STATE REGULATORY AGENCY FOR RADIATION AND NUCLEAR SAFETY

STRATEGY OF RADIOACTIVE WASTE MANAGEMENT IN BOSNIA AND HERZEGOVINA

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SUMMARY

In accordance with the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management and in order to fulfill obligations under the convention, Bosnia and Herzegovina has to take legislative, regulatory and administrative measures to ensure the availability of qualified staff, adequate financial resources, and infrastructure relating to radioactive waste management.

A centralized approach to radioactive waste management will be applied in BiH, which implies the storage of radioactive waste in a single storage facility for the BiH territory.

The State Regulatory Agency for Radiation and Nuclear Safety (hereinafter: Agency) will establish committees to perform the following activities:

- Defining a proposal of the location for the central storage facility for radioactive waste, taking into account the applicable legislation and consultations with the competent authorities in BiH;
- Drafting a regulation on radioactive waste management;
- Proposing the type and design of the central storage facility, including its security.

The Council of Ministers of BiH will determine the final location of the central storage facility for radioactive waste.

The Agency will issue regulations to establish a regulatory framework for the safe management of radioactive waste. The regulations will:

- define the prime responsibility of the legal person-waste generator for the collection and segregation of the waste generated within an authorized practice;

- establish the authorization of radioactive waste management practice, i.e. licensing of a technical service that will be the operator of the central storage facility for radioactive waste, and as well the authorization of the central storage facility.

The owner of the central storage facility will be the State, and upon a proposal of the Agency, the Council of Ministers of BiH will issue a specific decision transferring the use of the facility to the operator, which will perform tasks of radioactive waste management.

In case there are no legal persons interested to operate the facility, the Agency undertakes to act as the operator of the central storage facility.

Radioactive waste originated in past practices from military and civilian use, including the radiation sources stored in temporary storage facilities in BiH and installed radioactive lightning rods, will be collected in the central storage facility.

In addition to the funds from the budget of BiH institutions, the funds for the construction and equipping of the central storage facility and for the collection, transport, conditioning and storage of historic radioactive waste will be secured in cooperation with institutions and experts from the International Atomic Energy Agency and the European Commission.

Funding of the operator of the central storage facility will be provided from the budget of the BiH institutions on the basis of the annual work plan and also from other sources.

Generators of radioactive waste from authorized practices will pay an appropriate administrative tax for storage into the budget of the BiH institutions.

While acquiring a new source, the authorization holder and the supplier will stipulate provisions on the return of the source once it becomes disused.

The Agency will seek a way to solve the matter of permanent disposal of radioactive waste through the signature of an international agreement with a country that has appropriate capacities for the reception and processing of the waste or in another appropriate way.

The responsible bodies for the implementation of the strategy are the Agency, the authorized technical service (operator) for radioactive waste management and the authorization holders that generate radioactive waste.

A. RADIOACTIVE WASTE MANAGEMENT IN BOSNIA AND HERZEGOVINA

1. INTRODUCTION

1.1 Goal and purpose of the national strategy of radioactive waste management

The strategy of radioactive waste management defines objectives, requirements, and ways of their achievement through defining the roles and responsibilities of the subjects involved in generation, transport, processing, and storage of radioactive waste (International Atomic Energy Agency, 2009).

Under the Law on Radiation and Nuclear Safety in BiH[1] (hereinafter: Law), radioactive waste is the material remaining in any physical form as a by-product of practices or interventions and no longer foreseen for any use, and contains or is contaminated with radioactive substances at an activity or activity concentrations greater than clearance levels, i.e., it could lead to a radiation exposure that is not excluded from regulatory control.

Radioactive waste management is a set of measures and activities in dealing with radioactive waste, intended to achieve an appropriate protection of human health and the environment, both now and in the future (International Atomic Energy Agency, 1995).

The purpose of the national strategy is to ensure the highest degree of protection of the public and the environment from ionizing radiation, taking into account not to disrupt the routine use of ionizing radiation sources, in which particular attention should be paid to an appropriate assessment of risk to human health and the environment.

The national strategy of radioactive waste management is a basis for the application of relevant safety standards defined in national regulations, accepted standards and recommendations of the International Atomic Energy Agency (IAEA) and other relevant international organizations, above all the UN United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), International Commission on Radiological Protection (ICRP), International Radiation Protection Association (IRPA), International Commission on Radiation Units & Measurements (ICRU), World Health Organization (WHO) in order to achieve an appropriate protection of the public and the environment from harmful effects of ionizing radiation.

[1] Law on Radiation and Nuclear Safety in BiH (Official Gazette of BiH 88/07)

1.2 Justification for the adoption of the national strategy of radioactive waste management

According to IAEA classification (2001), Bosnia and Herzegovina belongs to B category of countries that use radionuclides in medicine, industry, and research. Despite a relatively limited use of radioactive material and other ionizing radiation sources in BiH, the adoption of a general strategy of radioactive waste management should be a priority both because the use of ionizing radiation is specific and sensitive, all with the aim of safe and effective use of ionizing radiation.

BiH is a country that neither has nuclear power plants, research nuclear reactors, uranium mines nor plans to construct them in the near future.

Radioactive material in BiH is used in medicine, industry, and research. In this, both unsealed and sealed sources of ionizing radiation are in use. Radiation sources are used in medicine for *in vitro* tests in clinical diagnostics, *in vivo* use of radiopharmaceuticals in clinical diagnostics and therapy, and in radiotherapy. The use of radiation sources in industry includes various control measurements in technological processes and plants (measurement of level, thickness, density, humidity, etc.), non-destructive testing methods, and quality control. Radionuclides are used for research purposes as radioactive markers for labeling some compounds and as tracers in physical, chemical, and biological researches. Also, radioactive material is used in radioactive lightning rods, fire alarms, radioluminiscent colors, etc. In addition to the above, some processes, such as fossil fuel burning in thermal power plants or bauxite processing, generate technologically enriched natural radioactive material of low activity.

In BiH, the Law regulates the system of controlling radiation sources, protection of the public, present and future generations, and the environment from exposure or potential exposure. The Law has set the goal – ensuring protection from ionizing radiation, i.e., radiation and nuclear safety – through:

- establishment and implementation of a system that enables the development and use of radiation sources in accordance with the requirements for the protection of public health and safety requirements;
- establishment and maintenance of a regulatory program for radiation sources and the achievement of compatibility with international standards on the safety of radiation sources and radiation protection; and
- establishment of a competent national regulatory body for radiation and nuclear safety.

BiH is a member of the International Atomic Energy Agency (IAEA), thus being obligated to establish and maintain radiation and nuclear safety in accordance with the:

- Basic Safety Standards (International Atomic Energy Agency, 2006), and

- International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources (International Atomic Energy Agency, 2011),

and as well with other relevant IAEA standards and guidelines on radiation and nuclear safety, and radioactive waste management.

In accordance with the Stabilization and Association Agreement with the EU, BiH has defined its future within the EU. The EU legislation relating to radiation and nuclear safety, including radioactive waste management, is based on the Treaty establishing the European Atomic Energy Community-EURATOM[2] and the regulations arising from the treaty. This includes a number of directives and other EU regulations, among which the following stand out:

- 96/29/EURATOM: Council Directive of 13 May 1996 laying down basic safety standards for the health protection of the general public and workers against the dangers of ionizing radiation;
- 2003/122/EURATOM: Council Directive of 22 December 2003 on the control of high-activity sealed radiation sources and orphan sources;
- 87/600/EURATOM: Council Decision of 14 December 1987 on Community arrangements for the early exchange of information in the event of a radiological emergency;
- 90/641/EURATOM: Council Directive of 4 December 1990 on the operational protection of outside workers exposed to the risk of ionizing radiation during their activities in controlled areas;
- 92/3/EURATOM: Council Directive of 3 February 1992 on the supervision and control of shipments of radioactive waste between Member States and into and out of the Community;
- 93/1493/EURATOM: Council Regulation of 8 June 1993 on shipments of radioactive substances between Member States;
- 2006/117/EURATOM: Council Directive of 20 November 2006 on the supervision and control of shipments of radioactive waste and spent fuel;
- 2011/70/EURATOM: Council Directive of 19 July 2011 establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste.

[2] Treaty establishing the European Atomic Energy Community (EURATOM), 1957.

2. Principles of radioactive waste management[3]

Responsible radioactive waste management requires implementation of the measures that will protect human health and the environment because an improper treatment of radioactive waste endangers human health and the environment now and in the future.

