GEORGIAN NATIONAL REPORT FOR THE JOINT CONVENTION ON THE SAFETY OF SPENT FUEL MANAGEMENT AND ON THE SAFETY OF RADIOACTIVE WASTE MANAGEMENT

THE SEVENTH REVIEW MEETING

LEPL Agency of Nuclear
and Radiation Safety

EXECUTIVE SUMMARY

Georgia is small country situated on the south Caucasus (Fig.1). Total square of Georgia is 69 700 km^2 with population 3.9 million. Georgia accessed to the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management at 2009. The first National Report was submitted at October 2011.

Fig.1.Geographic location of Georgia

This is Georgia's fourth National Report in terms of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management. In this recognition Georgia fulfils all responsibilities defined by the national legislation for nuclear and radiation safety, which based on the national Laws on Nuclear and Radiation Safety, on Radioactive Waste, national regulations related to radioactive waste management and National Strategy for Radioactive Waste Management for 2017-2031 years.

Within the present context, Georgia would like to reaffirm to the international community the importance of carrying out sound practices for the safety of spent fuel and radioactive waste management. In this report Georgia is planning to show development of its national system for radioactive waste management to meet IAEA standards and requirements of the Joint Convention.

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Georgia acceded to the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management in July 2009 and Georgia's obligations under the Joint Convention entered into force in October 2009. This is the fourth national report that has been compiled and made available for submission in October 2020. The first report was submitted to IAEA at October 2011.

The report summarizes Georgia's approach to the safety of spent fuel management and the safety of radioactive waste management and demonstrates how Georgia fulfills its obligations under the Joint Convention.

The country has no any nuclear fresh or spent fuel at the present time except those one (small amount of fresh fuel) being detained at the state borders as illegal materials. The country had only one nuclear research reactor IRT-M being under operation within 1959-1989 years period. The reactor belonged to E,Andronikashvili Institute of Physics (IP), which was joined to Tbilisi State University at 2011. The reactor decommissioning is practically completed. (Only entombed reactor core is remained on the place). The same institute operated subcritical assembly contained 1880 g of 36% enriched uranium, which was also decommissioned at 2015. Uranium of subcritical assembly was repatriated to the country of origin. The radioactive source (PuBe $1.5x10^8$ n•sec/sm^2) was sent to Centralized Storage Facility (CSF) for safe storage. As a results Georgia has not any nuclear installation and does not elaborate any plan for developing of facilities using nuclear fuel.

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CSF was operated by IP until 2016, when the CSF operation was transferred to newly established Department for Radioactive Waste Management (DRWM), which also conducts all management activities related to closed "Radon" type facility s.c. Saakadze disposal.

Georgia had great problems with s.c. "Orphan" radioactive sources, which was successfully solved: More than 300 DSRS were found and recovered; The legal base for establishing of state control and radioactive waste management was elaborated and adopted. The administrative and technical system for control of movement of radioactive substances were established.

Some radioactive waste generated during the decommissioning of the reactor are still kept in premises located at Applied Research Center of IP (reactor site). The waste should be proceeded and sent to CSF. Small amount of contaminated soil also kept at the storage facility of the Institute of Agrarian Radioecology. (The Institute of Agrarian Radioecology was joined to Georgian Agrarian University at 2011).

During the last years Georgia took active steps to develop its national system for radioactive waste management in accordance of the approved national strategy and cover the challenges identified for the country at JC 6th review meeting.

The revised overview for Georgian programmes to manage radioactive waste is provided by tab.1

Tab. 1 Overview matrix

Type of Liability	Long Term Management Policy	Funding of Liabilities	Current Practice / Facilities	Planned Facilities
Spent Fuel	Not Applicable			
Nuclear Fuel Cycle Waste	Not Applicable			
Application Wastes	Centralized storage facility. Disposal as an end point is considered	Owner pays for storage. If the owner is not known, the state provides financial support	Some treatment and conditioning at the site of CSF	New waste storage and processing facilities
Decommissioning	Centralized storage facility. Disposal as an end point is considered	Decommissioning of the research reactor is conducted by the operator within IAEA TC projects	Nuclear research reactor was shut down at 1989 – now being practically decommissioning	Continuing decommissioning and processing of the generated waste
Disused Sealed Sources	Centralized storage facility. Disposal as an end point is considered	Owner pays for storage. If the owner is not known, the state provides financial support	Collection of DSRS, Conditioning and safe storage	Storage and conditioning. Expand conditioning capabilities

Section B. Policies and Practices

Georgia has not separately developed document for radioactive waste management national policy. General requirements of the policy are defined by Laws on Nuclear and Radiation Safety and on Radioactive Waste and, subordinated legal acts, which set eight basic principles for radioactive waste management including “Polluter Pays” principle. It is important, that Georgian national policy (Technical Regulation No.189) clearly sets requirements for disposing of any radioactive waste (including DSRS) as an end point for whole process of radioactive waste management. At the same time the possibility of export of radioactive waste is also considered (Art 18. Para. 3. c of Law on Nuclear and Radiation Safety).

The last revision of the text of Law on Nuclear and Radiation Safety was conducted at 2015 and the law was adopted at the beginning of 2016 (after that only some negligible technical changes were incorporated into the text of the Law). The Law considers establishment of Department for Radioactive Waste Management (DRWM) (Art.6 para. 3), which should conduct management of radioactive waste on behalf of the state. The functions of DRWM are defined by Law on Nuclear and Radiation Safety (Art.5 para.5). DRWM is established at Agency of Nuclear and Radiation Safety (Regulatory Body) and can use all technical resources of the Agency, which is supervised by Ministry of Environmental Protection and Agriculture (Ministry of Environment and Natural Resources Protection before 2018). Meantime the Head of DRWM is assigned by Minister of Environmental Protection and Agriculture and accountable against him. The activity of DRWM can not be licensed according to the requirements of Law on Licenses and Permits (Art. 1 para. 2) as a state organization, but its activity requires obtaining of permit for environment impact assessment. This management system is created on the temporary base to use more effectively limited technical and human resources to ensure safety for radioactive waste management. It is foreseen to separate DRWM form Agency of Nuclear and Radiation Safety completely in future.

DRWM operates CSF and Saakadze disposal facility. It should be emphasized , that the disposal facility is closed and post closure measures are conducted. Before the establishment of DRWM no operator for Saakadze disposal was defined and, CSF was operated by scientific institute. Transfer of operator's function for CSF and Saakadze disposal to DRWM sufficiently increased effectiveness of radioactive waste management in the country.

Some licensees are kept at their facilities defined amount of radioactive waste as it is considered by conditions of their licenses.

Law on Nuclear and Radiation Safety sets general requirement (Art.34) for elaboration of national strategy for radioactive waste management. This requirement is more precisely defined by Law on Radioactive Waste (Art. Para.16), where special requirement for Government of Georgia is established to approve 15 years' strategy, which should include "analyses of the current situation in the country associated with radioactive waste management and information on measures to be implemented".

According to the existing requirements, 15 years (2017-2031) national strategy for radioactive waste management was elaborated and approved. The strategy is focused on the development of predisposal management of radioactive waste, which main tasks should be solved within the next 15 years. The main goals for improvement of radioactive waste management in Georgia within the next 15 years are defined by the strategy as followings:

a) Allocation of all radioactive waste management facilities (storage, waste processing, disposal facilities) on one site;

b) Enhancement of radioactive waste management infrastructure;
c) Development of radioactive waste processing capability;
d) Enhancement of nuclear and radiation safety and security for radioactive waste management;
e) Development and harmonization of national regulation for radioactive waste management with international norms and standards;
f) Development of administrative, human and technical resources

All above mentioned goals are served with established tasks, which should be solved to achieve the set goal.

The details for the strategy implementation are defined by action plans. Previously was developed two years action plan, which was renovated and new three years action plan was adopted. Continues development of new action plans are considered.

Georgia officially established (Art. 6 of Technical Regulation No,689 Categorization of Sources of Ionizing Radiation, Creation and Maintenance of Registry of Authorization, Sources of Ionization Radiation and Radioactive Waste) radioactive waste categories as defined by IAEA GSG-1.

Section C. Scope of Application

As it was mentioned above Georgia does not possess any nuclear fuel. Only some fuel elements kept at CSF are detained as illegal materials. The country also does not operate nuclear installations and does not produce radioactive sources. Big part of radioactive waste are waste generated during the reactor decommissioning, institutional waste and disused sealed radioactive sources, which according to Georgian legal requirements are defined as radioactive waste. Medical facilities mainly generate VSLW, which can be removed from regulatory control after some delay in decay storages established on the place. For this case Georgia has developed legal requirements for clearance procedures. It should be also emphasized that NORM is declared as a radioactive waste, if their further use is not foreseen.

All waste (except DSRS) stored in Georgia can be characterized as VLLW and LLW.

Section D. Inventories and Lists

CSF provides safe storage for 26 items of 200l concreted drums with radioactive waste generated during the reactor decommissioning (Tab.1, Annex 1). The waste were generated and conditioned within the implementation of IAEA TC project GEO/3/002 and assigned as LLW. Three concreted drums were also originated, when the contaminated water from the first underground tank was removed and purified at Saakadze disposal within IAEA project GEO9013. The waste are assigned as LLW.

Disused 1011 sealed sources and 517 unsealed sources are kept at CSF (Some small activity sources are consolidated under one regulatory number. For instance, DSRS from Technical Scientific Center Delta was transferred to CSF and consolidated under 46 regulatory number). The information for the sources inventory is kept by special software ARIS (Donated and operated by US support). All sources are stored in special containers. Some of them are handmade, which creates serious problem for possible leakage of radionuclides. The special activity for repackaging of these sources are started under IAEA TC project GEO9015.

Total physical inventory of all radioactive waste (including DSRS) kept at CSF was conducted at 2017 (Fig.2)

Fig.2 Physical inventory process conducted at CSF

Fig.3 gives distribution of sources kept at CSF by activity. The distribution of the same source by their numbers is given by Fig.4.

The high component of ^{90}Sr on Fig.3 is conditioned due to six recovered sources – Radiothermogenerators (RTG) with initial activity of ^{90}Sr 1 290 TBq for each of them.

Big part of ^{137}Cs sources consists of former soviet military installations. Mainly there are two different type of installations: the first contains two radioactive sources with initial activity ~ 0.2 GBq for each source and the second – one source with initial activity ~ 100GBq.

Five installation "Kolos" with ^{137}Cs sources (60 source in one installation with total initial activity 129.5 TBq) are also kept at CSF. Another big installation kept at CSF is RXM used for industrial radiography containing 81 ^{60}Co sources with current total activity 18.87 TBq.

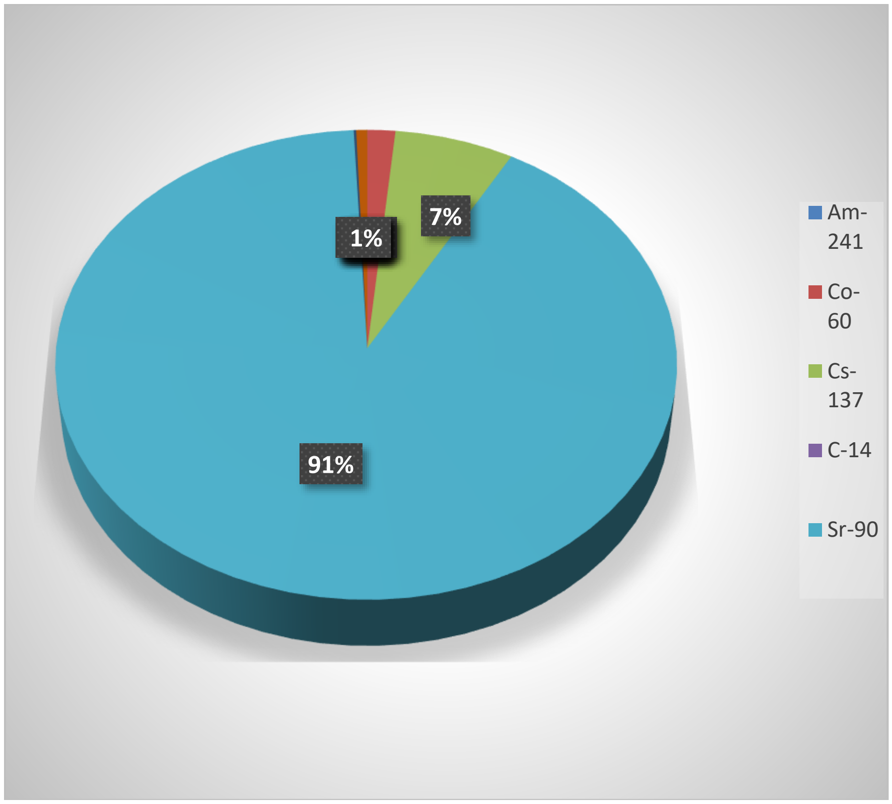


Fig.3 Disused radioactive sources activities kept at CSF

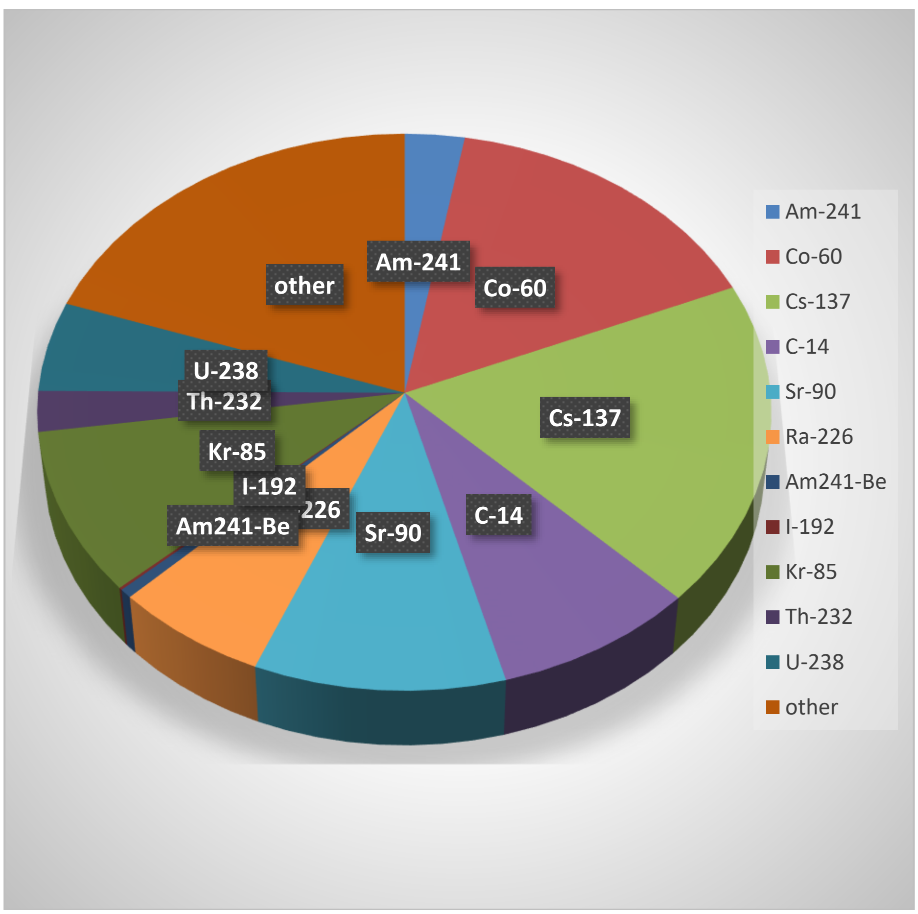


Fig. 4 Disused radioactive sources kept at CSF

If categorization of sources [1] is applied for sources stored at CSF, it can be concluded, that there are not the first category sources in the storage facility. The second category sources number is 30 (mainly ^{90}Sr, ^{137}Cs and ^{60}Co) and the third category – 98.

