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# Norwegian Support to Regulatory Authorities in Central Asia in Radioactive Waste Management

## Final report for activities in 2008-2012

Statens strålevern
Norwegian Radiation Protection Authority

**Reference:**
Zhunussova T., Sneve M., Romanenko O., Solomatina A., Mirsaidov I., B. Kuldjanov. Final report 2008-2012. Norwegian Support to Regulatory Authorities in Central Asia in Radioactive Waste Management. StrålevernRapport 2013:8. Østerås: Statens strålevern, 2013.

**Key words:**
Nuclear legacy, threat assessment, regulatory challenges, radioactive waste management, remediation.

**Abstract:**
With the support of the Norwegian Ministry of Foreign Affairs, the Norwegian Radiation Protection Authority has developed projects on a bilateral basis with the aim of assisting the regulatory bodies in Central Asian countries identify gaps in the regulatory framework and draft relevant regulatory requirements to ensure the protection of personnel, the public and the environment during the planning and conducting of remedial action with regard to past practices and measures for radioactive waste management and uranium legacy.

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**Emneord:**
Historisk radioaktivt avfall, trussel og risikovurdering, regulering, håndtering av radioaktivt avfall, oppryding

**Resymé:**
Med støtte fra Utenriksdepartementet, har Statens strålevern utviklet bilaterale prosjekter med sikte på å bistå myndighetene i de sentralasiatiske landene. Målet er å identifisere hull i regelverket og lage utkast til relevante regelverkskrav for å sikre beskyttelse av personell, befolkning og miljø under planlegging og gjennomføring av oppryddingstiltak med hensyn til tidligere praksis for håndtering av radioaktivt avfall og urangjenvinning.

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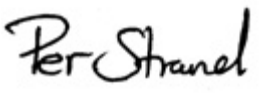
Head of project: Malgorzata K. Sneve
*Approved*:



Per Strand, Director, Department for Emergency Preparedness and Environmental Radioactivity.

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# Norwegian Support to Regulatory Authorities in Central Asia in Radioactive Waste Management

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**Statens strålevern**

Norwegian Radiation Protection Authority
Østerås, 2013

# Contents

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# 1 Executive summary

After the collapse of the Soviet Union in 1991, the former Soviet Republics not only became independent, they also inherited the legacy of radioactive wastes including those from uranium ore processing and tailings. The old Soviet regulatory documents are at present not any longer consistent with the present international standards and guidance and need substantial development.

With the support of the Norwegian Ministry of Foreign Affairs (MFA), the Norwegian Radiation Protection Authority (NRPA) has developed projects on a bilateral basis with the aim of assisting the regulatory bodies in Central Asian (CA) countries identify gaps in the regulatory framework and draft relevant regulatory requirements to ensure the protection of personnel, the public and the environment during the planning and conducting of remedial action with regard to past practices and measures for radioactive waste (RW) management in those CA countries. The initial three years (2008-2011) of the "Regulatory Support Programme" ended at the beginning of 2012. During the given period, the NRPA has assisted the regulatory authorities in Kazakhstan, Tajikistan, Kyrgyzstan and Uzbekistan with the development of threat assessment reports which identified the weaknesses to be addressed in the project along with the regulatory documents identified and required in the field of radioactive waste management. The scope of this particular project falls within the area of global safety issues and the regional CIS projects supported by the Norwegian MFA and is designed to ensure that activities related to radioactive waste management in Central Asia will be carried out in accordance with international standards and recommendations, taking into account past experience with Russian regulators.

In the threat assessment report (StrålevernRapport 2011:5) [1], which was completed and published earlier in 2011, each regulatory body analyzed the existing situation in their country, identified gaps and prioritized the legislative and regulatory documents to be developed first. It is important to underline that the threats connected with radioactive wastes were directly related not only to improper regulatory framework being in force and a lack of knowledge, but also to the lack of a well established national policy and strategy for radioactive waste management in each Central Asian country and weaknesses in the regulatory infrastructure. The main outcomes of the threat assessment report [1] are considered in the present report to provide a clear understanding of the existing situation at the beginning of the project.

The national policy and strategy should allocate responsibilities with regard to radioactive waste management and the actions necessary for providing resources and funding for safe, long-term RW management, maintenance of the availability of sufficient and qualified human resources to perform it, including resources for training and "R&D", and the implementation of institutional control and monitoring when needed or required for the safety of RW storage/disposal sites both during their operation and after their closure.

In the previous report [1], the NRPA also underlined the importance of strengthening the regulatory framework and infrastructure. Only with a strong regulatory infrastructure will it be possible to avoid the repetition of such experiences in ongoing practices and facilities or in new projects.

The current final report includes work completed within the "Regulatory Support Programme to Central Asia in the Period 2008-2012" [2] funded by the Norwegian MFA. This report briefly describes the situation in each country and the documents developed in the field of radioactive waste management with the assistance of the NRPA.

The main outcomes achieved in each participating Central Asian country are the following:

**Kazakhstan**- Inception Report; Regulatory Threat Assessment Report [3]; Proposal for new RW classification in Kazakhstan [4]; Proposal to establish the new major criteria for classification in Kazakhstan [5]; Draft regulatory document "Rules for Radioactive

Waste Disposal in the Republic of Kazakhstan" [6] and Final Report [7].

**Kyrgyzstan**- Inception Report; Regulatory Threat Assessment Report [8]; Guideline on Environmental Monitoring Around Radioactive Waste Storage Facilities[9]; Guidelines for Radioactive Waste Management [10] and Final Report [11].

**Tajikistan**- Inception Report; Regulatory Threat Assessment Report [12]; Draft law of the Republic of Tajikistan on "Radioactive Waste Management" [13], Requirements for carrying out monitoring of sites (radiation control) [14]; Guidelines for Radioactive Waste Management (PORO-10) [15] and Final Report [16].

**Uzbekistan**- Inception Report; Regulatory Threat Assessment Report [17], Proposal for new RW classification [18]; Requirements for monitoring radioactive disposal objects in the Republic of Uzbekistan [19], Requirements for the management and disposal of radioactive wastes in the Republic of Uzbekistan [20] and Final Report [21].

# 2 Introduction

During the former Soviet Union period, significant nuclear operations were carried out within the republics of Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan. These activities, which included in particular activities of the nuclear fuel cycle, and the closure and decommissioning of nuclear weapons test sites, produced a large amount of radioactive waste containing not only naturally occurring radioactive material (NORM). In addition to this, medical and industrial uses of radiation sources also produced relatively small amounts of radioactive waste in comparison with the aforementioned nuclear activities. In some of the Central Asian countries, the coal, oil and gas industries also produced a considerable amount of waste containing NORM. In Central Asia, uranium tailings are waste by-product materials from the rough processing of uranium-bearing ore which need proper regulations and management along with the other radioactive waste already mentioned.

These countries are close to each other geographically. They also share a similar status as newly independent states whose regulatory authorities were only recently set up. The process of remediating legacy sites of past activities and reducing the threats is now getting under way with the design and implementation of remediation activities, partly with international support. However, there were significant shortcomings in the regulatory basis for carrying out such remediation work, including a lack of relevant radiation and environmental safety norms and standards, licensing, inspection and enforcement procedures and requirements for monitoring etc., as well as the expertise for transforming such a basis into practice.

Accordingly, the objective of the present project was to assist the relevant regulatory authorities in Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan to develop robust and adequate national regulatory frameworks and procedures, taking account of international recommendations and other international good practices and experience. Once this has been developed, the countries will be able to carry out the remediation of legacy sites in a responsible, environmentally safe way.

With the support of the Norwegian Ministry of Foreign Affairs (MFA), the Norwegian Radiation Protection Authority (NRPA) took an initiative to develop projects on a bilateral basis with the aim of assisting the regulatory bodies in the CA countries identify and draft relevant regulatory requirements to ensure the protection of personnel, the public and the environment during the planning and conducting of remedial action with regard to past practices and the management of accumulated radioactive waste management in those CA countries. The initial three years of the project (2008-2011) “Regulatory Support Programme” ended in 2012. During the given period, the NRPA has assisted the regulatory authorities in Kazakhstan, Tajikistan, Kyrgyzstan and Uzbekistan with the development of the required regulatory documents in the field of radioactive waste management. The scope of the project falls within the area of global safety issues and the regional CIS projects supported by the Norwegian MFA, and is designed to ensure that activities related to radioactive waste management in Central Asia will be carried out in accordance with international recommendations, taking into account past experience with Russian regulators.

In the threat assessment report (StrålevernRapport 2011:5) [1], which was completed and published earlier in 2011, each regulatory body analyzed the existing situation in their country,, identified gaps and prioritized the legislative and regulatory documents to be developed first. It is important to underline that the threats connected with radioactive wastes were directly related not only to improper regulatory framework being in force and a lack of knowledge, but also to the lack of a well established national policy and strategy for radioactive waste management in each Central Asian country.

The threat assessment reports of these countries have shown that at the beginning of the project the regulatory framework for safe radioactive waste management had yet to be fully completed and required improvement and harmonization with the international recommendations and in particular with IAEA Safety Standards. It was noticed that in order

to remove the threats connected with the presence of radioactive wastes, both those which have already accumulated as a result of previous activities and those which are being generated in significant amounts now and which could be produced in the future, it was necessary at least to develop or review the following documents:

a) National policy and strategies for radioactive waste management for each country and proposals for radioactive waste classification - including the identification of relevant categories - and safety requirements for predisposal and disposal of radioactive waste in accordance with the IAEA recommendations, taking into account other national experience.

b) Regulatory documents on radioactive waste management including disposal.

c) Regulatory documents on radiation protection and establishing safety criteria for intervention and the remediation of contaminated sites and for addressing existing exposure situations.

d) Technical requirements for systematic radiation monitoring.

During these years, the project allowed participants to share expertise and experience in order to implement and improve their regulatory functions. Considerations were given to international recommendations and guidance as well as recognized international good practices based on the involvement of experts from Norway, Russia and other countries. Efforts were made to strengthen the capacity of the regulatory authorities in the participating countries, and to improve the professional skills and knowledge of the regulators. It seems that the achieved project goals helped promote a safety culture and an awareness of environmental protection among operators, regulators and other stakeholders in these countries. This in turn will support the wider implementation of national policies and strategies for the safe management of radioactive waste, environmental protection and sustainable development.

# 3 Radioactive waste management and regulatory issues in each country

## 3.1 Kazakhstan

Kazakhstan is among a number of countries characterized by ecological stress caused by several reasons. The territory of Kazakhstan is abundant with natural radioactive objects (from uranium and thorium anomalies to their deposits). That has predetermined the status of the Kazakhstan Republic as one of the largest sources of natural uranium raw material. Furthermore, it was also the location of the Soviet Union's testing grounds where nuclear tests were executed over the course of 40 years (from 1949 to 1989), entailing negative effects on the environment.

These negative changes affected the soil, flora and fauna, natural waters and lowest level of the atmosphere. There is an urgent need to quantify in terms of scale and degree of impact these factors have had on the public, i.e. to define a degree of public radiation safety. The General Assembly of the UN has confirmed these problems and issued three Resolutions regarding assistance to the Semipalatinsk Test Site:

- A/RES/52/169M "International cooperation and coordination of activity directed towards the rehabilitation of the public and the environment as well as the economic development of the Semipalatinsk Test Site in Kazakhstan", December 16, 1997;
- A/RES/53/1H "International cooperation and coordination of activity directed towards the rehabilitation of the public and the environment as well as the economic development of the Semipalatinsk Test Site in Kazakhstan", November 16th, 1998;
- A/RES/55/44 "International cooperation and coordination of activity directed towards the rehabilitation of the public and the environment as well as the economic

development of the Semipalatinsk Test Site in Kazakhstan", November 27th, 2000.

The aftermaths of the Chernobyl accident revealed the radio-ecological challenges to their utmost and led to regular radio-ecological studies. In Kazakhstan, this research was initiated by the Ordinance of the Council of Ministers of the Kazakh SSR dated the 21st of May 1989. Its further development took place after the Cabinet of Ministers of the Kazakhstan Republic issued decrees No. 1103 of 31.12.1992 on the "Urgent Measures Concerning Radio-ecological Situation Studies in the Kazakhstan Republic " and No. 363 of 30.03.1995 "on the "Additional Measures on Improving the State of Radiation in the Kazakhstan Republic".

### *3.1.1 Regulatory Threat Assessment Report. Kazakhstan*

The Republic of Kazakhstan (RK) has inherited its infrastructure for radioactive waste management from the former USSR. Its main features are the minimization of expenses for processing and disposing of waste, under estimation of the scope of challenges connected with its management including the safety aspects, which mainly leaves finding a solution to the problem to future generations.

The following main challenges were identified:

- safe radioactive waste management;
- monitoring of the environment and radiation facilities (the Semipalatinsk Testing Ground (STG), uranium tailings impoundments, etc.);
- detection and elimination of local sources of radioactive contamination of cities, towns and settlements;
- establishment of a system for the radiation monitoring of technogenic radioactive objects
- radon issues;
- scientific and technical support of radio-ecological studies, and radiation and ecological safety itself.

Over the past 15 years, numerous research projects and studies have been conducted in an attempt to resolve the aforementioned problems.

In Kazakhstan, priority is given to the management of radioactive waste because of the large amount of accumulated radioactive waste of all types from low- to high-level. This waste was produced, to a greater extent, by the military-industrial complex and the uranium and non-uranium industry, and, to a lesser extent, by the nuclear industry and in the process of nuclear applications in medicine, industry, education and research. Currently, there are radioactive wastes (RW) in Kazakhstan which originated from the extraction and processing of ores containing uranium, rare earth metals and polymetals as well as waste from phosphate extraction, hydrocarbons, coal and nuclear explosion products (Fig 1). There are also radioactive wastes from the operation of research reactors and power generation reactor BN-350, as well as disused sealed and open sources and radioactive materials.

The total quantity of radioactive waste in Kazakhstan amounts to 237.2 million tons with 15.4 million Ci of total activity, of which 450 tons are high-level RW with 1.9 million Ci activity; 6.5 million tons are intermediate-level RW with 13.2 million Ci activity; 230.7 million tons are low-level RW with 295 Ci activity.

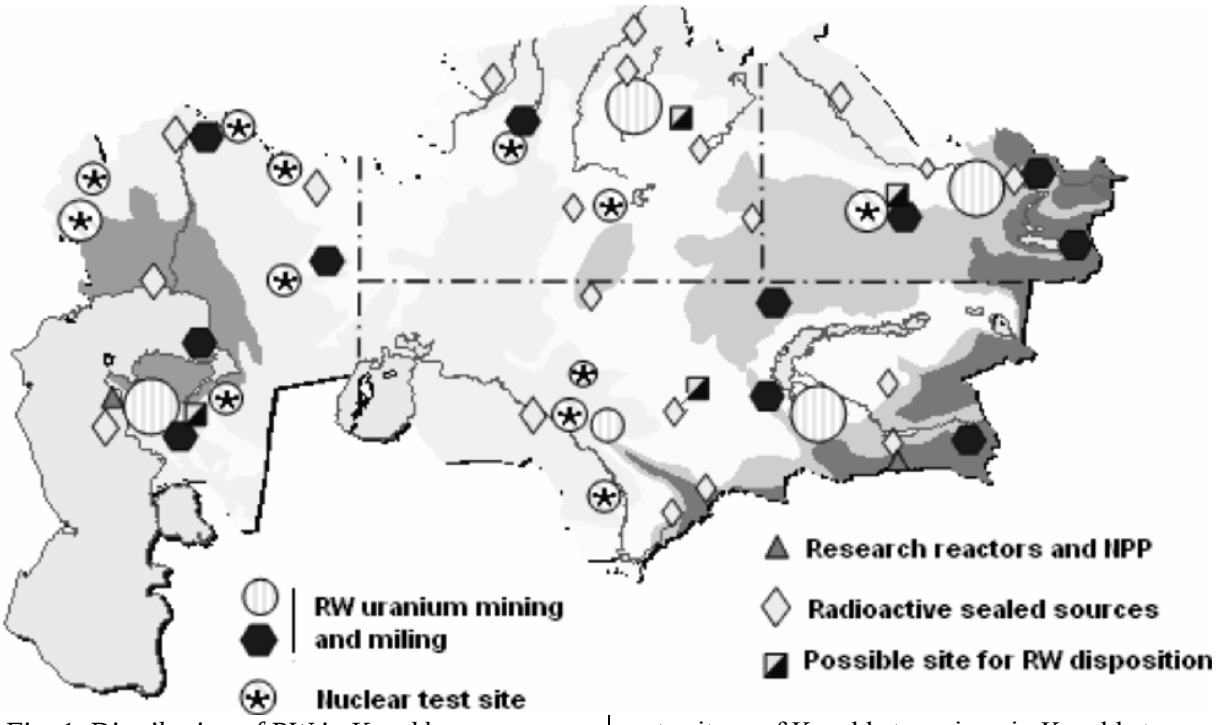


*Fig. 1. Distribution of RW in Kazakhstan (Source KAEC, Kazakhstan)*

The uranium industry, including exploration work carried out on sites of endogenous uranium ore in Kazakhstan, is among the intensive sources of natural radionuclides characterized by high ecological risk and discharged into the environment. These sites are mostly located in waste storage areas remaining after the mining and processing of uranium ore. The uranium ore deposits (prior to prospecting and exploration activity) cannot be directly considered as the contaminants and must be taken into account as a natural component of high natural geochemical and radiological background.

The next stage of the ore processing cycle is carried out in mills, usually located near several mines. Concentrate containing a maximum amount of uranium is extracted from the ore, and the remaining ore is accumulated in tailings impoundments. The capacities of the tailings impoundments are one order less than that of the dumps, but their average uranium content is higher. Dust blowing off the surface of tailings impoundments and diffusing radon can create a halo of contamination around them which exceeds the admissible values for the public. Waste of this group is the most significant one by volume (97% of all radioactive waste) and widely spread over the territory of Kazakhstan, since in Kazakhstan a large number of the uranium deposits were exploited and mined for a long time (more than 40 years); some of them are large and unique in terms of their resources.

Radon exhalation from the dumps and tailings and inhalation of radon or its decay products by people residing and working near its source increase the risk of occurrence of cancer diseases. This is the most severe health hazard caused by the presence of this waste and it needs to be evaluated. The release of radon from the dumps and tailings depends on many factors, such as the amount of waste, concentration of radium-226 (and Ra-224), humidity, etc. NRB-2012 (full title of the document: Hygienic Standards "Sanitary Requirements for Radiation Safety", issued in 2012) determines that restrictions are foreseen for the allowable equivalent equilibrium volume activity of radon in new buildings and in buildings that are in operation (100 and 200 Bq/m3 respectively).

The regulatory and legal framework of Kazakhstan did not fully support the needs of practical activities in the field of radioactive waste management. This refers to the harmonization of Kazakhstan's RW classification with international standards, development of regulatory requirements for conditioning, transportation, storage and final disposal of various types of radioactive waste, as well as requirements for appropriate

disposal facilities. The radioactive waste management system existing in Kazakhstan is not oriented towards the disposal of radioactive waste of all types and categories; an institution responsible for the realization of technical policy regarding the disposal of radioactive waste has not yet been assigned.

It is obvious that in order to manage and dispose of radioactive wastes accumulated/generated in Kazakhstan safely, it is necessary to provide a safety assessment, environmental impact assessment and full scale monitoring of the behaviour of radio nuclides in RW locations. However, the realization of these tasks in the near future appears to be rather problematic as there are only some basic elements of a national policy on radioactive waste management in the RK. As far as the strategy for RW management is concerned, it still should be developed in accordance with IAEA recommendations and based on the experience of other western countries. Furthermore, financial and human resource support mechanisms for the measures for the long-term and safe management of radioactive wastes have not yet been established in the country. No national organization for co-ordinating radioactive waste management in the country has been created in the Republic of Kazakhstan. Existing regulatory documents do not address the issues regarding the implementation of long-term institutional control and monitoring of the abandoned dams with radioactive wastes and future RW disposal sites both during their operation and after their closure. There is also a need to develop the safety criteria (reference levels) and measures to be taken for existing exposure situations (past practices). There is also a lack of safety requirements for different types of disposal facility in accordance with the different categories of radioactive waste. Safety criteria and clearance levels have not been established.

The regulatory basis existing in Kazakhstan covers the following objects and kinds of activity in the field of atomic energy use: power reactors, research reactors, waste processing companies, storage facilities for spent fuel and high-level wastes, storage facilities for low-level wastes, high-level wastes disposal, low-level wastes disposal, fuel production plants, uranium mining and processing, radioactive sources, by-product radioactive materials, radiography, packaging and transportation of radioactive materials, radiation protection, quality assurance, environmental protection, emergency situations planning, fire safety, carrying out of technological operations, maintenance service, training and certification of the personnel, nuclear safety, physical protection, safety analysis development, impacts on personnel, siting, designing and building, the organization and performance of research (including experimental work), decommissioning of installations, the account and the control of nuclear materials, etc.