- ***Protection of human health***

Radioactive waste must be managed in such a way as to secure an acceptable level of protection for health of both occupationally exposed workers and the public. In addition to the risks relating to other categories of toxicity, radioactive waste also poses a risk of increased exposure to ionizing radiation and therefore requires an appropriate radiation protection. Radiation protection is based on general principles, before all justification of practice, optimization of protection, and limitation of risk to individuals.

- ***Protection of the environment***

Radioactive waste must be managed in such a way as to provide an acceptable level of protection of the environment. Safe radioactive waste management implies minimal discharge of radioactive material into the environment during the waste treatment. The most acceptable approach to the waste management is concentration and isolation of radionuclides rather than their dilution and dispersion into the environment. Nevertheless, the waste management may result in the discharge of radioactive substances into the environment but within the authorized levels under the relevant regulations and licenses. An appropriate monitoring of the discharge of radioactive substances has to be regulated and established.

- ***Protection beyond national borders***

Radioactive waste must be managed in such a way as to take into account possible negative effects on human health and the environment beyond national borders. This is based on the ethical principle of public and environmental protection and on responsible behavior so that potential harmful effects in surrounding countries do not exceed the levels authorized in the home country regulations. Recommendations of the relevant international institutions, such as IAEA or ICRP, will be taken into account during the regulation of this principle.

- ***Protection of future generations***

Radioactive waste must be managed in such a way that predicted impacts on the health of future generations will not be greater than authorized limits. The purpose is to eliminate unacceptable risks, as

[3] The Principles of Radioactive Waste Management, IAEA Safety Series No. 111-F, IAEA, Vienna, 1995.

currently standardized, to future generations. Technically, it can be achieved by the isolation of the waste, which includes several barriers, either artificial or by combining natural and artificial barriers.

- ***Relieving the burden on future generations***

Radioactive waste must be managed in such a way as to not impose undue and extra burdens on future generations. Taking the future generations into account is of particular interest during the planning of waste management. It is the responsibility of the present generation to develop technology and construct plants and facilities for waste treatment, to fund waste management, and to control the entire process.

- ***National legislation framework***

Radioactive waste will be managed in accordance with the relevant national legislation framework. The relevant regulations need to define competencies and responsibilities of all institutions involved in the implementation of particular activities of waste management.

- ***Control of radioactive waste generation***

Generation of radioactive waste must be kept to the minimum practicable both in terms of activity and volume. To this end, different radioactive waste types should be segregated and grouped in order to reduce volume and facilitate treatment. Repurpose and reuse of radioactive material in other practices after the end of initial shelf life should be preferred with the aim of reducing generated amount of the waste.

- ***Radioactive waste generation and management interdependencies***

Interdependencies among radioactive waste generation and management must be taken into account. Radioactive waste management includes pretreatment, treatment, conditioning, storage, disposal, characterization, and transport. These activities are interdependent, so the origin and characteristics of the waste, and the way of its processing should be taken into account while designing the system of radioactive waste management.

- ***Safety of facilities and plants***

The safety of facilities and plants for radioactive waste management needs to be appropriately assured during their lifetime. While determining the location, design, construction, accepting into service, lifetime, and also during decommissioning of the facilities and plants for the waste treatment and storage, the priority should be given to the matters of safety, including the prevention and mitigation of emergency consequences. An appropriate level of quality control, appropriate staff structure, and specialized training in radiation protection should be continuously maintained.

3. The way of radioactive waste management

Generally, the radiation and nuclear safety principles contained in the IAEA Basic Safety Standards (2006) and IAEA International Basic Safety Standards (2011) and as well ICRP recommendations from 1990 (published in 1991.) and 2007 are the foundation for adoption of regulations in individual countries. The extent of applicability of every individual principle differs from country to country, depending on the extent of use of nuclear energy and ionizing radiation sources. In accordance with the use of nuclear energy and ionizing radiation sources, countries are divided into five groups (International Atomic Energy Agency, 2001):

- A – Countries with a limited application of a small number of radiation sources;
- B – Countries with multiple applications of radiation sources;
- C – Countries with research reactors, wide and multiple applications of radiation sources;
- D – Countries with nuclear power plants;
- E – Countries with nuclear power plants, research reactors, production and processing of nuclear fuel.

The degree of risk to human health and environmental impact, and accordingly, the required and implemented extent of regulation and control depend on the above.

Besides, internal structure of a country and its legal system structure affect the national strategy concept.

Usually the national strategy of radioactive waste management, previously prepared by the relevant authorities or independent professional organizations, is adopted on the central government level (OECD – Organization for Economic Co-operation and Development, 2004). National policy is implemented through laws and regulations and, if needed, other secondary legislation, such as rules, decrees, orders, etc. Laws are typically enacted by the national legislative body, while secondary legislation is adopted by the competent ministries or other government authorities. There is a practical difference between the countries with highly detailed legislation that serves as a direct source for the development of standards and guidelines and the countries in which technical standards are elaborated by the technical bodies authorized for the implementation of laws (Organization for Economic Co-operation and Development, 2004). As a rule, the standards are defined on the basis of recommendations provided by IAEA, ICRP, and NEA (Nuclear Energy Agency within OECD).

Radioactive waste management includes handling, pretreatment, treatment, conditioning, storage, transport, and final disposal of conditioned radioactive waste, and also the discharge of radioactive waste and material containing radioactive substances.

Generally, there are three strategic approaches to radioactive waste management, depending on the extent of radionuclide application in the country (International Atomic Energy Agency, 1998), as follows:

- Waste management performed by the waste generator, i.e., the holder of authorization for a practice involving ionizing radiation sources that generate radioactive waste;
- A centralized radioactive waste management, in which one or more central storage facilities serve for the disposal of the waste originated in other institutions;
- The combination of the above.

4. Overview of the situation in the field of radioactive waste management in BiH

4.1 Legislative framework

4.1.1 Law on Radiation and Nuclear Safety in BiH

The Law regulates the system of controlling ionizing radiation sources, protecting the public, present and future generations, and the environment from exposure or potential exposure to ionizing radiation (Article 1).

The law established a regulatory body in BiH, which is the State Regulatory Agency for Radiation and Nuclear Safety (hereinafter: Agency) whose aim is to perform administrative and professional tasks in the field of ionizing radiation (Article 4(1)). The Agency independently conducts regulatory control of the safety of radiation sources, radioactive waste safety, and transport safety (Article 4(2)).

The Law establishes the main elements of regulatory control: authorization, inspection, and penalties necessary to enforce the Law. Responsibilities for adopting regulations on the control of occupational, public, and medical exposures are also defined (Article 16(1)), and also on the safety of nuclear material (Article 16(2)).

The Law also provides for the adoption of regulations in the field of radioactive waste management (Article 17) and transport of radioactive material (Article 18).

The Law stipulates the development of an action plan of urgent public protection from ionizing radiation in case of an emergency, a nuclear accident or nuclear damage (Article 19).

4.1.2 Law on Health Protection in the Federation of BiH

The Law on Health Protection in the Federation of BiH[4] governs the principles, measures, organization, and implementation of health protection (Article 1). Within this, the law provides for the performance of some tasks in the field of radiation safety, as follows: monitoring and assessing health of personnel working with radiation sources; monitoring and assessing radiological safety of water, food, and building materials; radiation monitoring of the biosphere; radiological, chemical, and biological protection in case of an accident; control, dismantling, and storage of sealed radiation sources (Article 116).

Transitional and final provisions of the Law on Health Protection in the Federation of BiH stipulate that the Federation Institute for Public Health will conduct activities of radioactive waste management until the Agency has finally regulated this area.

[4] Law on Health Protection (Official Gazette of FBiH 46/10)

4.1.3 Regulations and decisions from the field of radiation and nuclear safety

Based on the Law, new radiation protection regulations have been published, as follows:

- *Regulation on the notification and authorization of practices involving ionizing radiation sources (Official Gazette of BiH 66/10)*. This regulation lays down the notification procedure, and for the Agency the implementation of authorization procedure for practices involving ionizing radiation sources (Article 1). Carrying out a practice includes, among other things, the transport, possession, use, termination of use, removal from service, and storage of the sources (Article 3). Under the provisions of this regulation, the Agency grants licences for the possession and use of the sources; transport; export and import of the sources; technical services; procurement, distribution, and manufacturing of the sources (Article 15). Also under the provisions of this regulation, the Agency issues approvals for transport (Article 20), import/export (Article 21), and storage of the sources (Article 37).