Some nuclear fuel elements detained as illegal materials are also stored at CSF:

- 16.3 % enriched Uranium 379 elements with total mass 916.243 g
- 3.4 % enriched Uranium 576 elements with total mass 2 638,765 g

Besides of the above mentioned other enriched Uranium materials are also kept at CSF:

- 2.1 % enriched Uranium 29 pieces with total mass 2944,91 g
- 1.2 % enriched Uranium 29 pieces with total mass 1.33 g

Total mass of enriched Uranium kept at CSF can be assessed as 6 609.9 g

Depleted Uranium materials (shielding devices for medical installations, powders and others) are also stored at CSF with total mass 5568.8 Kg.

Different amount of Pu (16g) and Th (2.914 Kg) at CSF.

Georgia has only one disposal facility for radioactive waste – s.c Sakadze disposal. The disposal facility covers an area of 51 883 m^2. The facility was closed at 1989, but the last burial was conducted at 1995. Saakadze disposal is typical „Radon" type facility with one underground disposal (Dimensions 20x10x5 m, two vaults with 4 sections for each) for solid waste and three underground tanks for liquid waste. (Liquid waste is fixed only in the first drum, which was already treated)

Vaults are not full (it is assumed that only 64% are full). The main type of waste buried are smoke detectors, some technical devices, contaminated soils and some sources mainly identified as LLW. Unfortunately no register is survived. The conducted investigations proved existence of ^{137}Cs, ^{60}Co and ^{226}Ra.

A number of small activity DSRS were kept at the storages of State Military Scientific-Technical Centre "Delta" were transferred to CSF and consolidated at 46 regulatory numbers.

As it was mentioned above the big part of radioactive waste consists of waste generated during the decommissioning of Georgian nuclear reactor IRT-M. The reactor decommissioning was conducted within IAEA TC projects GEO/4002, GEO/3/002, GEO/3/004 and GEO/9/012[1]. On the first step all fuel was removed and reactor core was covered by special (barium containing) concrete. This decision was issued due to absence the capability for dismantling of the rector systems and handling with generated waste for this period of time. As a result 1/3 of the reactor

[1] The reactor decommissioning is describing in Section F. "Decommissioning"

tank and experimental channels (as vertical, as horizontal ones) were filled up with special concrete. Some comparably high active parts of the reactor were put into the concrete as shown in Tab.1 of annex 2.

During the decommissioning of reactor auxiliary system (Project GEO/3/002) some comparably active parts were immobilized into the concrete matrix. As a result 200l 26 drums are stored at CSF. Other contaminated items (pipes, valves) characterized with inner surface contamination were hermetically closed and placed into s.c TTR building on the reactor site (Tab 2.3.5.6 Annex 1). Cleaning up of the items was postponed due to absence of the treatment capability for this period of time. The abrasive cleaning device was provide to IP only at 2012 within the frame of IAEA TC project GEO/9/011.

The next part of waste was generated when overpass connecting the reactor building with the cryogenic station was dismantled within project GEO/3004 at 2009-2011. (Tab.2 Annex 2). The same technology was used as for the waste generated during the previous activity – the tubes were closed hermetically and placed at TTR building.

Decommissioning of the reactor was completed by dismantling of cryogenic station, which was conducted within the frame of IAEA TC project GEO/9012 at 2014-2015. During the dismantling only 29 fragments were assigned as contaminated above clearance level (Tab.3 Annex 2). The contamination was defined as non-fixable surface contamination. Four elements form this 29 were cleaned up by abrasive cleaning device. Contaminated items were hermetically closed in one tubes as containers.

On the reactor site (Applied Research Center of the Institute of Physics) other reactor waste are stored. The External Spent Fuels Storage (ESFS) has 2 separate pools. Both pools are filled with water resulting from the emptying of the in-reactor storage facility. The specific activity of the pumped water (40 m^3) was very low (Tab.2). 18 used beryllium blocks were transferred from the reactor well-storage to the external spent fuel pool where they are stored under water in one of the pools. All the beryllium blocks are characterized by high dose rate (about 10-15 μSv/h at 1 m). As a result of the dismantling of the ventilation system, 8 filters were removed and also transferred to the external storage facility (pool) for spent fuel. Among these 8 filters, 6 filters were Petryanov filters of FP-200 and FP-500 types and 2 carbon filters of FPP-15 type. The dose rate of used 8 filters was low – 0.3-0.4 μSv/h.

Total activity stored at ESFS can be assessed as 224 GBq.

On the same site the liquid radioactive waste (mainly water from the reactor tank) is stored in 5 underground tanks with a total capacity of 550 m^3. Two tanks of 100 m^3 are located near the CSF building. These tanks collected liquid from the reactor building. They are now covered with vegetation and could not be find without searching for them.

Tab.2 ESFS water content

Volume m^3	Activity concentration Bq/l									
	^{3}H	^{40}K	^{60}Co	^{90}Sr	^{137}Cs	^{226}Ra	^{232}Th	^{234}U	^{235}U	^{238}U
40	7403,2	<39,4	<4,0	215,9	17,7	<63,4	<12,6	0,01	<0,001	0,005

The tanks are made of reinforced concrete with an internal stainless steel liner. They are equipped with a system of pipes and valves for filling and draining. The tanks are linked with the ambient atmosphere through a vent. There are no level measurement devices so that the manhole cover must be opened to assess the level.

Three other tanks are located near the laboratory of radiochemistry and those were used to collect effluents released from that laboratory. According to the information obtained from the center workers two tanks have a volume of 100 m^3 while the third one is about 150 m^3. They are made of reinforced concrete with an internal stainless steel liner. The upper lids of these tanks are covered with grass. They are equipped with a system of pipes and valves enabling filling and draining. The tanks are linked with the ambient atmosphere through a vent. There are no level measurement devices so that the manhole cover must be opened to assess the level. The most interested is the tank N3 (volume of water 65m^3), where concentration of tritium is above the clearance level.

On the site of Applied Research Canter in the building of radiochemical laboratory 8 pcs 200 l drums with slightly contaminated by ^{226}Ra soil are kept. The drums are over packed by other containers.

Not considering CSF the distribution of radionuclides for radioactive waste kept at Applied Research Centre can be characterized as followings: 89% ^{60}Co, 7% ^{152}Eu, ^{154}Eu and 4% ^{137}Cs.

At the territory of Anaseuli Institute of Tea and Subtropical Cultures the contamination of large soil areas were fixed. ^{137}Cs was assigned as a main contaminant nuclide. The soils was removed and kept in concreted pits. The last remediation activity was conducted at 2013, when contaminated soil was collected into three locations on the site. Meanwhile under support of Swedish radiation regulatory authority SSM the complex radiological investigation of the site was conducted at 2017-2019. When 3D distribution of the nuclides was assessed.[2] The activity for the site remediation is already started.

The ^{226}Ra slightly contaminated soil was cut at the Agrarian University and kept on place in special building .34 pcs. 220 l drums were used for this purpose.

License holder - Sanitar Ltd keeps oil filters contaminated by ^{210}Po.

[2] The detail description of the conducted activities and gained results are given in Section H "Existing Facilities and Past Activities"

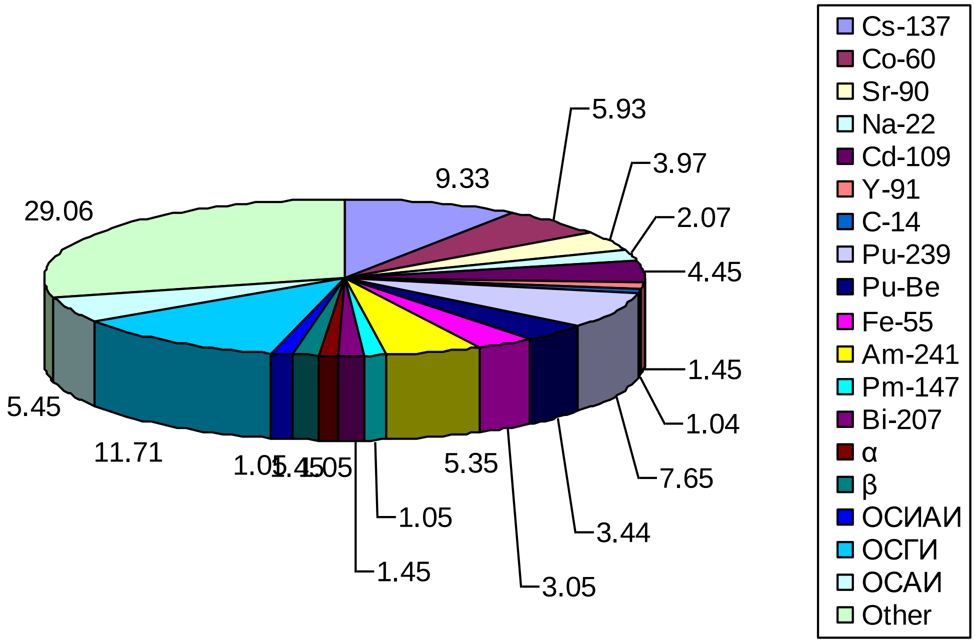


Fig. 5 Radioactive sources kept in Sukhumi

It should be noted that All radioactive waste (RAW) generated at the medical institutes in Georgia can assigned as VSLW and after some time keeping at the local storages can be released form regulatory control. Only DSRS usually is sent back to suppliers.

A number of sources are also kept in Sukhumi [3] (Fig.5)

Section E. Legislative and Regulatory System

IMPLEMENTING MEASURES

The implementing measures are defined in line with the goals and tasks identified by National Strategy for Radioactive Waste Management and based on the challenges for Georgia formulated at the sixth JC review meeting and, recommendations of IRRS mission held at the beginning of 2018

[3] Sukhumi is a capital of Abkhazia, which is officially recognized as an occupied territory. The number of sources were identified during joint inspection with IAEA in 2003. Georgian RB has not possibility to check the accuracy of this number at present.

- ***Identify the place for allocation of waste management facilities***

National Strategy considers allocation of all radioactive waste management facilities on one site. It is considered to arrange on one site storage, waste processing and disposal facilities. Considering this situation, two sites – Applied Research Center of IP (where CSF is located) and Saakadze disposal site can be discussed as main candidates. Due to its close placement to main road, strategic railway line and town Msketha (Mtsketha is assigned as cultural heritage), the first option seems less applicable, therefore the main interest was concentrated on the Saakadze site, where sufficient amount of waste are already accumulated. Additionally, on the same site the cementation facility was installed at 2018 within IAEA TC project GEO/9/013.

Based on the set goals the special research was conducted considering existing and possible future waste flow. As a possible candidate – Saakadze disposal site was chose for investigation. Additional investigation and data analyze for Saakadze site also was done. Conducted radiological, geological, hydrogeological, climate, seismic, urbanic and economical assessments proved the possibility to use the site for allocation of all waste management facilities. Based on the research data, Georgian government issued the ordinance No.2408 (November 21, 2019) identifying Saakadze site as a possible place for allocation of all radioactive waste management facilities.(see Sitting of facilities).

- ***Develop activity plan for construction of new waste storage and processing facilities***

According to the elaborated activity plan the following activities should be performed:

- Site selection;
- Development of general design of the facilities;
- Development of detail design of the facilities;
- Construction and equipping of the facilities

As it was mentioned above the first activity is already practically completed. The same can be said for the second activity. Under EU and Sweden support the project already was implemented and general design of the facilities are identified.

It is agreed to receive the support from EU and Sweden for the second activity. The project is already designed and agreed. The project implementation should be started at 2020.

The action document to receive the support for the last activity is under elaboration.

- ***Develop design for new waste storage and processing facilities***

As it is mentioned above based on EU and Sweden support the project for designing of new radioactive waste storage and processing facilities already was implemented. Considering the identified waste fluxes Functional Requirements Specifications

(FRS) and User Requirements Specifications (URS) were defined and general designs for storage and processing facilities were developed. Preliminary safety assessment for the facilities operation are also conducted. The next project for identifying the detail design will be started soon. The new project considers conducting of safety assessment, environment impact assessment and obtaining of necessary official permit for the construction of the facilities, which should be started within the next planned project. It is assumed to receive international support for the equipping of the facilities for safe and effective operation

- ***Upgrading of legal base for RWM in accordance with international standards***

Upgrading of national legal requirements usually is conducted periodically based on the existing needs and establishing of new international standards and norms, which should be implemented in national legal system. One of the best tool for comparative analyze of the situation is the report of IRRS mission. This mission was conducted in Georgia at the beginning of 2018. Based on the mission recommendations and suggestions the draft regulation covering regulatory requirements for all aspects of decommissioning is already prepared. The work for elaboration of new versions of Law on Nuclear and Radiation Safety, national BSS and regulatory requirement for WAC is going. New regulation for transport of radioactive substances are elaborated and officially adopted. It is also planning to upgrade the country system for authorization of nuclear and radiation activities and incorporate the corresponded changes into the legal documents. New legal requirements for decommissioning is already drafted.