A quite significant number of regulatory documents (238 titles) exist in Kazakhstan. Despite this fact, a considerable part of that (120 regulations and standards of atomic engineering and state standards) were either approved and put into force during the Soviet period by the authorities of the United Soviet Socialistic Republics (USSR) or are in fact the old regulatory documents of the Russian Federation. These documents (normative documents of the former USSR) do not correspond to or have not been harmonized with the recently approved and published international standards and need to be revised in order to provide an effective regulation of activities connected with use of atomic energy in Kazakhstan.

For example, issues related to RW processing, storage and final disposal are not developed well enough in a current regulatory basis. In particular only one method of underground disposal has been reflected in SPORO-97. At the same time, no requirements for closure of disposal facilities have been established. The requirements for radioactive waste disposal are not developed in detail because the suggested method of placing RW in underground facilities will definitely not be able to satisfy the requirement for a time period of longer than 50 years. There is no clear division between the requirements and the criteria for choosing sites and their usage. In addition, no disposal methods for low, medium and high-level wastes have been established. Existing regulation on radioactive waste disposal procedure needs to be improved in a form of document which defines both the siting criteria for RW underground disposal (geological, seismological, hydro geological) as well as the transfer procedure from operation to closure.

*Fig. 2. Rehabilitated dump on the East Mine which stockpiled 2,000 tons of radioactive metal structures and now makes them inaccessible for extraction and reuse. (Source KAEC Kazakhstan)*

In terms of radioactive waste processing, only the criteria on cementation and bitumization have been established, while criteria for high-level wastes processing and conditioning do not exist. It is necessary to define both technical criteria and safety requirements that form the basis of the limits, conditions and control of any radioactive waste predisposal management facility or activity. Requirements should be established for defining "waste acceptance criteria" in the design process and as part of the safety case and safety assessment.

In principle, it is possible to present a long list of aspects for which there are no well-established safety requirements in the regulation currently in force. Considering that Kazakhstan is part of the Joint Convention, an effort should be made to improve this situation as soon as possible.

In Kazakhstan, there are currently 67 sites of recent uranium exploration and mining activity which have been remediated, where remediation is defined as a complex of activities performed for the rehabilitation of a site to the condition required for the site to be used for agricultural needs, while excluding a possibility of impacts on the environment and the public, and where this re-cultivation involves more than 99% of wastes (in volume) produced by uranium exploration and mining (Fig. 2). It is possible to conclude wrongly that the rehabilitation of the abandoned mines and dams has basically already been completed in the RK and these radioactive wastes have been successfully disposed of. However, this is far from reality. The reality is that there is currently no licensed RW disposal facility in the RK and all waste existing in the country should be considered as being in a state of temporary storage. Accordingly, the activities performed with regard to the rehabilitation of abandoned mines and dams cannot be defined as activities for transferring these radioactive wastes to disposal sites in the sense accepted by the international community relating to RW disposal procedures. The rehabilitation activities that have been conducted are only primary measures performed with the purpose of decreasing present radiological risks for the public in areas with such mines and dams.

In fact, although Kazakhstan ratified the International Joint Convention on the "Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management" of 5th September 1997, it is obvious that, according to requirements of this document, it will be necessary to return to these objects in the future for their definitive conversion to radioactive waste disposal sites, as well as to those objects of the uranium mining industry where rehabilitation measures are yet to be implemented. Thus, these radioactive wastes will continue to pose a radiological threat to the public until they are definitively transferred to licensed radioactive waste disposal sites.

The question regarding radioactive waste disposal in the oil and gas production industry remains unresolved, while the amount of waste in this industry is increasing. The results of radio-ecological studies performed on the oil production sites revealed abnormally high concentrations of natural radionuclides of

radium and thorium in waters released on the surface almost everywhere when carrying out drilling. As already mentioned, the radiological risk for the public from these objects is essentially connected with the possibility of using the stored contaminated pipes and equipment. There is an understanding that in this case, the first priority is not the disposal solution, but to regulate this practice and to enforce it. Measures should therefore be taken for the safe and secure storage of the pipelines and other issues and to establish a proper and controlled method of storage. The contaminated soils on these sites are often salted and black-oiled. Vegetation is poor, which reduces radiological risks for the local population in terms of the cattle pasture on these sites. The level of radionuclides distribution monitoring remains at a very low level on these sites. It is therefore necessary to implement a safety assessment to determine what is really needed with regard to past practices, but measures must also be taken immediately to avoid the situation becoming worse than it is.

Radioactive wastes located on nuclear explosion test sites and generated in the process of nuclear tests or nuclear explosions in times of peace also need consideration (Fig. 3). However, unlike the situation with the radioactive wastes both already in existence and being generated in the oil and gas production sector of Kazakhstan, there is no further increase in the volumes of radioactive waste from nuclear explosions, and radiological monitoring has been performed on nuclear explosion test sites and the areas adjoining them that make it possible to keep the situation under control. However, this needs a cost efficiency analysis and optimization.

The following threats should be also noted:

- The problem of radioactive waste generated in the nuclear energy industry and nuclear applications and in particular with regard to the large amount of existing disused sealed sources;
- The need to define, as part of national policy, what will be the policy for the "clearance" of radioactive materials from regulatory control and specifically for materials containing naturally occurring radioactive materials (NORM). The establishment and application of a clearance concept and the establishment of activity concentration values for the clearance of raw materials. This is extremely important for the decommissioning of existing nuclear and other facilities, as well as for the management of radioactive material produced in the uranium and other mining and milling industries, and for the oil industry
- Normative documents for the long-term storage or disposal of radioactive waste have not yet been developed in Kazakhstan.

According to the statement made by the regulatory body, the regulatory basis in the country is sufficient for maintaining a safe working environment for personnel at all stages of the radioactive waste management process, namely, at the stages of RW formation, and predisposal management including storage and disposal. A safety assessment of activities with radioactive materials, as well as an assessment of the impact on the environment should be basic components in the field of atomic energy use in Kazakhstan and are subject to the obligatory approval of the authorities. When developing the safety assessment of activities, normal/abnormal operations as well as emergency situations should be considered. The Kazakhstan Final Report [7] concluded that radioactive waste management by personnel is strictly regulated and well controlled in Kazakhstan; exposure doses are within the limits allowed by NRB-2012 (not more than 20 mSv/y on average within any 5 consecutive years, but not more than 50 mSv/y within one year). Therefore the authors of the report decided to exclude from further consideration those threats that are connected with radiological risks for personnel who work with radioactive wastes and which can arise in the absence of the regulatory document.

However, problems related to the radiological threats for the public living near to the sites contaminated with radioactive wastes and near to temporary radioactive waste storage sites remain unresolved, especially from a long-term perspective. The basic gap in the regulatory

basis of Kazakhstan concerns the issues connected with the long-term storage of radioactive wastes and their disposal. Moreover, there are no effective mechanisms for the maintenance of long-term institutional control and monitoring, or funding and financial mechanisms for supporting the activities connected with the long-term radioactive waste management in Kazakhstan.

Thus, at the present moment in Kazakhstan, a large amount of radioactive waste has been accumulated and there is a tendency for its volume to increase, which requires that its safe management, including disposal, be guaranteed. Among the most important aspects of the mentioned problem it is necessary to point out:

- Imperfection of the radioactive waste management system.
- Incompleteness of a process of organizational measures on radioactive waste management.
- Lack of an effective financial mechanism which would meet the internationally acknowledged principles of the safe management of radioactive waste.
- Disregard for the above problems, which is a source of:
    - Unwarrantable risk of a hazardous impact of ionizing radiation on the public and the environment associated with the radioactive waste already accumulated in Kazakhstan.
    - Potential increase in radiation risks in future and probable rise of social-psychological tension in society connected with the intentions to develop the nuclear power industry in Kazakhstan.
    - Risks for the stable development of society associated with potential obstacles to the realization of the programme to speed up industrial development in Kazakhstan and addressing the economic burden of radioactive waste management placed on future generations.

The main radiological threats for the population of Kazakhstan can therefore be summarized as follows:

- Abandoned objects of the uranium mining industry, including those which have been partially rehabilitated, as well as those where rehabilitation has not yet begun;
- Radioactive wastes that have accumulated at uranium industry facilities during the decades of their previous activity;
- Radioactive wastes from nuclear tests. The areas of the Semipalatinsk test site on which the individual annual exposure dose can exceed 1mSv total almost 1800 km2. Furthermore, there are risks connected with the migration of radio nuclides through underground waters;
- Sites belonging to the oil and gas production industry where soil is contaminated by oil and natural radionuclides, as well as those on which radioactive pipes and equipment are stored;
- Absence of the full scale monitoring of radionuclides behaviour on sites of radioactive wastes allocation that results in insufficient data on the quantities of radionuclides in potable water and a foodstuffs, and consequently to the difficulty of estimating real exposure doses to which the public is exposed;
- Problems related to the long-term storage of RW and its disposal and the duration and scope of institutional control have not been defined.

Additionally, the following problems which require urgent and/or detailed analysis have been identified:

- The BN-350 reactor project did not consider the sorting and processing of solid radioactive waste (such waste is mainly stored in heaps in storage cells and trenches) and did not consider equipping for the removal of

radioactive waste from storage cells and trenches.

- There is a critical situation with the storage of liquid radioactive waste (LRW) from BN-350, caused by the corrosion of the tanks in which it is stored. Moreover, the existing tanks lack sufficient capacity to accept new LRW which will inevitably be produced in the course of reactor decommissioning.
- Spent fuel from the BN-350 reactor is packed and placed in metal-concrete containers for its dry storage for 50 years. However, the final decision on the management of spent nuclear fuel from BN-350 reactor has not yet been made and there is no corresponding infrastructure for its management.
- Since the 1970s in Kazakhstan, the radioactive waste from industrial enterprises, medical, research and development institutions has been ”disposed of” at the storage facilities without processing and without any safety assessment. These storage facilities have not been designed for the multilevel safety system for disposal and protection of the environment, and have not been licensed.
- Solid radioactive waste from industrial enterprises, medical, research and development institutions is ”disposed of” at different sites at the storage facilities of the Ulba Metallurgical Plant, MAEC KAZATOMPROM, NNC RK without any sorting, processing and conditioning. About 40,000 disused ionizing radioactive sources with a total activity of ~3×1015 Bq are ”disposed” of at the NNC RK storage facility. The long-term safety of radioactive waste storage at such “disposal facilities” has not yet been justified.
- The long-term safety of radioactive waste storage at so called “disposal facilities” has not yet been assessed.
- The classification of RW storage/”disposal” sites and keeping of the cadastre which should reflect the current situation with regard to radioactive waste in the country is not being carried out at present.
- The existing funding mechanism is sufficient only to maintain the achieved level of safety at the facilities. Modernization and reconstruction of the existing storage facilities, construction of new storage facilities, other installations within the radioactive waste management infrastructure, as well as measures on improving their safety are not financed at all at present.
- The regulatory and legal framework of Kazakhstan does not fully support the needs of practical activities in the field of radioactive waste management.

## 3.2 Main outcomes

Considering the results of the Threat Assessment Report, in the context of the present project attention was given to the elaboration of different draft regulations such as a proposal for a new radioactive waste classification system. This report also proposed a concept for RW management policy and strategy in the RK and presented a draft of the regulations on the disposal of low- and intermediate-level short-lived waste, low- and intermediate-level long-lived and high-level waste in the RK, as well as a draft of the regulations on radiological protection and radioactive waste management in the extractive and processing industries of Kazakhstan.

Special emphasis was given to the regulations on RW management for uranium mining by underground leaching, since at present, all uranium in Kazakhstan is mined by such a method. Taking into account that until recently, the management of radioactive waste by extractive and processing companies in Kazakhstan has been regulated inefficiently, the introduction of the above regulations will allow an improvement to a considerable extent in the system of radioactive waste management by the active enterprises and minimize the possibility of leaving the Government of Kazakhstan with additional non-rehabilitated and contaminated sites to be considered in the future as new liability sites.

### 3.2.1 Proposal for a new radioactive waste classification system

A detailed report containing a proposal for the new classification system was elaborated on in the context of this project [4].

There have been several basic RW classification schemes in the history of the RK. At present, the country uses the radioactive waste classification systems defined in the following documents: "Sanitary Regulations for Radioactive Waste Management (SPORO 1997)", "Ecological Code 2007" and "Sanitary-Hygienic Requirements for Ensuring Radiation Safety 2003" (SGTPORB-2003), the second document being adopted 10 years after the first. Moreover, the classification schemes introduced by SPORO 1997 were based on the RW management system implemented at that time in the former USSR.

According to the SPORO 1997, radioactive waste is classified according to the aggregative forms: liquid, solid and gaseous.

Liquid radioactive waste (LRW) comprises organic and inorganic liquids, pulps and slurries not subject to recycling, the specific activity of which is ten times more than the values of the "intervention levels" in water given in NRB-2012.

Solid radioactive waste (SRW) comprises spent disused radionuclide sources, non-recycled materials, products, equipment, biological objects, soil and also solidified liquid radioactive waste, in which the specific activity of radionuclides is greater than the values of the "minimum significant specific activity" (MSSA) given in NRB-2012, and when the radionuclide content is unknown, the specific activity is more than:

- 100 kBq/kg – for beta-radiation sources,
- 10 kBq/kg – for alpha-radiation sources,
- 1.0 kBq/kg – for trans uranium radionuclides.

Gaseous radioactive waste comprises non-recycled radioactive gases and aerosols originating from production processes, with the activity concentration exceeding the levels of admissible activity concentration (AAC) given in NRB-2012.

The report presents information on different ways of classifying solid RW into three types depending on an exposure dose rate value at 0.1 m distance from the waste surface: low-level (10-3 ÷ 0.3 mSv/h); intermediate-level (0.3 ÷ 10 mSv/h) and high-level (> 10 mSv/h). This scheme is considered to be convenient for the planning and realization of RW transport operations. However, it is clear that such classification is inapplicable for radioactive waste disposal. Another scheme sub-divides SRW depending on the degree of its surface contamination. While this scheme can be convenient for the treatment and sorting of RW before its decontamination, it is still inapplicable for radioactive waste disposal.

The third scheme sub-divides liquid and solid RW depending on the value of specific activity of radionuclides contained therein; it was introduced in SGTPORB-2003 and developed in the "Ecological Code 2007", which has been in force in Kazakhstan since 2007. In practice, this scheme was only applied to liquid RW. It is necessary to note that the direct disposal of liquid radioactive waste is prohibited at the legislative level in Kazakhstan. The status of SRW with the specific activities of transuranics within 1 kBq/kg and 10 kBq/kg is not quite clearly defined either.

The commercial use of materials and products with low levels of content of radionuclides is permitted in compliance with the SGTPORB-2003. The decision-making criteria for a possible commercial use of raw materials and products containing radionuclides is an anticipated individual annual exposure dose that should not exceed 10 μSv if used as planned, and an annual collective effective dose that should not exceed one man×Sv.

At present in Kazakhstan, at the stage of designing the processes generating RW and at the stage of selecting and justifying compliance with the requirements for waste storage facilities, a certain classification group was defined and presented in the Report.

The system of radioactive waste classification in the RK mainly satisfies the requirements for radiation safety and efficiency for predisposal radioactive waste management. But the same system does not satisfy the requirements for completeness and efficiency at the stages of conditioning radioactive waste and its further final disposal. The existing systems of RW

classification are rarely applied to disused sealed radioactive sources (DSRS).

The main idea of the new classification scheme follows the IAEA recommendations on the basis of the national policy and strategy (concept) for RW management in compliance with the degree of long-term waste isolation required for ensuring safety, taking into account the economic and social factors and the availability of necessary technologies for RW treatment in the country. Considering that there is still no commonly accepted and official strategy for RW management in the RK at present, the proposal was based on the list of radioactive waste and management technologies already existing in the RK, taking into account what will inevitably take place in near future.

The elaborated report "Proposal for New RW Classification in Kazakhstan" [4] provides very detailed justification of the proposed new classification scheme. In Kazakhstan following the findings obtained as a result of threat assessment analysis, priority was given to the elaboration of a new classification of radioactive waste for its long-term management. The following classification was recommended:

1) "very low-level waste",
2) "short-lived low- and intermediate-level waste",
3) "long-lived low- and intermediate-level waste" and
4) "high-level waste".

If necessary, the given classification may be supplemented with such types as:

5) "exempt" and
6) "very short-lived" RW.

The suggested classification should be also supplemented with provisions admitting the identification of large volumes of waste containing low concentrations of naturally occurring radionuclides, as well as disused sealed radioactive sources as particular groups of RW requiring special treatment. As the first step in the development of a new RW classification in Kazakhstan it was suggested considering introducing a new class of radioactive waste - "very low-level waste" - for solid radioactive waste. This class would include large volumes of waste containing low concentrations of naturally occurring radionuclides.

Methods for the disposal of different classes of waste must be defined together with the development of corresponding concepts of radioactive waste disposal and relevant criteria for waste acceptance for disposal.

A list of waste inspection parameters and standard procedures for their definition in order to specify radioactive waste must be prepared in compliance with the classification system requirements, radioactive waste registration system, and waste acceptance criteria for disposal and the requirements of the safety analysis reports.

### *3.2.2 Criteria for acceptance of waste for long-term storage and disposal*

In reviewing the radioactive waste classification system, the national counterpart also decided to review the basis and practice for establishing waste acceptance criteria in Kazakhstan.

According to the IAEA recommendations, the top-priority reason for the development of waste acceptance criteria (WAC) is ensuring the required radiation protection of the public and the environment in compliance with the international principles of radiation protection. These are quantitative or qualitative criteria specified by the regulatory body, or specified by an operator and approved by the regulatory body, for radioactive waste to be accepted by the operator of a disposal facility, or by the operator of a storage facility for storage. WAC might include, for example, restrictions on the activity concentration or total activity of particular radionuclides (or types of radionuclide) in the waste, or requirements concerning the waste form or packaging of the waste. These principles should be applied at all stages of long-term waste management, including the conditioning and packing of waste, as well as at the stages of operation and shutdown of RW disposal facilities. WAC are used for assessing the acceptability of waste packages as regards the safety requirements for particular disposal systems, including an object for final disposal as a whole.

The definition of WAC is an iterative process which should be implemented together with the designing of RWDF starting from the earliest stage and based on the results of assessing the designed characteristics of every phase of the disposal system.

Kazakhstan has some experience in developing WAC for some categories of radioactive waste. These WAC can act as a base for further WAC development, in particular for waste produced during the operation and decommissioning of the BN-350 reactor and research reactors in NNC RK, as well as for nuclear power units planned to be built in Kazakhstan in the future.

Requirements regarding the definition of WAC for low- and intermediate-level RW for its disposal at near surface disposal facilities are stipulated in the Kazakhstan normative document "Safety Regulations for the Near Surface Disposal of Radioactive Waste 2005" (PBPZRO-2005).

Normative documents for the long-term storage of radioactive waste have not yet been developed in Kazakhstan. Because of a lack of corresponding normative documents in the Republic of Kazakhstan, the WAC for its long-term storage can only be developed for each particular case. The issue concerning the WAC definition of unconditioned waste remains unsettled. Nevertheless, it is important to note that the IAEA Safety Requirements (SSR Part 5) establish that "waste packages and unpackaged waste accepted for emplacement in a disposal facility shall conform to criteria fully consistent with and derived from the safety case for the operational and post-closure safety of the disposal facility". Waste acceptance requirements and criteria for a given disposal facility are developed by the facility operator and approved by the regulatory body. These requirements ensure the safe handling of waste packages and unpackaged waste in normal and abnormal conditions and the fulfilment of the safety functions of the waste form and waste packaging with regard to long-term safety. The WAC specify the characteristics and performance requirements of the waste packages and the unpackaged waste to be disposed of, such as the radionuclide content or activity limits, the heat output and the properties of the waste form and packaging.

It is obvious that for the planned RW disposal facilities, for which a partial or full concept of long-term management is available, only the preliminary criteria for the acceptance of waste packages can be developed. These should specify the requirements for the characteristics of packed waste in a conservative way. As the concept of waste disposal is being developed, the criteria may gradually lose their conservatism until they become the particular RW acceptance criteria for the functioning disposal facility.

Assuming that such an approach could be applied in Kazakhstan too, the requirements for the establishment of acceptance criteria for the disposal of low- and intermediate-level waste at a near surface disposal facility, stipulated in the normative document "Safety Regulations for the Near Surface Disposal of Radioactive Waste 2005" (PBPZRO-2005), may be expanded to other facilities to the level of preliminary WAC for other classes of waste for which the requirements for its long-term management have not yet been developed in Kazakhstan.

The set values contained in this document, in particular those concerning the admissible levels of activity and radionuclide content, should be verified according to the specific safety assessment and safety case and adapted to the specific packages which will be used for other types of waste, taking into account the selected disposal option for the given type of waste. One of the major challenges in Kazakhstan is the management of waste produced from the uranium mining industry, oil-gas industry and nuclear explosions. In particular, the clearance and reference levels for the rehabilitation of contaminated sites remain the main issue. As for the rehabilitation of the Semipalatinsk Testing Ground, it is recommended not to apply general standards for waste management, but to control it as an existing exposure situation and to develop the corresponding intervention criteria.