- *Regulation on the requirements for transfer and use of ionizing radiation sources (Official Gazette of BiH 66/10)*. This regulation lays down the requirements for transfer and use of ionizing radiation sources (Article 1), terminating the use of the sources and nuclear material (Article 17), and the removal of solid and liquid waste from the work environment at the nuclear medicine departments (Article 59).

- *Regulation on inspection monitoring in the field of radiation and nuclear safety (Official Gazette of BiH 65/10)*. This regulation governs the way and procedure of inspection monitoring by the Agency (Article 1).

- *Regulation on ionizing radiation protection in medical exposure (Official Gazette of BiH, 13/11)*. This regulation lays down the main principles of individual protection from exposure to ionizing radiation in medical exposure, the responsibilities and obligations of the authorization holders, and also the rules, measures and organization of radiation protection in diagnostic radiology, nuclear medicine and radiotherapy (Article 1).

- *Regulation on radiation protection in occupational exposure and public exposure (Official Gazette of BiH, 102/11)*. This regulation defines the principles of radiation protection of exposed workers and the public in routine situations and radiological emergencies, and the dose limits for exposed workers. It applies to all activities associated with the risk of ionizing radiation, including the manufacturing, processing, handling, use, possession, storage, and transport of radiation sources.

- *Regulation on the authorization of legal persons performing medical examinations and the way of medical examinations of occupationally exposed workers (Official Gazette of BiH, 25/12)*. This regulation lays down the requirements that all health-care institutions have to meet to perform medical examinations of exposed workers, apprentices, pupils and students; the criteria for

establishing health status and work ability of exposed workers; the procedure and deadlines for all types of medical examinations; the way of assessing work ability of exposed workers; record keeping and retention.

- *Regulation on the categorization of radiation threats (Official Gazette of BiH 102/11)* lays down the categorization of radiation threats in accordance with international standards.

- *Regulation on the control of high-activity sealed radiation sources and orphan sources (Official Gazette of BiH 62/12)* lays down the requirements for legal persons that posses high-activity sealed sources, the activity levels defining the high-activity source, the obligations of high-activity source suppliers, the handling of orphan sources in case of their detection, the obligations of authorization holders relating to orphan sources, the obligations of legal persons collecting scrap metal relating to the detection of orphan sources, the costs incurred during the detection of orphan sources, etc.

- *Regulation on the way of record keeping for legal persons carrying out practices involving ionizing radiation sources (Official Gazette of BiH 67/12)* provides for the record keeping obligation, the types of records, and the way of their keeping.

- *Regulation on the safety of transport of radioactive material (Official Gazette of BiH 96/12)* regulates safe transport of radioactive materials that are imported, exported or transported in the territory of Bosnia and Herzegovina; the measures taken for their safe transport; activity limits for radioactive material and packages in transport; the way of classification, packaging, and labeling radioactive material and packages for transport; determining the transport index and the package category for transport; the obligations of subjects involved in transport; the way of controlling transport, contamination, and leaking packages; the obligations during transport and storage in transit, and other important matters relating to the transport of radioactive material.

- *Decisions on the requirements for legal persons to perform the practice of technical services (Official Gazette of BiH, 13/11)*. This decision lays down the minimum requirements that must be met by legal persons in order to carry out the practice of technical services for radiation protection, including: individual monitoring of occupationally exposed workers, radiation monitoring of the workplace and the environment, radiation safety assessment, design of radiation protection measures, etc. (Article 1).

Within its legally defined competencies, the Agency will issue a regulation on safe radioactive waste management, while the "Regulation on the way of collection, recording, processing, storage, permanent

disposal and discharge of radioactive waste material into the environment" is currently in force in accordance with the previously mentioned decision of the Council of Ministers of BiH[5].

4.1.4 Treaties in the field of radiation and nuclear safety applicable in BiH

4.1.4.1 Multilateral agreements

BiH has joined the following treaties and conventions:

- Statute of the International Atomic Energy Agency (Official Gazette of BiH – Treaties, 4/13),
- Treaty on the Non-Proliferation of Nuclear Weapons (Official Gazette of SFRY 10/70),
- Convention on Nuclear Safety (Official Gazette of BiH – Treaties, 3/10),
- Convention *on* Early Notification of a Nuclear Accident (Official Gazette of SFRY – Treaties, 15/89),
- Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (Official Gazette of SFRY – Treaties, 4/91),
- Convention on the Physical Protection of Nuclear Material (Official Gazette of SFRY – Treaties, 9/85),
- Amendments to the Convention on the Physical Protection of Nuclear Material (Official Gazette of BiH – Treaties, 3/10),
- International Convention for the Suppression of Terrorist Bombings (Official Gazette of BiH – Treaties, 7/03),
- International Convention for the Suppression of Acts of Nuclear Terrorism (UNTS – Vol. 2445, p. 89),
- Vienna Convention on Civil Liability for Nuclear Damage (Official Gazette of SFRY – Treaties, 5/77),
- Protocol to Amend the Vienna Convention on Civil Liability for Nuclear Damage (Official Gazette of BiH – Treaties, 16/12)
- Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (Official Gazette of BiH – Treaties, 2/12).

[5] Regulation on the way of collection, recording, processing, storage, permanent disposal and discharge of radioactive waste material into the environment (Official Gazette of SFRY, 40/86)

- Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matter (Aarhus Convention) (Official Gazette of BiH – Treaties, 8/08).

4.1.4.2 Bilateral agreements

- Agreement with the International Atomic Energy Agency (IAEA) on the Application of Safeguards in connection with the Treaty on the Non-Proliferation of Nuclear Weapons (Official Gazette of BiH – Treaties, 3/13)

- Revised Supplementary Agreement on the Provision of Technical Assistance by the International Atomic Energy Agency to Bosnia and Herzegovina (Official Gazette of BiH – Treaties, 2/10)

4.1.4.3 Memorandums of understanding

- Memorandum of Understanding between the State Regulatory Agency for Radiation and Nuclear Safety and the Environmental Protection Agency of Montenegro.

- Memorandum of Understanding between the State Regulatory Agency for Radiation and Nuclear Safety and the Slovenian Nuclear Safety Administration.

- Memorandum of Understanding between the State Regulatory Agency for Radiation and Nuclear Safety and the Radiation Safety Directorate of the Republic of Macedonia.

4.1.5 Other relevant instruments

Bosnia and Herzegovina has politically endorsed the "Code of Conduct on the Safety and Security of Radiation Sources", and supplementary "Guidance on the Import and Export of Radiation sources".

4.2 Institutional structure

The institutional structure, shown in figure 1, includes the Agency, technical services, and users.

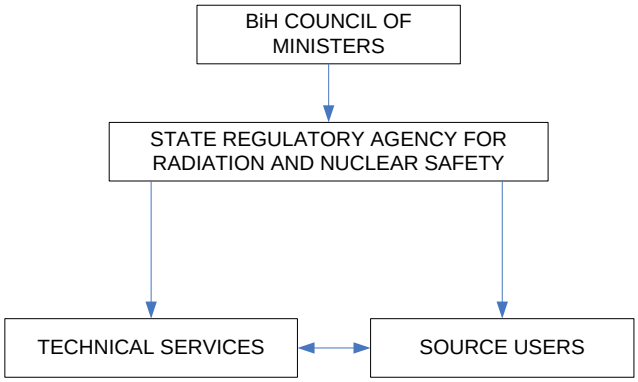

Fig. 1. Institutional structure of radiation and nuclear safety in BiH

4.2.1 State Regulatory Agency for Radiation and Nuclear Safety (Agency)

The Law established the Agency as an independent regulatory body that reports directly to the Council of Ministers of BiH. The Agency submits annual report on the situation of radiation and nuclear safety to the Parliamentary Assembly of BiH. Under the Law, the Agency acts as the regulatory body in BiH with the aim of establishing and maintaining a regulatory program for radiation sources, compatible with the relevant international standards. The Agency is the regulatory body that prepares and issues regulations and other legal documents as a framework for Agency's regulatory actions, defines appropriate criteria for the implementation of authorization, inspection etc. procedures. So, the Agency's role is both regulation and control. The Agency is authorized to:

- define policies in the fields of radiation and nuclear safety, safety principles, and the relevant criteria as a ground for its regulatory actions;
- prepare and issue regulations and instructions as a basis for its regulatory actions;
- define radiation exposures that will be excluded from regulation because they are not subject to regulatory control;
- establish and implement notification, authorization, and inspection procedures, and enforcement of regulatory requirements;
- require each operator to conduct safety assessment;
- enter the premises or facility at any time in order to perform the state inspection of the radiation source safety;
- issue, amend, suspend, or revoke, and impose authorization requirements for the import, export, production, purchase, reception, possession, storage, use, transit, transport, maintenance, recycling, and final disposal, and also for any other activity involving radiation sources;
- issue, amend, suspend or revoke approvals granted to technical services for radiation protection;
- define exclusions and exemptions regarding the possession and use of radiation sources, supporting it with a relevant document;
- take appropriate steps in case of a radiological emergency and a nuclear incident;
- establish and maintain the state register of ionizing radiation sources and exposed workers, and issued approvals;

- cooperate with other government authorities and other institutions in the matters relating to the scope of the Agency;
- define appropriate methods for the dissemination of public information about the ionizing radiation matters;
- define the proposed amount of administrative taxes for the issuance of authorizations and approvals; ensures that the taxes be collected;
- cooperate with other countries, the International Atomic Energy Agency (IAEA) and other relevant international organizations;
- be the governmental partner with the IAEA;
- represent Bosnia and Herzegovina internationally in the matters of radiation and nuclear safety;
- in cooperation with the relevant government agencies, take necessary security measures for radioactive and nuclear material and requests other competent authorities to perform monitoring in the country and at necessary checkpoints with the aim of detecting sources out of regulatory control;
- be prepared to assist in emergencies and respond in accordance with the national emergency action plan;
- define official arrangements with other relevant agencies involved in the regulatory process;
- provide opinions and recommendations regarding the accession to international conventions, and as well recommendations for adopting other international instruments in the field of radiation and nuclear safety;
- meet the obligations assumed by Bosnia and Herzegovina under international conventions and bilateral agreements, which refer to the radiation and nuclear safety and the application of safeguards for the purpose of non-proliferation of nuclear weapons.

4.2.2 Technical services

The Agency issued the decision on the practice of technical services, which defines the requirements for legal person to carry out this practice. This decision has not defined licensing of the technical services that intend to deal with radioactive waste management. A separate regulation will govern it, specifying the way of licensing technical services for radioactive waste management and minimum requirements that must be met by legal persons in order to meet certain standards and criteria for the waste management activities. Under the Law (Article 17), the Agency has explicit authorization for the issuance of regulations on safe management of radioactive waste.

Currently only the Public Health Institute of the Federation of BiH (hereinafter: institute) has personnel and technical capacities to perform the tasks of radioactive waste management in the BiH territory. These tasks include the collection of spent/disused sealed sources, mostly radioactive lightning rods, and to a less extent spent/disused sealed sources from industrial organizations and health-care institution, and also orphan sources.

4.2.2.1 Public Health Institute of the FBiH (Institute)

The institute was established under the Law on Health Protection[6] (1997). It carries out the radiation protection practice under the procedural decision of the Federation Ministry of Health[7], which authorizes the Institute to perform expert tasks in the field of radiation protection.

The institute was licensed by the Agency for the practice of technical service for radiation protection[8] in: individual monitoring of occupationally exposed workers, radiation monitoring of the workplace, radiation monitoring of the environment, quality control of radiation sources in diagnostic radiology, safety assessment of radiation sources, analysis of the concentration of radon and radon daughters, and consultations in the field of radiation and nuclear safety.

The practice of the institute based on the 2010 Law on Health Protection[9] includes, among other things:

- Monitoring and assessing health of personnel working with radiation sources, monitoring and assessing radiological safety of water, food, and building materials, and radiation monitoring of biosphere;
- Radiological, biological, and chemical protection in case of an accident;
- Control, dismantling, and storage of sealed sources.

A part of the institute's internal structure is the Center for Radiation Protection consisting of the Division for Public Exposure Control and the Division for Occupational Exposure Control that conduct:

- individual monitoring of exposed workers;
- control of the workplace;
- control of medical exposure;
- radiation monitoring of the environment (air, soil, water, food, items of general use, etc.);

[6] Law on Health Protection (Official Gazette of FBiH 29/97)

[7] Procedural decision of the Federation Ministry of Health no. 01-37-7245/01 of 29.11.2001

[8] Licence of the Public Health Institute of FBiH for the practice of technical service for radiation protection (no. 4-271-101/11 of 09.09.2011)

[9] Law on Health Protection (Official Gazette of FBiH 46/10)

- monitoring radioactivity in the air for early detection of radioactive contamination;
- dismantling, transport, and storage of spent/disused sealed radiation sources.

The Institute is currently the only institution in BiH that handles dismantling and management of spent/disused sealed sources in BiH.

4.2.2.2 Public health-care institution – Public Health Institute of the RS (institute)

The institute is a highly specialized health-care institution whose scope of work and practices are laid down in the Law on Health Protection[10] and the Law on Scientific Research Practice[11]. The institute carries out its activities through six branches in Banja Luka, Doboj, Trebinje, Istocno Sarajevo, Foca, and Zvornik.

The law has not authorized the institute for the practice of radioactive waste management. Until 2009 this practice had been performed in the RS by the former laboratory MDU Čajavec (Measuring and Detection Instruments) under a procedural decision issued by the RS Ministry of Health and Social Protection. No institution in the RS has been carrying out this practice since 2009.

The institute was established under the RS Government decision, and it is under the direct authority of the RS Ministry Health and Social Protection.

The institute has been licensed by the Agency for the practice of technical service for radiation protection in: individual monitoring of occupationally exposed workers, radiation monitoring of the workplace, radiation monitoring of the environment, quality control of radiation sources in diagnostic radiology, control of radionuclide activity in biological samples, radiation safety assessment and design of radiation protection measures, safety control of radiation sources, and consultations in the field of radiation and nuclear safety.

Within the institute, the Radiation Protection Center performs the following tasks:

- Estimation of radionuclides in soil, air, water, food items, items of general use, and building materials;
- Monitoring of radioactivity in the air for early detection of radioactive contamination;
- Radiation control and dosimetry;
- Development of elaborate studies on the assessment of ionizing radiation levels.

[10] Law on Health Protection (Official Gazette of RS 106/09)

[11] Law on Scientific Research Practice (Official Gazette of RS 112/07, 13/10)

4.2.2.3 Carriers of radioactive material

Radioactive material in transport is classified as Class 7 Dangerous Goods. Under the Law, the Agency licenses legal persons for the transport of radioactive material and issues approvals for the transport of radioactive material.

In practice, radioactive materials have been transported to BiH thus far:

- by air (airplanes), followed by road transport to the users;
- by road, directly to the users.

Spent radiation sources were transported by road to the temporary storage facilities of radioactive material.

Registered road transport carriers of radioactive material must be licensed under the regulation on notification and authorization of practices, have an ADR certificate for the conveyance used to transport the material, and also an ADR certificate issued by the competent authorities for the crew transporting the material.

The Agency has issued nine licences for the transport of radioactive material.

4.3 Users of radiation sources in BiH

The users of radiation sources in BiH are health-care institutions, industry, technical services, and scientific research institutions.

Generally, ionizing radiation sources are divided into radioactive sources and radiation generators. Radioactive sources contain radionuclides emitting ionizing radiation. They are divided into sealed and unsealed sources. Radiation generators do not contain radioactive material but instead generate radiation through a physical process, e.g. electron fluence collides with the anode and generates X-rays.

There are four clinical centers in BiH that use unsealed and sealed radiation sources, and two more health-care institutions that use unsealed sources at their nuclear medicine departments.

Industrial companies using radiation sources can be divided into two groups: those that use the sources in industrial radiography and those that use fixed and portable industrial gauges. There are 20 industrial radiography companies in BiH, 11 of which are in the RS and 9 in the FBiH. Industrial fixed and portable gauges are used in 18 companies, 9 of which in the RS and 9 in the FBiH.

Table 1 shows a summary overview of the source users by practice and type of application of the sources.