- ***Collection of DSRS at Central Storage Facility***

Collection of DSRS at CSF is going permanently on routine base. When radioactive source become disused, the owner, according to authorization condition, should send it back to supplier. In case of legacy source it should be sent to CSF. License conditions define the right of license holder to store the source on the place. If it is impossible to send the source to supplier, finally every disused radioactive source should be stored safely at CSF. DRWM is responsible to collect all legacy sources and provide their transport safe storage at CSF. In other case license holder should prepare DSRS for transferring to CSF. The best example for the sources collection is repackaging and transfer to CSF small activity sources from Military Technical-Scientific Center Delta.

- ***Recondition of some DSRS stored at Central Storage Facility***

Some legacy DSRS stored in CSF are placed into old or handmade containers. Conducted leakage tests identified the leakage of nuclides from these containers and appearance of hot spots. Followed to conducted tests special decontamination activities were performed at CSF. To avoid further nuclide leakage it was decided to recondition old DSRS. This campaign has another goal: during the recondition the future disposal of DSRS should be considered – the sources can be repackage in such manner those considers their future possible disposal in bore holes. The recondition campaign is started within IAEA TC project GEO/9/015. The organization having experience in such activity is contracted by IAEA. The representatives of this organization together with Georgian specialists should start the activity, which should be continued only by Georgian specialists. The planned work considers establishment of temporary recondition facility at the entrance of CSF (Fig.6)

All necessary assessments were conducted and SoW prepared. The working programme is elaborated in details. The activity should be started at 2020.

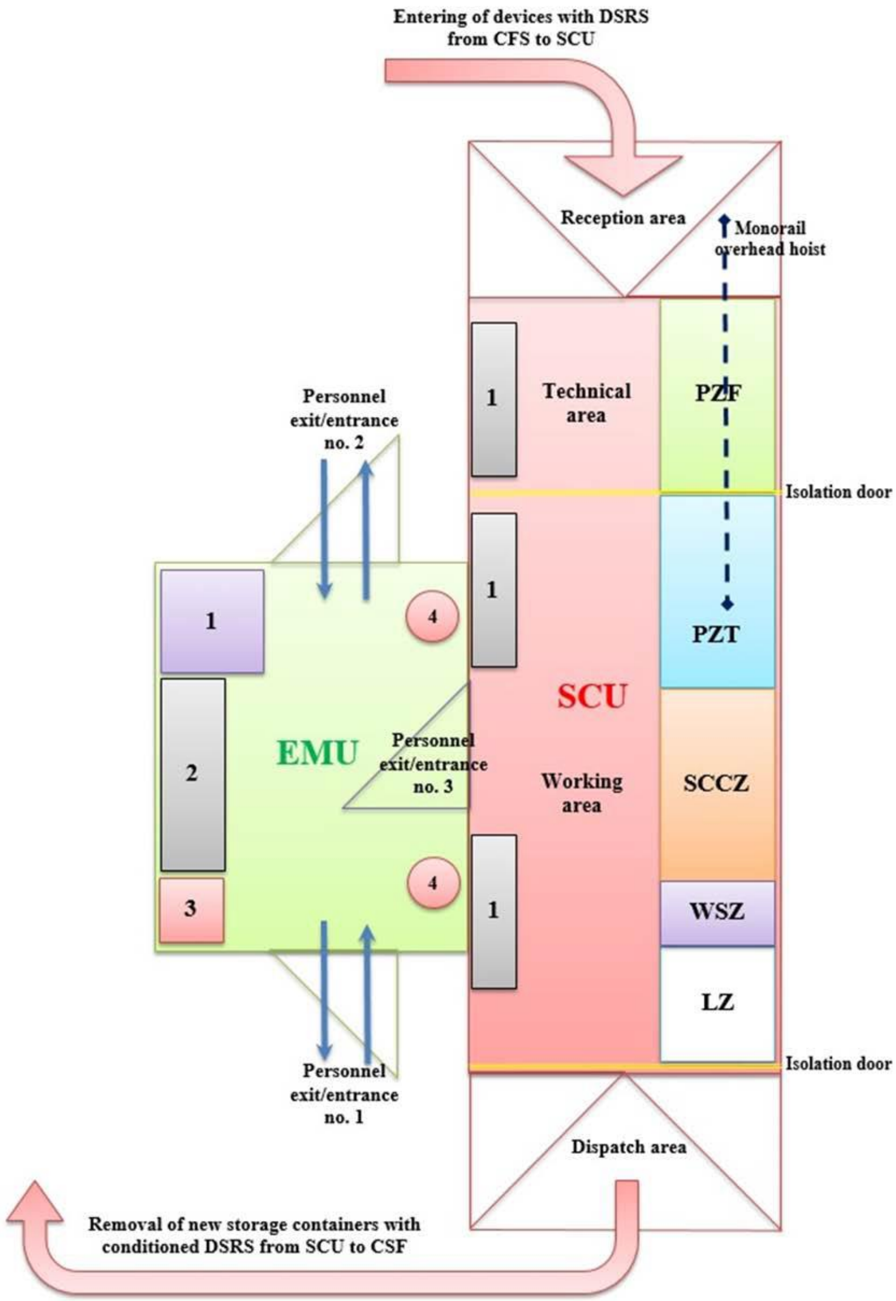


Fig.6 Scheme of temporary facility for recondition of DSRS

- ***Development of human expertise and resources***

Agency of Nuclear and Radiation Safety (ANRS) together with DRWM take active steps for development of human expertise and resources as defined by the National Strategy. The great attention is paid for education of young specialists. Bachelor, magister and doctorate programmes are established for nuclear and gradation safety (covering also radioactive waste management issues) at Georgian Technical University and Tbilisi State University. As a result one worker of DRWM gained Ph.D at Georgian Technical University.

Development of national system for radioactive waste management requires upgrade of human expertise and knowledge for the same area, therefore Georgia plans to build its capacity for development and effective utilization of radioactive waste management system. It is planned to use external sources for incorporation of international standards in national system and considering existing experience in other countries. In collaboration with Swedish radiation regulatory authority (SSM) and Sweden organization Sida new project is developed. The project considers fulfilment of the following main tasks:

- Conducting of self-assessment, identifying gaps and needs for building capacity;
- Development of building capacity plan;
- Short-term capacity building;
- Long-term capacity building

It should be emphasized that the short-term capacity covers operation of planned new facilities for predisposal waste management and, long-term capacity building – has wider goal considering all steps of radioactive waste management, including disposal option.

The project implementation is already started.

- Separation of regulatory and operational functions inside the government in line with international good practice

The complete separation of functions of ANRS and DRWM is planned in future, after development of national system for radioactive waste management, but not detail plan is still elaborated.

LEGISLATIVE AND REGULATORY FRAMEWORK

Safe and secure management of radioactive waste, at all stages from generation to disposal requires the presence of a national legal framework which guarantees political commitments, regulation and assigned responsibilities. The country conducts a major up-date of its legal and regulatory infrastructure for the management of radioactive waste. National legal base for handling with radioactive waste mainly consist of:

- Law on Nuclear and Radiation Safety;
- Law on Radioactive Waste;
- Law on licenses and Permits;
- Technical Regulation No.189 on Handling with Radioactive Waste;
- Technical Regulation No.123 on Safety Assessment Report for Radioactive Waste Storage Facility;
- Technical Regulation No.124 on Safety Assessment Report for Radioactive Waste Near Surface Disposal Facility;
- Georgian basic safety standards (Technical Regulation No.450) Radiation Safety Norms and Basic Requirements Related to Handling with Ionizing Radiation Sources;
- Technical Reregulation No.689 Categorization of Sources of Ionizing Radiation, Creation and Maintenance of Registry of Authorization, Sources of Ionization Radiation and Radioactive Waste;
- Decree No.26 of the Minister of Environment Protection and Natural Resources on Security of Nuclear and Radiation Facilities, Radioactive Sources, Radioactive Waste and Other Sources of Ionizing Radiation;
- Decree No.72 of the Government of Georgia, Technical Regulation – on Rules for Transport of Nuclear and Radiation Substances.

As international legal tools Georgia joined to the following conventions and agreements being under IAEA auspice:

1. Convention on the Physical Protection of Nuclear Material (CPPNM);
2. Amendment to the Convention on the Physical Protection of Nuclear Material (CPPNME);
3. Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (RADW);
4. Convention on Early Notification of a Nuclear Accident (NOT);
5. Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (ASSIST);
6. Revised Supplementary Agreement Concerning the Provision of Technical Assistance by the IAEA (RSA);
7. Agreement on the Privileges and Immunities of the IAEA (P&I);
8. Treaty on the Non-Proliferation of Nuclear Weapons

Georgia also joined to European agreement for transport of dangerous good by land – ADR.

In this way Georgia endorsed CoC, its supplementary guidance for export –import of radioactive materials and guidance for management of DSRS. Georgia also signed up the agreement with IAEA for application of safeguards in connection with NPT entered into force on June 3, 2003 (INFCIRC/617) by Law No. 2111. The additional protocol of the safeguards entered into force on the same day. Georgia submits report on implementation UN resolution No.1540.

Based on the existing and adopted legal requirements the reform for state regulation of nuclear and radiation activity and especially for radioactive waste management was conducted, when DRWM was established for operation of state owned radioactive waste management facilities.

Georgian Law on Nuclear and Radiation Safety sets general requirements for handling with radioactive waste (Art.34). The Law also defines license system for same activity. The law gives detail description of the license procedures and list of documents should be submitted to RB for issuing the license. Meanwhile the general requirements for license procedure are defined by Georgian Law on Licenses and Permits.

Georgian legislation considers conducting of Safety Assessment (SA) for radioactive waste storage and disposal facilities. SA should be conducted every ten years or by requirement of RB, which is responsible to review Safety Assessment Report (SAR) and approve the results. SAR for CSF and Saakadze disposal facilities were issued and approved at 2015. The requirements for contest of SAR for storage and near surface disposal facilities are defined by technical regulations No.123 and 124.

Law on Radioactive Waste defines general requirements for establishing of radioactive waste management system in Georgia. The Law sets principles for radioactive waste management generally corresponded to the basic principles defined by IAEA. The Law defines main responsibilities of waste owners (producers) and Department for Radioactive Waste Management (DRWM) as an operator for state owned facilities. The site selection requirements for radioactive waste management facilities are also considered. The legislation also pays especial attention to the rights of citizens. The special activity to upgrade the Law is already started.

Georgian national BSS – Technical Regulation No.450 Radiation Safety Norms and Basic Requirements Related to Handling with Ionizing Radiation Sources sets special requirements for licensees working with radioactive waste (Art.15). The regulation also establishes exclusion, exemption and clearance procedures (art.6) as defined by International Atomic Energy Agency (IAEA) RS-G-1.7. The site release procedures are also defined.

More detailed requirements for radioactive waste management are given by Technical Regulation N189 on Handling with Radioactive Waste, which covers all stages for handling with radioactive waste: waste generation, treatment and conditioning, emplacement into storage and disposal facilities and transport. Distinguishes between state and licensee operated storage facilities are made. The regulation also covers the following subjects: response on incidents and physical protection system. The regulation obliges radioactive waste owner (producer) to send its generated waste to DRWM after period of time defined by license condition. The main requirements for decommissioning activity are also set. New regulation for regulation of decommissioning activity is already elaborated.

It is important emphasized that Georgia has separate regulation – Technical Regulation No.689 defining requirements for registration of radioactive waste and their classification as given by IAEAS GSG - 1.

The requirements for safe transport of radioactive waste as in general for all nuclear and radiation substances are defined by Technical Regulation – on Rules for Transport of Nuclear and Radiation Substances. The regulation "On Security of Nuclear and Radiation Facilities, Radioactive Sources, Radioactive Waste and Other Sources of Ionizing Radiation" considers establishing of special classes of waste to define physical protection measures for them.

As it was mentioned above, Georgian Law on Nuclear and Radiation Safety defines license system for same activity. The law gives detail description of the license procedures and list of documents should be submitted to RB for issuing the license. Meanwhile the general requirements for license procedure are defined by Georgian Law on Licenses and Permits. It is important to emphasize that all activities related to handling with radioactive waste and decommissioning should be licensed. License should be issued for unlimited period of time for general activity. In case of conducting new separate activity, the license should modify radiation protection programme and obtain approval form RB.

Georgian legislation strongly prohibits import and transit of radioactive waste. Only export of radioactive waste is allowed by issuing of special permit. The permit issuing system is also defined by Georgian Laws on Licenses and Permits and on Nuclear and Radiation Safety. (Permit is usually issued for defined activity and covers one year period of time). Import, export and transit of radioactive sources are also covered by permit system. It should be emphasized that importer of radioactive source should provide warranty to send back the source when it became disused to avoid additional burden for the state.

The main actors on the field of radioactive waste management and their roles are defined by Georgian legislation as followings:

- **President of Georgia**

The President approves the Laws which pass through the Parliament.

- **Georgian Parliament**

The role of the Georgian Parliament is review of the proposed drafts of the Laws and respective update of the documents through 3 steps iterative process, followed by transfer of the document which successfully passed via Parliament review process to the President.

- **Georgian Government**

The role of Georgian Government is to approve of National Strategy and its supplementary action plan for radioactive waste management and other regulations, which are prescribed by Georgian legislation

- **Ministry of Environmental Protection and Agriculture[4] of Georgia**

The role of Ministry of Environment Protection and Agriculture is mainly focused on state control of ANRS activity, coordination on elaboration of new norms and standards, issuing environmental impact assessment permit for operation of radioactive waste management facilities, exercise control over the implementation of the state programmes, establishment of international relations, review and approving of reports submitted by DRWM and ANRS

- **Ministry of Economy and Sustainable Development of Georgia**

The role of Ministry of Economy and Sustainable Development is defined to ensure metrological testing of the equipment using during handling with radioactive waste and issuing the permit for construction of facilities;

- **Ministry of Internal Affairs of Georgia**

The role of Ministry of Internal Affairs is to ensure and supervise accident consequences mitigation activity and, physical protection system for facilities and transportation security.