In general, the development of requirements for the elaboration of the WAC for different types of waste and facilities should be the goal for a Kazakhstan state authority for radioactive waste management which it is recommended is established in future. Nevertheless, as the establishment of such a state authority can be a long process, the work on developing

requirements for the elaboration of the WAC can be started in near future by the NAK "KAZATOMPROM", NNC RK and NTSC in close co-operation with the regulatory authority KAEC RK and other interested parties.

It is also considered reasonable to start work on developing preliminary WAC for the disposal of very low-level waste, which it was initially recommended be introduced in the Republic of Kazakhstan.

The regulatory authority the Atomic Energy Committee of the RK will approve the WAC for the disposal of very low-level radioactive waste, including the large volumes of radioactive waste with low concentrations of naturally occurring radionuclides.

It is necessary to underline once more that the processing of radioactive waste which lacks a functioning disposal facility may be carried out in compliance with the preliminary WAC stipulated in accordance with the requirements for a conceptual disposal facility. However, it is necessary to specify a type of disposal facility (i.e. near surface, surface or deep geological formations) prior to developing such preliminary WAC.

### *3.2.3 Concept for a radioactive waste management strategy in Kazakhstan*

As mentioned above, the introduction of a new radioactive waste classification system requires a clear-cut vision of the goals. The final goal of RW management is its safe disposal. The achievement of this goal is defined by the radioactive waste management policy and strategy to be developed in the country. Without any concept of RW management strategy in Kazakhstan it makes no sense to introduce a new waste classification system in the country. That is why, in order to support the logical integrity of the given report, a concept for a radioactive waste management strategy in Kazakhstan has been proposed.

It is obvious that the development of a final policy and strategy can be made only after additional studies and auxiliary analysis, including a feasibility study on the aspects concerning RW management. However, the authors of the given report consider that the suggested concept for a RW management strategy is the most acceptable for the Republic of Kazakhstan.

Moreover, the authors of the given report believe that it will be impossible to realize the officially adopted programme for speeding up industrial development in Kazakhstan without developing the nuclear power industry in the country. That is why the suggested concept for a RW management strategy, in addition to the management of previously accumulated radioactive waste, considers the management of RW which will be produced in future, including waste being generated by new nuclear power plants and arising from their further decommissioning.

Taking into account the scope of the existing problems and challenges mentioned above, the solution is likely to involve elaboration and approval by the government and systematic realization of the state policy in the sphere of radioactive waste management on the basis of the development and introduction of a long-term strategy for radioactive waste management.

The goal of the strategy to be developed would be the completed establishment and guaranteed effective functioning of an integral radioactive waste management system in Kazakhstan, allowing for the achievement of the safe management (including disposal) of radioactive waste of all types and categories accumulated in previous years, arising at present and produced in future, with a rational use of financial, engineering and human resources, taking into account international practice.

The most important thing for establishing such a system is the development of legislative and regulatory principles and infrastructure allowing the complete cycle of management of radioactive waste of all types and categories from its production to its disposal. The main elements of the legislative and regulatory principles and infrastructure are:

- Legislative acts, standards, regulations and guidelines in the sphere of radioactive waste management;
- State administrative authorities in the sphere of radioactive waste management and state regulatory authorities for nuclear and radiation

safety empowered to enforce the legislative and regulatory framework;

- Specialized enterprises carrying out conditioning, transport, storage and disposal of radioactive waste;
- Equipment and technologies for collecting, sorting, processing and packing radioactive waste, and vehicles and packing sets for transport of radioactive waste;
- Facilities for the predisposal management, interim storage and disposal of radioactive waste;
- Financing of current radioactive waste management and operation of facilities at all stages of their life-cycle until the exemption of radioactive waste from regulatory control and establishment of new enterprises for its processing, storage and disposal.

The RK needs to establish a national policy with the main principles, objectives and definitions of responsibilities, including a financial mechanism. On the basis of this policy, a national strategy should be developed by the national organization in charge of the radioactive waste management of radioactive waste. This strategy should be coordinated or approved by the regulatory body and finally by the government. The policy and the strategy must be reviewed periodically: the policy in 10 -15 years and the strategy around every 5 years. Revisions should be at governmental level.

It is assumed that realization of the policy and strategy should start just after their development and governmental approval on the basis of the suggested concept. Hence, the actions aimed at decreasing the existing level of threats can be divided into two categories: what should be done in the long-term and what can be realized in the near future. For the long-term, it is necessary to transfer safely radioactive wastes accumulated in Kazakhstan to the licensed radioactive waste disposal sites. A proposal for the realization of the strategy may be carried out in several stages.

It is reasonable to expect completion of the following actions during the first stage of 5-15 years' duration:

- To compile a complete cadastre of existing RW in the country, namely: to carry out a full inventory of every RW "storage/disposal" site; to assess the risk associated with the existing "storage/disposal" sites, including those "disposal" facilities that were erected during the Soviet period; to classify these in accordance with their degree of risk, availability of time required to prevent dispersion of radionuclides, and to make a decision on their further management (for instance, concentrated re-disposal and localization at one disposal facility or local isolation of RW); to carry out zoning of the sites by their degree of risk and to establish priorities; to introduce centralized and permanent accountancy of RW on the basis of annual inventories.
- To assign responsibilities for the elaboration of the safety assessment and safety case required in each case.
- To investigate or to determine the main existing waste streams and further potential waste streams in the country.
- To adopt a law on radioactive waste, in which it will be necessary to define a clear-cut state policy concerning RW management, and to approve the national programme concerning radioactive waste including nuclear waste, to clearly establish the state regulation and responsibilities/duties of the participants involved in realizing the RW management strategy. This policy and strategy will define the end management points for the considered categories of radioactive wastes and suitable technical options for RW management. This law should also consider the creation of financial mechanisms and funding for sustainable radioactive waste management activities and facilities.
- To improve legislative acts, standards and regulations consistent with latest international recommendations in the sphere of radioactive waste management, decommissioning and remediation of existing exposure

situations, including the clarification and implementation of exemption and clearance criteria and levels.

- To ensure the establishment of a protection (remediation) strategy for the existing exposure situations; define the objectives to be achieved by means of the protection strategy; specify appropriate reference levels and criteria for deriving reference levels which can be directly measured when implementing radiation control.
- To ensure that regulation provides for the involvement of interested parties in decisions regarding the development and implementation of protection strategies as appropriate; ensuring that information is available to individuals subject to exposure to potential health risks and on the means available for reducing their exposures and the associated risks.
- To develop criteria and hygienic specifications for the rehabilitation of sites contaminated by radionuclides that could provide socially comprehensible guarantees of radiation safety for the population local to the sites with radioactive contamination.
- To develop a proposal for a new classification of radioactive wastes including identification of corresponding categories because the existing classification system in Kazakhstan does not link each category of radioactive wastes to the end management point.
- To develop and approve safety criteria and requirements (regulations) for the design, sitting, construction, operation, closure and establishment of institutional control needed for disposal facilities in accordance with the approved national policy and strategy on radioactive waste management.
- To review and strengthen the regulatory basis for the licensing of future disposal facilities including the elaboration and independent review of the safety assessment, safety case and environmental impact assessment;
- To establish safety requirements for the development of the safety assessment and radiological impact assessment for the contaminated sites and, in accordance with the results of these assessments, to take the necessary measures to reduce the risks on the contaminated sites.
- To implement in the short term the authorization process for all radioactive waste management facilities and activities. To assign responsibilities for the elaboration of the safety assessment and safety case required in each case.
- To strengthen enforcement mechanisms to avoid the repetition of the existing exposure situations and to implement the national policy and strategy for radioactive waste management, decommissioning and remediation properly and in accordance with regulatory framework.
- To organize long-term monitoring and control (institutional control) over the abandoned objects of the uranium industry, nuclear test sites and oil and gas production sites, and to build fences to prevent unauthorized access to the contaminated sites where necessary.
- To establish a national organization for long-term radioactive waste management, including its long-term storage and disposal.
- To form an effective mechanism of financing radioactive waste management.
- To ensure the safe operation of existing RW management facilities.
- To start the removal and conditioning of operational radioactive waste from the storage facilities at BN-350, in NNC RK, at the Ulba Metallurgical Plant.
- To upgrade or to extend installations on the basis of good practices and

tried-and-tested technology for processing, conditioning and packing radioactive waste according to the approved national policy and strategy and waste acceptance criteria for the acceptance of radioactive waste storage and disposal.

- To start work on siting, designing, constructing and commissioning facilities for the disposal of very low-level waste and short-lived low- and intermediate-level waste, as well as a centralized storage facility for the interim storage of high-level and long-lived low- and intermediate-level waste.
- To make a decision on the feasibility of constructing a disposal facility in deep geological formations if the programme for developing the nuclear power industry in Kazakhstan (planned construction of new NPPs in the country) is to be adopted. In the case of a favourable decision, to start work on selecting a site for the construction of a disposal facility for high-level and long-lived low- and intermediate-level waste in deep stable geological formations.
- To develop a national programme for staffing and training the required human resources for implementing the national policy and strategy for radioactive waste management.
- To strengthen the trust of the public concerning radioactive waste management in Kazakhstan.

It is presumed the following will be realized during the second stage (from 35 to 40 years):

- To rehabilitate the sites contaminated with waste from the uranium mining and oil-gas industries.
- To develop technologies and equipment, and perform rehabilitation work on the sites contaminated as a result of nuclear explosions in Kazakhstan.
- To complete the elimination of dangerous storage facilities for radioactive waste, including those erected during the Soviet period and prior to the introduction of RW regulation in Kazakhstan.
- To continue the removal and conditioning of operational radioactive waste from the storage facilities at BN-350, in NNC RK, at the Ulba Metallurgical Plant, and to hand it over for disposal.
- To develop and implement a research and development programme for site selection and the establishment of disposal sites, the development and approval in due course of a feasibility study on developing a point of disposal; to study the characteristics of the selected sites, development of radioactive waste disposal technology and the construction of disposal sites; design and conduct the necessary assessment of the security; implement the construction, licensing and commissioning.
- To accomplish work on the construction and commissioning of assets for the disposal of very low-level waste, short-lived low- and intermediate-level waste, as well as a centralized facility for the interim storage of high-level and long-lived low- and intermediate-level waste.
- To dispose of all the accumulated very low-level waste, short-lived low- and intermediate-level waste.
- To carry out the safe interim storage of high-level and long-lived low- and intermediate-level waste.
- In the case of a favourable decision on the feasibility of constructing a disposal facility in deep geological formations, to design, construct and commission a storage facility for the disposal of high-level and long-lived low- and intermediate-level waste in deep stable geological formations.

Notwithstanding the fact that the issues of financing RW management in Kazakhstan require an additional thorough study, one can already assume that it will be feasible to develop an effective mechanism for financing activities in the sphere of radioactive waste management if the following is done:

- Establish a state fund for RW management.
- Define a procedure for reducing the amount of state subsidies for RW management and increasing the financial contribution made by the producers of radioactive waste (along the lines of 'polluter pays'). Control the end use of the state fund for radioactive waste management.
- Define a procedure for financing reconditioning work when needed, storage and the disposal of historic radioactive waste arising from practical activity during the Soviet period.
- Provide constant and sufficient financing of measures for radioactive waste management.

To improve the system for managing radioactive waste from industrial enterprises, medical, research and development and other institutions, as well as "historic" radioactive waste produced during the Soviet period, it is plainly advisable to found regional specialist plants for the collection, conditioning and storage of radioactive waste with its further transfer for disposal to the regional disposal facilities. The mentioned process can be carried out by means of:

- Establishing regional specialist plants for conditioning radioactive waste from industrial enterprises, medical, research and development and other institutions in compliance with the acceptance criteria for disposal and storage at the regional disposal facilities (in particular, the introduction of updated systems for identifying and controlling disused ionizing radiation sources and radioactive waste) and ensuring their safe operation. The state should promote the reuse and reprocessing of ionizing radiation sources in every possible way when it is practicable and acceptable from the point of view of safety and security
- Assessing the safety status of the "disposal" facilities of the specialized enterprises for radioactive waste management and other organizations; development of technologies for the removal of radioactive waste and relevant equipment for the re-disposal of all or part of the radioactive waste at the regional disposal facilities.
- Developing and introducing technology (on the basis of proven technology and best practices) for conditioning disused sealed radioactive sources for their long-term storage, taking into account their further disposal.
- Reassessing the safety status of radioactive waste "disposal" facilities, which were established during the Soviet period and putting them in an ecologically safe condition.

To improve the infrastructure for the safe transport of radioactive waste from producers or the sites where it has accumulated to the storage or disposal facilities it is necessary to:

- Certify a fleet of containers for packing and transporting radioactive waste of all types and categories, taking into account the needs at various stages of waste management and the procedures and conditions for handing it over for storage or disposal to the corresponding storage/disposal facilities.
- Arrange s fleet of vehicles and monitoring instruments for transporting radioactive waste both within the industrial sites and from producers to the specialist radioactive waste management enterprises.

It is necessary to envisage and realize an authorization process at all the stages of the radioactive waste management process which elaborates on the safety assessments and safety cases which will include measures on emergency preparedness and emergency response for any incidents and emergencies.

### *3.2.4 Regulation for the disposal of radioactive waste. Main safety criteria*

In the context of this project, a draft regulation was developed for the disposal of low-intermediate level short-lived, low-intermediate level long-lived and high-level

waste in the Republic of Kazakhstan. It covers the key criteria and principles for safe disposal. The regulation for the disposal of very low-level waste in the Republic of Kazakhstan has not yet been developed, since the introduction of this category of waste is expected to take place in the future and, accordingly, the development of these rules will be the subject of further work.

The proposed regulation sets forth the principles, criteria and basic safety requirements for the near-surface disposal of radioactive waste and for the disposal of high activity radioactive waste in deep geological formations, and seeks to avoid an unacceptable level of risk to human health and the environment in the present and in the future. This draft regulation will establish requirements for the safety assessment, site selection, design, operation and closure and institutional control of disposal facilities for solid and solidified radioactive waste. These regulations should be considered by the institutions and organizations which participate in activities relating to the generation of radioactive waste requiring disposal.

The regulation establishes the requirements for the safe disposal of the following types of solid or solidified radioactive waste:

- waste arising from the use of radioisotopes in various industries;
- waste (equipment, facilities) produced during the extraction, processing and transportation of minerals (gypsum, phosphate, non-ferrous and rare metals, lignite, natural gas, crude oil) or containing surface materials contaminated with radioactive substances above the specified limits;
- waste arising from the operation or decommissioning of sites and facilities, including nuclear weapons, in which radioactive materials are produced, stored or used.

This draft regulation tried to establish quantitative and qualitative acceptance criteria for the disposal of radioactive waste, which are based on:

- establishing limits for the specific activity of radionuclides in the waste;
- limiting the total activity of radionuclides to be disposed of in each batch of radioactive waste for disposal;
- establishing standards for the waste form and packaging for disposal.

It is important to note that, according to the IAEA safety recommendations, waste packages and unpackaged waste to be accepted for emplacement in a disposal facility shall conform to criteria that are fully consistent with, and are derived from, the safety case for the disposal facility in operation and after closure. This means that it is difficult to establish quantitative criteria for the waste acceptance criteria without considering the specific design and features of the disposal facility. Waste acceptance requirements and criteria for a given disposal facility have to ensure the safe handling of waste packages and unpackaged waste in conditions of normal operation and anticipated operational occurrences. They also have to ensure the fulfilment of the safety functions for the waste form and waste packaging with regard to safety in the long term.

### *3.2.5 Regulations on Radiological Protection and Radioactive Waste Management in the Extractive and Processing Industries of Kazakhstan*

There are three main sources of radiation exposure for personnel in the extractive and processing industries of Kazakhstan: external gamma-radiation from ore, concentrates, etc.; inhalation of dust containing long-lived alpha-emitting radionuclides; and inhalation of short-lived products of radon decay. Therefore, it is necessary to take thorough measures on radiological control over the mining and processing of minerals containing radioactive ores to protect people involved in such activities and control the implementation of the requirements for dose limitation.

Significant radiation exposure can also occur in the mining and processing of ores generally not referred to as radioactive,, as well as from depositions, mineral sediments, etc. that can accumulate in oil and natural gas production. Such exposure can lead to personnel receiving doses exceeding the established limits, thus making the radiological control measures necessary.

As a rule, the mining and processing of radioactive ores lead to the production of a large volume of radioactive wastes. The tailing dumps of uranium mills are the dominant form of waste. The improper treatment of such wastes can lead to doses significantly exceeding the dose limits for people. The wastes of other plants for the mining and processing of minerals, including oil or natural gas production, can also lead to a significant exposure of the personnel and public if the waste is improperly treated.

The suggested regulations cover the regulatory and organizational aspects of controlling personnel and public exposure in the extractive and processing industries of Kazakhstan, as well as the aspects of managing radioactive wastes produced in these industries. The regulations describe the radiation protection system that is to be applied to the technological processes in the extractive and processing industries and to their wastes, and define the role and responsibilities of different interested parties.

Most of the wastes of industries covered by the given regulations contain, in addition to radionuclide components, other contaminants that can pose a hazard to human health or the environment. Notwithstanding the fact that the given regulations do not apply to the management of the above contaminants, when developing the system for managing radioactive materials and wastes, relevant consideration shall be given to these dangerous matters.

Wherever feasible, it is necessary to treat all radioactive wastes produced at mineral mining or processing sites in compliance with the provisions of the given regulations. Very low-level wastes can be disposed of on mining sites. For the near-surface disposal of low- and intermediate-level short-lived wastes it is necessary to follow the aforementioned regulations on RW disposal in Kazakhstan that were developed in the context of this project.

## 3.3 Tajikistan

Although Tajikistan is not a nuclear country, it was one of the most important sources of uranium and rare earth metals in the former USSR. There are many sites in Tajikistan where uranium, heavy metals and other high-risk technological waste are buried. Many of the tailings and waste dumps are located in active seismic regions, mudflow areas, areas prone to flooding groundwater, as well as near rivers that form the basis of the extensive river basin of Central Asia. There is no nuclear fuel in the country but there are high level wastes – from radioisotope thermoelectric generators (RTGs) which are temporarily stored in the Republican Waste Storage Site (50 km from Dushanbe) and uranium tailing dumps located in the north of Tajikistan. Radioactive wastes in Tajikistan originate mainly from the use of radioactive sources in medicine but also from uses in research, education and industry.

The problem is extremely serious and the potential consequences associated with its poor political decision could have an impact on the ecology of Central Asia. Those areas where there are large quantities of man-made uranium require complex scientific and practical research involving scientists from all the Central Asian countries because there is still no regional scientific data on uranium tailings and waste dumps. At present, Tajik scientists are actively working to resolve the aforementioned problems: several international projects are being run through the ISTC, NATO and IAEA to improve the material and technological base of specialized laboratories and some results have been obtained for presentation and discussion.

Most of these projects were directed at developing a system of monitoring those uranium tailing dumps and establishing the laboratories for maintaining the monitoring. None of these projects took into account the legal framework that is the core for carrying out remedial and control activities on these uranium tailings.

### *3.3.1 Regulatory Threat Assessment Report; Tajikistan*

Tajikistan has a number of uranium ore deposits and mining and milling facilities which operated in the past. The country's own ores and imported raw materials were processed mainly at the former Leninabad Geochemical Combine facility (currently State Enterprise (SE) "Vostokredmet") and also at other hydro-metallurgical plants located in the vicinity of uranium ore extraction sites (Adrasman, Taboshar, Isphara, etc.). Presently, the only operating enterprise in the Republic of

Tajikistan which still has the potential to process uranium ores using an acid leach extraction process is the SE "Vostokredmet". This enterprise is also responsible for the storage and safe management of the ten tailings facilities and waste rock piles which are situated in the vicinity of each of the former uranium facilities. Due to the recent significant increase in the price of uranium, the uranium mining residues have become a focus of interest for various different investors and commercial companies who are considering reprocessing the waste rock piles and mill tailings of northern Tajikistan.

It is interesting to note that the mine wastes at the Adrasman site were recently successfully reprocessed to produce a lead concentrate. Otherwise, all underground and open pit mines and old radium and uranium facilities have been closed and decommissioned, but most of them are still not remediated.

Based on the estimates of SE "Vostokredmet", the total amount of residual uranium in the tailings and waste rock piles in the Republic of Tajikistan is about 55 million tons. The total activity of these wastes is estimated to be approximately 240-285 1012 Bq. The total volume of waste rock piles and tailings in the vicinity of former hydrometallurgical plants and chemical-leaching sites is more than 170 million tons.