Table 1. Summary overview of institutions/organizations using ionizing radiation sources

Institutions/organizations source users	Type of application	Source / Radionuclide in use	Source category[a] / radiotoxicity[b]
Health-care institutions			
Clinical centers and hospitals	Teletherapy	Co-60	1
	Brachytherapy	Ir-192 Cs-137	2-4
	Radiotherapy, nuclear medicine	I-131	Class B. High
	Diagnostic radiology Nuclear medicine	I-131,I-125, I-123, P-32, Sm-153, Tl-201, Ga-67, Tc-99m	Class C. Medium Class D. Low
Industry			
Public and private companies	Industrial radiography	Ir-192, Se-75	2
	Fixed and portable industrial gauges	Co-60, Cs-137, Am-241, Kr-85, Sr-90, Am-241/Be, Pu-239/Be, Cf-252	3-5
Technical services/scientific research institutions			
Institutes and universities	Standards for calibration of instruments	Solid standards and radionuclide solutions	N/A
Other			
Industrial facilities, residential buildings	Lightning protection	Eu-152/154, Co-60	4[c]
Industrial facilities, buildings	Smoke detectors	Am-241	5

[a]- Categorization of sealed sources under the Regulation on notification and authorization
[b]- Radiotoxicity of unsealed sources under the Regulation on the requirements for transfer and use of sources
[c]- Categorization by initial activity (A≈14.8 GBq for Eu-152/154 and A≈7.4 GBq for Co-60)

4.4 List of radiation sources in use in BiH

The overview of radiation sources is based on the data from the State Register of Sources, established by the Agency. Summary overviews of the radiation sources in use are shown in tables 1, 2, 3 and 4.

4.4.1 Sealed radiation sources

Table 2. Overview of sealed radiation sources used in BiH by category and type of application

Category	Application	Radionuclide(s)	Amount
1	Teletherapy	Co-60	2
	Total		**2**
2	Industrial radiography	Ir-192, Se-75	12
	Total		**12**
3	Brachytherapy (HDR)	Ir-192	3
	Total		**3**

4	Fixed and portable industrial gauges	Am-241, Co-60, Cs-137, Am-241/Be, Pu-239/Be	35
	Brachytherapy (LDR)	Cs-137	1
	Total		**36**
5	Fixed and portable industrial gauges	Kr-85, Sr-90, Tl-204, Co-60, Cs-137, Am-241, Cs-135	12
	Smoke detectors	Am-241	≈30,000
	Other	Fe-55, Cd-109, Ni-63, Cs-135, Pm-147	5
	Total		**17**

In addition to the above, there is a certain number of lightning rods installed before 1990 that contain radioactive material. Such rods belong to the class of lightning rods with early streamer emissions, with radioactive material placed on the top of the installation, serving to ionize the surrounding air, thus creating streamers upward because of higher air conductivity. Although their effectiveness has never been confirmed by the scientific community, lightning rods with radioactive material were manufactured and distributed in many countries. Radioactive lightning rods in BiH came from the Nuclear Science Institute "Vinca", Belgrade, and later they were distributed and installed by several companies. The radionuclides used in lightning rod installations are most often Eu-152/154, with initial activity of approximately 14.8 GBq, and much less Co-60, with initial activity of 7.4 GBq. The construction of radioactive lightning rods has four designs, three of which contain Eu-152/154 in the form of capsule, while Co-60 is in the form of ring. Radioactive material was placed on the top of the standardized 6 m high metal mast or on the top of poles 17, 20.5 and 25 m high. The installation includes 16 kg of lead suitably placed around the radioactive material with the aim of ionizing radiation protection below the lightning rod. The installation of new radioactive lightning rods in the BiH territory is prohibited under the provisions of the Regulation on notification and authorization.

Table 3. Overview of radioactive lightning rods in BiH

Radionuclide	In use
Eu-152/154	296
Co-60	53
Total	**349**

The existing lightning rods on the buildings neither have their original function anymore because several half-lives of incorporated radionuclides have expired nor they provide an effective protection from atmospheric discharge. These lightning rods with incorporated radionuclides may pose a safety and security problem in case of loss of control over them.

A certain number of lightning rods were lost, mostly because of war operations and building devastations.

4.4.2 Unsealed radiation sources

Unsealed radiation sources are in use in health-care institutions – nuclear medicine departments, for therapeutic and diagnostic purposes. Technical services and scientific research institutions use standard solutions for the calibration of instruments for measuring activity.

Table 4. Overview of unsealed sources in use in BiH by the type of use and consumption

Application	Radionuclide	Typical amount in use (GBq/semi-annually)	Radiotoxicity[a]
Radiotherapy	I-131	5846	Class B. High
Diagnostic radiology	I-125[b]	0.1 MBq/set	Class B. High
	Tc-99m	7323	Class D. Low
	Tl-201	29.6	Class C. Medium
	Ga-67	7.9	Class C. Medium
	I-123	8.8	Class C. Medium
	Sm-153	45	Class C. Medium
	P-32	0.4	Class C. Medium
Calibration	U-232	1 Bq	N/A
Calibration	Am-241	1 Bq	N/A
Calibration of instruments	Sr-90	20 Bq	N/A

[a]- under the Regulation on the requirements for transfer and use of sources
[b]- *in vitro* diagnostics

Two clinical centers in BiH plan to introduce PET/CT diagnostics, which will result in the import of a certain daily amount of very short-lived radionuclides and require more attention from the perspective of radiation protection.

4.5 Overview of storage facilities for radioactive waste

4.5.1 Characterization of waste

Under the Law, radioactive waste means the material remaining in any physical from as a by-product of practices or interventions and no longer intended for use and: (i) contains or is contaminated with radioactive substances at activities or activity concentrations greater than the clearance levels under regulatory requirements, and (ii) an exposure that is not excluded from regulatory control.

The Agency databases have complete data on temporary storage facilities for radioactive waste in the BiH territory. Radioactive waste in these facilities is characterized, i.e., the amount and type of the stored waste are known. Radioactive waste in BiH mostly consists of sealed radiation sources which do not meet technical or other preconditions for further use. Besides, nuclear medicine departments generate radioactive waste containing short-lived radionuclides used in radiotherapy and diagnostic radiology.

A summary overview of the stored sealed sources is shown in tables 5 and 6.

Table 5. Overview of the stored sealed sources in BiH by category and type of application.

IAEA category	Application	Users' temporary storages	Temporary central storage facilities
1	**Total**	**0**	**0**
2	Calibration		
	Total	**0**	**4**
3	Calibration		4
	Fixed and portable industrial gauges	1	
	Total	**1**	**4**
4	Fixed and portable industrial gauges	**117**	40
	Brachytherapy (LDR)		6
	Calibration		7
	Total	**117**	**53**
5	Fixed and portable industrial gauges	19	8
	Calibration		10
	Other - Calibration		1,028
	Other – Smoke detectors		2,847
	Total	**19**	**3,893**

Table 6. Overview of the stored radiation sources from lightning rods in BiH

Radionuclide	Dismantled and stored
Eu-152/154	133
Co-60	15
Total	**148**

Within its competencies laid down in the Law, the Agency will issue a regulation on safe radioactive waste management. The basis of the waste management is the waste characterization, which is achieved by the waste classification, i.e., categorization. Generally, both methods aim to define important properties of radioactive waste for the purpose of as possible safe and effective waste treatment. The categorization, which is more comprehensive, includes activity and half-life of

radionuclides contained in the waste, and also the point of origin, physical state, type of radioactive waste, and the conditioning state (International Atomic Energy Agency, 2007). The classification of radioactive waste is based on activity and half-life of radionuclides contained in the waste (figure 2) (International Atomic Energy Agency, 2009). Radioactive waste is classified by activity into exempt waste, very low level waste, low level waste, intermediate level waste, and high level waste. Exempt waste contains activities below the exemption level, as defined in the "Regulation on the requirements for transfer and use of Ionizing radiation sources," and is considered non-radioactive waste. Radioactive waste is classified by half-life into waste containing very short-lived radionuclides (with half-life less than 100 days), short-lived radionuclides (with half-life up to 30 years) and long-lived radionuclides (with half-life greater than 30 years).