- **Ministry of Foreign Affairs of Georgia**

The role of Ministry of Foreign Affairs is to exercise control over the fulfilment of the commitments of Georgia under international agreements, coordinating relations with international organizations;

- **Agency of Nuclear and Radiation Safety**

Agency of Nuclear and Radiation Safety (ANRS) acts as state Regulatory Body for any nuclear and radiation activity in Georgia including handling with radioactive waste. The Agency was established as a Legal Entity of Public Law under the Ministry of Environment Protection and Agriculture (former Ministry of Environment Protection and Natural Resources) as transformation of former Department for Nuclear and Radiation Safety due to conducted reform. As a result of the reform effective independence of RB was increased. ANRS is responsible state organization for authorization, regulation, inspection and enforcement for activity involved radioactive waste. ANRS also conducts state control on physical protection systems, elaborates draft laws and regulations, establishes international relationships and, conducts first responder actions in case of radiological emergency situations to assess the existed situation and issue corresponded recommendations.

- **Department for Radioactive Waste Management**

Department for Radioactive Waste Management (DRWM) was established as a result of conducted reform to manage state owned radioactive waste. It operates CSF and Saakadze disposal (closed) were all radioactive waste should be accumulated. The establishment of the Department provided re-establishing of state

[4] The Ministry was established by joining of Ministry of Environment Protection and Natural Resources and Ministry of Agriculture at the December of 2017

control on Saakadze disposal and unifying the state system for radioactive waste management (one operator for both facilities – storage and disposal).

The activity of DRWM is not covered by license according to the Law “On Licenses and Permits” (At.1 para. 2). The rights and responsibilities of DRWM as a state organization are defined by laws and decrees. In particular, basic functions of DRWM are set by Law “On Radioactive Waste” (Art. 5 para.5) mainly considering handling with state owned radioactive waste, operation of State owned radioactive waste management’s facilities (CSF and Saakadze disposal) and conducting decontamination and rehabilitation of radiologically contaminated objects. DRWM also can establish international contacts in area of its activity

- **Radioactive waste producer**

The main role of Radioactive Waste (RAW) producers (operator of radiation and/or nuclear facility) is to ensure minimization of radioactive waste generation and safe and secure management of the generated RAW until their transfer to the DRWM. Waste producer shall be responsible for:

- Technical, financial and administrative management of generated wastes in full compliance with the requirements of applicable legislation and regulations and conditions of granted license;
- Development, execution and periodic review of site or specific facility RAW management plans, which are to be based on the national RAW management policy and strategy;
- The establishment of the necessary technical infrastructure and processes to ensure safe management of RAW under the producer’s responsibility.

Regulatory Body

Georgian national Regulatory Body was established at the beginning of 1999, when regulatory functions were assigned to Ministry of Environment and Natural Resources Protection and Nuclear and Radiation Safety Service was established within the Ministry for practical application of regulatory activities. During the years the Service was transformed to the Department. The big reform was conducted at the begging of 2016 when Department for Nuclear and Radiation Safety was transformed to Legal Entity of Public Law Agency of Nuclear and Radiation Safety (ANRS). The reform had the main goal to increase independence of RB, by assigning of regulatory functions to ANRS. The functions between the Ministry and ANRS were clearly split by requirements of Law on Nuclear and Radiation Safety. The reform also considers establishment of Department for Radioactive Waste Management (DRWM) as a state operator of radioactive waste management facilities. Before CSF was operated by scientific organization – Institute of Physics and no operator for Saakadze disposal was defined. As a result of the conducted reform one operator – DRWM for both facilities were assigned. DRWM was established at ANRS on temporary base (as it was explained before) for effective using of limited resources. The splitting of functions between ANRS and DRWM was conducted by legal requirements established by Law on Nuclear and Radiation Safety”. The staff of ANRS was increased up to 24 persons. Besides of DRWM is includes:

- *Inspection and Response Service*

The service conducts regulatory inspections and takes enforcement actions considered by Georgian legislation (penalties[5], termination of license). The obligation of the service is also conducting of first response on emergency situation for radiological; assessment and issuing recommendations for further migratory actions.

- *Authorization Service*

The Service conducts review all documents submitted for issuing of license and permit and preparing the decision. The Service also conducts review of licensees annual reports submitted to RB exercise electronic inventory for all sources of ionization radiation, facilities and corresponded activities in Georgia

- *Administrative Service*

The Service takes administrative and financial measures necessary for regulatory activity.

As a result of the conducted reform the following advantages can be identified:

- Speed up taking of the decisions
- The possibility to establish direct contacts with other organizations
- Effective knowledge management
- Accumulate limited human resources on place
- Increase effectiveness for the project management

ANRS is open to public. According to Georgian legislation all information, which is not assign as confidential can be provide to public.

ANRS practice open discussions of newly drafted regulations before their submission for final approval.

The name of the Ministry was changed several times. The last changes were occurred at the December of 2017, when two miniseries – Ministry of Environment Protection and Neural Resources and Ministry of Agriculture were split and Ministry of Environmental Protection and Agriculture (MEPA) was established. All functions of the Ministry of Environment Protection and Natural Resources were transferred to MEPA.

Section F. Other Safety Provisions

Responsibility of License Holder

According to the requirements of Law on Nuclear and Radiation Safety (Art.16 para.2) any handling with radioactive waste should be licensed. The issuing of license

[5] Penalties are defined by Administrative Code

is required also for decommissioning activity. License is the only official document confirming the legitimacy of any nuclear or radiation activity in Georgia. The license is issued by ANRS for unlimited period time. export of radioactive waste requires issuing of special permit, which is valid during one year after issuing by ANRS. Law on Licenses and Permits defines general conditions for issuing license and permit. List of documents to be supplied for obtaining of license or permit is defined by Law on Nuclear and Radiation Safety. All documents for issuing of license and permit and, any other document can be submitted electronically via special wed site.

Description of license holder's responsibilities are mainly accumulated in Art. 23 of Law on Nuclear and Radiation Safety and Art.16 of Georgian national BSS (Technical Regulation No.450) Radiation Safety Norms and Basic Requirements Related to Handling with Ionizing Radiation Sources. The last one also sets requirements for general contest of Radiation Protection Programme, which is a main document should be submitted together with others to RB to gain the license. Meantime Law on Nuclear and Radiation Safety requires conducting of SA for high risk activities. Operation of radioactive waste management facilities (Centralized Storage and disposal facilities) is assigned as high risk activity and requires performing of SA and issuing of SAR.

License holder has right to keep safely (if adequate conditions exist) generated waste on the site while as it is defined by license condition. According to the requirements of Technical Regulation No.189 on Handling with Radiation Waste every license holder should conduct collection, separation and pre-treatment of generated waste according to its license conditions. License holder is obliged to inform RB for any changes related to license condition (generation of waste, sending it to CSF or others). For instance, Technical Regulation No.689 Categorization of Sources of Ionizing Radiation, Creation and Maintenance of Registry of Authorization, Sources of Ionization Radiation and Radioactive Waste sets requirement for maximum ten days within of this period of time license holder should inform RB for sending of DSRS to CSF or to suppliers.

License holder is also obliged to submit every year safety report to RB briefly summarize the all activities and related safety issues for one year period. The report should be submitted form 1 March to 1 April period of time.

License holder's activity should be inspected by RB. The frequency of the inspection depends on the risk assigned to licensee's activity. For handling with radioactive waste it is usually every year inspection, but additional (unplanned) inspection also can be conducted in case of necessity case of finding of non-conformities with license conditions, licensee can be fined, even its activity can be terminated.

HUMAN AND FINANCIAL RESOURCES

Georgia has lack of human resources for conducting of handling with RAW. It was one of the reasons why DRWM was established within ANRS. (DRWM staff is only 4 persons). To grow up new personnel the special education programmes were established at the Georgian Technical University and Tbilisi State University. The programmes cover all aspects of radiation safety including the radioactive waste (RAW) management area. International support to grow up new specialist also should be emphasized. Workshops, trainings, scientific visits and fellowships organized by IAEA are especially important for Georgia. Additionally should be emphasized Sweden support to increase the country capacity for RAW management (as was mentioned above).The country needs to issue national programme for education at the sphere of nuclear and radiation safety. The first activities for elaboration of the country policy on that way already conducted.

Georgian financing system in the field RAW management based on principle "Polluter pays" defined by Law on Radioactive Waste. According to the Law requirements (Art. 9 para.2) the owner (producer) of RAW should pay for all procedures related to handling with waste. The storage prices are not diffracted according to waste type and activity. The document approved by Georgian Government at 2016 on Cost estimation for Services Provided by LEPL Agency of Nuclear and Radiation Safety of Ministry of Environment and Natural Resources Protection only sets general price for storing of RAW at CSF.

All activities with legacy RAW and contaminated areas should be financed by state budget. The activity of DRWM for operation of CSF and Saakadze disposal is also supported by state budget.

Quality Assurance

Requirements for elaboration and establishment of Quality Assurance Programmes (QAP) for radioactive waste management are not clear considered at the existed regulations. Technical Regulation No.450 sets general requirements for QAP and obliges every license holder to elaborate and implement QAP. It is clearly underlined that Quality Management System (QMS) can be considered as a part of Integrated Management System (IMS).

Operational Radiation Protection

New Georgian national BSS – Technical Regulation No.450 Radiation Safety Norms and Basic Requirements Related to Handling with Ionizing Radiation Sources corresponds to international standards [2] and sets requirements for optimization of radiation protection, justification of activity and limitation of doses. Annual effective and equivalent dose limits for workers and public are defined according to international standards (Tab.3).

Tab. 3 Annual Dose Limits

Type of Dose	Dose Limits		
	Workers	16-18 Years Old Workers	Public

Effective Dose	20 mSv (Averaged over five consecutive years. No more than 50 mSv per year)	6 mSv	1 mSv (In exceptional case can be more, but must 1 mSv averaged on consequence five years)
Equivalent dose to the lens of eye	20 mSv (Averaged over five consecutive years. No more than 50 mSv per year)	20 mSv	15 mSv
Equivalent dose to the extremities (hands and feet) or to the skin	500 mSv	150 mSv	50 mSv

National BSS also defines limit for discharge into environment – annual effective dose to population 0.1 mSv. Clearance and site release levels and procedures are also defined by national BSS.

All these requirements with others should be implemented during the operation of radioactive waste management facility. Every licensee is obliged to issue radiation protection programme describing in details implementation of optimization principle and meeting with all required safe norms and standards. Real implementation of all procedures describing in radiation protection programme is controlled by RB via conducted inspections and review of submitted safety reports

Emergency Preparedness

Emergency preparedness and response system for radiological events is legally mainly defined by

- Law on Nuclear and Radiation Safety;
- Law on Civil Safety;
- Law on Planning and Coordination Policy for National Safety;
- Decree of Government of Georgia No.508 (September 24, 2015) on Adoption of Civil Defense Plan;
- Decree of Government of Georgia No.640 Preparedness and Response Plan on Nuclear and Radiation Emergency;
- Order of Minister Environment and Natural Resources Protection N150 on Rules to Response to Illicit Trafficking of Nuclear and Radiation Materials and'
- Degree of Government of Georgia No 397 "on Actions to Response in Case of Detection Nuclear and Radioactive Materials in Airports, Naval Ports and border Check Points".

Georgia also adopted national CBRN strategy covering major areas: Prevention, Preparedness, Detection and Response. The corresponded action plan for 2015-2019 years also was implemented. Georgia is member of conventions on Early Notification of a Nuclear Accident (NOT) and on Assistance in Case of Nuclear Accident and Radiological Emergency (ASSIST) and takes active parts in exercises arranged by IAEA..

Law on Civil Safety sets general requirements for emergency response and civil safety. Meantime Law on Planning and Coordination Policy for National Safety defines general principles for policy and sets requirements for establishing of National Safety and Crisis Management Council at Prime Minster as an advisory body. Law on Nuclear and Radiation Safety defines general approaches for preparedness and response on radiological emergency situations (Chapter VIII). Other Law, Decrees and Orders define particular responsibilities for all type of emergency situations. Decree No.508 identifies Emergency Management Agency (subordinated to the Ministry of Internal Affairs) as a leader origination for response of any type emergency situations. Mealtime the Decree recognizes different types of emergency situations and identifies functions for response on them. Radiological and chemical emergency situations. is recognized. as a function no.11 and main responsibilities for response is delegated to Ministry of Environmental Protection and Agriculture (MEPA) and ANRS. Emergency Management Agency, Department of Patrol Police and Security Police of Ministry of Internal Affairs, Ministry of Defense, Ministry of Agriculture, Land Transport Agency, Air Transport Agency, Naval Transport Agency of Ministry of Economy and Sustainable Development are assigned as support organizations. In case of national emergency situations all measures should be coordinated by Georgian Prime Minister based on conclusion of National Safety Council, which serves him as an advisory body.

Georgian legislation (Law on Nuclear and Radiation Safety Chapter VIII) recognizes three types of nuclear and radiological accidents (or incidents): Facility, National and Trans-border. The Law (Art.6) defines responsibility of Regulatory Body (RB) in case of accident: "Participate in activities for preparedness and response on nuclear and radiation incidents and accidents according to Georgian legal requirements". It is important to emphasize that RB shall be the contact institution with respect to the fulfillment of the terms and conditions of international documents ratified by Georgia in the field of nuclear and radiation emergency preparedness and response. RB also obliged to conduct first investigation of emergency situation and issuing recommendation for mitigation of the consequences of the occurred incident or accident.

The emergency situation shall be managed by special center established at Ministry of Internal Affairs (if it is necessary). The role of first responders assigned to Emergency Management Agency, which members should follow recommendation issued by ANRS workers, therefore specialist of ANRS are obliged to arrive on the place the first and investigate situation to set clear picture for further actions. Additional different organizations should be involved in mitigation action as it is given above. The activity of MEPA and ANRS are defined by Decree of Government of Georgia No.640. In case of finding suspicious radiological good or radiological emergency at at the border tha responsibilities and activities are defined by Degree of Government of Georgia No 397. ANRS also plays role of key organization on this case to assess the situation and define the activities for its solving.