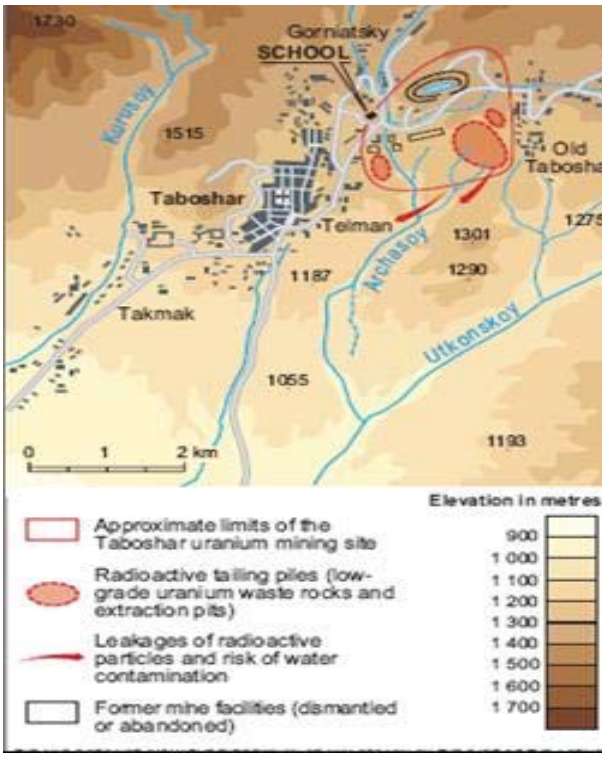


*Fig.4. Taboshar tailing site (Source UNDP 2005)*


*Fig. 5. Scheme of Degmay tailings in the surroundings of Khudjand and Chkalovsk. (Source NRSA, Tajikistan)*

The waste rock piles and tailings at Taboshar (Fig.4), Adrasman and Degmay (Fig. 5) (which is on the outskirts of Chkalovsk) are not well contained. In particular, the surfaces of the tailings usually have no protective cover and the surface is eroded or damaged by burrowing animals. There is exposure of significant amounts of contaminants, which are subject to dusting and wind blow. Covers over these tailings and waste rock piles are usually washed away by water, mudslides and wind, thus becoming a source of highly contaminated drainage water that migrates into surface and ground water bodies. The local population commonly uses the same sources of water. In many areas where water is in short supply it is common to have livestock grazing and watering using such contaminated waters; local horticulture also uses these drainage waters for irrigation and even for rice paddies and orchards located near the sites of uranium waste piles.

Illegal excavation and collection of non-ferrous metals from tailings and waste rock piles and mines has become more frequent. This creates serious concerns regarding the transfer of contamination as well as the exposure of the individual diggers. There is a concern that these metals are sold on at local, illegal markets in Tajikistan or even transported abroad.

Taking into consideration the available world practice and experience in the field of supervision former uranium facilities, it is necessary to note that the management of waste from the mining of uranium ores and uranium extraction is an important issue in guaranteeing environmental and public radiation safety. The existing uranium industry waste tailings impoundments in the Tajikistan Republic have been partially rehabilitated. However, the condition of all the tailings impoundments in the town of Taboshar, in particular the “Poor Ores Mill”, requires intervention to prevent the potential threats. That is why it is necessary to complete an action plan during the first stage of the rehabilitation work at the uranium tailings impoundments. During the second stage it is necessary to fulfil the corresponding rehabilitation actions at other uranium tailings impoundments.

The rehabilitation work requires large financial investment. It is necessary to provide for the secondary processing of the uranium waste with investments made by national and foreign companies, funds and sponsor-countries.

Given the urgency of the problem, the joint project was initiated by the Norwegian Radiation Safety Authority (NRSA) and the NRPA. This project was totally devoted to resolving this basic problem, taking into account international experience. A set of documents was developed with the intention of establishing safety requirements for the safe management of those uranium wastes.

As part of this joint project with Norway, the regulatory authority of Tajikistan received substantial expert assistance with improving their legislative basis and developing new laws. Qualified international experts provided comments and proposals on improving or elaborating new regulatory and legislative documents. However, none of the actions taken can guarantee that the improved or elaborated regulatory framework developed under this joint project is enough for the safe management of radioactive wastes. In Tajikistan, it is necessary to develop another set of new documents in order to have a full set of documents for the safe management of radioactive waste, and to train the inspectors of the regulatory authority to perform their inspection activities professionally, and require users to comply with the license conditions. The lack of professional inspectors contributes to the barriers against issuing the necessary licenses and further control of the sites. These problems will be addressed in future project activities with the NRPA.

Until recently, radioactive waste management in the Republic of Tajikistan was basically regulated by sanitary rules created between 1984 and 1991 (when Tajikistan was part of the former USSR) and also by a number of legislative documents which relate to the subject of industrial and other toxic waste management in general.

The development of special standards in the sphere of radiation safety was promoted by the advancement of international cooperation between the Republic of Tajikistan and the IAEA. In 1997, Tajikistan ratified the “Treaty on the Non-Proliferation of Nuclear Weapons”. In accordance with the statements of this treaty

another agreement was signed in 1999 between the Republic of Tajikistan and the IAEA: the "Agreement on the application of safeguards in connection with the treaty on the non-proliferation of nuclear weapons" (an additional protocol on the guarantees was signed in November 2004)

A number of other important regulations in the sphere of radiation safety are currently being developed in the Republic of Tajikistan, and in particular the following:

1) Sanitary rules "Norms for Radiation Safety" (СП-2.6.1.-001-06).
2) Basic sanitary rules for establishing radiation safety (ОСПОРБ)
3) Sanitary rules for radioactive waste management (СПОРО).
4) The rules for the state accounting of radioactive materials and radioactive wastes.
5) Radiation safety requirements for scrap metal reprocessing and re-use.
6) Regulation "Management of mineral raw materials containing enhanced NORMs".
7) Regulations on the expertise of documents related to the justification of nuclear and radiation safety of planned or existing uses of nuclear and radiation sources
8) Requirements of the Nuclear and Radiation Safety Agency for carrying out the regulatory control and inspection of radiation safety at enterprises and other activities which are relevant to the radioactive materials and other sources of ionizing exposures.
9) Rules on radiation safety during transportation of the radioactive materials and radioactive wastes.

At the same time, the legal and regulatory framework of the Republic with regard to the safe management of the former uranium industries is still not well developed and therefore requires improvements and harmonization with international recommendations, in particular with the Basic Safety Standards of the IAEA. The standards and guidelines on how to provide safe management, rehabilitation and in some cases secondary reprocessing of the uranium waste rocks and tailings are either absent or not implemented because of a lack of experience. There is also a lack of adequate mechanisms for putting the already existing laws into operation properly.

In particular, there are no clear requirements for environmental monitoring and data reporting, and the assessment and recording of doses to which personnel and the public are exposed at the uranium legacy sites are not well developed. The exemption and clearance safety criteria as well as the exemption and clearance levels which have to be established and which apply everywhere including the former uranium facilities according to the IAEA BSS, have not became an effective tool for radiation protection practice and the safe management of the former facilities in the country.

In Tajikistan, the regulatory basis for uranium mining and processing (as for other ore mining and its processing activities) is not covered by regulations addressing other types of radioactive waste. Therefore, it was important to identify specifically the legislative and regulatory provisions in Tajikistan that are applicable to the former uranium facilities and to justify the solution to their problems.

It is impossible to ensure environmental and public safety and the secondary processing of uranium industry waste without the corresponding legislative and regulatory framework and professional staff. In this regard, the joint project of the Nuclear and Radiation Safety Agency of the Academy of Sciences of the Tajikistan Republic and the NRSA is highly important and timely for the Tajikistan Republic, as it provides the development of a normative legal framework for controlling uranium production waste, mining activities, secondary processing and training of professional staff that is a foundation for the implementation of any programmes concerning the uranium tailings impoundments in northern Tajikistan.

The Threat Assessment Report demonstrated that the legacy problems left behind by uranium mining and milling in Central Asia are not very different. The most important constraints for the development and implementation of efficient regulatory control,

monitoring systems and the planning and implementation of remediation plans can be summarized as follows:

1) Inadequate regulatory and legislative framework for the safe management of radioactive waste.
2) Costs of remediation and limited availability of national funding.
3) Regulatory development issues.
4) Inadequate knowledge of the inventory of legacy components and the risks associated with them.
5) Very varied public and social attitudes toward the legacy sites.
6) Inadequate legislative and regulatory framework for the operation, closure and environmental remediation of mines.
7) Lack of personnel with uranium mining and milling experience or knowledge of remediation activities.
8) Shortage of state-of-the-art equipment and machines.
9) Cross-border regional problems related to the former uranium facilities in Central Asian countries.

At present, Tajikistan needs a consistent and reliable assessment of its legacy sites and components, which should include:

- Characterization of the inventory of both radioactive and non-radioactive contaminants.
- The effluent and influent streams from the sites and emissions into the air.
- Information on the geotechnical stability of the sites, erosion, stability of the current containment barriers, if any, and the design details of the containment barriers.
- A safety assessment and an environmental impact assessment.

Developing an understanding of a site requires an appropriate monitoring and surveillance plan, including specifications of where to sample, how to sample, and how many samples must be taken, etc. The use of the recently acquired instruments and equipment should be incorporated into these plans.

The decisions regarding in-situ stabilization or relocation of residues such as tailings should be based on the assessment results obtained on the basis of the new data.

As for filling all of the gaps in the regulatory and legislative framework in Tajikistan, the following safety requirements or actions were identified for development and implementation:

- Elaborate the draft national policy and strategy for radioactive waste management to be approved and implemented by the government.
- Review, update and elaborate the necessary legal and regulatory framework for the safe management of existing exposure situations and radioactive waste. This includes the regulatory basis for the licensing of future disposal facilities, including the elaboration of safety assessments, safety cases and environmental impact assessments.
- Review, update and elaborate the necessary legal and regulatory framework (including authorization, inspection and enforcement) for the safe management of radioactive waste and radioactive waste management facilities, including those linked with the production of NORM waste.
- Clearly define how the responsible organizations will realize the national policy for radioactive waste management with use of the available technical measures and financial resources.
- Define how and when the identified objectives and tasks will be achieved.
- Define what level of competence is necessary in order to achieve these tasks, and how it will be provided.
- Develop the management pathways for each type of radioactive waste, through all stages of the RW life cycle (from the moment of generation to disposal), as part of the national strategy for radioactive waste;

- Strengthen the trust of the public concerning radioactive waste management and remedial action.
- Establish mechanisms for providing resources and funding for the safe decommissioning, remediation activities and long-term RW management.
- Guarantee the availability of sufficient and qualified human resources to perform the rehabilitation activities and safe management of radioactive wastes, including resources for training and R&D where needed.
- Implement the monitoring of radioactive waste storage facilities and disposal sites both during their operation and after their closure (including post-closure institutional control where needed).
- Perform the safety assessment and radiological impact assessment for the contaminated territories and take the necessary measures to diminish the risks in accordance with the results of this assessment.
- Carry out long-term monitoring and control over the abandoned objects of the uranium industry, and take the necessary security measures to prevent unauthorized access to the contaminated sites.
- Develop safety requirements for the design and implementation of radiation monitoring of the sites contaminated with natural and artificial radio-nuclides.
- Develop and implement projects concerning the final disposal or secondary processing of radioactive materials.
- Develop and implement the necessary projects concerning restoration.
- Introduce the safety requirements for existing exposure situations including the establishment of the quantitative criteria defining the "reference levels" and consider that the rehabilitation of the sites will be strongly dependent on the established safety criteria (reference levels) and the existing exposure situation.
- Develop criteria and hygienic specifications for the rehabilitation of sites contaminated by radionuclides. This could provide socially comprehensible guarantees of radiation safety for the population local to the sites of radioactive contamination.
- Develop regulatory documents for maintaining the radiation safety of personnel and the public during the subsequent use of the site, buildings and structures after rehabilitation. Guidance should be developed for the derived levels of residual contamination of the site with radioactive substances for several most probable options for their use after rehabilitation, for example, sites of unlimited use; sites of limited use for industrial purposes with the use of radioactive materials; sites of limited use for industrial purposes without the use of radioactive materials.
- Develop derived reference levels for the radiation parameters that can be directly measured when implementing radiation control.
- Develop a classification scheme for radioactive waste in accordance with the recently approved IAEA international recommendations in this regard.
- Develop and approve safety requirements (regulations) for the design, siting, construction, operation, closure and establishment of institutional control needed for disposal facilities in accordance with the approved national policy and strategy on radioactive waste management.
- Authorize projects concerning the secondary processing of the uranium tailings impoundments with the purpose of extracting uranium.

In the case of secondary processing of the uranium tailings impoundments and extraction of uranium or other minerals from mine

waters, it is necessary to implement and enforce an authorization process that will require the potential investors to be responsible for the implementation of the projects concerning restoration at every tailings impoundment involved. This process should include:

- Performance of a safety assessment and radiological impact assessment.
- Rehabilitation and secondary processing of the uranium tailings impoundments.
- Final disposal and rehabilitation of the off-balance ores and extraction of uranium from mine waters.
- Final disposal and rehabilitation or dislocation of the secondary processing of the uranium tailings impoundments.
- Organization and implementation of the requested (when needed) institutional control of existing tailings impoundments.

The NRPA project will give priority to these regulatory documents, which should be developed to eliminate existing gaps in the regulatory basis, based on an assessment of what possible future influence the absence of these documents might have on the public.

It is also clear that in order to remove the threats associated with the presence of radioactive wastes - both those which have already accumulated as a result of previous activity and those which are currently being generated in significant amounts and which could be produced in the future - it is necessary to develop at least the following documents:

- A national policy and strategy for radioactive waste management.
- A new classification scheme for radioactive waste, including identification of the corresponding categories.
- Safety requirements for the design, siting, construction, operation, closure and establishment of institutional control needed for disposal facilities in accordance with the approved national policy and strategy on radioactive waste management.
- Safety requirements for the management of radioactive waste.
- Safety requirements for existing exposure situations as well as a clearance policy and clearance levels to be applied.

It is also clear that in order to remove the threats associated with the presence of extensive sites contaminated by radionuclides, their rehabilitation is required and, accordingly, it is necessary to develop a legal and regulatory framework defining:

1) Responsibilities of the government, the licensees (operators) and other interested parties in existing exposure situations.
2) Justification and optimization of protective actions in existing exposure situations, including safety-related criteria such as “reference levels” and derived quantities to be directly measured.
3) Institutions or organizations to be responsible for the remedial actions and the implementation of institutional control in areas with residual radioactive materials.
4) Criteria and hygienic specifications on the rehabilitation of sites contaminated with radioactive materials.
5) Regulatory framework preventing the occurrence of similar situations in the future.

The reviewed regulatory framework of Tajikistan had shown that the normative regulatory base in the field of radioactive waste management produced in the former uranium production industry and in other uses of radiation sources has not yet been fully completed, and it requires improvement and harmonization with the latest approved IAEA Safety Standards. In particular, there is still a lack of standards and recommendations on how to provide safe management and rehabilitation. In some cases, the enterprises cannot make a decision on the expediency of the secondary processing of the uranium

production waste due to a lack of experience and adequate mechanisms for performing such work within the current legislation.

During the threat assessment process it was revealed that in first stage it was necessary to develop the following normative documents of high priority for the country with regard to radioactive waste regulation:

1) Law on radioactive waste (some provisions in this law include policy and strategy statements).
2) Rules of radioactive waste management (PORO).
3) Routine of state accountancy and control of radioactive material and radioactive waste.
4) Procedure for issuing a license on activity dealing with the exploitation, mining and production of uranium, as well as with the secondary processing of waste from the uranium industry.
5) Regulation on ensuring radiation safety for the stock-piling and disposal of radioactive scrap metal.
6) Regulation on the treatment of mineral raw material and material with a high content of natural radionuclides.
7) Regulations regarding the expert examination of documents substantiating the guaranteed nuclear and radiation safety of nuclear installations, radiation sources and quality of declared activity.
8) Rules of radiation safety in the transportation of radioactive material and radioactive waste.
9) Safety requirements for:
    a. existing exposure situations;
    b. shutdown and decommissioning;
    c. remedial actions;
    d. monitoring.

## 3.4 Main outcomes

In the context of the present project, attention was given to the elaboration of some of the aforementioned documents. The following documents were developed as part of this bilateral project:

- Threat assessment report, which revealed a weakness in the regulatory management of legacy sites in the country.
- Law on Radioactive Waste Management (which included some provisions on RWM policy and strategy – a separate document is in the process of elaboration). The current law was developed under Task 3 of the project and is currently with the Tajik Parliament for approval.
- Rules of radioactive waste management (in full compliance with IAEA standards but based on the Russian version. Inconsistencies with IAEA standards were excluded. The document has been elaborated and is pending approval by the director of the NRSA and legal approval since it is considered to be a legal document and cannot come into force without legal approval). These rules were developed under Task 3 of the current project.
- "Requirements for carrying out monitoring of sites (radiation control)". This document was developed in accordance with the IAEA Safety Standards. The document has been elaborated and is pending approval by the director of the NRSA and legal approval since it is considered to a legal document and cannot come into force without legal approval).

### *3.4.1 Law on Radioactive Waste Management*

The drafted law establishes the main principles of state policy in the sphere of radioactive waste management. The law also establishes that the financing of the government programme on radioactive waste management is carried out by the Government of the Republic of Tajikistan from a special state fund and by attracting other sources of

financing. The proposed legislative body clearly defines the governmental responsibilities in the sphere of radioactive waste management. It establishes the responsibilities of local executive bodies of the government and local authorities in the sphere of radioactive waste management. An important issue is the establishment of the national inventory of radioactive waste.

According to the draft law, licensees who perform activities at any stage of the radioactive waste management process are obliged to ensure safety during the design, siting, construction, operation and decommissioning of structures and equipment intended for radioactive waste management, and to carry out a safety reassessment of the operating facilities intended for radioactive waste management in a timely manner so that all improvements have been executed in case it is necessary to increase the safety of such facilities.

Responsibilities with regard to the storage and disposal of radioactive waste are defined in the draft law. Other issues established in the law are: the maintenance of physical protection during radioactive waste management; and the operation of radioactive waste storage facilities; closing (conservation of) radioactive waste storage facilities; the procedure of placing, designing, constructing and putting into operation the objects intended for radioactive waste management. Consideration was also given to the social guarantees for citizens who live or work in the areas where radioactive waste storage and facilities intended for radioactive waste management are located.

### 3.4.2 Guidelines for Radioactive Wastes Management (PORO-10)

These guidelines established requirements for the maintenance of radiation safety of personnel and the public for all kinds of radioactive waste management activities and facilities. It should be noted that these guidelines follow IAEA safety standards. The guidelines are extended to those organizations which produce radioactive waste as a result of their activity, organizations which collect, store, transport, process and dispose of radioactive waste, as well as those the organizations involved in the design and construction of objects in which the RW will be produced, stored, processed and disposed of.

The guidelines include the main principles of radioactive waste management; criteria for radiation safety in radioactive waste management; the basic requirements guaranteeing the safety of personnel and the public at all stages of the radioactive waste management process; collection, storage, transportation, processing and disposal of radioactive waste, both at the nuclear-power engineering enterprises and in other organizations where radioactive waste is produced.

Clear allocations of the responsibilities of the operator or licensee are established in this regulation, which include among others the elaboration of the safety assessment and safety case.

This regulation establishes the safety requirements for the development and operation of facilities (installations) and the realisation of radioactive waste management activates with regard to the location and designing of facilities, construction and commissioning of the facilities, facility operation, and shutdown and decommissioning of facilities. Requirements for reprocessing and conditioning of radioactive waste were also established.

The guidelines contain a whole chapter devoted to the control, characterization and classification of radioactive waste (RW). The proposed classification scheme is similar to the international recommendations:

- Exempt waste (EW)
- Very low-level waste (VLLW)
- Very-short-lived waste (VSLW)
- Low-level waste (LLW)
- Medium-level waste (MLW)
- High-level waste (HLW)

General requirements are provided for accepting radioactive waste from the organization. The interdependence between all stages of the waste management process should be taken into account to achieve continuity of operation and coordination of the entire radioactive waste management process.

Safety requirements were also established for the clearance and discharge of radioactive materials from regulatory control. Exemption and clearance values were provided.

Preliminary and general safety requirements are presented in the draft regulation on the disposal of radioactive waste. These requirements will need to be expanded when a clear national policy for radioactive waste management has been established and the disposal options that will be implemented in the first priority have been defined.

### 3.4.3 Requirements for Carrying Out the Monitoring of Sites (Radiation Control)

This detailed regulation provides provisions for monitoring (radiation control) enterprises dealing with the extraction and reprocessing of radioactive ores which have been closed, preserved, have changed their line of business or have been handed over for use in other fields of the economy.

Clear allocations of responsibilities of the operators were established. Operators shall establish and implement monitoring programmes to ensure that public exposure due to sources and facilities under their responsibility are adequately assessed and controlled and that the assessment is sufficient to verify and demonstrate compliance with the authorization. These programmes shall include monitoring of the following as appropriate: external exposure from such sources; discharges; radioactivity in the environment and other parameters important for the assessment of public exposure.

This regulation covers detailed requirements for monitoring and surveillance programmes that shall be carried out prior to and during the construction and operation of a disposal facility and after its closure, if this is required by the safety case. The waste disposal facilities considered include those at which waste is placed on the surface (for example, at some sites for waste from the mining and milling of uranium or thorium ore) and near to the surface (low- and intermediate-level waste). Details concerning the content and implementation of monitoring and surveillance of the surface facilities programme have been agreed upon with the regulatory authority.

