

Pursuant to Article 16(1) of the Law on Radiation and Nuclear Safety in BiH (Official Gazette of BiH, 88/07) and Article 61(2) of the Law on Administration (Official Gazette of BiH, 32/02 and 102/09), the director of the State Regulatory Agency for Radiation and Nuclear Safety issues the

**REGULATION  
ON THE MONITORING OF RADIOACTIVITY IN THE ENVIRONMENT**

**Article 1  
(Subject)**

This regulations governs the way and requirements for systematic examination of radioactivity in the environment in Bosnia and Herzegovina.

**Article 2  
(Definitions)**

(1) The terms, as used in this regulation, mean:

- a) *Radionuclide concentration in the environment* consists of individual specific activities ( $\text{Bq kg}^{-1}$ ,  $\text{Bq m}^{-3}$ ,  $\text{Bq l}^{-1}$ ,  $\text{Bq m}^{-2}$ ) of all key radionuclides in an area and at certain locations in the environment as a result of emissions.
- b) *Measurement method* is a general description of the logical sequence of operations that are performed during the measurement.
- c) *Specific methods* for determining radionuclide concentrations include activity measurements with properly calibrated alpha, beta and gamma counters, i.e., properly calibrated spectrometers, in the samples previously prepared by a radiochemical or another standard method.
- d) *Non-specific measurement methods* are the methods applied to determine the total alpha, beta or gamma activity of the tested sample.
- e) *Sample, composite sample* is a representative portion of air, water, soil or another material collected for testing from a measurement location in a defined time interval and as defined under this regulation. Samples can be single or composite. Single sample is a sample collected by a single operation from the material to be tested. Composite sample is a sample collected in a defined time interval or the collection of one or more single samples that were collected in a defined time interval.
- f) *Sampling* is the process of collecting samples.

(2) Other terms as used in this regulation have the meanings as defined in Article 3 of the "Regulation on radiation protection in occupational and public exposure" (Official Gazette of BiH, 102/11).

**Article 3  
(Way of monitoring)**

(1) Systematic examination of the environmental radioactivity (hereinafter: radioactivity monitoring) shall be performed so as to consider all possible pathways of public exposure (external irradiation, inhalation, and ingestion).

- (2) Radioactivity monitoring shall include activity measurements for the radionuclides that significantly contribute to the effective dose, with the aim of assessing the level of public exposure and controlling the exposure.
- (3) Measurements within the radioactivity monitoring shall be performed so as to allow monitoring of changes in radioactive contamination of the environment and external radiation over time.
- (4) Radioactivity monitoring shall include collection of the data needed to interpret radioactivity measurements and estimate the effective dose, such as the amount of precipitation, other relevant meteorological and hydrometeorological data (e.g., discharge of running water), the amount of distributed drinking water, etc.
- (5) Radioactivity monitoring results shall be validated and prepared in a way to be used to assess and monitor changes in environmental public exposure, and as well to decide about possible protective actions in case of increased environmental radioactivity in order to reduce population health risk from ionizing radiation.

#### **Article 4**

(Scope and types of measurements)

- (1) The level of external radiation and radionuclide activity in the environment shall be determined by measuring the ambient dose equivalent of gamma radiation and its rate in air, and as well the radionuclide activity in the environmental samples.
- (2) The ambient dose equivalent rate of gamma radiation in air shall be measured with a calibrated instrument that can continuously register daily changes of the ambient dose equivalent rate of gamma radiation in air.
- (3) The ambient dose equivalent of gamma radiation in air shall be measured with calibrated thermoluminescent dosimeters.
- (4) Radionuclide activity in the environmental samples shall be measured by gamma spectrometry method and specific methods for some radionuclides (uranium and strontium).
- (5) Specific methods for determining radionuclide concentrations in the environmental samples include activity measurements with proper alpha, beta and gamma counters, i.e., proper spectrometers, in the samples previously prepared by adequate methods (a radiochemical separation or another standard method).

#### **Article 5**

(Sampling and sample preparation)

- (1) Sampling and sample preparation shall be done so as to reduce the loss of radionuclides during those operations to the minimum possible level.
- (2) Preparation and testing of single samples shall be done in the shortest time possible after the sampling in order to determine the presence of short-lived radionuclides and enable timely performance of appropriate actions in case of increased radioactivity.