Nuclear and radiation activity's authorization procedure considers existence of emergency plans. The documents submitted to RB by license applicant should contain detail description of potentially possible incidents and all measures will be taken by licensee to mitigate their consequences.

Art.24 of Law on Nuclear and Radiation Safety defines responsibilities of licensee in case of nuclear and radiological accident (or incidents) as followings:

- Send notification to Regulatory Body, as well as to any other authorities according to the facility radiation emergency response plan;
- Immediately inform the population of the potential hazard;
- Mitigate the consequences of a radiation accident and/or incident and take actions to protect workers and other persons from its harmful impact;
- Monitor the irradiation of workers and the spread of radionuclides in the environment;
- Limit and control the radiation exposure for workers involved in the liquidation of the radiation accident and/or incident consequences;
- Carry out measures defined by the legislation of Georgia to prevent a radiation accident and/or incident and liquidate its consequences.

The used concept for management of mitigation operations is the so-called "all hazards" approach, which means that management of operations and basic infrastructural building blocks are the same for all types of emergencies. In Georgia this approach has been implemented by the Law Civil Safety. The law considers implementation of different mechanisms in case of different scale accidents. For instance in case of national accidents the decisions will be issued by Prime Minister of Georgia based on recommendations of Safety and Crisis Management Council. The Law also considers establishing of Operational Centers being responsible for taking mitigation actions.

The same approach was used in elaboration of national strategy for mitigation of CBRN threats covering the main aspects for Chemical, Biological, Radioactive and Nuclear threats assessment and mitigation.

DRWM is also involved into emergency mitigation activity as organization operating CSF, where all radioactive waste possible generate during the response should be stored safely. Additionally, DRWM has function to conduct decontamination of areas affected due to radiological incident or accident (after mitigation activity)

1. Nuclear Research Reactor IRT-M

1.1 History

In 1957, not far from Tbilisi, the capital of Georgia, the construction of an IRT-2000 - open pool type nuclear research reactor commenced on behalf of the Institute of Physics of the Georgian Academy of Sciences. It was the first nuclear facility in the Caucasus region, and its construction was completed in August 1959. The commissioning of the reactor and its testing on different levels of power, including the designed 2000 kW, were carried out in October-November 1959, and its regular operation began in January 1960. The research reactor was located in the Applied Research Centre (formerly known as the Nuclear Research Centre) of the Institute of Physics of Tbilisi State University. The several workshops were situated on the territory of the center. During the whole period of operation (from1960 to 1988), the reactor underwent two major refurbishments, when the reactor pool was replaced (aluminum was changed to stainless steel) and reactor power was increased up to 8 MW. As a result the reactor name was changed to IRT-M (modernized). The reactor was used for experiments on low temperature (temperature of liquid nitrogen, even on temperature of liquid helium), therefore the big cryogenic station was constructed at the territory of center connecting to the reactor building by special system of tubes.

Operation of the reactor was terminated by the decision of the USSR State Regulatory Body (Gosatomenergonadzor) in January 1988, which requested to increase the level of the reactor safety in response to the tragic accident at the Chernobyl Nuclear Power Plant.

During all period of operating from 1959 to 1988, the total period of working on power made up to 70 000 hours, energy-producing – 6 GW*day. The reactor used mainly fuel elements wit 90% enriched Uranium. After the reactor shat down all fuel as fresh and as spent was sent out of border of Georgia.

1.2 Decommissioning Process

To conduct the reactor decommissioning activity special Detailed Decommissioning Plan (DDP) has been prepared in accordance with the guidance given in the IAEA standards [3,4] and advice provided by the IAEA via the relevant Technical Co-operation Project (GEO/4/002) - Conversion of Research Reactor to a Low Power Facility [5].

The plan considered three stages:

I – Concreting of lower part of redundant Research Nuclear Reactor IRT-M and cumulated high radioactive waste. (IAEA Project GEO/4/002, 1999-2002);

II – Dismantling of the Technological systems of the Nuclear Research (IAEA technical cooperation project GEO/3/002, 2005-2008);

III – Dismantling of external technological system of the low-temperature complex (pipe system connecting to the cryogenic station and the station itself) of decommissioned IRT-M nuclear reactor **(**IAEA technical cooperation projects GEO/3/004, 2009-2011. and GEO/9/012 (2014-2016)***.***

STAGE I

The decision for concreting of lower part of the reactor tank (including the reactor core) was based on the following criteria:

- No radioactive waste storage facility existed at that time;
- Lack of financial and human resources and technical devices

The preparatory work was carried out in 2000-2001, and the work on cconcreting the reactor tank; 8 experimental horizontal channels; the waste in the dry storage vertical channels; the waste in the storage well and the waste in the storage well was carried out in 2002 (Tab.1, Annex 2). The most important technological process was the process of concreting the lower high radioactive part of reactor with radioactive intratank equipment located in it. The special underwater concreting was used for concreting of lower 1/3 part of the reactor tank (including the core).

As a result of the work the lower part of the reactor tank with a volume of about 20 m^3 (at the whole volume of the tank about 55 m^3), 31 dry assemblies (with the total volume of about 6 m^3) with radioactive wastes (with the total volume of about 8 m^3), 8 horizontal experimental channels with the total volume of about 2 m^3, and two underground tanks with radioactive wastes were concreted. Thus, the total amount of high-grade cement mortar with boron used for the concreting of the above-mentioned parts of the reactor was 36 m^3. The conducted radiological survey proved acceptance of the method by point of view of radiation exposure.

All activities were conducted within IAEA TC project GEO/4/002 Conversion of Research Reactor to a Low Power Facility. The decommissioning activities were continued under IAEA TC project GEO/3/002 Decommissioning of the IRT-M Research Reactor

STAGE II

The activities were conducted within IAEA TC project GEO/3/002, which aimed “To decontaminate and to dismantle the remaining radioactive parts of the IRT-M research reactor and to manage safely the radioactive waste generated from the dismantling operations”. The project scope was defined as a dismantling of all radioactive devices located inside the reactor building, including the followings:

1) A dual-circuit cooling system of the reactor.

2) A system of mechanical and chemical purification of the coolant of the primary circuit of the reactor cooling system.
3) A part of the pipeline of the system of circulation of gaseous helium.
4) A system of filters intended for cleaning of air from radioactive gases and aerosols being ventilated from the above-reactor space and different special technological rooms prior to their release to the atmosphere.
5) Devices of mechanical and chemical purification of water of pools intended for temporary storage of the fuel assemblies and cassettes.

Before the dismantling activity special decommissioning programme was developed and approved by RB. The programme elaboration was based on previously conducted measurements. The secondary circuit was assigned as a radiologically clean. (RB approved the decision to consider this under the clearance level.) All other parts were characterized by inner surface contamination. The main contaminant nuclides were ^{60}Co and ^{137}Cs. Taking into consideration, that IP has not its own well developed decontamination technique, the decontamination of the reactor parts were not conducted until the special tools and methods will be developed. All dismantled parts (pipes) were segmented, sealed hermetically. To reduce the volume big pipes were used as containers for small pipes. All pipes were hermetically number and labelled. Special inventory for dismantled items were established (Annex 1). All items were safely placed at s.c. TTR building at Applied Research Centre. Small parts characterized with comparably higher contamination will be immobilized into the concrete. The concreted 200 l drums containing the radioactive waste were placed in module of the CSF. All drums were labelled by special number and weight estimation (Fig 7).

Fig.7 Drums with concreted waste

Resigns also were subject to immobile into the concrete matrix. For stainless steel boxes were used for these purpose. Lead palates were placed between the inner and outer walls. The mass of each box was - 43 kg and volume 0.07326 m^3, which allowed using 4 boxes for immobilization of 0.28 m^3 resigns into 4 boxes. The boxes were welded hermitical and put into boxes filled up with concrete. The dose rate on the surface of the boxes was 50-55 μSv/h. After concreting of drums with boxes containing resins, the dose rate decreased to 7-10 μSv/h.

The beryllium blocks (18 pieces)from the reactor well-storage were transferred to the external storage facility. As a result the in-reactor storage facility was fully emptied of and 40m^3 water. was pumped out into the external pool. The specific activity of the pumped-over water at this time of period was very low and was equal 10^{-8} - 10^{-9} Ci/L.

During the dismantling of ventilation system 8 filters were dismantled (6 filters were Petryanov filters of FP-200 and FP-500 types and two carbon purification filters of FPP-15 type, The radioactive dose rate of used, eighth filters was low – 0.3-0.4 μSv/h. They all were transferred to store into the special building on the applied research centre.

All conducted activities were verified by final monitoring and issuing of final report approved by RB

STAGE III

The first part of the activities were conducted within IAEA TC project GEO/30004. During the project long pipes connecting cryogenic station to the reactor building was dismantled. The pies were crewed up or cat by abrasive devise. According to the obtained radiological monitoring results, the maximum value of radioactive contamination on the internal surface of this pipe caused, mainly by radionuclide ^{60}Co is 380 Bq/cm^2, and the maximum dose rate on the surface of this pipe - 6 μSv/h. The total activity of the pipes under dismantling makes $1.8x10^9$ Bq.

The same methodology was used – pipes were closed hermetically and placed at TTR building until they will be cleaned up. (Tab. 2,Annex 2)

As a result of the carried work, the dismantling of all pipelines was made. The total length of pipes (except pipeline with dimensions 360x11mm) was 1380m and the weight of all dismantled pipes about 9500kg.

The total length of pipeline with diameter 630x11mm was 237m and total weight 34500kg. From these wider pipes there were made 47 Pipe-containers; 36 of them have length of 4.7m each, and 11 of them from 1.2m to 4.3m. Pipes with smaller diameter were cut and sealed in those containers. Containers were stored in the building of so-called (not completely built) three-zone nuclear reactor TTR (Fig.8).

The second part of the activities were conducted within the project GEO/9/012. The project considers dismantling of cryogenic station, which contained different technological installations and big volume vessels. All items were characterized with inner surface contamination. (Main contaminate $^{137)}$Cs). All items were dismantled by using abrasive cutting, welding and screwing (Fig. 9)

Fig.8 Container Pipes

Using the requirements for clearance established by Georgian legislation only 29 items were recognized as radiologically contaminated (Tab. 3 Annex 2), Four from them were already cleaned using abrasive cleaning device. Others were paced into big container, closed hermetically and placed into TTR building. Further activity for cleaning of contaminated items is foreseen. Conducted final survey confirm absence of any radiological contaminated items in cryogenic station after the completion of the dismantling activity.

Fig.9 Dismantling of installations in cryogenic station

2. Subcritical Assembly

Subcritical assembly “Breeder-1” was belonged to the Institute of Physics of Tbilisi State University (IP). The assembly contained 1880 g of 36% enriched uranium and PuBe source (1.5 x10^8n/sec). Biological shielding was provided by water, bore-paraffin and lead.(Fig. 10).

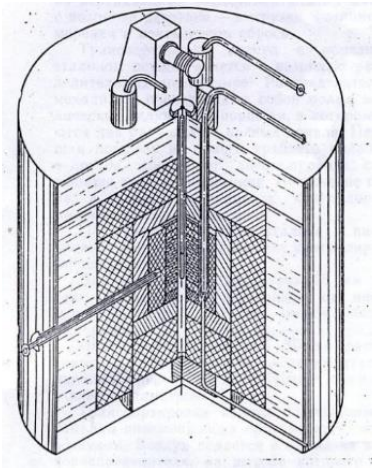


Fig.10 Scheme of subcritical assembly "Breeder-1"

The power of the assembly was 0.9 W. The neutron flux at vertical channels was equal to 10^7n/sec·cm^2. The assembly was used for neutron activation analyze, but due to failure of electronic equipment the assembly was out of use for last years. Based on international initiative for reducing of application of HEU the RRRFR (Russian Research Reactor Fuel Return) programme was initiated and supported by US. Special contract among IAEA, IP and Russian Federal State Unitarian Enterprise "Scientific Research Institute Scientific Industrial Association (LUCH) was issued considering dismantling of the assembly and repatriation of nuclear materials to Russia. The Czech company ÚJV Řež, which provided special container ŠKODA VPVR/M (Fig.11) for transport of nuclear material.

It is considered that easier and safer to start the assembly dismantling from the top, therefore special decision was issued to dismantle the roof of the building where the assembly was situated. Special decommissioning plan was developed by IP and agreed with RB. According to the plan, the following actions were conducted Fig.12)

- Dismantling of the building roof;
- Emptying water biological shielding vessels;
- Removing of all technological devices (including vertical channels) from the top of the assembly;
- Removing of the assembly top;
- Removing of empty biological shielding vessels;
- Removing of bore-paraffin biological shield;
- Removing of lead biological shield;
- Removing of two reflectors for core (first - bore-paraffin and, second – graphite);
- Removing of core and placing into special "basket"
- Transfer of the core form "basket" to ŠKODA VPVR/M container;
- Removing of PuBe source and placing into neutron shielding containers;
- Overpackage of ŠKODA VPVR/M container and placing on the transport mean.

Fig.11 ŠKODA VPVR/M *container for transport of HEU from "Breeder-1"*

Fig.12 Dismantling of the subcritical assembly

All activities were conducted at 2015. As a result, HEU was sent to Russia by aircraft and PuBe source was placed at CSF for safe storing.

Section G. Safety of Spent Fuel Management

Georgia does poses any spent nuclear fuel.

Section H. Safety of Radioactive Waste Management

General Safety Requirements

Law on Radioactive Waste defines the following main principles for radioactive waste management:

- Principle of safety - the management of radioactive waste shall be carried out according to recognized international standards, including taking adequate measures that shall ensure the protection of human health and the environment from the harmful effects of radioactive waste;
- Principle of the protection of future generations – Radioactive waste shall be managed in such a way that predicted impacts on the health of future generations will not be greater than relevant levels of impact that are acceptable today.
- Principle of control of radioactive waste generation - Generation of radioactive waste shall be kept to the minimum practicable.
- Security Principle - Radioactive waste management facilities shall be provided with appropriate infrastructure in order to prevent any illegal activities related to radioactive waste throughout the period of their existence;
- Principle of transparency of radioactive waste management systems - Any information provided for by the legislation of Georgia on radioactive waste location and radioactive waste management shall be accessible to the public;
- Polluter pays principle - A radioactive waste producer or owner shall cover the costs associated with radioactive waste management;
- Environment protection principle - Radioactive waste shall be managed in such a way as to provide an acceptable level of protection of the environment;
- Principle of protection beyond the country's border - Radioactive waste shall be managed in such a way as to assure that possible effects on human health and the environment beyond national borders will be taken into account.