Specific recommendations were formulated for different types of existing situation for which it could be necessary to implement a monitoring programme. The regulation requires that different factors need to be considered, e.g. pathway analysis, types of radiation monitoring, programmes for monitoring practices and interventions, monitoring of radioactive discharges within practices, pre-operational studies, monitoring in the operational stage, monitoring of radioactive waste disposal facilities after closure, monitoring in emergency exposure situations, education and training, recording monitoring data, environmental sampling in existing exposure situations and surveillance methods.

It is important to underline that safety requirements are also provided for dose assessment and the interpretation of monitoring results.

The NRPA rendered considerable valuable assistance in strengthening the weaknesses revealed by the jointly elaborated threat assessment report. This assistance was of great value when elaborating and reviewing the aforementioned documents and clarifying the existing national situation with regard to radioactive waste management.

It is not possible to start any activities in the country without there being legislation in place. Taking into account the EURASEC project on remediation activities in Tajikistan which is expected to start in 2013, this is a great step in the regulatory supervision of uranium tailings where remediation activities are foreseen. NRPA experts have brought all drafts elaborated by the NRSA experts in line with IAEA standards to ensure the protection of personnel, the public and the environment during the planning and execution of remedial actions for past practices and RW management in Tajikistan.

## 3.5 Kyrgyztan

In the bilateral project between the NRPA and the SAEP entitled “Support in the development of a regulatory body for radiation and nuclear safety in the Kyrgyz Republic” in 2009-2011, multilevel reporting has allowed an evaluation of the existing situation with regard to radiation safety in the Kyrgyz Republic (KR) and the analysis of gaps in policy and strategy, regulating infrastructure and the normative and legal framework. A qualitative assessment of

the revealed gaps according to the project purpose on cooperation should help the authorities of the KR to make the decision on strengthening the regulatory body for radiation safety, differentiating the responsibilities from those of the other regulatory bodies, and developing subordinate legislation for the declaration of regulatory requirements.

Summarizing the cooperation in the context of the project in the KR the following tasks have been completed: threat assessment report including analysis of the existing regulatory framework in the country; creation of a regulatory infrastructure in the KR for the safety of personnel, the public and the environment; development of a new regulatory document on radiation and ecological protection in the management of RW; development of a technical manual on specifications for the scheme of regular monitoring around RW storage in the KR.

### *3.5.1 Regulatory Threat Assessment Report; Kyrgyzstan*

The number of problems which have arisen in relation to the objects of uranium heritage in Kyrgyzstan became the precondition for beginning and developing the project entitled "Support in the development of a regulatory body for radiation and nuclear safety in the Kyrgyz Republic". In the past, the KR was one of the suppliers of natural uranium in the USSR; three out of the 11 largest manufactures of the former "Ministry of General Machine Building" of the USSR were in the territory of Kyrgyzstan. In the mountain and frontier areas of the country, the mines and factories which process the uranium ore have been in operation since 1907. One legacy of the long-term activity of these enterprises is the considerable quantities of radioactive waste in dump pits and tailing dumps. The state of these tailing dumps and dump pits today leaves much to be desired because in the period which has passed since the disintegration of the USSR, serious remedial actions have only been performed on individual objects.

The main influence on the radio-ecological situation in the KR is that of the stores used to house wastes formed by the mining and processing of uranium and thorium ores. The dominant factor leading to such a conclusion is the considerable volume of disposed wastes.

According to the data of the state cadastre of wastes, there are 35 tailing dumps and 37 dump pits of rocks within the Kyrgyz Republic (Fig. 6). Out of 35 tailing dumps, 29 stores contain the residues of processed uranium-containing ore and five tailing dumps hold materials containing thorium, a residue from the mining of rare earth elements. The total amount of solid radioactive wastes exceeds 145 million m3, and the space occupied by them totals around 650 hectares.

Since March 1999, 35 tailing dumps and 25 dump pits containing radionuclides of the uranium and thorium series have been transferred to the control of the Department of Monitoring, Forecasting of Emergency Situations and the Management of Tailing Dumps, which is a structural division of the Ministry of Emergency Situations of the Kyrgyz Republic. The department is responsible for the creation of supervision and monitoring services on the sites of the former uranium enterprises, and for preserving protective structures and the coordination of all rehabilitation programmes.

The governmental programme for the rehabilitation of uranium tailing dumps was developed before 1999, but no monitoring and recovery work was performed at the expense of public funds on tailing dump sites. The analysis necessary for defining priorities with regard to the realization of the rehabilitation strategy has only been conducted on the basis of the available data on gamma dose rates and some data on the concentration of radon (Rn) in tailing dumps.

In addition, there are some small sites polluted by radioactive waste of the uranium and polymetallic industry in Kyrgyzstan. Such sites are in an area of influence of all major deposits of the Republic. In such situations, any soil, building materials, heating materials, rags, ashes, scrap metal and so forth polluted with radionuclide are regarded as radioactive waste. For example, such waste would include the following

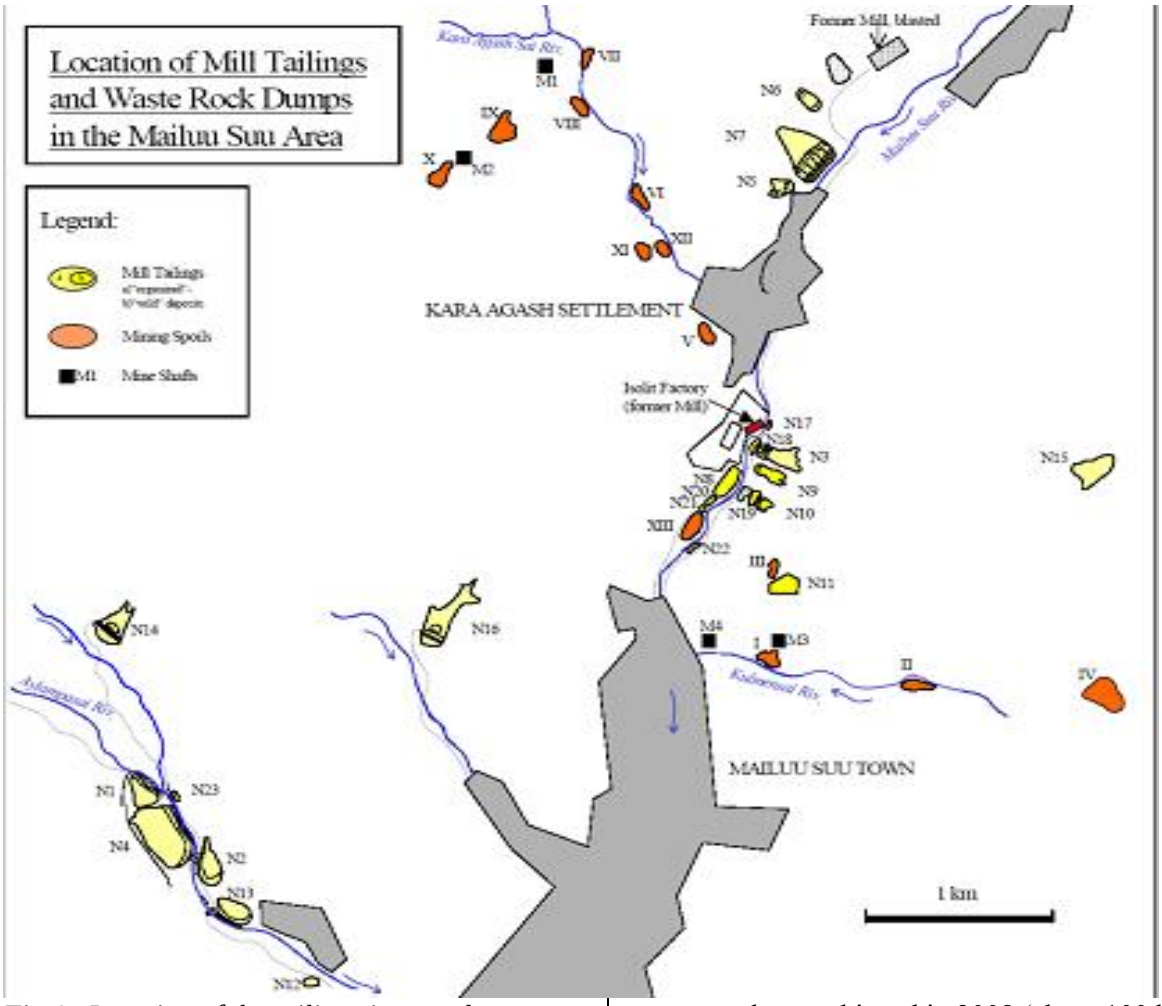


*Fig.6. Location of the tailings impoundments and waste-rock dumps sites in Mayluu-Suu (Source SAEP, Kyrgyzstan)*

- The heating materials used by several tens of houses in the settlement of Minkush. The effective dose rate of gamma radiation of these materials is 0.80 - 1.5 µSv/hour, with a specific α impurity of 2000 - 4000 Bk/g. The regulatory authorities are currently trying to solve the problem of with-drawing this heating material and decontaminating the attics of buildings.
- The canvas fabrics which the in-habitants of Minkush have dug out of the closed mine and then used in everyday life as bedding covers and so forth. The effective dose rate of gamma radiation of these materials is 50 µSv/hour and a specific content of radionuclides of the uranium series in the order of 10 - 5000 Bk/g. The partial withdrawal of these wastes had been achieved in 2008 (about 100 kg), but no decision has been reached regarding the remaining mass of waste.
- Scrap metal which has been polluted as part of the activities of processing factories and is found in different parts of the Republic (repeated export attempts and cases of use for building, melting needs, and needs relating to water supply). The effective dose rate of gamma radiation of these materials is 0.30 - 1.5 µSv/hour, with an α impurity observed on all surfaces.
- The ashes formed by the burning of coal containing mineral uranium. There are cases of unauthorized burning of such coal by the local population or public organizations (e.g. there are records relating to a kindergarten and schools) throughout the KR. The effective dose rate of gamma radiation of such ashes is 0.30 - 0.9 µSv/hour, with a specific α impurity of 2 - 12 Bk/g.

According to the data collected by the geological parties of the KR, in each region of the Republic there are some local sites with an elevated radiation background caused by magmatic rocks. The mid-annual dose in these parts can make up to 2 - 5 mSv/year.

There are deposits of fossil coal with a raised natural radiation background of 0.25 - 4.5 μSv/hour (deposits of "Agulak", "Southern", "Dzhergalan", "Central"). All of these coal deposits are located near to former uranium ore mining sites (Minkush, Kadzhisaj). Coal mining has been authorized on some open pit mines where the radiation background does not exceed 0.25 μSv/hour.

According to the current legislation of the Kyrgyz Republic, disused sealed radioactive sources (DSRS) are considered radioactive waste if the appointed term of operation has expired or they are recognized as defective. At present, 378 radioactive sealed sources are registered (Cs-137, Co-60, Am-241, Ra-226, Pu-238, Cf-252, So-57) in the Republic with some of them in operation, and some stored in the organizations at the enterprises.

In order to manage the Republic's radioactive waste, there is an installation called the Point of Radioactive Waste Disposal (PRWD) where disused radioactive sources and material polluted with radioactive waste has been placed for storage and "disposal". This installation (PRWD) is located 28 kilometres along the highway from Bishkek's "Manas" airport and 7 kilometres from the urban settlement of Manas (Fig. 6).

The PRWD was built in 1964 according to the standard design used in the former USSR. Eight canyons are filled and suspended, two are in operation and ten are held in reserve. Above the canyons, the hangar is equipped with an alarm system and mechanized telpher. 2872 radioactive sources with a total activity of more than 46.6 thousand curies have been "disposed of" in the last 10 years. No safety assessment has been performed yet for this installation.

*Fig.7 Conditioned DSRS in one of the canyons in the Point of Radioactive Waste Disposal (PRWD).*

The destruction of tailing dumps can lead to an ecological catastrophe, not only within Kyrgyzstan itself, but also in its neighbouring countries, as almost all rivers in Kyrgyzstan flow into Kazakhstan, Uzbekistan and Tajikistan. The adjacent states could then be polluted, which would in turn generate political, social and economic tension in the region. The situation is aggravated by that fact that the majority of the country's tailing dumps are in areas of high seismic activity, landslides, mud flows and high waters, or on sites with close groundwater occurrence (bedding of underground water). The surfaces of tailing dumps and dump pits are exposed to natural and anthropogenic influences, and their condition worsens year on year.

The "Threat assessment" report is the result of three inter-related reports:

- Report 2.1. Review of the analytical data on the radiation condition and regulatory bodies in the KR (radiation environment and irradiation doses associated with radioactive waste).
- Report 2.2. Compilation of the data connected with the maintenance of radiation safety at the radioactive waste storage sites of Kara-Balta, Mayluu-Suu and Minkush, and comparison with IAEA recommend-dations and other national approaches.

- Report 2.3. Report on the estimated threat, identifying priority areas for regulating development based on the status of current regulating documents and threats presented by various sites and equipment.

According to the threat assessment report, the basic objects of regulation with regard to managing RW and radiation protection in Kyrgyzstan are:

- Storehouses of low-level radioactive wastes (tailing dumps and mountain dumps) of the former uranium industry.
- HMP Limited Joint-stock Company "KGRK" - the factory specializing in the release of protoxide and oxide of uranium (the operating enterprise).
- Burial place of sources of ionizing radiation (point of radioactive-waste disposal PRWD), Bishkek.
- Ionizing radiation sources operated by industrial enterprises.
- Medical institutions (nuclear medicine, radiation therapy).
- Natural anomalies (local sites with a raised natural radiation background).

The condition of all these objects was negatively affected by various factors, mainly: political issues (absence of strategy, inefficient regulation and imperfect legislative and normative base), time (the life cycle of the majority of artificial objects is more than half a century) and human (a lack of professionally trained experts).

The normative legislative base of the KR was analyzed by the experts participating in the project for the purpose of defining the efficiency of this base in regulating radiation protection and safety of radioactive waste management. The following basic conclusions have been drawn from this analysis:

- The existing legislative and regulatory framework of the KR contains old and incomplete requirements for the acceptance of regulatory provisions on radiation protection.
- It is necessary to develop a national policy and strategy for radioactive waste management in accordance with the international recommendations and international agreements which have been ratified by the state.
- The hierarchy of documents of the legislative base concerning radiation safety and RW management is not complete. There is a significant number of gaps (more than 60 % of the entire system in comparison with IAEA recommendations), and essentially only the lower levels of the hierarchical structure (rules, standards, provisions, instructions, etc.) have been defined.

The analysis of the regulatory infrastructure and legislative and regulatory framework has shown that the KR also needs to develop and strengthen itself in this respect, there is no principal regulatory body regulating radiation protection and the safety of radioactive waste in any of the supervising departments in the country. Owing to the uncertainty regarding the functions of the basic regulatory body of the country, some mechanisms for the regulation, supervision and realization of the main safety principles do not work:

- there is no state policy or strategy in the field of radiation safety and RW management in place and approved by the government;
- there is no co-ordination of actions between various regulatory bodies concerning nuclear and radiation safety with regard to personnel, the public and the environment;
- there is no safety assessment of operating enterprises or installations where radiation sources are produced, used and stored;
- there is no effective system of authorization of activities, inspections, enforcement and realization of the regulatory processes;
- there is no monitoring, supervision and inspection control of radioactive waste storehouses radiation sources external to the enterprises;
- regulatory frameworks for the safe use of radiation sources in the country are poorly developed; there are no

regulatory requirements for the safety and physical safety of radiation sources;

- there is no prevention of the formation of orphan sources of ionizing radiation and RW or any control over objects where there are existing orphan radiation sources formed in the past;
- regulatory and legal frameworks for the mining and processing industry are also insufficient since there are no regulatory requirements for safety assessments, monitoring and supervision and institutional control.

The following processes were noted as the factors causing anxiety to the operating regulatory bodies and stipulating the need to increase the effectiveness of their activities:

- Deterioration of the environment for the local population as a result of ageing infrastructure at the radioactive waste storage sites and the absence of appropriate institutional and regulatory controls.
- Transfer of radioactive and chemically toxic substances across big distances, both within the Republic and across national borders.

According to the analysis of the existing legislative and regulatory framework of the KR, there is a need to:

- develop a legislative and regulatory framework (policy and strategy, institutional system and statutory acts) in the field of radiation and waste safety;
- revise and develop a standard national legislative base for radiation safety which is not currently harmonized with international recommendations.

In order to efficiently control radioactive waste, the government should approve and implement a national policy and strategy on the management of radioactive waste. This policy and strategy should correspond to the nature and quantity of radioactive waste in the country, should specify the required regulatory control, and should consider corresponding social factors. The policy should clearly allocate responsibilities with regard to safe radioactive waste management and regulatory control. Financial mechanisms should be established for compliance with this purpose. The policy and strategy should be compatible with IAEA Fundamental Safety Principles and with the international recommendations, agreements and codes which have been ratified by the state. The national policy and strategy should be the basis for decision-making concerning the safe management of radioactive waste.

The majority of legislative acts have a framework character, and are unduly abstract and declarative. There are no standards for direct actions which require the more concrete definition of procedures and mechanisms for their implementation in subordinate regulatory acts. Duplicate and inconsistent provisions have been accepted by different departments which are pursuing their own (corporate or narrow departmental) interests.

There is no legislative base or methodology for calculating the impact on the health of citizens and the environment as a result of radioactive pollution. In the field of radioactive measurements and monitoring, the system of national standards, regulations and requirements is either unfinished, or does not correspond to international regulations and standards. The considerable powers of local governments in their own territories are not reflected in the general legislation of the KR.

There are no legal instruments for the displacement of radioactive waste in the case of transboundary transfer, or mechanisms of operation for the placing of radioactive waste and allocation of ecological responsibility to the proprietors of these objects during their privatization. The government of the Kyrgyz Republic should establish an effective system of protective actions for reducing the inappropriate radiation risks connected with unregulated sources of (natural and artificial origin) and pollution from previous actions or events compatible with principles of justification and optimization.

The government should ensure the availability of technical services concerning safety, such as services for personal dosimeters, ecological control and equipment calibration. The government should not necessarily render technical services. However, if no suitable commercial or non-governmental supplier of

the necessary technical services is available, the government has to create the conditions required for such services. The regulatory agency should approve the technical services which can benefit safety.

It is necessary to review the normative base in comparison with the new recommendations of the IAEA Basic Safety Standards (BSS) on Radiation Protection, including the requirements for both planned and existing exposure situations, emergency situations, and safety assessments, starting from the perspective of designing services and activities.

It is also necessary to establish and implement the integrated database of radioactive wastes, their characteristics, and their influences on the environment and the public, etc.

The state structures, research organizations, private structures and public organizations present in the institutional system in the KR covering the problems of the former uranium legacy and operating sources of radiation hazards were presented in the threat assessment report.

Analysis of institutional management bases in the KR has drawn the following conclusions:

- Some structures at state level and some structures of scientific, private and joint ventures participate in management and have certain institutional possibilities, necessary equipment and potentiality. However, it was noted that all of them suffer from a lack of financial resources, no coordination of their activities or exchange of the received results both in the country as a whole, or regionally, which certainly has a negative influence on the decision making process with regard to the problems connected with safety radioactive tailing dumps and mine dumps in the Kyrgyz Republic.
- The government should establish and support a corresponding governmental, legal and regulatory structure for safety, in which duties should be clearly distributed.
- In cases where there are several regulatory bodies, as is the case of the KR where there are 6, the government should require the coordination of their regulatory functions to avoid any omissions or inappropriate duplication and avoid inconsistent requirements proceeding from the different power-holding bodies. The duties and functions of each authority should be clearly defined in the corresponding legislation.
- The government should guarantee the corresponding coordination and communication between the various authorities interested in such spheres as:
    1) Safety of personnel and the public;
    2) Environmental protection;
    3) Emergency planning and response;
    4) Management of radioactive waste;
    5) Responsibility for nuclear damage (including interstate conventions and regulatory control);
    6) Nuclear safety;
    7) State budgetary system and control of nuclear materials;
    8) Safety concerning water use and food consumption;
    9) Land use, planning and construction;
    10) Safety when transporting dangerous cargoes, including nuclear and radioactive materials;
    11) Mining and processing radioactive ores;
    12) Control over the import and export of nuclear and radioactive materials;
    13) Security and integrity of radio-active sources (especially categories 1 and 2).
- Through the legal system, the government, should establish and support a regulatory body and give it the competence and resources necessary to carry out the responsibilities and obligations for the regulatory control of practices and activities established by law.