Classification of the radioactive waste generated at the nuclear medicine departments is based on the "Regulation on the way of collection, recording, processing, storage, permanent disposal and discharge of radioactive waste material into the environment."[12] According to this regulation, solid waste consists of waste material containing beta/gamma (and slightly alpha) emitters and plastic, pad, cloths, metal, glass, etc., used in medicine, while liquid waste means liquid waste material containing radionuclides in amounts higher than derived concentrations for drinking water for the groups of individual members of the public, as defined in the "Regulation on maximum permissible limits of radioactive contaminations of the environment and the performance of decontamination."[13]

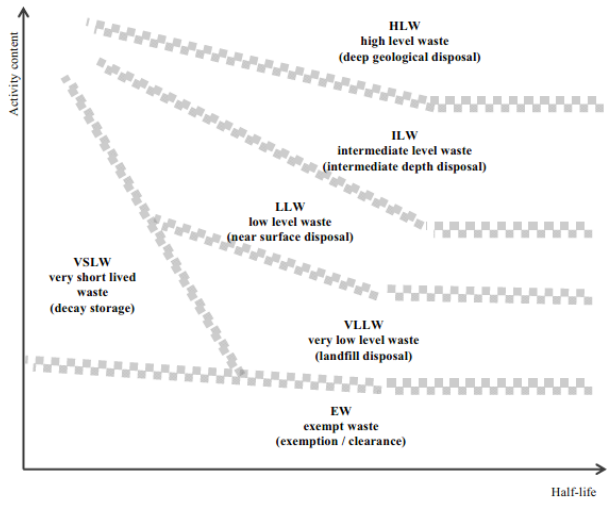

Fig. 2. IAEA classification scheme for radioactive waste (2009)

[12] Regulation on the way of collection, recording, processing, storage, permanent disposal and discharge of radioactive waste material into the environment (Official Gazette of SFRY 40/86)

[13] Regulation on maximum permissible limits of radioactive contamination of the environment and the performance of decontamination (Official Gazette of SFRY 8/87)

4.5.2 Temporary central storage facilities for spent radiation sources/radioactive waste

There are temporary storage facilities for radioactive material in BiH. In addition to centralized temporary storage facility in both BiH entities, there is a certain number of temporary storage facilities in the companies that use or used radiation sources for their regular business activities. Temporary storage facility serve for the storage of disused or orphan radiation sources in order to improve safety and security and reduce the risk of unauthorized use, including malicious use of radioactive material.

Nuclear medicine departments have premises for temporary storage of radioactive waste until the activity level falls below the clearance level, when the waste is considered non-radioactive waste.

4.5.2.1 Temporary storage facility (TS-1)

The Federation Public Health Institute handles radioactive waste management in TS-1.

TS-1 was purposely selected within the IAEA Technical Co-operation Project BOH/4/002AEA, "Managements of sealed radiation sources in the areas affected by the war," for the storage of spent sources, before all dismantled radioactive lightning rods.

The original purpose of the storage facility was storage of up to 500 radiation sources with an activity up to 14,8 GBq for a relatively long period (50 years) or until the competent authorities have made the decision on the way of radioactive waste management (Tzyplenkov, 2004). Growing needs and the detection of high-activity disused sources gave the reason for the reception and storage of sources from industrial and military use.

The storage capacity allows up to 10 barrels of 200 L with conditioned waste or sources in original protective containers of similar dimensions. The facility je enclosed, the access is limited, and there is 24-hour police surveillance, thus preventing access by unauthorized persons.

The report of the IAEA expert mission which was in BiH from 5 to 9 November 2012 contains the mission's opinion to BiH that the existing TS-1 facility is not suitable for long-term use.

4.5.2.2 Temporary storage facility 2 (TS-2)

TS-2 is in the premises of the former calibration laboratory for radiation monitors and dosimeters. There are ongoing activities within IPA program for BiH for reopening of the calibration laboratory for ionizing radiation, which is on of the reasons for relocation of radioactive material from this storage facility. The sources are in their original protective containers except for radioactive lightning rods that are grouped and stored in a container. State inspectors for radiation and nuclear safety determined on the spot that this storage facility no longer meets safety and security requirements, so further storage of sources in this facility is forbidden, and the transfer of the stored material to the new central storage facility is urgent.

4.5.3 Temporary storage facilities for spent radiation sources/radioactive waste with users

BiH also has temporary storage facilities in the companies that use or used radiation sources. As a rule, these are unused isolated premises in which spent radiation sources are stored in original containers until their transport to the central storage facility. These storage facilities are locked to prevent unauthorized access, and most of them have physical security within the company, i.e. plant as a whole. Still, physical security of the facilities is not satisfactory because the stored sources pose a high-level risk. Also, as a rule, temporary storage facilities are not equipped with a radiation monitoring system. All sources in these storage facilities pose a potential risk to the public and the environment because they are not used for their original purpose, which is why it is necessary to transfer them to the new central storage facility.

4.5.4 Storage facility for radioactive waste at the nuclear medicine departments

Temporary storage facilities exist within nuclear medicine departments in six health-care institutions. Regulation on the requirements for transfer and use of sources stipulates requirements for the use of unsealed radiation sources at the nuclear medicine departments. The provisions of this regulation provide for removal of radioactive waste from the workspace.

Nuclear medicine departments handle and store solid and liquid radioactive wastes with very short-live radionuclides, as follows: phosphorus (P-32), gallium (Ga-67), technetium (Tc-99m), iodine (I-123, I-125, I-131), thallium (Tl-201), and samarium (Sm-153). Solid waste consists of used needles, gloves, bottles, prep pads, etc., and also used generators (Mo-99/Tc-99m), while liquid waste consists of excrements of the patients treated by radiopharmaceuticals. Temporary storage facilities of health-care institutions with nuclear medicine departments store a new amount of solid waste on a daily basis. The date of receipt is taken into account and periodically, based on an assessment, when the activity level falls below the exemption level under the Regulation on the requirements for transfer and use of sources, the stored waste is removed from the storage facilities and disposed of along with other municipal waste. Liquid waste is discharged into the sewage after an assessment that the remaining activity is below the exemption level.

4.6 Conclusion

It is necessary to carry out immediate activities towards determining the location of the new central storage facility for radioactive waste originated in the territory of BiH because the current situation in radioactive waste management in BiH is unsatisfactory.

Once the location is determined, it is necessary to secure funds in the budget of BiH institutions for the construction of the new or reconstruction of a possibly existing facility on the location, suitable for the storage of radioactive waste.

The new location and the waste storage facility must comply with the international standards relating to this field.

B. STRATEGIC MEASURES FOR RADIOACTIVE WASTE MANAGEMENT IN BiH

1. Strategy of radioactive waste management

1.1 Purpose

The strategy defines a general approach to achieving safe radioactive waste management, and the role and responsibilities of the competent institutions and organizations dealing with radioactive waste management in BiH.

The strategy is in line with the "Policy on the safety of ionizing radiation sources in BiH" and general principles of safe radioactive waste management in accordance with the IAEA standards.

The strategy will be reviewed every five years.

1.2 Radioactive waste management

There are practices in BiH that generate radioactive waste, which results in the need for its safe management in order to protect the public and the environment from the risk of exposure to ionizing radiation.

In accordance with the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, each contracting party must take legislative, regulatory, and administrative measures to ensure the availability of qualified personnel, adequate funds, and infrastructure relating to radioactive waste management in order to meet the obligations under the convention.

So, BiH must have all necessary infrastructure for the safe management of radioactive waste generated in the BiH territory.

A centralized approach to radioactive waste management will be implemented in BiH, which means the storage of radioactive waste in a single facility for the entire BiH territory.

The Agency will establish committees tasked with the following activities:

- Drafting a regulation on radioactive waste management;
- Making a proposal of potential locations for the central storage facility for radioactive waste, taking into account the applicable regulations and consultations with the competent authorities in BiH;
- Proposing the type and design of the central storage facility for radioactive waste in BiH, including the security of the facility.

The central storage facility will have to comply with the safety and security standards under the radioactive waste management regulations issued by the Agency, and the relevant international standards on the protection of workers, the public, and the environment during the lifetime of the storage facility also after decommissioning.

The owner of the central storage facility will be the State of Bosnia and Herzegovina, and upon a proposal of the Agency, the Council of Ministers of BiH will issue a separate decision on handing over the facility to the authorized technical service to use it for radioactive waste management. The service will be the operator of the central storage facility and perform waste management activities.

This practice is of a considerable interest to the society, and it is possible that no legal persons show interest in radioactive waste management in the central storage facility, which may happen because they do not have adequate human resources, technological capacities and see no economic profitability. In that case, the Agency will establish within its organizational structure a new division for radioactive waste management originated in BiH, which will be effectively independent in its work in relation to the existing Division for Authorization and Notification, which operates within the Agency.

1.3 Regulatory control

Under the Law, the Agency conducts regulatory control of radiation and nuclear safety, including safe radioactive waste management. Accordingly, the Agency will issue regulations in order to establish a regulatory framework for the safe management of radioactive waste, including the requirements and ways of waste management. The regulations will contain the principle of prime responsibility; requirements for the clearance from regulatory control; minimal generation of radioactive waste; waste classification and categorization criteria; criteria for controlling the discharge of waste material into the environment; the ways of managing spent and disused sealed sources, radioactive waste originated at nuclear medicine departments, historic waste inherited from the past period, NORM waste, orphan sources, and radioactive waste originated in emergencies; permanent disposal, import and export of radioactive waste, and public access to information.