Law on Nuclear and Radiation Safety, Georgian National BSS (Technical Regulation No.450), Technical Regulation No.189 and other legal documents set requirements for effective implementation of the given principles.

Law on Nuclear and Radiation Safety sets general requirements for radioactive waste management (Chapter X) and decommissioning activity (Chapter XII). Georgian national BSS gives more detailed safety requirements (Art.15) for handling with radioactive waste. Safety criteria for discharge into the environment is also defined. Technical Regulation No.189 establishes requirements for creation of integrated system for radioactive waste management emphasizing the interdependence of different steps in this system. Meantime especial attention is paid to establishment of barrier system to prevent leakage of radionuclide from waste matrix to environment. According to Georgian legal requirements during the handling with waste, the following main factors should be considered: Type of waste generation, criticality for nuclear materials, physical, mechanical and chemical properties of the waste and its classification.

EXISTING FACILITIES AND PAST PRACTICES

Georgia has Centralized Storage Facility (CSF), which was put in operation at 2007 based on the order of the President of Georgia No. 840, September 18, 2004. CSF was constructed on the site of Applied Research Center (former nuclear center) of Georgian Institute of Physics by support of Department of Energy of USA. CSF was equipped by radiation monitoring devices within IAEA TC project GEO/3/003. The purpose of the storage facility construction was storing of all radioactive waste including DSRS. The another facility related to radioactive waste is near surface ”Radon” type disposal situated at 30 km distance from Tbilisi. The disposal was closed at 1995.Some radioactive waste sill kept at the territory of the Institute Agrarian Radiocology which is part of Georgian Agrarian University now. Some DSRS (mainly with small activity) are kept at State Military Scientific-Technical Center “Delta”

CSF is two floors building (one floor is situated underground) (Fig.13) operated by Department for Radioactive waste Management (DRWM). Each floor contains four modules (boxes) for keeping radioactive waste. Two modules have square 67 m^2 each and other two - 33 m^2 each. So, total square of each floor is 200 m^2. The entrance of each module is equipped with reinforced iron gates having locks. The entrance of each floor is also equipped with iron gates.

Fig.13 View of CSF

There is a special road for trucks to transfer heavy containers to the entrance of aboveground floor of the storage. Heavy loads also can be transferred by special bridge crane to the entrance of underground floor. Movement of loads can be carried out by special technical means. The storage building is equipped with electrical safeguard and air ventilation system. At emergency turn off of electricity an additional electric supply is also provided (5 kW power electric generators). Near the storage building a small building was constructed. This building contains three modules. The first one is for monitoring, the second - for sources of emergency electric supply, the third - rest room for personnel. Additional small room was constructed at the entrance of the storage building, which is used for conducting of measurements and keeping of the equipment. The storage binding is equipped with special security systems to fix any motion. New Radio Frequency IDentification (RFID) system was established at CSF based on the support of US DoE. Small DSRS were collected in boxes. All containers and boxes were sealed by special tags (Fig.14), which reflect the radiations generated by special antennas inside CSF building.

Fig.14 DSRS package with reflector tag

RFID system allows fixing of unauthorized opening the package (container) or moving it outside CSF building. The signal can be received at DRWM office identifying which container was moved or opened. Whole site of Applied Research Center is under protection of special guards, whose office located at the entrance of the site. The site is equipped by video cameras, which also installed into CSF modules. The video cameras transfer live pictures to monitoring room, guards' office and office of ANRS. In case of fixing any illegal motion the video camera automatically records the event. Emergency signal will be sent to guards' room and, DRWM workers will receive SMS with notifying content. Two keys principle is implemented for CSF- storage facility can be opened together only by two workers of DRWM using special cards and their finger prints. CSF modules are equipped with gamma detectors, which monitor is installed into the monitoring room. Additionally detectors for monitoring of radiation background were established around CSF building. The activity was performed within IAEA project GEO/9013.The building was upgraded (smooth floor, upgraded drainage system and others) to increase safety level for stored radioactive waste. All stored radioactive sources have regulatory numbers starting with "S" for sealed sources and with "U" for unsealed sources. All sources are placed into shielding containers. In case of necessity some of these containers were constructed manually.

The radioactive waste generated during the reactor decommissioning (their characterization is given above in Section D), especially tubes from cooling and other auxiliary systems, are characterized by low specific surface activity and big volume; Therefore they are kept safely in the other especially arrange building (s.c.TTR building) in vaults to avoid filing up of CSF storage modules (Fig. 15).

The abrasive cleaning device to handle with contaminated objects were installed in TTR building within IAEA TC project GEO/9/011 (Fig.16).

The device is characterized by the following properties:

- Using plasma cutting;
- No liquids;
- Closed area avoiding speeding of radiation;

- Separation of drops from waste particles;
- Filtration;
- Visual control

Fig.15 Decommissioning waste at TTR building vault

As it was mentioned above some contaminated soil is kept at the territory of former Anaseuli Institute of Tea and Subtropical Cultures. The site was investigated by Georgian specialist based on the support of Swedish radiation safety authority SSM. At the first stage geological investigation was conducted to identify soil structure, underground waters distribution. It was identified that on the depth until 3-4 meters no underground waters were identified. The soil composition was defined as a clay with low possible pentation for different particles. The conducted radiation survey identified hot spots. Based on the spectroscopic investigation ^{137}Cs was assigned as a main contaminant[6]. On the defined points samples of soil from different depths were taken and radionuclide content was analyzed. Unconditional clearance level was used to identify the contamination of the soil. Based on the obtained results 3D distribution of radionuclides were defined. Additionally, abandoned cellar (former laboratory) on the site was investigated and hot spots were identified. Two orphan sealed ^{137}Cs sources (with activity 10mCi of each) were found in the cellar and recovered (Fig.17).

The contaminated capsules for liquid ^{14}C (which were used during the investigation conducted by the institute in the past) also were found.

Additionally investigation of the site using special georadar device also was conducted to identify possible underground structure (Fig.18).

[6] A series of different radionuclides were identified. The presence of beta radionuclide ^{14}C was also fixed.

Fig.16 Abrasive cleaning device

Fig.17 Investigation of the abandoned cellar

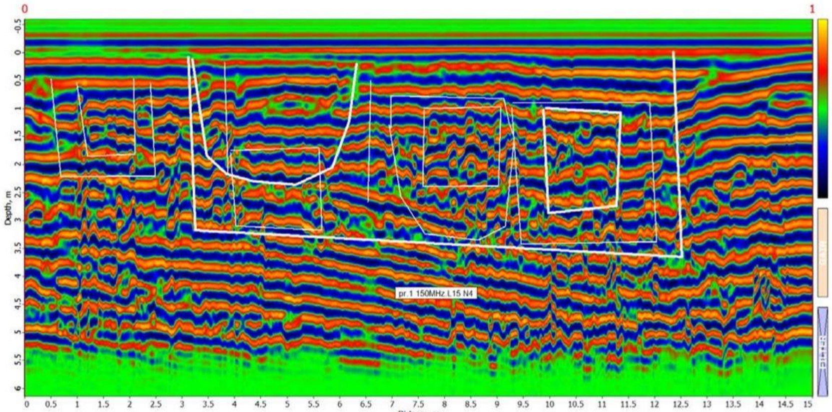


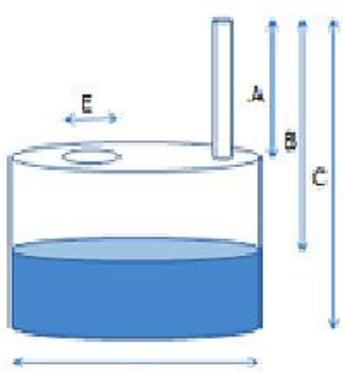
Fig.18 One of the georadar's profile

During the investigations the sizes of three places were identified, where in the past years underground pits for storage of the contaminated soil collected on the site were organized The places were surrounded the special fence to avoid intrusion of humans and domestic animals.(Outside the fence the radiation background is natural).

Analyzing the collected information, the whole picture of the contaminated site was clearly set - the sizes of underground storages are identified, spatial distribution of radionuclides on the site and contaminated spots into the cellar were defined. It is important to emphasize. That contamination can be assigned as statically and no changes can be waited in the nearest months or year.

The next step is remediation of the site. It is planned to cut contaminated soil, collected it in the hermetically closed drums and provide safe storage. As the first phase, the soil will be cut from places outside of surrendered pits and cellar (these places are closed for free intrusion). The special plan is already elaborated and agreed with Regulatory Body. The plan considers collecting of soil in the drums, it's compressing and handling with secondary waste (like water generated during the soil compressing or contaminated tools and others). The activity can be assigned as completed only after final survey and obtaining of regulatory approval, which is issued. The activity is already started.

Georgia has only one historic disposal site, which was closed in 1989, (although the last disposal, in the form of the burial of a disused ^{60}Co medical source, was in 1995). The disposal site is situated in 30 km from Tbilisi, at village Saakadze. (s.c. Saakadze disposal) It was designed for storing both solid and liquid waste. The disposal facility had been designed in the Soviet times as one of a "Radon" type facility. The disposal facility covers an area of 51 883 m^2 (As it was described at Section D). DRWM was assigned as the disposal operator since 2016. There are no details or an inventory of waste (or disused sources) buried in the facility. The facility contains one underground disposal (Dimensions 20x10x5 m) for solid waste and three underground tanks for liquid waste. The tanks have opened vertical pipes allowing rain water to penetrate into the tanks. (Fig.19)



(meters)	TANK 1	TANK 2	TANK 3
A	3,15	3,15	3,15
B	5,2	5,65	5,4
C	5,85	6,15	6,15
D	7,8	9,5	9,5
E	0,75	0,75	0,75

Fig.19 Dimensions of underground tanks

The first investigation of the site was conducted by specialists of Department of Nuclear and Radiation Safety in cooperation with experts from Swedish regulatory body SSM at 2011 [6]. During this investigation radioactively contaminated water was fixed into the first tank (nuclide ^{226}Ra). The detailed investigation of the site was conducted within EU project GE.4.01/08. According the data gained during the investigation the disposal site is located into proper geological formations Fig.20 shows data obtained by method of electrical conductivity.

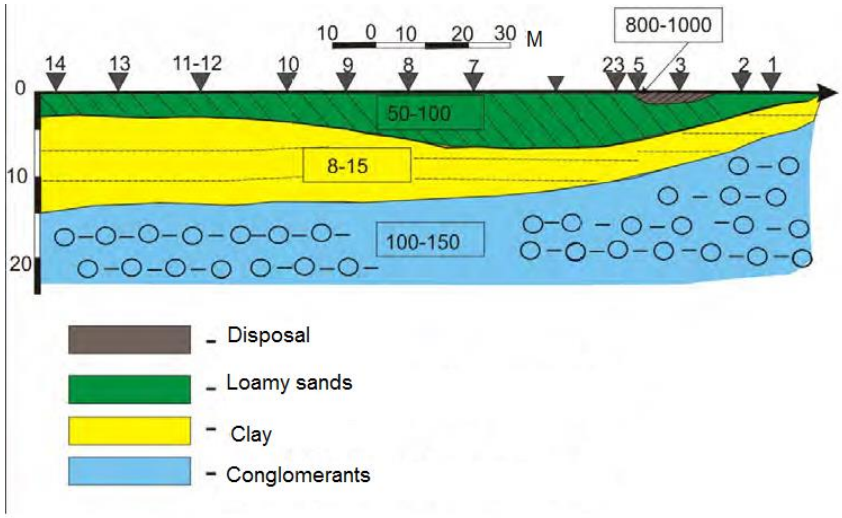


Fig.20 Geological characterization of the disposal site

The solid waste disposal is divided into two vaults The vaults are filled up approximately only 64% (See section D).. According to oral information into the vaults can be following radioactive sources: ^{60}Co (1.3 x10^{13}Bq), ^{137}Cs (1.18 x10^{13}Bq), totally ~10^{11}Bq of long lived nuclides (^{14}C, ^{90}Sr, ^{226}Ra, ^{232}Th, ^{238}Pu, ^{239}Pu, and ^{241}Am). The pictures taken by special camera into vaults fixed smoke detectors and other devices (Fig.21)

.

Fig.21 Waste inside the vaults

The disposal site was surrounded by fence. The special project by support UK in collaboration with IAEA was conducted at 2104 considering upgrade of security properties of Saakadze disposal (New update fence, water and electric supply and demolition of some old buildings, reconstruction of entrance check point). New upgrades were made at 2016 to ensure safety of the disposed waste. (See. Institution measures after closing).

A new cementation facility was established on Saakadze disposal site.(Fig.22)

Fig.22 Technological devices of the cementation facility

The facility was supplied within IAEA TC project GEO/9/013. According to the IAEA tender's result Amec Foster Wheeler Nuclear Slovakia s.r.o. provided the facility for Georgia. The facility allows cementation liquid and solid waste producing limited amount of concreted drums per day (up to three drums per day).
As it was mentioned above there three underground tanks with water inside. According to investigation the radiological content was identified into the first tank (see Tab. 4)

Tab. Radiological content of water in the first tank

Volume m^3	**Activity concentration Bq/l**						
	^{3}H	**^{40}K**	**^{60}Co**	**^{90}Sr**	**^{137} Cs**	**^{226} Ra**	**^{232}Th**
41	158,0	<100,4	<10,7	2	<7,5	2019,6	<25,7

The water was purified and generated waste solidified. The activity was conducted within IAEA TC project at 2017. (See. Institution measures after closing).