- The government should guarantee that the regulatory body is effectively independent in decision-making with regard to safety. In order to be effectively independent, the regulatory body should have sufficient power, personnel and access to financial resources for the appropriate fulfilment of its duties.
- Existing state institutes pursuing narrow departmental purposes compete for grants. Because of the bad coordination of actions, none of the establishments participating in management has full, authentic operative information. The information is scattered and often appears inconsistent.
- The absence of specific powers of these subjects of the given legal relationship, as well as the mechanisms of interaction between them, require coordination among the organizations, including local authorities, yet this is absent.
- The main operative department in this system is the Ministry of Emergency Situations of the KR, which is assigned the coordination of departmental activity with regard to decision-making on the prevention and liquidation of emergency situations, including radioactive pollution. However, in reality, its coordinating influence becomes apparent only during the liquidation of those emergency situations which have occurred. The actual influence of the Ministry of Emergency Situations of the KR on other departments during their decision-making process for the prevention of threats of radiological safety is minimal.
- The main regulatory authorities are the bodies for environmental protection and health, but owing to the absence of a regulatory structure concerning radiation safety and RW management, regulatory mechanisms have not been developed, i.e. these departments do not conduct any systematic monitoring of radioactive pollution and its influence on public health.
- Furthermore, there is no system for the transfer of information by operators to the regulatory bodies regarding the monitoring and supervision programme and the execution and results of this programme. There is also no information transfer system for the programme of maintenance of radiation safety, or the protection of personnel and the public. There is no practice of carrying out safety assessments at the design and operation stages.
- There is no inspection control (planned and unplanned) for the radiation of dangerous objects, including RW storehouses. Inspection control is necessary for checking the conformity of the radiation safety status of each site with the established safety requirements and licensee conditions.
- Local governments are only required to participate in the liquidation of emergency situations, which relieves them of the responsibility for carrying out precautionary actions. Thus there is a demand for the improvement of the powers of the regulatory body to take action when no safety requirements and instructions have been established for operators:
    - there has been no transfer of uranium processing facilities to private ownership, for example, Joint-stock Company "KGRK"; operational tailing dumps were not transferred to the balance of the enterprise, and transferred only to an operative management.
    - there are no institutional methods or approaches for defining the responsibilities of proprietors of uranium processing or RW storage facilities;
    - there are no advantages at privatization of ecologically dangerous enterprises and facilities for uranium-processing, dormant tailing dumps and dump pits;
- There are departments and laboratories capable (in terms of facilities,

equipment and personnel) of carrying out the radio-ecological monitoring of tailing dumps in the country, but each laboratory carries out its own work almost without liaising with each other and interested state departments, which makes the work unsystematic and disparate, and the results unreliable and unusable for decision-making purposes.

- A chronic lack of financial assets and laboratories (including medical and biological) understaffed with the qualified experts capable of conducting research according to the international standards, and insufficient technical equipment for carrying out testing and the calibration of existing equipment all fail to allow valuable and qualitative analytical activity to take place.
- There is no education system, training or information necessary for maintaining national knowledge and informing organizations and the public about the state of affairs on radiation protection and safety.

Thus, it is possible to ascertain that communication between the departments defining the policy in this area is extremely insufficient in terms of decision-making with regard to the management of radiation protection and RW. This leads to weak coordination, duplication and a reduction in the responsibility of each of the participants in the RW management process. The existing institutes do not provide effective and coordinated planning, management and realization of measures for the safety of radioactive objects.

The regulatory framework in the field of radiation safety was analyzed in comparison with the IAEA recommendations and standards and successful national approaches of other countries.

The international recommendations given in the safety requirements of the IAEA and, especially, GSR Part 1 "The governmental, legal and regulating structure for safety", GSR Part 3 "Radiation protection and safety of radiation sources" and GSR Part 5 "Predisposal management of radioactive waste" have been used as a basis for the review and development of the draft regulatory documents. This approach allows consideration of the problems connected with a policy and makes it possible to develop a waste management strategy and directives on the management of wastes for the purpose of securing an acceptable level of protection of public health and the environment.

## 3.6 Main outcomes

### *3.6.1 Guideline on the Management of Radioactive Wastes*

According to the SAEP, this Guideline on the Management of Radioactive Wastes was developed for the Environmental Safety Centre of the SAEP and F (ESC), which is the official regulatory body on radiation safety in the KR. The main line of activity of the ESC in the field of radiation safety regulation is the development of a control system for the ecological and radiation safety of the public, personnel and environment in the Kirgiz Republic.

The purpose of the Guideline on Regulation of Radioactive Wastes is to establish elements of a management system for the safe handling of radioactive wastes to achieve the main principles of safety published in the recommendations of the ICRP and the IAEA.

In the review process it was noticed that the same document includes both the functions and responsibilities of the regulatory body (authorization, inspection, monitoring, etc.) that are more properly to be reflected in a legislative body, along with a few safety requirements for the predisposal management of radioactive waste. It was also noted that the safety requirements for disposal facilities, safety assessment and safety cases need to be carefully review and expanded.

This guideline establishes requirements for management and administrative requirements, functional modelling – the construction of a model (description) of a process which reflects the internal structure of the process, its entries and exits, interrelations and interdependence with other processes in networks of processes – and also the classification and identification of signs features characterizing the process in

the form of functions. The guideline establishes a procedure of state control and supervision for ensuring radiation safety in the management of radioactive waste from industry, medicine and scientific research. It states that the requirements stipulated in the guideline are obligatory for officials and employees of the basic regulatory body and territorial administrations involved in realizing the state supervision of radiation safety. This document also establishes some responsibilities and rights of the operators.

The guideline establishes requirements on:

- Management control.
- Powers of the regulatory body.
- Operators under control (laboratories selected to participate in the system of monitoring).
- Management technical requirements.
- Authorization process: licenses, notification and other official documents establishing positive or negative conclusions.
- Process for releasing RW storage facilities from regulatory control.
- Inspection control carried out by the regulatory body.
- Methods and tools for evaluating the safety of facilities.
- Consideration for appealing against decisions of the regulatory body.

### 3.6.2 *Guideline on environmental monitoring around radioactive waste storage facilities*

This guideline establishes regulatory and technical requirements for the design and operation of state environmental radio-ecological monitoring around radioactive waste storage sites at the planning, operation and closure stages. The basic focus of this document is to provide requirements for the monitoring of waste storage sites formed as a result of the mining and processing of radioactive ores.

This guideline establishes the requirements for ensuring regular monitoring around RW storages facilities. The guideline focuses mainly on radiological aspects, however, non-radiological control is also considered as it is often carried out simultaneously and can give additional information which can help with the radiological assessment. Monitoring is considered part of a radiation protection programme for personnel, the public and the environment. Monitoring should be considered at the planning, operation and closure stages of all kinds of radioactive waste management facilities or activities. This guideline does not consider other elements of radiation protection.

The guideline applies to the bodies responsible for state supervision. The requirements of this guideline are binding in the Kyrgyz Republic for all legal and natural persons, irrespective of their form of ownership, which are engaged in activities connected with all kinds of radioactive waste management. The guideline extends to all organizations which produce RW as a result of their activities; to organizations which gather, store, transport, process and dispose of RW, and to organizations which design and build facilities where RW will be formed, stored, processed and disposed of. The guideline also extends to tailing dumps and dump pits of the former uranium and other former metallurgy industries where wastes containing natural radionuclide, the concentration of which exceeds clearance levels from regulatory control, are stored.

This detailed regulation establishes requirements for monitoring (radiation control) enterprises dealing with the extraction and reprocessing of radioactive ores which have been closed, preserved, have changed the line of business or have been handed over for use in other fields of the economy.

Responsibilities of the operators have been clearly defined. Operators are required to establish and implement monitoring programmes to ensure that public exposure due to sources and facilities under their responsibility are adequately assessed and that the assessment is sufficient to verify and demonstrate compliance with this guideline and authorization limits and conditions. These programmes shall include monitoring of the following, as appropriate: external exposure from such sources; discharges; radioactivity in the environment and other parameters important for the assessment of public exposure. At the same time the document establishes that the regulatory body can

execute a limited (reduced) radio-ecological programme for an independent control of the results submitted by the operator, and confirm that doses to members of the public are below the restrictions established in the license.

This regulation covers detailed requirements for monitoring and surveillance programmes that shall be carried out before construction, during the construction and operation of a disposal facility and after its closure, if this is required by the safety case. The considered waste disposal facilities include those at which waste is placed on the surface (for example, at some sites for waste from the mining and milling of uranium or thorium ore) and near to the surface (low and intermediate level waste). Details concerning the content and implementation of the monitoring and surveillance of the surface facilities programme have been agreed with the regulatory authority.

Specific recommendations were formulated for different types of existing situation for which a monitoring programme may have to be implemented. Regulation requires the consideration of different factors, e.g. pathway analysis, types of radiation monitoring, programmes for monitoring activities and interventions, monitoring of radioactive discharges within activities, pre-operational studies, monitoring in the operational stage, monitoring of radioactive waste disposal facilities after closure, monitoring in emergency exposure situations, education and training, uncertainty of monitoring results, recording monitoring data, environmental sampling in existing exposure situations, surveillance methods and use of monitoring data in the estimation of doses. A special chapter was devoted to the type and frequency of inspection surveys. It is important to underline that safety requirements were provided for dose assessment and interpretation of the monitoring results.

The document presents a number of records or registers to be fulfilled by the operator or the regulatory body.

## 3.7 Uzbekistan

The Republic of Uzbekistan, located in Central Asia (area - 447,400 sq. km, population – 28,048 million people), was one of the most important uranium producing regions of the former USSR. At present, the mining of uranium is mainly carried out by the way of in-situ leaching (ISL) and partially by heap leaching. The main uranium deposits in the Republic are located close to the towns of Uchkuduk, Zarafshan, Zafarabad, Nurabad, Angren, Charkesar and Krasnogorskiy.

During intensive mining, the ore was extracted, sorted and then sent for processing to the Navoi Mining-and-Metallurgical Combine in the town of Navoi (in the Republic of Uzbekistan) and the Leninabad Mining-and-Chemical Combine (now SE “Vostokredmet” in the town of Khudjand, in the Republic of Tajikistan). The significant part of the wastes generated as a result of sorting was stored on the sites of the mines, and on the slopes of the river valley from Yangiabad to Angren in particular. The same picture could be found in other mining regions.

In December 2009, technical actions resulting from the partnership with and help received from the Norwegian Radiation Protection Authority (NRPA) with regard to the development of regulatory documents, including guidelines, standards and management, were discussed at a meeting in Norway. In August 2010, a contract was signed between the NRPA and the state regulatory authority of Uzbekistan, SI "Sanoatgeokontehnazorat" regarding the work to be performed within the scope of the project and entitled “Support with the development of standards and regulations on the management of radioactive waste and its long-term monitoring”.

### *3.7.1 Regulatory Threat Assessment Report; Uzbekistan*

The materials provided regarding the uranium objects of the Republic of Uzbekistan contained brief historical data, information on the actual state of the objects, a description of remediation activities previously executed on the sites, an analysis of their efficiency, definition of the priority of the objects with


*Fig. 8. Uranium industrial facilities in the Republic of Uzbekistan (Source INP, Uzbekistan)*

regard to the urgency and promptness of the acceptance of the necessary measures, and finally an estimation of the threats to the public and the environment.

The low-grade ores taken off the accounting balance had been transported from the original mining site in the Central-Kyzylkum province mainly to the suburbs of Uchkuduk, where they were dumped and are still located today. The operation of some mines in the Republic of Uzbekistan ceased in the 1980s. The working areas of most mines were not restored. The underground workings (drifts and drives) were water sealed, and mine waters with high content levels of uranium, radium and accompanying toxic metals can be found in some of the old mines. Some working holes were not sealed, and the mine waters flow into the neighbouring streams and rivers and seep into the permeable sedimentary rocks, and can leak into the underground waters.

At present, uranium mining in the Republic of Uzbekistan is carried out only by a single method of in-situ chemical leaching. This means that the significant part of the off-balance ores and wastes at the uranium mining and processing facilities, which contain various concentrations of uranium, thorium and products of their decay, was generated in the past.

Up until 1992, no actions had been taken on the rehabilitation and remediation of the tailings in the Central-Kyzylkum province in view of the large amount of vacant territory and the absence of any need to reuse the lands allotted for the mining of minerals. During the last 15 years, 10 projects have been developed in the Republic of Uzbekistan aimed at the remediation of the contaminated lands and former waste dumps at 14 sites (Fig 8) where the uranium facilities in the Central-Kyzylkum province were located. The Threat Assessment Report [16] presents detailed information on the situation of these 14 sites.

The total volume of all the wastes is over 13.5 million m3, and that of the rock dumps and off-balance ores is over 600 million m3. It follows that it is urgently necessary to restore the former uranium mines at Yangiabad and Charkesar in East Uzbekistan, which are neither owned by nor are under the responsibility of the active uranium producers such as the Navoiyskiy MMC.

**Charkesar uranium mine**

The Charkesar uranium mine is located in the foothills of the Kuraminskiy mountain range in the Pap region of Namangan province (oblast) of the Republic of Uzbekistan in the northwestern part of the densely populated Fergana valley. The deposit was operated in two mines: Charkesar-1 and Charkesar-2. The deposit was exploited by mining and by the

technique of in-situ (mine) leaching up to 280 m in depth. There are 12 sites of radioactive contamination on the surface: industrial sites of excavations, heap and in-situ leaching, and dumps of off-balance ores. The total area of the Charkesar mine wastes amounts to 482,000 $m^3$, and the wastes are located in an area of 20.6 ha. The total activity of radionuclides contained in the wastes is valued at 3·1013 Bq.

The settlement of Charkesar with a population of 2,500 people is situated in the valley of a small mountain river. Production ceased in the mid-1980s and the mines were partially decommissioned. The area of man-induced contamination makes up 100,110 $m^2$, and the volume of radioactive rock in the dumps amounts to 338,700 $m^3$. The dose rate of gamma-radiation on the dumps' surfaces ranges from 60 to 140 μR/h; the total alpha-activity of the dumps material varies from 6,000 Bq/kg to 25,000-500,000 Bq/kg depending on the range factor of the survey. The dose rates in residential and civic buildings are used to calculate external exposure doses for the local residents, which vary from 1.5 to 4 mSv/y. The radon content has been specified for assessing internal exposure values for the residents. The obtained results have shown that the radon concentration varies widely (17–375 Bq/$m^3$), tending towards a 1.8 fold increase The effective dose due to its decay produces ranges from 1.5 to 3.3 mSv/y.

Mine waters flow from the mouths of a number of mine workings. The discharge of each water flow amounts to 3-5 l/s. The mine waters form a stream flowing into a small creek in the direction of the residential area of Charkesar. The stream waters contain high concentrations of uranium, radium and radon. The absorption site of drainage waters adjoins the fenced-in territory in the south. It stretches for 350 m along the Ingichka-sai river-bed where the wire fence is located.

*Fig. 9 Bottom sediments of the drainage waters stream of the Charkesar-2 mine. (Source SISIM, Uzbekistan)*

In 1989-1990, the site territory was restored: the mouths of underground mine workings were blasted, the industrial buildings and structures were dismantled, and the dumps were covered with a layer of neutral soil. The exact disposal locations of radioactive structures and processing equipment are unknown. In the 1990s, there was no control and monitoring of the situation at the working site. The integrity of inert covering was broken. The sidewalls of the dumps were washed out by flows of rainwater and waters from melted snow. The above reasons, including the failure to remediate the entire area of the site, cause the formation of radioactive contamination of the soil surfaces. Mine waters started to drain from the two shafts (main and ventilation) of mine No. 2 (Fig 9). The water flowing from the mine demonstrates visual evidence of acid; however the local population uses it for irrigation and watering cattle. Visual inspections and the sampling of soil, wastes, mine waters and vegetation are carried out at the above facility at regular intervals. Radiation monitoring is also carried out on the houses and administrative buildings in Charkesar.

After the mine had been abandoned, the drift remained open and therefore represents a danger to the safety of local residents. The ventilation drift is located among the low hills, and the contaminated mine water currently flows from it (at about 3-5 litres per second) under artesian pressure. The measured activity of 238U in the effluent water lies in the range of 26-36 Bq/l. The dumps of gangue of uranium low-grade ore are stored on the site.

There are also fragments of foundations of industrial structures and concreted openings of foundation pits. The site of the former Charkesar-1 mine is located in the deserted, arid high-mountain valley near its outlet. Soil in the vicinity of the mine consists of random alluvial deposits. The mine site stretches across the valley for about 1.5 km.

**Yangiabad uranium deposit**

There are three facilities dealing with uranium mining activity in this region with the facilities being located not far from the settlement of Yangiabad. Mining had been carried out for 40 years. The primary concern is associated with contamination in the mines themselves, in the waste storage facilities and at the installations for ore grading, storage and loading in Yangiabad and Angren. The former mining facilities around the settlement of Yangiabad are located in the hills along the valley sides. At present, some evident fragments of small buildings of the former sorting station and the gangue dumps covered with coarse gravel can be found there. Before they were covered, the dose rates at the low-graded ore and waste dumps reached 7 μSv/h. Gravel was specifically selected as the covering material since it had low radiation intensity and could be easily delivered to the facility. There are no signs of erosion or instability of the surfaces of covered dumps. However, the concrete foundations of buildings both in whole and in parts can still be clearly identified on the site. At other facilities, which still remain untreated, the measured maximum gamma-radiation dose rate amounts to 25 μSv/h.

The surface of the area round the mine outlet is contaminated to a certain degree. The drift is fully water sealed with mine waters with rather a high content of uranium (up to 30 Bq/l) and other microelements. Those waters flow directly to the river, one of the main water sources in the valley.

The last decade saw the establishment of the special division on the restoration and control of the former uranium facilities. Certain recovery actions were carried out, such as the removal or covering of the most of the contaminated areas of that facility. However, at present, all the recovery activities at the facility have been suspended because of a lack of financial support. Proper protection of the former facilities has not been provided; the structures where the wastes are located are frequently damaged and do not meet the corresponding requirements, and the geological conditions are unstable. The contaminated water discharged from the facilities is used for irrigation.

The town of Yangiabad is situated 140 km from Tashkent, the capital of the Republic of Uzbekistan. The Yangiabad site is 77 hectares. The residential buildings were mainly erected from imported building material in 1950. The mine administration site and the rock milling shop directly adjoin the town. Studies of the radiological state of the town of Yangiabad have shown that the radon concentration inside the rooms is less than 100 $Bq/m^3$, and the effective annual dose will not exceed an annual average activity concentration due to 222Rn of 300 $Bq/m^3$.

In general, these uranium production and waste disposal sites are subject to wind and water erosion, leading to the risk of radioactive exposure for the residents through inhaled air and the intake of food and water. The neighbouring states are frequently at risk, too, in view of the common water basin in Central Asia.

The mines and processing plants ceased at different times in 1961-1995, and only some primitive recovery actions have been performed at the waste management facilities situated near the big settlements. The decommissioning and closure of the conventional uranium mines were carried out without any significant engineering or regulatory practice and sufficient funds. The former facilities were often left without taking any safety or control measures. These potentially unsafe and unprotected facilities create a challenge for public health and are potential sources of adverse consequences for the environment. After the attainment of independence, the Republic faced an absence of qualified experts and experience in the given field. The major factors defining the state strategy in the field of radiation safety and a radioactive waste in the Republic of Uzbekistan are the presence of radioactive waste, including waste from the extraction of uranium, the mining industry and other sources, and also the necessity for the rehabilitation of sites in Uzbekistan, on which there were adverse radiation conditions

resulting from a lack of technologies for processing and rehabilitation used in the early stages. From 1992 to 2002, a number of laws, namely the “Law on state sanitary inspection”, “Law on radiation safety” and the “Law on wastes” have been approved in the Republic of Uzbekistan. In 2009, Uzbekistan ratified the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management. Resolution № 211 of the Cabinet of Ministers of the Republic of Uzbekistan “Action programme for the environmental protection of the Republic of Uzbekistan 2008-2012” was passed on 18.09.2008, and as result, in 2010, the Cabinet of Ministers of the Republic of Uzbekistan adopted the “Organizational technical arrangements on the preparation and implementation of projects for the rehabilitation of radioactive tailing pits”. The purpose of the given project is to develop the necessary standard requirements and rules for dealing with radioactive waste from uranium manufacture.

In 2009, the materials concerning the uranium tailing dumps in Central Asia were considered at the International Forum in Geneva. The Incorporated Declaration by the four most polluted Central Asian countries was accepted by the United Nations agency the IAEA, the European Union, the European Bank of Reconstruction and Development and OSCE. The Declaration urges the international community to unite its efforts concerning this problem. Later, in November 2009, the technical meeting on the radiation protection of the public from radioactive wastes in Central Asia took place at the IAEA headquarters to discuss and coordinate with the member states on a contractual basis.

Being a member state of the IAEA, the Republic of Uzbekistan supports the principles, safety standards and obligations of the agency’s member states concerning the management of uranium resources. Taking into account the international obligations, a number of international projects (TACIS, INTAS, IAEA, NATO, etc.) were carried out with a view to estimating and analyzing environmental conditions and situations from the point of view of public health on some former uranium objects.

The regulation of nuclear and radiation safety is a national responsibility for each state. However, radiation risks can cross national borders and, consequently, international cooperation helps to improve global safety by an exchange of experience and increases in the options for managing these threats, preventing conflicts and subsequently reducing the dangerous consequences.

Each state has their own duty towards safety preservation, and is expected to observe the safety measures and discretion concerning their obligations. The IAEA safety standards render assistance to the states with regard to the performance of their obligations according to the general principles of the international law. In addition, the international standards guarantee confidence of safety and promote interstate commerce and trade.