- (3) During the preparation of composite samples, portions of the composite sample shall be prepared in the shortest time possible after the sampling, followed by the testing of the composite sample immediately after the last sample portion is prepared.
- (4) In case of emergency monitoring, the sampling period shall be shorter than the sampling period under normal circumstances and adapted to the accident scale.
- (5) Testing equipment for the environmental samples shall have minimum detectable activities for relevant measurements methods that are equal to or below those specified in table 1 of Annex to this regulation.
- (6) Reported measurement results shall contain the combined standard measurement uncertainty for  $k = 2$ .

### **Article 6**

(Examination of the external radiation level)

- (1) The external radiation level shall be examined with the devices for continuous measurement of the ambient dose equivalent and thermoluminescent dosimeters, placed 1 m above non-cultivated grass area.
- (2) Licensed technical services for radiation monitoring of the environment (hereinafter: technical services) shall send measurement results of the ambient dose equivalent in the environment for the previous month to the State Regulatory Agency for Radiation and Nuclear Safety (hereinafter: the Agency) by the third day of the following month at the latest, and in case of emergency they shall immediately notify the Agency.
- (3) The Agency shall monitor the system of timely warning about a possible accident.

### **Article 7**

(Determination of radionuclide activity in the environment)

- (1) Radionuclide activity shall be determined in the samples of air, precipitation, surface water, drinking water, food, feed, and soil.
- (2) Aerosol samples shall be collected by continuous air pumping through the filters of known efficiency. Gamma spectrometry method shall be used to determine radionuclide activities in aerosol, expressed in  $\text{Bq m}^{-3}$  of air, in a composite monthly sample.
- (3) A sampler shall be used to continuously collect samples of solid and liquid precipitation at a height of 1 m above non-cultivated grass area of at least  $0.6 \text{ m}^2$ . Gamma spectrometry method shall be used to determine radionuclide activities in composite monthly samples of precipitation, which are expressed in  $\text{Bq m}^{-2}$  and  $\text{Bq m}^{-3}$  of the sampled precipitation.
- (4) Non-arable soil shall be sampled by profile, from three different depths (0–5 cm, 5–10 cm and 10–15 cm) of the profile to obtain the data about the distribution of radionuclides by depth. It is necessary to remove roots and stones during the sample preparation. Radionuclide activities in soil shall be determined by gamma

spectrometry method and expressed in Bq kg<sup>-1</sup> of dry sample.

- (5) Radionuclide concentrations in the samples of surface water shall be measured in composite samples collected in a single operation. Gamma spectrometry shall be used to determine radionuclide activities of gamma emitters. The concentration of tritium <sup>3</sup>H in surface water samples shall be determined by its activity measurement with a liquid scintillation or proportional counter.
- (6) Devices with 30 times lower limits of detecting gamma emitters than the authorized limits for radionuclides in drinking water shall be used to determine radionuclide concentrations in drinking water. The total activities of alpha emitters, beta emitters and the tritium activity in drinking water shall be measured with a liquid scintillation or proportional counter. The activity of <sup>90</sup>Sr in drinking water samples shall be determined by the measurement of beta radiation activity after radiochemical separation.

### **Article 8**

#### (Principles of food sampling)

- (1) During the examination of radionuclide pathways through the food chain, the samples must be selected so as to estimate annual intake of radionuclides into the body of an individual from the reference group, while:
  - a) Population diet habits should be taken into account, and the samples for testing should be the closest possible to the end of the food chain; in case of emergency, the monitoring shall be extended to the beginning of the food chain;
  - b) The foodstuffs for testing should be representative for the area selected for estimation of annual intake, i.e., agri-industrial production should exist in that area;
  - c) Non-typical foodstuffs shall be sampled for testing to identify the pathways with the highest expected impact of emissions (reference group and critical pathway);
  - d) While sampling the food of herbal origin, the advantage shall be given to the foodstuffs with large leaves that are intended for human consumption and mature longer;
  - e) Always the same type of foodstuffs should be selected for testing in order to compare results over the years.
- (2) Milk samples shall be collected in dairies or directly from producers. Samples of other foodstuffs shall be collected on green markets, and food product samples in large stores or directly from producers.
- (3) Composite food samples consist of soup, main dish, salad, and dessert and shall be collected in larger food-serving or communal feeding facilities, kindergartens, etc.
- (4) Feed samples include fresh bulk feedstuffs, dry bulk feedstuff and fodder for various types and categories of animals.