Sitting of Proposed Facilities

One main goal of 2017-2031 years national strategy for radioactive waste management is allocation of radioactive waste management facilities on one site for developing of integrated system of radioactive waste management and meet Georgian and international requirements and standards [7,8]. National strategy considers allocation of radioactive storage, processing and disposal facilities on one site. It is assumed that such type arrangements enhance should increase the effectiveness of the activities for radioactive waste management, enhance radiation safety and nuclear security conditions, making more cost effective all planned actions. Currently Georgia has two facilities for RAW management – CSF and s.c Saakadze disposal. One of them is located on territory of Applied Research Center (former nuclear reactor site) near the town Mtsketha (West form Tbilisi) and another at the site located east from Tbilisi. The conducted investigations prove that existing storage facility construction does not meet the requirements to develop its safety functions. Moreover, the conducted seismic assessment showed that seismic resistance of the building is sufficiently less than required for this area, therefore the decision was issued to construct new storage facility and decommissioning the existing one. Georgia has not facility where treatment and conditioning of RAW can be conducted. (Institute of Physics at Applied Research Center operates only one small installation). According to the goal defined by the National Strategy this type of facility should be established at the same site where the storage will be located. It also should be considered that disposal facility should be arranged on the same site. It should be emphasized that general requirements for site selection are defined by Georgian Law on Radioactive Waste (art.7). Considering actual situation in Georgia, it is very difficult to find new place appropriated for allocation of all these facilities. The real candidates are two – Applied research Center (where CSF is located) and Saakadze disposal site. The preliminary investigations for both sites were conducted considering ideas for conceptual design of the facilities. The investigations prove advantages and disadvantages for both sites. Advantage for applied Research center can be defined the possibility easily reach the site form Tbilisi, but same time it also should be considered that the site is located very close to strategic road and railway line in vicinity of historical town Mtsketha, which is assigned by UNESCO as a cultural heritage. The site is belonged to the Institute of Physics and construction of new facilities requires transfer of properties, which also seems problematic. Establishing of new disposal facility is connected to great financial expenditures. At the same time existing “Radon” type facility can be rearranged by adding new functions (for instance bore holes for long-lived or high active sources). It also should be considered that Saakadze disposal site is comparable far from settled place, but has good road system for connections to Tbilisi and other cities. Taking in account all mentioned Saakadze disposal site looks more appropriated place for allocation of all RAW management facilities. Based on this conclusion additional investigation for the site was conducted at 2019. The investigation was conducted based on the support of Swedish radiation safety authority SSM covers the following tasks:

- Radiological data;
- Geological characteristics;
- Hydrology and geochemistry;
- Meteorology and seismic data;
- Urban situation;
- Social impacts;
- Transportation routes;
- Energy supply;
- Physical Protection;
- Stakeholder involvement

The investigation considers the inventory of RAW exiting in Georgia, legal base and generally analyzed possible methods for the treatment and end forms of RAW. The investigation showed acceptance of Saakadze disposal site for allocation of proposed waste management facilities. Based on the obtained results Georgian government issued the ordinance No. 2408 (November 21, 2019) identifying Saakadze site as a possible place for allocation of all radioactive waste management facilities.

DESIGN AND CONSTRUCTION OF FACILITIES

To achieve the goals defined by National Strategy Georgia has received the support from EU and Swedish radiation safety authority (SSM) through design and implementation of the project "Development Radioactive Waste Infrastructure in Georgia". The project considers support to Georgia in design and construction of new RAW storage and processing (treatment and conditioning) facilities. The first phase of the project was implemented at 2019 aiming issuing of general design of the facilities The especially arranged tender identified German organization DMT, which together with Georgian specialists were working for solving the project tasks. During the project implementation the following main activities were conducted:

- Review of national legal requirements

All existing national legal requirements related to RAW management were reviewed and analyzed to set cleat picture for legally bounded conditions to reach the set goal

- RAW inventory review

The national RAW (including DSRS) inventory was reviewed and analyzed to issue recommendations for possible processing methods and disposal options.

- Review existing methods for treatment, conditioning and disposal of RAW

Considering the exiting situation in Georgia, short review of treatment and conditioning methods and disposal options possibly applicable for the country were reviewed. It was emphasized interdependence of different steps of RAW management and impossibility not define waste processing method without considerations of disposal options and end form of RAW.

- Identification of URS and FRS

Based on potentially applicable treatment and condition methods User Requirement Specifications (URS) and Functional Requirement Specifications (FRS) and corresponded waste processing scheme were identified (Fig.23).

- Developing of Design Basis

The storage functions, treatment and conditioning methods with general requirements were identified (Fig.24).Considering exiting and possible future waste flow some methods can be assigned as not applicable for Georgian situation (For instance, supercompaction and incineration). Basic characteristics for designing of storage and processing facilities were identified (Fig.25). In the definition of this characteristics the future decommissioning option was also considered. The location of the facilities on the Saakadze disposal site also was identified (Fig.26). It is proposed to construct one big building, which contains storage facility, processing facility, laboratory and office rooms.

- PSA for storage and processing facilities

Preliminary Safety Assessment (PSA) of proposed storage and processing facilities were conducted. Several initial events were postulated and assessed. Preliminary safety functions were identified.(More detail information is given at Safety Assessment of Facilities).

- Development of WAC

Based on the results of PSA preliminary Waste Acceptances Criteria was developed for the storage and processing facilities considering each treatment method

- SBS and BM

Based on the obtained results System Breakdown Structure (SBS) and Bill of Materials (BM) also were developed.

The second phase of the project considers issuing of detail design of facilities, conducting environment impact assessment and obtaining authorization for construction. The implementation of the phase of project is already started.

Georgia plans to conduct recondition campaign for DSRS stored at CSF. A number of them are kept in handmade or old (exhaust) containers causing leakage of radioactivity fro them DRWM conducts periodical monitoring of hot spots at CSF building and decontamination activity in case of finding such contaminated spots.

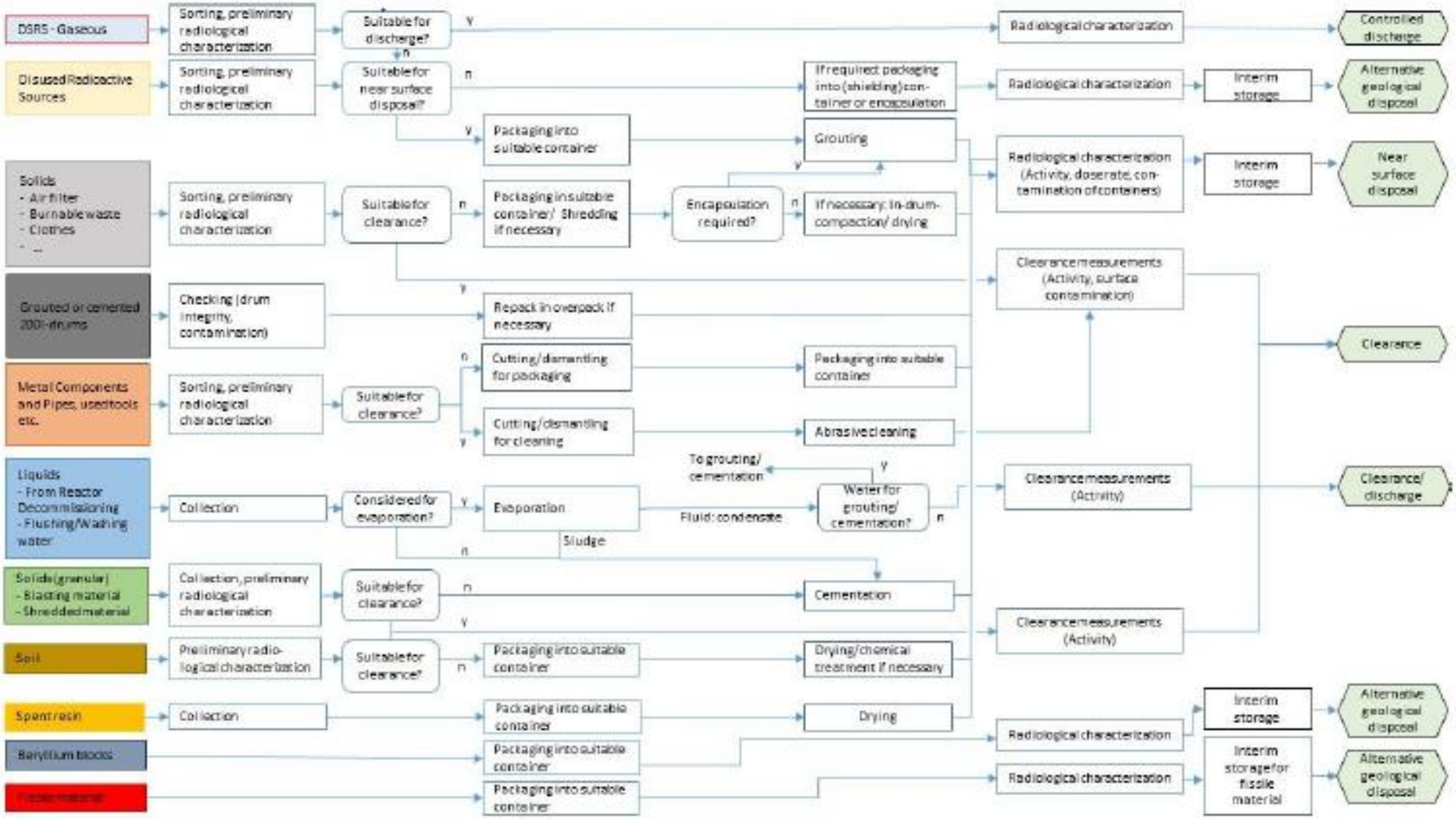


Fig.23 RAW processing scheme

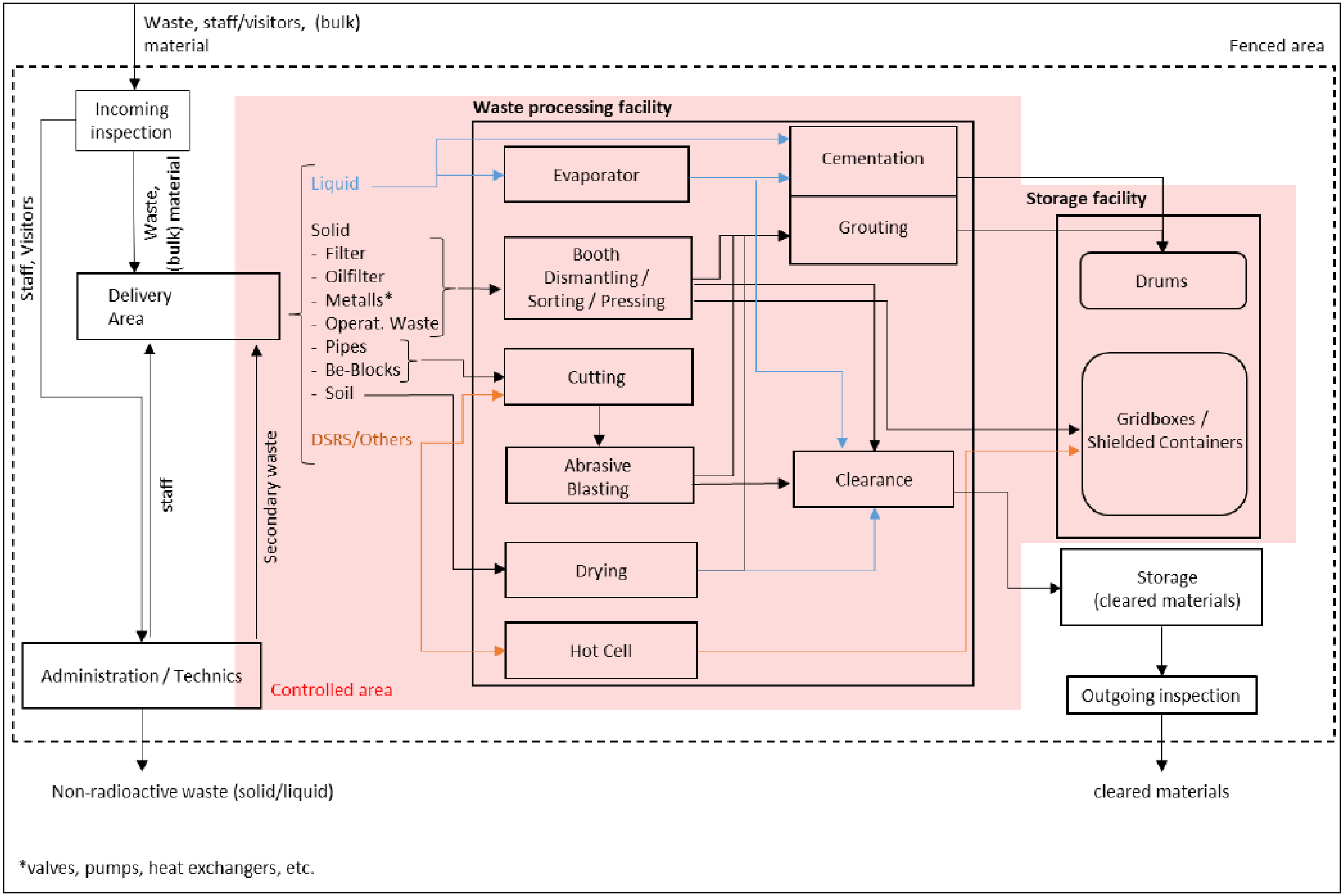


Fig.24 Storage functions and processing method

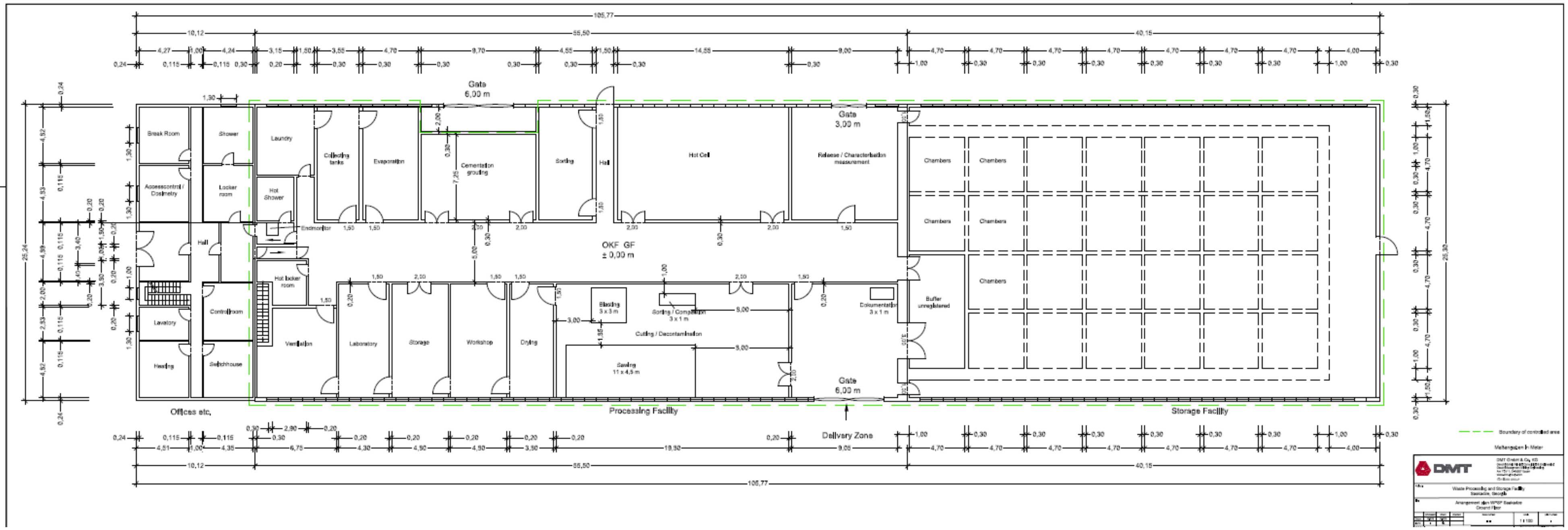


Fig.25 General design of storage and processing facilities

Fig.26 Location and composition of the facilities

To prevent spreading of radioactivity it was decided to repackage of DSRS. At the same time future disposal option was considered. It is decided to put DSRS in especial hermetically closed capsules, which can be stored at CSF in shielding containers. The activity is planned to perform within IAEA TC project GEO/9015. The special SoW was elaborated and approved. The tender is conducted and Hungarian Izotop was assigned as a winner company.