The regulations will establish the authorization of practice of radioactive waste management. Any legal person that performs the practice of technical service for radioactive waste management must be authorized by the Agency and subject to inspection monitoring.

It is the Agency's responsibility to supervise the implementation of regulations on safe radioactive waste management.

1.4 Prime responsibility

Prime responsibility for safe radioactive waste management generated from the use of radiation sources rests with the holder of authorization for the practice involving ionizing radiation sources until the technical service authorized for radioactive waste management takes over the waste.

1.5 Clearance from regulatory control

Clearance from regulatory control will apply to the previously authorized sources and materials for which later measurements and assessments show that the radioactivity is below authorized clearance levels.

1.6 Minimization of radioactive waste

In order to reduce the generated waste, the legal persons authorized for practices involving radiation sources that generate or manage radioactive waste will adopt measures for minimal generation of radioactive waste. These measures include:

- strict compliance with the regulations on radioactive waste management and standard operating procedures based on the regulations;
- the use of minimal amounts of radioactive material;
- the use of short-lived radionuclides as much as technically possible;
- prevention of radioactive contamination of work areas and the environment.

All of the above will be assessed by the Agency during the authorization procedure.

1.7 Classification of radioactive waste

In accordance with the IAEA recommendations, radioactive waste will be classified and categorized based on radionuclide content, activity, and half-life into exempt waste (containing radionuclides whose activity is below exemption levels), low and intermediate level radioactive waste containing very short-lived radionuclides (half-life less than 100 days), low and intermediate level radioactive waste, and high level radioactive waste. A separate and at the same time the most numerous subclass of anticipated radioactive waste consists of disused sealed sources. Once no longer in use, sealed sources will be classified by activity as low-, medium- and high-level waste containing very short, short and long lived radionuclides respectively. In addition to the classification based on activity and half-life of radionuclides in the waste, the waste generated from the use of unsealed sources, from radiological emergencies or interventions will be additionally categorized by physical form as solid (combustible/non-combustible, compactable/non-compactable) and liquid (aqueous and organic). Also, it will be assessed whether the waste contains substances of other classes of dangerous goods (so called mixed waste).

1.8 Controlling the discharge of waste material into the environment

Legal persons authorized for the practices involving ionizing radiation sources must control the discharge of radioactive material, originated as a result of their activities, into the environment. Controlling the discharge of radioactive material into the environment must be done taking into account the limits defined in the regulations.

1.9 Central storage facility for radioactive waste

The Agency will authorize a technical service for radioactive waste management that will act as the operator of the central storage facility.

The authorized technical service-operator of the central storage facility will be responsible for radioactive waste management in BiH, including waste collection, transport, handling, dismantling, processing, conditioning, and storage until the final disposal. These activities and procedures for all stages of the facility management will be documented.

The authorized technical service-operator of the central storage facility has the prime responsibility for the security of the facility, radioactive material and sources in it, and for the establishment and implementation of adequate security measures.

The security of the central storage facility will be provided in coordination with the operator, the Agency, and the BiH Ministry of Security.

The collection, transport and handling of radioactive waste may be done by other legal persons based on the Agency's authorizations for these practices.

The operator will submit the annual work plan on the storage facility management to the Agency for adoption, and send the annual report on the facility management to the Agency.

The central storage facility will serve for the reception of radioactive waste containing radionuclides with half-life greater than 100 days, generated from authorized practices in public and private organizations, which, among other things, means:

- storage of sealed sources of all categories in original protective containers;
- conditioning of spent sealed sources Categories 4 and 5 so as to enable the return of sources for their further treatment for permanent disposal;
- storage of conditioned sealed sources and other radioactive waste;
- conditioning and storage of radioactive waste originated as a consequence of a radiological emergency, i.e., interventions and remediation;
- conditioning and storage of orphan sources.

1.10 Management of spent sealed radiation sources

While acquiring a new source, the authorization holder will stipulate in the contract that the sources will be returned to the supplier after they have become disused. This will be assessed during the authorization process.

The sealed radiation sources that were purchased earlier and are not subject to the rule above will be stored in the central facility after the expiry of their shelf life.

The authorized technical service (operator) for radioactive waste management will take over and store spent/disused sealed sources.

1.11 Management of radioactive waste generated at the nuclear medicine departments

Radioactive waste generated at the nuclear medicine departments will be temporary stored until the activity falls below the authorized clearance levels, after which it will be considered non-radioactive waste. To this end, health-care institutions with nuclear medicine departments will establish temporary storage facilities for solid radioactive waste, and if necessary, reservoirs for temporary storage of liquid radioactive waste.

The characterization of solid radioactive waste will include as a minimum: radionuclide concentrations and activities, pathogenic properties, toxicity (heavy metals, cyanides, etc.), flammability, compressibility, the presence of absorbed liquid waste, a physical description (glass, needles).

The characterization of liquid radioactive waste will include as a minimum: radionuclide concentrations and activities, an indication whether these are aqueous or organic solutions, information about the homogeneity of the liquid and other toxic properties (biological waste, chemically corroding liquids, etc.).

1.12 Orphan sources and radioactive waste resulting from emergencies

The operator for the radioactive waste management will take over and store the sources that are identified as orphan sources. It will also take over and store contaminated material detected in scrap metal and all radioactive material originated in other radiological emergencies.

1.13 Waste from past activities

Radioactive waste generated from past activities includes, among other things:

- sealed sources installed in radioactive lightning rods;
- sealed sources stored in temporary storage facilities, generated from military and civilian use;
- sealed sources installed within some technological processes in the companies that have closed the business;
- stored scrap metal containing thorium;
- depleted uranium;
- radioactive material from military use;
- radiation sources and material from other practices.

Radioactive lightning rods, installed before 1990, are the most numerous group of sealed radiation sources. In practice, radioactive lightning rods are not installed anymore, and in fact they haven't been

installed for a longer period. With the owner's consent, the remaining radioactive lightning rods have to be dismantled, transported to the central storage facility, conditioned, and stored. This will be done in cooperation with institutions and experts from the European Commission and the IAEA.

Radioactive waste currently stored in temporary storage facilities in BiH that comes from military and civilian use will be transported to the central storage facility. Most of the relevant activities refer to the stored sources that were transferred from military calibration laboratories (about 80%) or from the institutions and organizations which don't use the sources anymore but the sources have remained as a part of a no longer used technology or work process. Regardless of their current financial standing (operational, bankrupt, with unresolved property law issues, etc.), such institutions and organizations need to show interest for the removal of sources. Dismantling, transportation and preparation for the storage will be done in cooperation with institutions and experts from the European Commission and the IAEA.

Construction activities and other activities on the ground on which ammunition with depleted uranium was used could lead to the collection of depleted uranium penetrators. The authorized technical service for radioactive waste management will take over and store the depleted uranium.

1.14 Technologically enhanced naturally occurring radioactive material-TENORM

TENORM is a natural substance in which individual radionuclide concentrations are changed by the human activities, so that the activity level is greater than the exemption level laid down in applicable regulations. TENORM includes large amounts of low active radioactive material, and as such it will not be stored, but the contaminated ground will be remediated using technical and technological measures. Technical services authorized for radiation protection may be engaged for such tasks.

1.15 Permanent disposal

The Agency will seek a way to resolve the matter of permanent disposal of radioactive waste, e.g. through a treaty with a country that has appropriate capacities for the reception and treatment of radioactive waste or in another appropriate way.

1.16 Export and import of radioactive waste

Radioactive waste in BiH will not be imported in BiH for processing, storage or any other reason except in case of return of the radiation sources originated from BiH and for which the Agency issues relevant approvals under applicable regulations in BiH.

Radioactive waste will be exported, e.g. for permanent disposal, with previously obtained Agency's approval under the applicable regulations in BiH and international regulations for the transport of radioactive material and radioactive waste.

1.17 Public access to information

Radioactive waste management activities will be conducted transparently, with the right of the public to access the information to the extent that will not threaten safety and security, in which the Agency reserves the right to assess the extent of threat against safety and security. Information about the waste management methods, compliance with the safety standards, effects on the public and the environment is considered public information and will be available to the public upon request. Information about the security procedures will be available to the competent authorities and the Agency.

1.18 Funding of radioactive waste management

Funding of the authorized technical service that will operate the central storage facility and manage radioactive waste will be provided from the budget of BiH institutions on the basis of the annual work plan, and from other sources. The funding will cover the tasks and equipment listed in the annual work plan of the authorized technical service-operator, and the activities relating to the security of the storage facility, previously approved by the Agency.