**Article 9**  
(Goal of the monitoring)

- (1) The purpose of radioactivity monitoring is to observe environmental radioactivity which results from global and local pollution due to the use of ionizing radiation sources, and to observe the presence of natural radioactivity and increased natural radioactivity originating from technical and technological processes.
- (2) In case of unexpected increase in radioactivity, the radioactivity monitoring ensures the data for timely implementation of radiation protection measures.

**Article 10**  
(Monitoring program)

- (1) Radioactivity monitoring includes the measurement of external radiation level above the ground surface and of radionuclide concentrations in air, solid and liquid precipitation, soil, surface water, drinking water, food, and feed.
- (2) Sampling locations for the purpose of measurements within the radioactivity monitoring should be selected so that the results will serve to assess radiation hazard to the environment and public exposure.
- (3) Types of samples tested for radioactivity, sampling locations and sampling intervals are defined in the "Program of systematic examination of the environmental radioactivity" shown in table 2 of Annex. The annual "Program of systematic examination of the environmental radioactivity" shall take into account changes in the environmental radioactivity observed in the monitoring results from previous years, which will serve to amend the program at the end of the current year for the following year.

**Article 11**  
(Monitoring providers)

- (1) Measurements within the radioactivity monitoring shall be performed by technical services licensed for radiation monitoring of the environment or for individual measurements within the monitoring.
- (2) Technical services shall conduct tests within the monitoring in accordance with the "Program of systematic examination of the environmental radioactivity."
- (3) Technical services shall send a report on performed measurements in accordance with the requirements laid down by the Agency.

**Article 12**  
(Content of the monitoring report)

- (1) The report on performed measurements within the radioactivity monitoring shall contain:
  - a) a table overview of the radioactivity monitoring program;

- b) sample collection methods and data;
  - c) sample preparation methods and data;
  - d) measurement methods (time of sample testing, sample testing geometry, etc.);
  - e) geographic coordinates of sampling locations or measurement locations in case of measuring the level of external radiation;
  - f) measurement results with measurement uncertainties;
  - g) an analysis of measurement results;
  - h) a comment on measurement results.
- (2) The expression of measurement results shall include the time of sample collection.
- (3) Measurement results for the radionuclide concentrations in samples shall be expressed as specific radionuclide activities.
- (4) If a technical service has any justified reason to propose amendments to the program of systematic examination, it shall indicate it in the annual report.

**Article 13**  
(Emergency monitoring)

The level of radioactive contamination shall be measured during the emergency in order to:

- a) determine the category of emergency by quick control and collection of relevant samples during or immediately after the emission;
- b) obtain relevant data for remedial actions and impact assessment of the emergency;
- c) collect information to provide them to the public.

**Article 14**  
(Permissible exceptions in determining  
the isotopic composition of radionuclides)

Exceptions from the principle of determining the radionuclide composition shall be permitted only provided that the isotopic composition is well known and that it does not change over time, or that the dose assessment takes into account maximal possible exposure resulting from the potentially most unfavorable isotopic composition of the sample.

**Article 15**  
(Emergency measurements)

In case of an emergency, the total sample activities shall be measured under Article 14 in order to assess radiation threat, provided that the relevant verification of isotopic composition follows.

**Article 16**  
(Sampling frequency)

When samples are collected continuously, the frequency of sampling, i.e., measurements, shall depend on the radionuclide half-life, the time of radionuclide travel to an individual,

and the duration of non-continuous emissions. The frequency shall enable an assessment of average annual doses under acceptable assumptions on constant emission rate during the sampling interval.

#### **Article 17**

(Sampling frequency in case of emergency)

In case of emergency, unscheduled planned and larger unplanned emissions, the sampling frequency shall be adapted to the needs to assess the situation, i.e., to assess the increased level of radioactive contamination and corresponding hazard level.