The threat assessment report identified gaps in the regulatory documents of the Republic of Uzbekistan and risks owing to the lack thereof or their underdevelopment. The threat assessment report also reviewed which IAEA Safety Standards need to be applied when reviewing the national legislative and regulatory framework for radiation safety and safe radioactive waste management. Table 1 presents the identified gaps in the regulatory documentation on radioactive waste management in the Republic of Uzbekistan.

The lack of classification of radioactive waste in the Republic of Uzbekistan complicates the final decision with regard to the practical problems of managing such RW. The task consisted of studying the available literature of the IAEA and the countries of the European Union on classifications of radioactive waste, the analysis of existing documents in the Republic of Uzbekistan and the development of a draft regulatory document “Guideline on classification of radioactive waste in the Republic of Uzbekistan”. The developed requirements on classification of radioactive waste in the Republic of Uzbekistan were coordinated with the State Committee on the Protection of Nature, and the Academy of Sciences and are awaiting approval by SI "Sanoatgeokontehnazorat".

Other important regulatory documents include “Requirements for the management of radioactive waste” and “Requirements for the monitoring of storage facilities and their

disposal". These two documents were developed taking into account the international standards. The first document was submitted to the State Committee on the Protection of Nature for endorsement. The second document was approved by the NRPA and submitted for endorsement to the State Committee on the Protection of Nature.

During the next stage of the joint work with the NRPA, it was proposed carrying out the following tasks:

- Develop a concept for managing the radioactive waste of the former uranium mines of the Republic of Uzbekistan for 2012-2021. It was strongly recommended including all the radioactive waste in the country to have one overall picture and one national approach.
- Research the radio-ecological condition of storage facilities and disposal of radioactive waste in accordance with the regulatory document "Requirements on monitoring" developed as part of the present project.
- Develop sanitary regulations for carrying out radio-ecological monitoring of the environment.
- Develop regulations supporting radiation safety of long-term radioactive waste storage points.
- Develop an estimation procedure for the condition of facilities (points) for the long-term storage of radioactive waste.

*Table 1. Summary data on the identification of gaps in regulatory document*

| **Document** | **Existing regulatory base of the Republic of Uzbekistan** | **Risk as a result of underdevelopment of the document** |
|---|---|---|
| The national policy and strategy for the management of radioactive waste (which should include all existing radioactive waste and waste that will potentially be produced in the country in future).<br>It is recommended following the recommendations given in IAEA document NW-G-1.1 "Policies and Strategies for Radioactive Waste Management". | The national policy and strategy on the management of radioactive waste in the Republic of Uzbekistan developed as part of the programme of actions on environmental protection in Uzbekistan for 2008-2012 in a number of laws and sanitary rules. Modification is required | The lack of an integral approach to a radioactive waste issue in the country can lead to serious errors in the decision-making process. At the same time, such a situation does not allow the decision-making process to be optimized and does not allow the stable management of radioactive waste, decommissioning and reclamation. |
| Classification of radioactive waste, including waste from the uranium industry | Developed in SanPiN № 0251-08 and requires improvement, which was Task 3 of the present project. | The vagueness and lack of systematization in the data on radioactive waste from the uranium industry can lead to errors in decision-making. |
| Requirements on the levels of removal of regulatory control, optimization, and the levels of actions for taking measures in existing irradiation situations according to international recommendations. | The sanitary standards and rules № 0193-06, and standards on radiation safety НРБ-2006 have been developed thus far. New standards on radiation safety are to be developed according to international standards. | The absence of criteria for the optimization of protection, and the release from regulating control makes it impossible to control the RW management process during the transfer of materials, equipment or territory to the public for general or limited use. |
| Regulatory requirements on the safe management of radioactive waste, including RW from mining and crushing. | Partially developed in SanPiN № 0251-08. | The safe management of RW means not exceeding the doses received by personnel and the public from all kinds of RW management. The absence of this document can lead to the incorrect planning of work and the risk of over-radiation during RW management. |
| Regulatory requirements for the development of a safety case and safety assessment for any activity or the equipment at a RW management site (including designing, planning, construction, shutdown, decommissioning, the period after closure and rehabilitation, as necessary) | Absent | The safety case and safety assessment are key components of safety and planning RW management. The absence of the requirements for their development make it impossible to plan for all possible consequences. |

| | | |
|---|---|---|
| Regulatory requirements for the final disposal of radioactive waste. | Absent | The inadequate final disposal of radioactive waste creates a radiation threat for the public and the environment in the present and for the future generations. |
| Institutional control of the equipment of stopped and closed deposits and disposals | There are only internal requirements for the control of stopped equipment of closed enterprises. | Consecutive institutional control of the equipment and the establishment of a system for the notification and awareness of the public will reduce the risk of the public receiving high doses of irradiation and the threat for the environment. |
| Requirements on closure safety, decommissioning and recultivation of past and existing sites. | Partially developed. | The absence of this document can lead to incorrectly planned work, which will cause the incorrect distribution of resources, as a result of which, the efficiency of remediation activities will decrease. Moreover, there is a risk of over-radiation of personnel and the public |
| Adequate legal base for establishing effective regulatory infrastructures. | Partially developed. | There is a risk of insufficient institutional control over objects of the uranium industry. Interaction between the authorized bodies will make it possible to strengthen the functions of the regulatory body. |

## 3.8 Main outcomes

There are a number of laws and statutory acts in force in the sphere of RW management at present in the Republic of Uzbekistan. Nevertheless, the current state of the normative base is unsystematic and suffers from duplication and insufficient normalized indicators. In addition, some of the regulatory documents require improvement according to the latest international recommendations.

### *3.8.1 Guidance on the classification of radioactive wastes in the Republic of Uzbekistan*

Task 3 involved analyzing the classification of radioactive waste, including documents of the IAEA, EU, USA and the Russian Federation. The IAEA member states currently apply a single classification scheme in which different RW classifications are used based on the physical, chemical and radiation properties of the RW. This scheme is based on the IAEA publication on the classification of radioactive waste. In this document, the classification of waste is mainly based on the degree of isolation and radiation protection necessary for guaranteeing the long-term safety of the RW.

The proposed parameters of the new system of categorization include the half-life periods of the radionuclides prevailing in the structure of the waste and the levels of their activity (these can be expressed through total activity or specific activity (SA)). These criteria do not give exact quantitative boundaries between the various categories of waste; they are used to indicate the level of danger represented by specific kinds of RW. Such an approach essentially differs from that accepted in Russia where the boundaries between the various categories of RW are absolute. There is no formal release of waste from regulatory control and the category of VLLW in standard documents of the Republic of Uzbekistan that creates serious problems with management and, especially, the disposal of such waste. Therefore these categories have been considered more in detail.

The draft guidance document determines the requirements for classifying radioactive waste in the Republic of Uzbekistan. This document contains the classification of radioactive wastes, and criteria for radiation safety in RW management. According to this document, the organization where the radioactive wastes are formed is responsible for the safe management of them until the moment of transfer of the radioactive wastes to another organization.

An important issue for safe radioactive waste management is the recognition that the safety case and safety assessment should be considered as basic elements of safe RW management. The document establishes that the safety strategy is an integrated approach adapted for achieving the safe disposal of the RW. The safety strategy generalizes all RW management strategies at the various stages, including the characteristic of the site and the wastes, planning the storehouse, the operation and closure of the facility, and working out the safety case, safety assessment, research and design. It is necessary to give special attention to the safety case and its role in the decision-making process for the authorization of disposal facilities.

The proposed classification system is based on the level of radioactivity in the radioactive waste, the half-life period of radionuclides, aggregate state and source of formation. According to the level of a radioactivity, RW are subdivided into 4 categories:

- Very low-level wastes (VLLW), which may subject to release from regulatory control
- Low-level wastes (LLW),
- Medium-level wastes (MLW),
- High-level wastes (HLW),

Values of activity concentration are established for the different categories of radioactive waste. Classification is also given according to the half-life period. In terms of their half-life period, radioactive wastes are subdivided into short-lived, medium-lived and long-lived. However, as established by the guidance document, any classification should be used for the final goal – the disposal or safe storage of the RW. Disposal can be used as a basis for the classification scheme in order to ensure conformity and coordinate the various stages of the RW management process.

### 3.8.2 Requirements for the management of radioactive waste in the Republic of Uzbekistan

Under the management of radioactive wastes (RW) it is necessary to understand the various kinds of activity which help reduce their influence on the health of the public and the environment. The process includes minimization of RW formation, account and control, and also collection, processing, recycling, neutralization, transportation, storage and removal of RW from regulatory control. It is necessary to develop a RW management safety system in order to comply with the requirements for keeping the risk to personnel and the public to a reasonably low level.

In developing this document, existing documents on radioactive waste were analyzed and this revealed that the Republic of Uzbekistan has no sufficient legal framework in the field of radioactive waste management, nuclear wastes and their recycling. At the same time, these problems are becoming more and more real every year. It was therefore necessary to develop a regulatory document which would represent a set of scientific, technical and organizational principles, criteria and safety requirements for RW management in line with current legislation.

The legislation of some countries regulating the management of radioactive wastes, has legislation tailored to the specific situation within its borders. The distinction between political and legal decisions in the field of RW management is conditioned by legal traditions, the scale of nuclear power development, the level of legal culture of the society, state, and the public, and the state of the economy and radioecology, among other factors. The radioactive waste streams existing in the country and the technological solutions that were decided to be used for its management in accordance with the national policy and strategy in this field plays alsoa considerable role in environmental protection policy.

In preparing this document, a review of the IAEA international standards and procedures and the legal base of the European Union on the management of radioactive wastes were provided. The analysis of existing regulatory documents in the field of management of radioactive wastes including the uranium industry was carried out and requirements for RW management in the Republic of Uzbekistan were developed. The given requirements are currently with the State Committee for Nature of the Republic of Uzbekistan for consideration.

The requirements for managing radioactive waste were developed according to the Republic of Uzbekistan's laws on "Radiation Safety", the "State of Sanitary Supervision", the "Protection of Nature" (1992), the "Protection of the Atmospheric Air", "Wastes", and the "International Basic Safety Standards for Radiation Protection and Safety of Radiation Sources", GSR Part 3, with recommendations of the IAEA for the disposal of radioactive wastes and for the management of radioactive wastes formed during the mining and milling of ores, Standards of Radiation Safety (NRB-2006) and Basic Sanitary Regulations for Ensuring Radiation Safety (OSPORB-2006) of the Republic of Uzbekistan and SPORO-2002 of Russia.

The present requirements for the management of radioactive waste have been established for ensuring the radiation safety of personnel and the public for all kinds of RW management in the country. The requirements will be obligatory for execution in all regions of the Republic of Uzbekistan by all legal and natural persons, irrespective of their status and pattern of ownership, who are engaged in activities connected with the formation and management of all kinds of RW.

The requirements are extended to include organizations which form RW as a result of their activities; to organizations involved in the collection, storage, transportation, processing and disposal of RW, as well as to organizations which design and build objects where RW will be formed, stored, processed and disposed of.

The authorities responsible for the state supervision of radiation safety and radioactive waste management should be guided in their activities by the present requirements. The requirements consist of the following sections: general licensee responsibilities; license application, safety case and safety assessment; integrated approach to safety; stages of the preliminary management of radioactive waste; development and functioning of facilities for the management of radioactive waste;

management of radioactive waste formed during the mining and milling of ores. The developed document specifies the rules for applying to work with radioactive waste, which should include the safety case, safety assessment and environmental impact assessment, and describes in detail the duties of the operator with regard to the management of radioactive waste.

Particular emphasis is placed on maintaining the integrated approach to safety where it is important to establish a clear and effective control system, to conduct constant records and reports on radioactive waste, including disused sealed sources and waste from processing installations and facilities for RW storage, and registers of the characterization and transfer of waste. The interrelationship between all stages of preliminary RW management and the influence of admissible alternative disposal options should be considered. Duties of the operator concerning the maintenance of physical protection and nuclear safety of radioactive waste are noted.

The stages of preliminary RW management, with emphasis on the control of RW formation ensuring measures for minimizing the formation of wastes and their influence on the environment are considered in detail in these requirements. The basic stages of RW management, such as gathering and sorting RW, conditioning, storage, transportation and disposal, as well as measures for ensuring safe RW management at all stages of the management process are also considered. Aspects of characterization, categorization and classification of radioactive waste at the gathering stage are considered as well.

The RW acceptance criteria, which should describe precisely the characteristics of the packed and unpacked waste in usual and abnormal conditions, and consider the required radiological, mechanical, chemical and biological properties of the waste and packing, are stated in the requirements. The operator shall ensure that radioactive waste to be transferred to other facilities or waste management process steps meets the waste acceptance criteria established by the operator of the subsequent step. The procedures for the reception of waste have to contain provisions for the safe management of waste that fails to meet the acceptance criteria; for example, by taking remedial actions or by returning the waste.

The aspects of RW management from gathering to processing are considered in the requirements. The treatment of waste may be necessary for safety, technical or financial reasons. Radioactive waste has to be processed in such a way that the resulting waste form can be safely stored until its final disposal. The requirements also state the duties of the operator with regard to managing disused radioactive sealed sources, recycling and reuse of RW, release of radioactive waste into the environment and removal from regulatory control.

The development and operation of RW management facilities are considered in the requirements, where the problems concerning the choice of a site for RW facilities and facility projects are described in detail. They also state the stages of building and commissioning of the facilities, process of operation and the decommissioning stage required once the facility project has been developed and approved by the regulating bodies. The safety aspects to be considered during the RW management facility site selection stage, the designing and building of such a facility, its operation and subsequent closing are also considered. Special attention is given to the issues of safety assessment, safety analysis, protection optimization, i.e. the condition at which any additional efforts to control doses do not guarantee their further reduction, as well as to matters of monitoring, supervision and institutional control at a post-closure phase.

The requirements for managing radioactive waste formed during the mining and milling of ores, including their classification, and the protection of personnel against the radiological dangers of waste from the mining and milling industry have been developed, and the radiological protection of the public and management options for such waste have been considered. It is necessary to note that the developed requirements for managing radioactive waste formed during the mining and milling of ores are a new link in the system of regulatory documentation on the management of radioactive waste in the Republic of Uzbekistan.

### 3.8.3 Requirements for Monitoring Radioactive Waste Disposal Objects in the Republic of Uzbekistan

Any future development of the nuclear industry will require the need to make decisions regarding the problems of the safe management of radioactive waste. One such problem in the Republic of Uzbekistan is the creation of a set of scientific, technical and organizational principles, criteria and requirements for carrying out radiation monitoring at RW storage and disposal sites which comply with the legislation in force.

The requirements for the monitoring of RW storage and disposal facilities have been developed according to the laws of the Republic of Uzbekistan on "Radiation safety", "State sanitary inspection", "Protection of Nature", "Protection of the Atmospheric Air" and "Wastes", along with the IAEA International Basic Safety Standards "Radiation Protection and Safety of Radiation Sources" (GSR Part 3), the IAEA International requirements "Disposal of Radioactive Waste" (SSR Part 5), the Safety Guidance "IAEA. Environmental and Source Monitoring for Purposes of Radiation Protection, IAEA Safety Standards Series No RS-G-1.8, Vienna (2005)", the Norms of Radiation Safety NRB-2006 and Basic Sanitary Regulations for Ensuring Radiation Safety OSPORB-2006 of the Republic of Uzbekistan.

The requirements contain the following sections: principles and objectives of monitoring; preconditions for radiation monitoring; responsibilities of the parties; monitoring programmes; measurement strategies; environmental sampling of existing irradiation of the public; monitored objects; an estimation of irradiation doses; management system; training of personnel.

The document establishes that radiation monitoring is not required for those sources or activities whereby their value of a dose of radiation means they can be released from regulatory control. When an authorized practice or facility requires the establishment of a monitoring programme, this will be reviewed and approved in the context of the authorization process and conditions will be included in the given authorization.

Clear allocation of the responsibilities of the operators has been established. Operators shall establish and implement monitoring programmes to ensure that public exposure due to sources and facilities under their responsibility are adequately assessed and that the assessment is sufficient to verify and demonstrate compliance with the authorization. These programmes shall include monitoring of the following, as appropriate: external exposure from such sources; discharges monitoring; radioactivity in the environment and other parameters important for the assessment of public exposure.

At the same time, the document establishes the responsibilities of the regulatory body which is responsible for establishing technical requirements for the organization of monitoring and ensuring quality and to review them on a regular basis; to check the monitoring data submitted by the operator; and to provide evidence that the monitored objects are properly observed and controlled. The government or regulatory body may delegate specific monitoring responsibilities to other agencies (third parties).

The choice of specific monitoring programmes is dictated by the used final result. This regulation covers detailed requirements for monitoring and surveillance programmes that shall be carried out prior to and during the construction and operation of a disposal facility and after its closure, if this is part of the safety case. The waste disposal facilities considered include those at which waste is placed on the surface (for example, at some sites for waste from the mining and milling of uranium or thorium ore), or near to the surface (low and intermediate level waste). Details concerning the content and implementation of the monitoring and surveillance of a surface facilities programme will be agreed upon with the regulatory authority. This guide covers the specific monitoring of facilities intended to confine and contain radioactive waste — mainly in the period after operations at the facility have ceased and the facility has been closed.

Specific recommendations were formulated for different types of existing situation for which it may be necessary to implement a monitoring programme. The regulation requires the consideration of different factors e.g.: pathway

analysis, types of radiation monitoring, programmes for monitoring activities and interventions, monitoring of radioactive discharges within activities, pre-operational studies, monitoring in the operational stage, monitoring of radioactive waste disposal facilities after closure, monitoring in emergency exposure situations, education and training, recording monitoring data, environmental sampling in conditions of existing exposure situations and surveillance methods.

The document establishes that the periodic safety assessment of a disposal facility has to be aimed at providing an overall assessment of the status of protection and safety at the facility. Periodic safety assessments cannot replace the activities relating to analysis, control and surveillance that are continuously carried out at disposal facilities.

Specific requirements are provided for different types of facilities such as the surface and near-surface disposal of RW and monitoring the tailing dumps and working areas of uranium mining enterprises. General requirements for monitoring different media (water, atmospheric precipitations and aerosols, food and solids) are provided.

It is important to underline that safety requirements were provided for: pathways analysis, measurement strategies, dose assessment and the interpretation of monitoring results.

# 4 Common identified problems

Technologies related to the mining and processing of uranium ores were developed by the same research and design institutions attached to the Ministry of General Machine Building of the former USSR. Correspondingly, the features of the uranium production legacy in Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan (as well in the Russian Federation, Ukraine and countries of Eastern Europe) are similar.

It is important to underline that the Central Asian countries have already taken steps over several years, with the support of the international community, to improve the legacy situation from past practices which were not well regulated or regulated according to the radiation safety requirements, which are now out of date.

## 4.1 The existing situation

According to the threat assessment report [1], about 800 million tons of radioactive waste have accumulated in Central Asia and are waiting for their safe final solution. For instance, radioactive waste in Kazakhstan makes up 237.2 million tons with a total activity of 5.7·1017 Bq, including 450 tons of high-level RW with an activity of 7.03·1016 Bq; 6.5 million tons of intermediate-level RW with an activity of 4.88·1017 Bq; and 230.7 million tons of low-level RW with an activity of 1.09·1013 Bq. The total amount of accumulated radioactive waste in Tajikistan makes up 55 million tons over an area of 170 hectares. According to the different estimates, the total activity of this waste amounts to approximately 240-285 TBq. By far the largest volume of waste is associated with uranium mining and ore processing and other mining industry waste. Significant amounts of much more highly active radioactive waste associated with the rest of the nuclear fuel cycle and military applications also remain unmanaged, particularly in Kazakhstan. This waste has arisen in part from the operation of nuclear facilities but further wastes are anticipated as decommissioning work progresses.

From 1961 to 1995, mining ceased at most of the mines. However, remediation was performed at only a few facilities located near the important settlements. The current situation is aggravated by the fact that many radioactive waste "storage" facilities are located in regions of seismic activity, in landslide- and mudflow-prone sectors, in zones subject to flooding and high ground water levels and also near the banks of rivers that form the base of the large water basin of the Central Asian region. Many tailings are situated near towns of different sizes, populated areas and state borders.

In central Asia, there are several radioactive waste "storage" facilities that could be deemed ecologically sensitive due to their negative impact on public health and the environment and are at risk of being destroyed by possible natural disasters and natural-anthropogenic cataclysms.

At present, there is no unified regional system that could conduct systemized monitoring of trans-boundary environmental pollution and exchange information in this field and coordinate practical activities to solve uranium legacy issues. Even though the legislative base regulating the field of radioactive waste management has been developed to some degree in all the countries, the existing legislation is not harmonized with international norms and requirements.

The issue of finding a final solution for the radioactive waste requires urgent attention. In order to meet an internationally accepted level of safety, it is necessary to reduce the risks associated with the radiation contamination of the Central Asia ecosystem which requires the establishment of an industry for managing radioactive material including its final disposal.

It is necessary to note that remediation measures have been implemented at very few facilities; remediation has not been performed in many cases at all, and no special funds for the recovery of radiation safety have been established yet. Another essential constraint for the development of national plans concerning the remediation measures is the lack of a strong regulatory framework and infrastructure.