Generators of radioactive waste from authorized practices will pay an appropriate administrative tax for storage into the budget of the BiH institutions. It is estimated that the costs for managing the central storage facility will amount to about KM 80,000.00 in 2015, upon licensing of waste storage facility and the operator. Most of the existing radioactive waste should be collected from the temporary storage facilities into the central facility in 2015, which would considerably reduce the operator's costs for the management and maintenance of the central storage facility in 2016. The Agency will submit amendments on the "Decision on the amounts of administrative taxes for the authorizations issued by the State Regulatory Agency for Radiation and Nuclear Safety" to the Council of Ministers of BiH, introducing special administrative taxes for taking over disused or spent radiation sources, paid by the owners of the sources that must be stored. The tax will be determined so as to cover annual management and maintenance costs of the central storage facility.

The funds for the construction of the central storage facility are estimated at KM 250,000.00 (in case of constructing a completely new facility) or much less (in case that an existing facility is allocated by the Council of Ministers of BiH for reconstruction) will be secured from the budget of the BiH institutions.

The amount of about KM 500,000.00, approved by the IAEA in the national project of technical cooperation "Strengthening of radioactive waste management in Bosnia and Herzegovina 2014 and 2015," will be used for equipping the central storage facility and training of the operator's and regulator's personnel. The European Commission IPA program will be used for the conditioning of collected disused radiation sources and their possible collection and transportation for the companies that cannot afford it.

The U.S. assistance program (Department of Defense, Global Threat Reduction Initiative – GTRI) will also help purchase and install security equipment for the central storage facility.

It is expected that the establishment of the central storage facility results in the inflow of money into the budget of the BiH institutions, collected from the storage approval taxes, which will depend on the number of radiation sources that need to be stored. These funds will cover the costs of (re)construction of the storage facility, operator's work activities, and maintenance costs.

The authorized technical service (operator) for the central storage facility will participate in the interventions relating to orphan sources at own cost, but the Agency will cover these costs through the budget of the BiH institutions or in another way.

After the lifetime of the central storage facility, the Agency will provide the funds through the budget of the BiH institutions and other sources in order to transfer and transport the stored radioactive waste to another storage facility in the BiH territory or abroad, for permanent disposal and decommissioning of the central storage facility.

2 Overview of the activities relating to the strategy of radioactive waste management

The strategy will be implemented by the Council of Ministers of BiH, the Agency, the authorized technical service (operator) for the central storage facility, and source users in accordance with their competencies and responsibilities.

Implementation of the Strategy of radioactive waste management in BiH			
Purpose/Goal	**Indicators**	**Way of verification**	
- To establish a system of radioactive waste management with clearly defined competencies and responsibilities	- Regulation on radioactive waste management - The central storage facility for radioactive waste is operational.	- Radioactive waste management regulation is published. - The technical service (operator) for radioactive waste management is authorized.	
Activity	**Activity result**	**Way of verification**	**Implementer**
Radioactive waste management			
- Developing a regulation on radioactive waste management	- The regulation on radioactive waste management is developed.	- The regulation on radioactive waste management is adopted.	- Agency, committee
- Developing a proposal for location, type, and design of the storage facility	- The proposal for location, type, and design of the storage facility is developed.	- Proposal for location, type, and design of storage facility adopted	- BiH CoM, Agency, committee
- Preparation of a tender for (re)construction of the storage facility, including obtaining of necessary approvals and permits and meeting other legal obligations	- Successfully completed selection of the contractors for the facility	- Contractors for the facility are selected. - Construction project is designed.	- BiH CoM, Agency, committee - Agency, contractor
- (Re)construction of the storage facility in accordance with the adopted construction project	- Completed construction works on the storage facility	- Technical handover of storage facilities is completed.	- Agency, contractor
- Equipping the storage		- Handover of equipment in the	

facility with both standard and specific radiation measuring instruments	- The storage facility is equipped for handling the radioactive waste	buildings is completed.	- Agency, technical services
- Authorization of technical services - Adoption of the decision on handover of the storage facility for use	- Authorized technical service (operator) - The Decision on handover of the storage facility for use	- Authorization for the technical service (operator) is issued - The decision is published in the Official Gazette of BiH.	- BiH CoM
Regulatory control			
- Developing a regulation on radioactive waste management - Developing a regulation on the authorization of technical services for radiation protection practice, including radioactive waste management - Authorization of the technical service-operator of the central storage facility - Developing a regulation on nuclear security	- Regulatory control of radioactive waste management is established.	- Regulations are published in the Official Gazette of BiH. - The technical service/operator of the central storage facility is authorized. - Carriers of radioactive material are licensed.	- Agency
Prime responsibility			
- Assessment of the prime responsibility during the authorization of practices based on applicable regulations	- The principle of prime responsibility of the authorization holder is applied during licensing.	- Licences for practices involving sources are issued.	- Agency
Clearance from regulatory control			
- Measurement and assessment of radioactivity of the material during the discharge into the environment	- Radiation assessment of the material discharged into the environment	- Report on radiation assessment and measurements during the discharge of material into the environment	- Agency, technical service
Minimization of radioactive waste			
- Assessment of	- Standards for	- Licence for carrying	- Agency, authorization

compliance with the principle of minimizing radioactive waste	minimization of radioactive waste generated by the authorization holder are met.	out practices involving radiation sources	holders
Characterization of radioactive waste			
- Defining the classes of radioactive waste in BiH	- Radioactive waste generated in BiH is classified.	- The classification is included in the regulation on radioactive waste management.	- Agency, technical service (operator)
Controlling the discharge of waste material into the environment			
- Measuring radioactivity of the substances discharged into the environment	- Radioactivity content in the substances discharged into the environment is verified against the licence requirements.	- Reports on measurements	- Agency, technical service authorization holder
Central storage facility for radioactive waste			
- Reception, treatment and storage of radioactive waste - Radiation monitoring - Safety assessment	- Radioactive waste is stored. - Radiation measurement - Risk from the storage facility to workers, the public and the environment is defined.	- Reports on the disposal of radioactive material - Radiation measurement reports - Safety assessment reports	- Technical service (operator)
Management of spent/disused sealed radiation sources			
- Return of spent/disused sealed sources to the manufacturer	- Reduction of radioactive waste amount	- Sales contract on sealed sources contains a clause on the return of sources after the expiry of their shelf life.	- Agency, authorization holder
- Storage of spent/disused sources	- Properly stored spent/disused sealed radiation sources	- Report on the storage of spent/disused sources	- Agency, authorization holder, technical service (operator), licensed carrier
Management of radioactive waste generated at the nuclear medicine departments			
- Handling of radioactive waste generated at the nuclear medicine departments in	- Radioactive waste generated at the nuclear medicine departments is	- Nuclear medicine licences for authorization holders	- Agency, authorization holders

accordance with the licensing requirements laid down in the regulation on authorization - Temporary holding of radioactive waste until the activity levels fall below the clearance levels for discharge into the environment	properly stored.		
Orphan sources and radioactive waste generated as a result of emergencies			
- Handling and storage of orphan sources	- Removal of orphan sources and remediation of public exposure	- Report on the storage of orphan sources	- Agency, technical services
Waste from past activities			
- Collection of the waste generated in the past and stored in temporary storage facilities - Collection and storage of radiation sources and other radioactive waste	- Waste is collected and transported to the central storage facility.	- Waste is stored in the central storage facility	- Agency, Licensed technical services (operator)
TENORM			
- Assessment of TENORM impact on workers and the public	- Risk to workers' and public health is identified. - The way of remediation is established.	- Report on remediation	- Agency, technical services
Permanent disposal			
- Finding a way to permanently dispose of radioactive waste from BiH	- Permanent disposal of radioactive waste is defined.	- Agreements with the countries with capacities for permanent disposal of radioactive waste	- Agency Precondition: an agreement on the way of permanent disposal of radioactive waste
Export of radioactive waste			
- Export of radioactive for permanent disposal	- Permanent disposal of radioactive waste	- Agreement on the transport of radioactive waste abroad to the destination for waste processing	- Agency

Information transparency			
- Presentation of the information about the compliance with the regulations and safety standards	- The public is informed about the safety aspects of the radioactive waste storage and impact on the public and the environment.	- Information, including safety assessments of the storage facility operation	- Agency, technical services
Funding of radioactive waste management			
- Funding the operations of the technical service (operator) for the central storage facility	- The costs of technical service (operator) are covered.	- Financial reports	- Agency

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