#### **Article 18**

(Technical requirements for measuring instruments)

In order to assess the compliance of the exposure level with the authorized effective dose limit, the sensitivity of the equipment and methods shall be such to enable detection of the dose value that is below one third of the authorized dose limit.

#### **Article 19**

(Special monitoring)

Special radioactivity monitoring of the environment (hereinafter: special monitoring) shall be introduced to obtain relevant data for remedial actions and assess the population health risk from the residues of ammunition with depleted uranium, and as well to collect information to provide them to the public.

#### **Article 20**

(Content of the special monitoring)

The elements to develop a special program for examination of radioactive contamination of the environment surrounding the locations where ammunition with depleted uranium was used are developed for locations in the municipalities Hadzici and Han Pijesak, and are shown in table 3 of Annex.

#### **Article 21**

(Goal of emergency monitoring)

Radioactivity monitoring in emergencies is performed with the aim of timely obtaining:

- a) the data about the level and type of external radiation and radioactive contamination;
- b) the information that competent accident management authorities need to decide about necessary protective, remedial and other intervention actions;
- c) the information needed to decide about the type and level of protection for the units that will eliminate the consequences of the emergency;
- d) the information for the public about the degree of hazard;
- e) the information needed to identify persons who will need long-term medical screening after the emergency;
- f) the information for international exchange.

## **Article 22**

(Responsibilities for monitoring the emergency)

In case of emergency, the competent authorities shall begin to determine the level of hazard and likely developments as early as in initial phase and also during the emergency, with the aim of timely identifying any new hazards, assessing the emergency consequences, and deciding about the range and type of protective, remedial and other intervention actions.

## **Article 23**

(Systematic examination program for emergencies)

- (1) The Agency shall develop a systematic examination program for an emergency in the initial phase of the emergency and inform thereof the technical services which perform measurements within the radioactivity monitoring.
- (2) As necessary, the systematic examination program for the emergency shall be amended, depending on the development of the emergency.
- (3) Locations, scope and frequency of sampling in emergencies are shown in table 2 of Annex.

## **Article 24**

(Responsibilities of technical services in case of emergency)

- (1) Technical services which perform emergency monitoring shall report measurement results to the Agency during the emergency in the shortest possible time intervals.
- (2) Technical services which perform emergency monitoring shall send a report on performed measurements to the Agency at the latest 15 days after the emergency ends.

## **Article 25**

(Penalties)

Any non-compliance with the provisions of this regulation shall be punished under the applicable legislation.

## **Article 26**

(Entering into force)

This regulation shall enter into force on the eighth day following its publication in the Official Gazette of BiH.

Sarajevo, 2014

DIRECTOR  
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**ANNEX**

**Table 1: MINIMUM DETECTABLE ACTIVITY (MDA) FOR THE MEASUREMENT METHOD**

<b>TYPE OF MEASUREMENT</b>	<b>MEASUREMENT METHOD</b>	<b>MDA FOR THE METHOD</b>
<b><i>EXTERNAL RADIATION IN THE ENVIRONMENT</i></b>		
<i>ON-LINE</i> DOSE MEASUREMENT ( $H^*(10)$ )	Network for continuous measurement of the ambient dose with GM detectors $H^*(10)$	>10cps/ $\mu$ Sv/h
<i>OFF-LINE</i> DOSE MEASUREMENT	Measurement of the ambient dose with passive dosimeters (TL dosimeters) $H^*(10)$	10 $\mu$ Sv
<b><i>AIR</i></b>		
MEASUREMENT OF RADIONUCLIDE ACTIVITY – PARTICULATE MATTER	Gamma spectrometry measurement (HPGe)	10 $\mu$ Bq/m <sup>3</sup> (Co-60)
<b><i>PRECIPITATION</i></b>		
MEASUREMENT OF RADIONUCLIDE ACTIVITY IN PRECIPITATION ( <i>fall out</i> )	Gamma spectrometry measurement (HPGe)	10 mBq/L (Co-60)
<b><i>SURFACE WATERS (rivers, lakes, seas)</i></b>		
MEASUREMENT OF RADIONUCLIDE ACTIVITY IN SURFACE WATER	Gamma spectrometry measurement (HPGe) Determination of Sr 89/90 activity	10 Bq/L (Co-60) 10 Bq/L
<b><i>DRINKING WATER</i></b>		
MEASUREMENT OF RADIONUCLIDE ACTIVITY IN DRINKING WATER	Gamma spectrometry measurement (HPGe) Determination of Sr 89/90 activity Determination of tritium (H-3) activity Determination of the total alpha/beta activity	0.5 Bq/L (Co-60) 0.4 Bq/L 10 Bq/L
<b><i>SOIL (non-arable land)</i></b>		
MEASUREMENT OF RADIONUCLIDE ACTIVITY IN SOIL	Gamma spectrometry measurement (HPGe)	1 Bq/kg (Co-60)
<b><i>FOOD</i></b>		
MEASUREMENT OF RADIONUCLIDE ACTIVITY IN FOOD	Gamma spectrometry measurement (HPGe) Determination of Sr 89/90 activity	0.5 Bq/kg (Co-60) 0.4 Bq/kg
<b><i>FEED</i></b>		
MEASUREMENT OF RADIONUCLIDE ACTIVITY IN FEED	Gamma spectrometry measurement (HPGe) Determination of Sr 89/90 activity	0.5 Bq/kg (Co-60) 0.4 Bq/kg

