naturally occurring radioactive materials					Step 7			
D5468 Remediation Process for Areas Affected by Past Activities and Accidents					Step 5	Step 7		
D5477 The Management System for the Predisposal Management and Disposal of Radioactive Waste								Step 7
D5489 Storage of spent nuclear fuel		Step 3			Step 5	Step 7		
D5500 Application of the clearance concept						Step 3		
D5505 Monitoring for Protection of the Public and the Environment							Step 3	
D5512 Borehole Disposal Facilities for Radioactive Waste								Step 3

take place on nuclear legacy sites and that the terms "decommissioning" and "remediation" shall be used in the document being under development.

When discussing the draft terms of reference for the development of Safety Guide DS512 Borehole Disposal Facilities for Radioactive Waste for the purposes of further discussion and submittal to the Safety Standards Commission, it was proposed to consider the document as a useful one for the countries of the African continent when disposing of spent sources of ionizing radiation.

National experience of the Committee's member states

At meetings of the Committee held during the 2014—2017 cycle, reports were presented with relevant materials being discussed covering national experience of 14 member states (Table 6) in the field of the safe management of radioactive waste.

Table 6. National experiences of member states in the 2014–2017 WASSC cycle

Country	Committe
Egypt, Belgium, Finland	WA55C_38
Germany, Poland	WA55C_39
Canada, Hungary, India	WA55C_4o
South Africa	WA55C_41
Great Britain, Japan	WA55C_43
Mexico, Switzerland, Ukraine	WA55C_44

The structure of the report on national experience traditionally consists of two parts: the first part presents an overview on the state-of-art nuclear power program and the use of radioactive substances in economic activities with relevant prospects indicated for the further development, whereas the second part covers relevant aspects of national regulation with an evaluation enabling to

assess their level of harmonization with the IAEA recommendations.

National approach applied in India and presented at WASSC_40 (November 2015) in the report of the Committee member Dr. C. P. Kaushik and observer J. S. Yadav strikes as quite an interesting one: the National Concept of India set to ensure the protection of people and the environment is based on the following RW management principles:

- decay storage of short-lived radionuclides;
- dilution and dispersion for low-level LRW;
- concentration and storage of ILW and HLW.

New approaches to radiation protection

In his presentation titled as "Prudence and Conservatism in Radiation Protection", Roger Coates, President of the International Radiation Protection Association (IRPA), gave some examples revealing the relationship between cost and the clearance levels set for various radionuclides.

It has been shown that remediation activities allow reducing actual doses with a coefficient of no less than 100 with the values achieved being close to the natural background ones. UK experience showed that the costs associated with the remediation of radioactively contaminated territories with relevant measures taken to reduce ^{137}Cs specific activity from 1 Bq/g to 0.1 Bq/g amount to several billion pounds. The incomparability of financial costs with the achieved radiation safety effect was stated suggesting the revision of the criteria increasing their value by a factor of 10—100. For example, to minimize differences between natural and artificial radionuclides, specific activity of 1 Bq/g was proposed to be set as the total minimal value with the value of 0.1 Bq/g taken for ^{60}Co, ^{65}Zn, ^{106}Ru, $^{134/137}$Cs, $^{238/239/240/241}$Pu, ^{241}Am accordingly. The most rigid criterion is supposed to be set for ^{129}I accounting for 0.01 Bq/g.

Conclusions

Continuous development and improvement of safety standards is a mechanism allowing the IAEA to demonstrate the feasibility of safety criteria set for the protection of people and the environment from the effects of ionizing radiation at all stages of RW management.

Current activities of the Radioactive Waste Safety Standards Committee are focused on addressing large-scale challenges, primarily associated with the disposal of radioactive waste and nuclear decommissioning.

References

1. Report of the president of the organizational meeting for the fifth review meeting / Organizational Meeting 14—15 May 2014, JC/OM.5/P.14/Rev.1, 2014.

2. Classification of Radioactive Waste, МАГАТЭ Safety Standards Series No. GSG-1, IAEA, Vienna (2009).

3. Status and trends in spent fuel and radioactive waste management / IAEA nuclear energy series No. NW-T-1.14, Vienna (2018).

Information about the authors

Sobolev Andrey Igorevich, Doctor of Technical Sciences, Professor, Special Adviser on scientific and technical issues, FSUE "RosRAO" (6, Pyzhevskiy Lane, Moscow, 110017, Russia), e-mail: AISobolev@rosrao.ru.

Bibliographic description

Sobolev A. I. The Safe Management of Radioactive Waste: Contemporary IAEA Activities. *Radioactive Waste,* 2019, no. 2(7), pp. 41—48. DOI: 10.25283/2587-9707-2019-2-41-48. (In Russian).