Making due allowance for some small variation in climatic and geographic conditions, the legacy problems left behind by uranium mining and milling in Central Asia are not very different from those of other countries. The most important constraints for the development and implementation of efficient regulatory control, planning in advance and implementing remediation plans as well as the design and implementation of a monitoring system where needed can be summarized below.

## 4.2 Regulatory and legislative framework for the safe management of radioactive waste

It is obvious that in order to eliminate existing threats, it is necessary to manage (and dispose of) radioactive wastes accumulated/generated in Central Asia taking into account international safety standards and recommendations. However, it seems rather problematic to realize this task in the near future as only some basic elements of national policy and strategy for radioactive waste management are in place in the republics. The national strategies for radioactive waste management need to be developed and implemented in accordance with the IAEA recommendations and international good practices. They should define how the responsible organizations will realize the national policy for radioactive waste management with the use of available technical measures and financial resources.

Moreover, mechanisms of financial and human resources for supporting the long-term and safe management of radioactive wastes have not yet been established. National organizations in Central Asian countries which would co-ordinate radioactive waste management at the national level have not been created. An important issue is the development and approval of a classification scheme for radiation in accordance with the recently approved IAEA international recommendations in this regard. There is also a lack of safety requirements for different types of predisposal management facilities. Similar actions need to be taken for the establishment of safety requirements (regulations) for the design, siting, construction, operation, closure and establishment of institutional control needed for disposal facilities in accordance

with the approved national policy and strategy on radioactive waste management. This includes the regulatory basis for the licensing of future disposal facilities including the elaboration of the safety assessment, safety case and environmental impact assessment.

## 4.3 Costs of remediation and limited availability of national funding mechanisms

None of the Central Asian countries have set aside any funds for mine closure and remediation. Except for Kazakhstan, none of these countries has a systematic national programme for the remediation of legacy sites. Considering that GNP in Kyrgyzstan, Tajikistan and Uzbekistan is considerably lower than in Kazakhstan, it is considerably more difficult for these governments to dedicate adequate funds to this purpose without an incentive. A combined national/international financing programme would be a feasible approach in these cases. At the same time, no funding mechanism has been created at the governmental level nor such requirements for the licensee or the operator to create one since the beginning of the operational phase. There is a need to establish mechanisms for providing resources and funding for safe decommissioning, remedial actions and long-term radioactive waste management.

## 4.4 Inadequate knowledge of the inventory of the legacy components and the risks associated with them

Except for some obvious cases, such as Mayluu-Suu and similar sites, there are presently insufficiently reliable data for assessing the "realistic" risks presented by the legacy sites. A reliable database is paramount for justifying and prioritizing the remediation, especially in the case of some less obvious sites.

From the perspective of the current knowledge of the state of affairs it appears to be necessary to obtain first a consistent and reliable assessment of the legacy sites and components, which should include:

- The characterization of the inventory of both radioactive and non-radioactive contaminants.
- The effluent and influent streams on the "storage" sites and emissions into the air.
- Information on the geotechnical stability of the sites, erosion, stability of the current containment barriers, if any, and the design details of the containment barriers.
- In order to understand a site, an appropriate monitoring and surveillance plan must be set up including specifications of where to sample, how to sample, and how many samples must be taken, etc. The use of the recently acquired instruments and equipment should be incorporated into these plans.

The preparation of effective and efficient remedial plans requires additional data to that available for most of the legacy sites today. The decision regarding in-situ stabilization or relocation of residues such as tailings should be based on the results obtained on the basis of the new data.

## 4.5 Radiation safety regulatory issues

Concerning the sufficiency of national regulatory documents in relation to international recommendations on assessment, planning and remedial activities, it is useful to consider three basic aspects. Existing legal and regulatory documents do not address the issues regarding implementation of safety requirements for existing exposure situations including the long-term institutional control and monitoring of the abandoned dumps with radioactive wastes as well as future radioactive waste disposal facilities during their design, construction, commissioning, operation, closure and post operational control when needed.

Concerning application in the Central Asian countries, decisions on the prioritization of remediation of all the different legacies are not well justified and optimized. This is connected with the fact that no accurate quantitative criteria have been established defining

reference levels for the actions to be taken. IAEA Safety Standards [21] establish that the government and the regulatory body or other relevant authority shall ensure that the established strategy for the control of existing exposure situations is commensurate with the risks associated with the existing exposure situation and that remedial or protective actions yield sufficient benefit to outweigh the detriments associated with taking them, including detriments in the form of radiation risks.

The implementation of remedial actions (remediation) does not imply the elimination of all radioactivity or all traces of radioactive material. The optimization process may lead to an extensive remediation but not necessarily to the restoration of pre-existing conditions. The regulatory body or other relevant authority and other parties responsible for remedial or protective actions shall ensure that the form, scale and duration of such actions are optimized. While this optimization process is aimed at providing optimized protection of all exposed individuals, priority shall be given to those groups of individuals whose residual dose exceeds the reference level and all reasonable steps shall be taken to avoid doses remaining above the reference levels. Reference levels shall typically be expressed as an annual effective dose to the representative person in the range 1–20 mSv or other equivalent quantity, the actual value depending on the feasibility of controlling the situation and past experience in managing similar situations. The regulatory body or other relevant authority shall periodically review the reference levels to ensure that they remain appropriate in the light of prevailing circumstances.

Concerning these recommendations, it is not clear how to perform rehabilitation of the sites contaminated with radionuclides because regulatory requirements for remediation and clearance of such sites are absent. Radiation protection criteria for areas after their remediation are not defined quantitatively, e.g. based on different options or assumptions for subsequent land use. In other countries, regulatory documents define radiation protection criteria depending on a special-purpose designation of its future use. See, for example, those developed for legacy sites in northwest Russia [22] within the Russian-Norwegian regulatory cooperation programme. Such criteria could provide socially comprehensible guarantees of radiation safety for the population living in the vicinity. Requirements for institutional control, including monitoring, are not established either. There is a need to establish derived reference levels for the values of radiation parameters which can be directly measured when implementing radiation control, as indicated further in reference [22].

Measures for the supervision of legacy management need to be developed taking into account the arrangements in the country for radioactive waste management, including final disposal. While such interim storage and disposal facilities do not exist or are in need of improvement, and while the performance requirements for such facilities are not in place, the technical standards for the management of different categories of radioactive waste arising in legacy management are complex to determine. The two issues, legacy and waste management, need to be considered in an integrated fashion, and for example, take into account appropriate requirements on waste treatment and packaging consistent with protection objectives during transport and storage, and after disposal. Requirements on institutional control and security measures to prevent unauthorized access to the contaminated areas and/or radioactive material also need to be developed.

Resolution of these issues can be found only through the performance of safety assessments corresponding to the requirements for safety and protection. The requirements and assessment capabilities are still largely absent within the regulatory framework in the Central Asian countries.

## 4.6 Legislative and regulatory framework and infrastructure for mine operation, closure and environmental remediation

Since independence, a major handicap in the Central Asian countries has been the fact that there was no adequate technological, regulatory framework and infrastructure in place. The regulatory requirement to assess, authorize, inspect (monitor) and, if justified, remediate the legacy sites must come from a

consistent set of legal health and environmental protection requirements and from the mining law.

There is a need to review, update and elaborate the needed legal and regulatory framework (including authorization, inspection and enforcement) for the safe management of mine operation, closure and environmental remediation including those radioactive wastes and radioactive waste management facilities linked with the production of NORM waste. It is important to consider the authorization of any project concerning secondary processing of the uranium tailings impoundments with the purpose of extracting uranium.

Not all the countries have well established safety requirements for the secondary processing of uranium tailings impoundments and the extraction of uranium or other minerals from mine waters. There is a need to implement and enforce an authorization process which will require the potential investors to be responsible for the implementation of the projects concerning restoration at every tailings impoundment involved. This process should include: performance of a safety assessment and radiological impact assessment; rehabilitation and secondary processing of the uranium tailings impoundments; final disposal and rehabilitation of the off-balance ores and, as necessary, extraction of uranium from mine waters, or secondary processing of the uranium tailings impoundments. Finally the implementation of institutional control at existing tailings impoundments wherever this is needed.

A set of legal acts, decrees and regulations which govern remediation are in place and are being applied in Kazakhstan. An understanding of the complexity of the remediation issues, prompted by the case of Mayluu-Suu, is developing in Kyrgyzstan and the other countries.

In the present situation, the regulatory procedure does not always request safety assessment and radiological environmental impact assessments in the sense practiced in other uranium mining countries, not even for situations of considerable potential hazard. A consistent set of practical regulations based on an environmental, risk and safety assessment approach is highly recommended for adoption in the Central Asian countries. This should include the use of the relevant international standards and guidelines. This could, ultimately, also facilitate the availability of international funding.

There is a need to mention, as was recognized in the Threat Assessments performed by the countries, that there is in place a weak regulatory control and enforcement system under ongoing practices (uranium and non-uranium mining and milling) potentially giving rise to the creation of new uncontrolled large contaminated areas. In some of the countries there is more than one regulatory authority and improved coordination of the regulatory control actions, including enforcement, is needed. The introduction of good regulatory procedures and practice of constructive interaction with the remediation proponent (operator) could be facilitated by involvement of experienced external experts.

### 4.7 Lack of personnel with uranium mining and milling experience or knowledge of remedial actions

This problem concerns all levels: the government administration that provides the regulatory framework and the funding, the regulatory authorities reviewing the applications, issuing the authorizations and controlling (inspecting) the activities and facilities, and the operators responsible for safety during the entire life of the activities and facilities and finally implementing the remedial actions. The resolution of this problem will require the development and implementation of a national programme for the selection and qualification of the needed personnel at all levels, including on-the-job training, supported by experienced international experts.

### 4.8 Very varied public and social attitudes toward the legacy sites

Dealing with the existing exposure situations like those existing in the Central Asia countries requires considerable work by all interested parties and an extensive information campaign targeting the local population. The health and environmental risks presented by the legacy

sites are perceived very differently by the various interested parties including the public.

The local populations near the legacy sites are often unaware of or complacent about health hazards. For example, at Taboshar in Tajikistan, local people use contaminated uranium mining and milling materials and objects for construction purposes. There is a small farm operating below a large tailings pile at the top of a valley, directly on the stream that carries the periodic seepages from a tailings pile. Local people see no problem in grazing their animals directly on the tailings and waste rock piles overgrown with grass. Concerned groups working on the site are too narrowly focused on subtle details of the impact of the legacy sites, which are incomprehensible to the local population.

### 4.9 Shortage of state-of-the-art equipment and machines

Besides the tools needed for data collection, evaluation and interpretation, there is a lack of state-of-the-art machinery used in mining and tailings remediation. There is little suitable computer software, no GIS and plotters available for preparation of remediation plans, no laser scanning surveying instruments to support remediation work, no proper drilling rigs and sampling devices for investigation of the sites. A particular problem is going to be the lack of machines (e.g. bulldozers and scrapers) capable of working on steep slopes, e.g. for building covers. No large size (100+ t) haulage trucks are available for the relocation of waste rock or tailings. The available machinery is old and small in size (often dating back to the 1980s), which does not allow efficient implementation according to international standards. Unless large scale investments can be made in machinery, the remediation activities can proceed only at a slow pace.

### 4.10 Cross border regional problems related to the former uranium facilities in Central Asia countries

The cross border issues of monitoring and remediation of the former uranium facilities in the region are rather sensitive because most of the facilities are located near the borders of the adjacent states. The river systems are the main factor related to the cross border aspects of the problem.

The Syr-Daria River is the main artery of potential contaminant transfer as the watershed spreads from Kyrgyzstan and flows through the Fergana Valley in Uzbekistan and the other countries. A significant number of uranium residues and tailings piles are situated within the system. Consequently, the integrated monitoring of water contamination with radionuclides and chemical elements due to the possible impact of the former uranium facilities is a real issue of international significance.

# 5 Conclusions and recommendations

The conclusions and recommendations presented here apply to all the mentioned Central Asia countries: Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan. The review of the regulatory framework of these countries has shown that the regulatory basis in the field of management of the waste of the former uranium production industry has not been fully completed yet and requires improvement and harmonization with the IAEA Safety Standards and other international recommendations on good practices. In particular, the countries still have weak regulatory framework on how to provide safe management and remediation.

The elaboration and implementation of a national policy and strategy for radioactive waste management is of high priority considering:

1) the level of the threats connected with the legacies increases continuously due to the continuing degradation of old facilities and the new and renewed operation of uranium mining, oil and gas production and other mining industries;
2) the likely increase in the amount of radioactive waste in the future in the event that plans to build new nuclear power plants (e.g. in Kazakhstan) and the decommissioning of existing nuclear installations are realized;

3) the lack of funding mechanisms and financial liability for the shutdown and decommissioning of operating facilities and the remediation of the existing sites;

4) end points for the management of existing radioactive wastes as well as those which could arise in the future are not yet defined;

5) the lack of well established safety requirements for the protection of personnel, the public and the environment in existing exposure situations.

From the situation described in this paper it is obvious that in order to remove the threats and reduce the risks associated with the nuclear legacies, including those which have already accumulated as a result of previous activities, and those which are generated in significant amounts now and which could be produced in the future, it is necessary to enhance the legal and regulatory framework with the aim of:

1) Clearly identifying responsibilities of the government, the licensees (operators) and other interested parties in existing exposure situations.

2) Taking the measures needed for the justification and optimization of protective actions in existing exposure situations, including safety-related criteria as "reference levels" and derived quantities to be directly measured.

3) Clearly identifying institutions or organizations to be responsible for remedial actions in areas with residual radioactive materials as well as the national organizations that will be responsible for the development and implementation of the national strategies for radioactive waste.

4) Identifying radiation protection objectives and related derived criteria for remediation of radioactively contaminated sites and facilities.

5) Establishing a strong and effective legal and regulatory framework including the proper enforcement capabilities to provide independent supervision of the safe management of remedial actions and radioactive waste management and at the same time providing the assurance that similar situations will not be repeated.

6) Carrying out a review of operator-prepared, and completely independent versions of radiological environmental impact assessments of proposals for legacy remediation, and in accordance with the results of the assessments, providing robust and transparent regulatory decisions. Contributions to decisions on priority activities for remediation are particularly important, based on radiation protection issues but also taking account of other environmental and human health protection issues.

7) Supervising from a regulatory perspective the implementation of institutional control, including the long-term monitoring of and control over the abandoned objects of the uranium industry, nuclear test sites (in Kazakhstan) and other legacy areas where it is necessary to prevent unjustified exposure of the public.

To meet these objectives it is necessary to review, develop or approve and implement where already drafted, according to the latest international recommendations, as well as the requirements of the Joint Convention on the Safe Management of Spent Nuclear Fuel and the Safe Management of Radioactive Waste, the following legal and regulatory documents:

1) national policy and strategy for radioactive waste management;

2) classification of radioactive waste including identification of corresponding categories of management;

3) radiation protection requirements for the protection of personnel, the public and the environment in existing exposure situations including those needed for the remediation and rehabilitation of areas affected by past practices;

4) safety requirements for the predisposal management of radioactive waste; and

5) safety requirements on the design, siting, construction, operation, closure

and establishment of institutional control needed for disposal facilities in accordance with the approved national policy and strategy for radioactive waste management;

In all Central Asian countries the national policy should list the actions necessary for the establishment of mechanisms for providing resources and funding for safe long-term RW management, maintenance of the availability of sufficient and qualified human resources to perform the safe handling radioactive wastes, including resources for training and "R&D" and implementation of institutional control and monitoring, for the safety control of RW storage/ disposal sites both during their operation and after their closure. However, political declarations will not be enough and consequently additional steps for their realization are required. Steps towards realizing a national policy are provided in the documents of the IAEA. One thing is certain, the transfer of the radioactive wastes accumulated in Central Asian countries to safe disposal facilities can only be realized in the long term.

Nevertheless, in the near future, it is possible to decrease existing threats by undertaking the following actions:

Reviewing the draft regulations developed in the context of the present project and presenting them to the corresponding authorities for their final approval and implementation as soon as possible.

1) Defining responsibilities for the actions to be taken in each facility or activity.
2) Carrying out the safety assessment and radiological impact assessment for the contaminated territories and, in accordance with the results of this assessment, taking the needed measures to diminish the risks.
3) Carrying out long-term monitoring and institutional control of the abandoned objects of the uranium industry, and also building fences where it is necessary to prevent unauthorized access to the contaminated areas.
4) Carrying out long-term monitoring and control of nuclear test sites and also building fences where it is necessary to prevent unauthorized access to the contaminated areas.
5) Carrying out regulatory control and long-term monitoring and control of gas and oil production sites having the contaminated soils and storage places for the contaminated pipes and equipment, and also building fences where it is necessary to prevent unauthorized access to the contaminated areas.

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# 7 List of abbreviations and acronyms

| | |
|---|---|
| ASIR | Ampoule Sources of Ionizing Radiation |
| DSRS | Disused sealed radioactive sources |
| EDR | Exposure Dose Rate |
| EIA | Environmental Impact Assessment |
| EKO | East-Kazakhstan Oblast |
| EPA | Environment Protection Agency |
| FA | Fuel Assembly |
| FEP | Features Events and Processes |
| HLW | High Level Waste |
| IAEA | International Atomic Energy Agency |
| ICME | Irtysh chemical and metallurgical enterprise |

ICRP International Commission on Radiation Protection

IEI Integrated Engineering and radiological Inspection

ILW Intermediate Level Waste

INP NNC Institute of Nuclear Physics of the National Nuclear Center of the Republic of Kazakhstan

IRS Ionizing Radiation Source

ISL In situ leaching

ISTC International Scientific and Technological Centre

KAEC Kazakhstan Atomic Energy Committee

LI Level of Intervention

LILW Low and Intermediate Level Waste

LMA Level of Minimal Activity

LLW Low Level Waste

LRW Liquid Radioactive Waste

MAAD Mean Aerodynamic Activity Diameter

MDE Maximum Design Earthquake

MEMR Ministry of Energy and Mineral Resources of the Republic of Kazakhstan

MINT RK Ministry of Industry and New Technology of the Republic of Kazakhstan

MSA Minimum Significant Activity

MSSA Minimum Significant Specific Activity

NNC RK National Nuclear Center of the Republic of Kazakhstan

NPP Nuclear Power Plant

NORM Naturally occurring radioactive materials

NRB Norms of Radiation Safety

NRC Nuclear Regulatory Commission

NRPA Norwegian Radiation Protection Authority

NRSE Norwegian Radiation Safety Authority

NRN Natural Radio Nuclides

NSF Nuclear Spent Fuel

NSRWDF Near-Surface Radioactive Waste Disposal Facility

NTSC Nuclear Technology Safety Center

OECD Organization for Economic Co-operation and Development

PBZRO Regulations of Safety for Near Surface Disposal of Radioactive Waste

PCT Pumping Compressing Tubes

QAP Quality Assurance Programme

RK Republic of Kazakhstan / Kyrgyzstan

RPP Radiological Protection Plan

RSE Republican State Enterprise

RSS Radiation Safety Standards

RTG Radioisotope thermoelectric generators

RW Radioactive Waste

RWDF Radioactive Waste Disposal Facility

RWMP Radioactive Waste Management Plan

RWS Radioactive Waste Storage

SA Specific Activity

SAR Safety Analysis Report

| | |
|---|---|
| SCR | Self-sustaining chain nuclear fission reaction |
| SE | State enterprise |
| SES | Sanitary Epidemiologic Service |
| SGTPORB | Sanitary and Hygiene Requirements for Radiation Safety Ensuring |
| SNTS | Semipalatinsk Nuclear Test Site |
| SPORO | Sanitary Regulations for Radioactive Waste Management |
| SPZ | Sanitary-Protective Zone |
| SRRWM | Sanitary Rules for Radioactive Waste Management |
| SRW | Solid Radioactive Waste |
| STG | Semipalatinsk Testing Ground |
| UMP | Ulba Metallurgical Plant |
| UMULM | Uranium Mining by Underground Leaching Method |
| USSR | Union of Soviet Socialist Republics |
| VLLW | Very Low Level Waste |
| WAC | Waste Acceptance Criteria |

Statens strålevern
Norwegian Radiation Protection Authority

**StrålevernRapport 2013:1**
Virksomhetsplan 2013

**StrålevernRapport 2013:2**
Ultrafiolett stråling, solskader og forebygging

**StrålevernRapport 2013:3**
Dismantlement of nuclear facilities decommissioned from the russian navy: Enhancing regulatory supervision of nuclear and radiation safety

**StrålevernRapport 2013:4**
Вопросы Обеспечения Ядерной И Радиационной Безопасности При Утилизации Радиационных Объектов: Выведенных Из Состава Военно-Морского Флота Российской Федерации

**StrålevernRapport 2013:5**
Overvaking av radioaktivitet i omgivnadene 2011

**StrålevernRapport 2013:6**
Implementation of the IAEA Code of Conduct on the Safety and Security of Radioactive Sources and its supplementary Import/Export Guidance

**StrålevernRapport 2013:7**
Avvikshåndtering i norsk stråleterapi

**StrålevernRapport 2013:8**
Norwegian Support to Regulatory Authorities in Central Asia in Radioactive Waste Management – Final report for activities in 2008-2012

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