**Table 2: PROGRAM FOR MONITORING RADIOACTIVITY IN THE ENVIRONMENT**

TYPE OF MEASUREMENT	FREQUENCY OF SAMPLING/MEASUREMENTS A) Routine conditions B) Emergency – measurement	SAMPLING LOCATIONS
<b><i>EXTERNAL RADIATION IN THE ENVIRONMENT</i></b>		
ON-LINE DOSE MEASUREMENT (H* (10))	A) CONTINUOUSLY/60 min. B) EVERY 10 min.	22  (Banja Luka, Bihac, Bijeljina, Gacko, Gorazde, Gradacac, Ivan Sedlo, Jajce, Livno, Mostar, Novi Grad, Sarajevo, Tuzla, Visegrad, Zenica, Han Pijesak, Sokolac, Cemerno, Gradiska, Foca) + 2 for storage facilities
OFF-LINE DOSE MEASUREMENT	A) CONTINUOUSLY/QUARTERLY B) FIRST MONTH: weekly FIRST YEAR: monthly	22  (Banja Luka, Bihac, Bijeljina, Gacko, Gorazde, Gradacac, Ivan Sedlo, Jajce, Livno, Mostar, Novi Grad, Sarajevo, Tuzla, Visegrad, Zenica, Han Pijesak, Sokolac, Cemerno, Gradiska, Foca) + 2 for storage facilities
<b><i>AIR</i></b>		
MEASUREMENT OF RADIONUCLIDE ACTIVITY – PARTICULATE MATTER	A) CONTINUOUSLY/MONTHLY B) FIRST WEEK: daily FIRST YEAR: monthly	2  (Banja Luka, Sarajevo)
<b><i>PRECIPITATION</i></b>		
MEASUREMENT OF RADIONUCLIDE ACTIVITY IN PRECIPITATION ( <i>fall out</i> )	A) CONTINUOUSLY/MONTHLY B) FIRST MONTH: weekly FIRST YEAR: monthly	2  (Banja Luka, Sarajevo)

**Table 2: PROGRAM FOR MONITORING RADIOACTIVITY IN THE ENVIRONMENT (cont.)**

TYPE OF MEASUREMENT	FREQUENCY OF SAMPLING/MEASUREMENTS A) Routine conditions B) Emergency – measurement	SAMPLING LOCATIONS
<i>SURFACE WATERS (rivers, lakes, seas)</i>		
MEASUREMENT OF RADIONUCLIDE ACTIVITY IN SURFACE WATER	A) TWICE A YEAR / TWICE A YEAR B) FIRST WEEK: daily FIRST YEAR: monthly	16  RIVERS Bosna (downstream from Zenica), Drina (where it enters and exits BiH), Neretva (downstream from Mostar), Una (downstream from Bihac), Sana (downstream from Sanski Most), Sava (where it enters and exits BiH), at the Vrbas estuary into the Sava, LAKES Bileca Lake, Busko Lake, Lake Modrac, Lake Perucac, Pliva Lake, Visegrad Lake SEA Adriatic Sea (Neum)
<i>DRINKING WATER</i>		
MEASUREMENT OF RADIONUCLIDE ACTIVITY IN DRINKING WATER	A) ONCE A YEAR / ONCE A YEAR B) FIRST MONTH: weekly (gamma spectrometry) FIRST YEAR: monthly	22  (Sarajevo, Mostar, Bihac, Tuzla, Zenica, Livno, Gorazde, Gradacac, Jajce, Sanski Most, Travnik, Neum, Banja Luka, Bijeljina, Doboj, Gradiska, Zvornik, Prnjavor, Teslic, Trebinje, Foca, Siroki Brijeg)
<i>SOIL (non-arable land)</i>		

MEASUREMENT OF RADIONUCLIDE ACTIVITY IN SOIL	A) TWICE A YEAR/TWICE A YEAR B) FIRST YEAR: monthly, first layer (0–5 cm)	6  (Banja Luka, Bihac, Bijeljina, Sarajevo, Tuzla, Visegrad)
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**Table 2: PROGRAM FOR MONITORING RADIOACTIVITY IN THE ENVIRONMENT (cont.)**

TYPE OF MEASUREMENT	FREQUENCY OF SAMPLING/MEASUREMENTS A) Routine conditions B) Emergency – measurement	SAMPLING LOCATIONS
<i>FOOD</i>		
MEASUREMENT OF RADIONUCLIDE ACTIVITY IN MILK	A) QUARTERLY / QUARTERLY B) FIRST MONTH: daily (gamma spectrometry without sample preparation) FIRST YEAR: monthly	10  (Sarajevo, Bihac, Zenica, Maglaj, Tuzla, Kozarska Dubica, Sipovo, Snjegotina, Bileca, Aleksandrovac)
MEASUREMENT OF RADIONUCLIDE ACTIVITY IN THE COMPOSITE SAMPLE	A) ONCE A YEAR / ONCE A YEAR B) FIRST MONTH: daily (gamma spectrometry without sample preparation) / FIRST YEAR: monthly	6  (Sarajevo – e.g., a hospital, kindergarten, restaurant; Banja Luka – e.g., a hospital, kindergarten, restaurant)

MEASUREMENT OF RADIONUCLIDE ACTIVITY IN FOOD	A) ONCE A YEAR / ONCE A YEAR (e.g., cabbage, spinach, tomato, sweet pepper, potato, carrot), 6 SAMPLES OF FRUITS (e.g., strawberry, apple, pear, plum, grapes, peach) and 6 SAMPLES OF ANIMAL ORIGIN (e.g., eggs, meat and fish) B) FIRST MONTH: daily (gamma spectrometry bez preparation of sample)	4  (Sarajevo, Mostar, Banja Luka, Doboј)
<b><i>F E E D</i></b>		
MEASUREMENT OF RADIONUCLIDE ACTIVITY IN FEED	A) TWICE A YEAR / TWICE A YEAR B) FIRST MONTH: daily (gamma spectrometry without sample preparation) FIRST YEAR: monthly	6  (Mostar, Sarajevo, Tuzla, Banja Luka, Doboј, Bijeljina)

**Table 3: SPECIAL MONITORING**

<b>TYPE OF MEASUREMENTS</b>	<b>SAMPLING AND METHOD OF MEASUREMENTS</b>	<b>FREQUENCY OF SAMPLING/ MEASUREMENTS</b>	<b>SAMPLING LOCATIONS</b>
MEASUREMENT OF URANIUM ISOTOPE CONCENTRATION IN SURFACE WATER	Sampling of surface waters – grab sampling of 5 L of water	Twice a year/ Twice a year	6  (Hadzici, Han Pijesak)
MEASUREMENT OF URANIUM ISOTOPE CONCENTRATION IN DRINKING WATER	Sampling of drinking water – grab sampling of 5 L of water	Twice a year/ Twice a year	6  (Hadzici, Han Pijesak)

MEASUREMENT OF URANIUM ISOTOPE CONCENTRATION IN MILK	Sampling of milk – grab sampling of 5 L of milk	Twice a year/ Twice a year	4 (Hadzici, Han Pijesak)
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