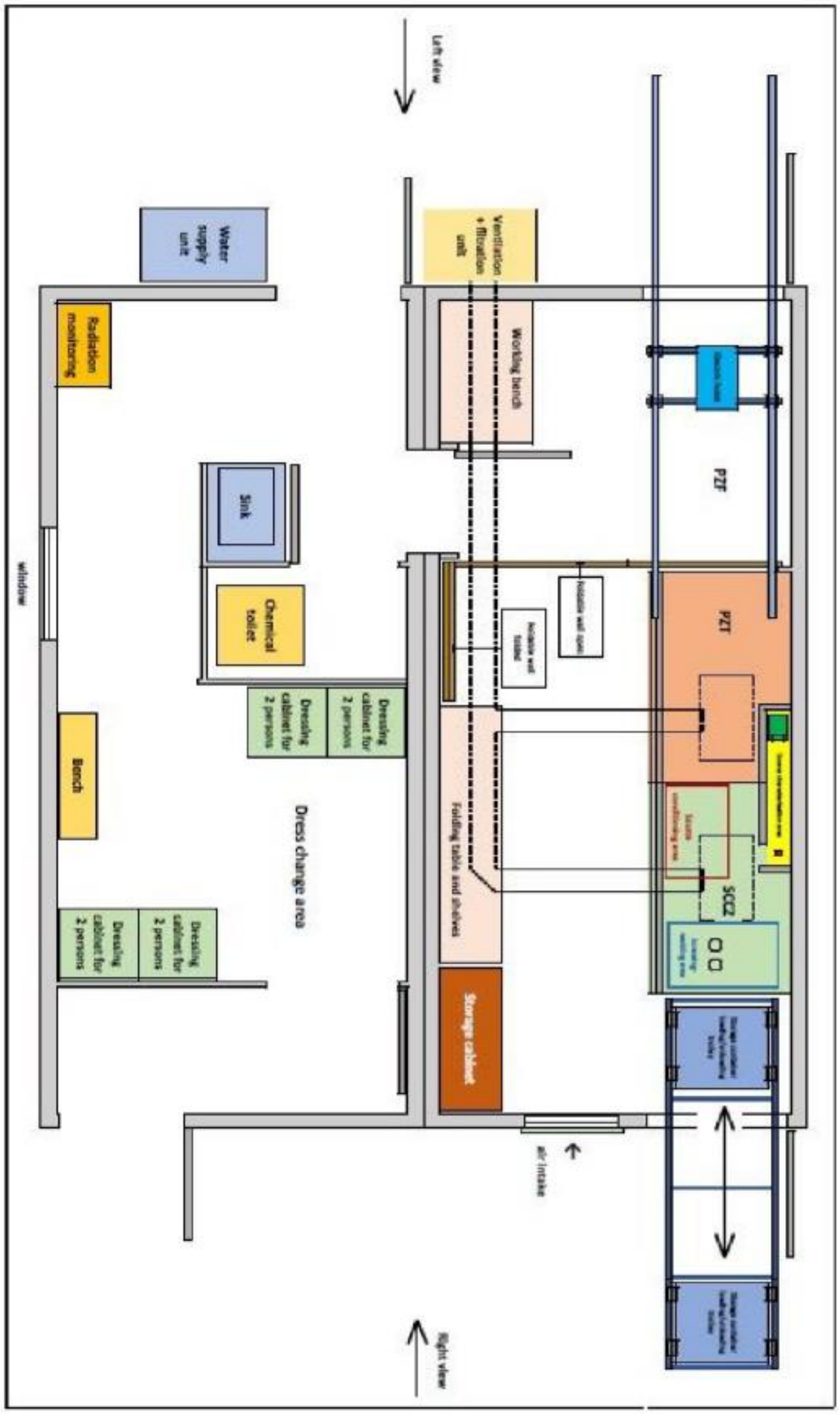


Fig.27 Scheme of Source Conditioning Unit (SCU)

It is plan to install two containers at the entrance of CSF – one Entrance and Monitoring Unit (EMU) and another – Source Conditioning Unit (SCU) (Fig.6) The both units will be s supplied by water and electricity. SCU will have especially shielded space for sources repackaging (Fig.27). It is planned that together with Hungarian experts Georgian specialist will work. At the first stage together with Hungarian experts will be repackaged some number of all type sources and then the activity will be continued by Georgian specialists. All materials will be supplied within IAEA project. The containers will be used on temporary base until the repackage company will be completed. The activity for the containers installation is already started.

SAFETY ASSESSMENT OF FACILITIES

Georgian legislation sets requirements for conducting of Safety Assessment (SA) for high radiation risk activities (Law on Nuclear and Radiation Safety Art.11 para.3) every 10 years. Safety Assessment Report (SAR) should be submitted to Regulatory Body for review and approval. Two regulations - Technical Regulation No.123 on Safety Assessment Report for Radioactive Waste Storage Facility and Technical Regulation No.124 on Safety Assessment Report for Radioactive Waste Near Surface Disposal Facility adopted at 2017 defines detail requirements for SA process.

Strategic investigations of two facilities – CSF and Saakadze disposal was conducted at 2012-2014 within EU project G.4.01.08 [9]. Based on the gained results SA for both facilities were conducted at 2015 within EU project G.4.01.09 [10]. The both-deterministic and probabilistic approaches were used. Several possible scenarios were established. Final consideration of the scenarios was done based their probabilities. Computer code “GoldSim” was used for calculations. The reports were discussed with RB and corresponded corrections were made based on RB recommendations and requirements.

Several recommendations were issued for CSF. Some of them are already considered: new foot and hand monitor is established at the entrance of CSF, fire extinguishers are charged, and drainage system is under continues monitoring, cutting of bushes, special measures against rodents are taken. Additionally SA seismic and environment impact assessments were conducted. Unfortunately seismic assessment showed unsatisfactory level for CSF for this region, therefore new plans arranged to construct new storage facility at the Saakadze disposal site and transfer all waste to this facility. Meanwhile all measures are taken to improve safety condition of existed storage facility.

For saakadze disposal 300 years of passive control was considered. The liquid waste was not considered during the assessment. It was assumed that the liquid waste will be treated at the nearest future. (The Liquid waste are already treated) According to conducted evaluation no leakage of solid waste is foreseen at evaluation period. Based on the issued recommendations several actions already taken:

- The solid waste vaults were covered by special materials to avoid water penetration into the vaults;
- Lightening system was arranged, the site was guarded and video monitoring system was established;

- Preparatory work for treating of liquid waste was conducted (waste will be treated at October-November);
- Arrangement for radiological monitoring system was done (internet connection was established. The system will be installed at October-November);
- The construction of waste processing (waste cementation) facility on site is started

As it was mentioned above Preliminary Safety Assessment (PSA) was conducted based on the Design basis of new storage and processing facilities. 87 PSI were assessed. Accidental situation for dropping of radioactive waste, possible fire, seismic event and aircraft crash were considered. The probable contamination places were identified. The conducted analyze prove acceptance of the issued general design.

Operation of Facilities

The license for operation of CSF was issued to the Institute of Physics (IP) at 2005. CSF was transferred to Department for Radioactive Waste Management (DRWM) at 2016. At the transfer stage CSF inventory was conducted together by DRWM and IP workers. After establishing of new operator (DRWM) the following improvements at SCF were done:

- Repairing electrical supply and backup system;
- Repairing system for transferring live video signal to ANRS office (DRWM premise);
- Installation of new foot and hand monitoring equipment at CSF entrance
- Installation one radiological monitoring system around CSF building and transfer of signal to DRWM premise;
- Enhance of CSF security by installation of RFID system
- Preparing for installation of whole body contamination measurement device
- Starting of the activity for recondition of DSRS kept at CSF

For safe and secure transport of radioactive waste, based on US and UK support, Georgia has received especially equipped truck. The truck has shielded wall to protect driver and gamma and neutron dosimeters (Fig.28). The truck also is equipped with video cameras and GPS. The data is transferred to DRWM office in live regime. Using the truck a number of activity for transport of radioactive waste were already conducted.

Before 2016 no operator for Saakadze disposal was assigned. Based on the conducted reform DRWM was defined as the disposal operator. After establishing of operator several activities for enhancing safety and security were taken (please, see Institution Measures After Closure).

Fig.28 general and in side view (dosimeters are marked) of truck

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INSTITUTION MEASURES AFTER CLOSURE

The requirements for post closure period for radioactive waste management facility are defined by Technical Regulation No.189 on Handling with Radiation Waste.

Before establishing of regulatory control no information was exist for closed “Radon” type disposal at Saakadze site. The detailed investigation of the Saakadze site was conducted within EU project G4.01/08. Some preliminary study was already conducted by RB together with Swedish radiation regulatory authority – SSM. The site investigation covered a number of tasks. Hydrogeological and meteorological data was collected from the existed information sources. Unfortunately no geological data for the site was existed. The site geological investigation was conducted using the following methods: electro resistance, georadar and drilling of boreholes. The method fixed three different layers of soil. Additional investigations were made used georadar. Especial attention was paid to fixation of underground water table. No underground water was fixed till 50 m depth.

The investigations fixed existence of parts of old exhausted tubes and foundations. To prove the obtained information special drilling activity was carried out. 16 boreholes were made to investigate geological structure and conduct radiation measurement to assess possible migration of radionuclides into soil. Some drilling results are given on Fig.29. Radiological investigations proved that no radioanuclide migration does not carried out. The same results were given by investigation of samples taken from different points of soil surface and water around the site. The results of geological investigation of boreholes have good agreement with the results obtained by electro resistance and georadar investigations.

As it was mentioned above, investigations proved that disposal is typical “Radon” type near surface disposal with dimensions 20x10x5 m. containing two vaults which are covered by massive concrete plate. The vaults mainly contains low level waste and some sources.

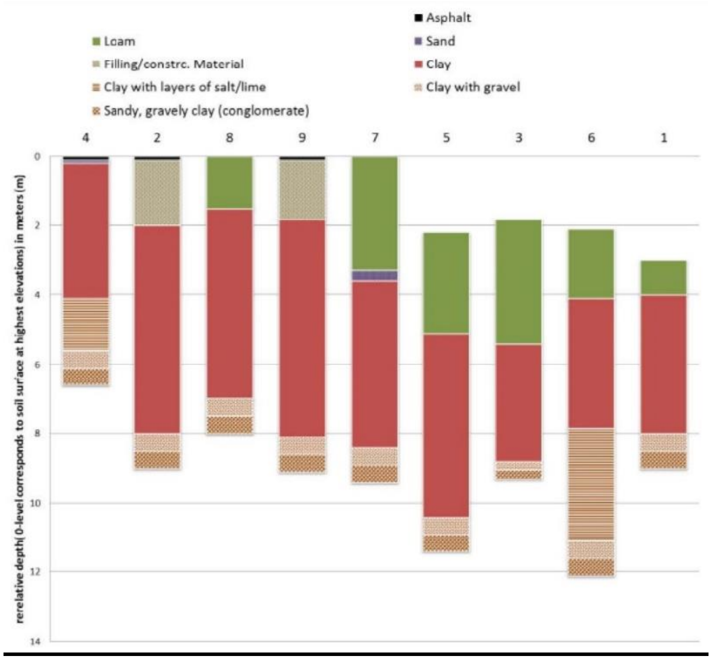

Fig.29 Drilling results

Especial attention should be paid to three underground tanks (see “Existing Facilities and Past Practices”) designed to keep liquid radioactive waste. All tanks have special vertical ventilation tubes, which are opened allowing rainfall water penetrated into the tanks. Now rainfall water penetration is terminated.

As it was mentioned above only liquid containing into the first tank was assigned as radioactive waste (Tab.3). During G.4.01/08 project implementation the pictures of inside the tanks were obtained using the special camera (Fig.30)

Fig.30 Inside view of the first tank

The tanks are made from concrete. All inner surfaces of the tanks are covered by stainless steel, but condition of the covering layer is not good. Into the first tank is possible to fix cracks. Into the second and third tanks the layer is partially removed from concrete walls. No leakage of liquid is fixed now, but it could occur in future;

therefore, handling with liquid radioactive waste was necessary to conduct. The activity was conducted within IAEA TC project GEO/9/013. The tender conducted by IAEA defined Russian FSUE Radon as a winner, which together with Georgian specialists carried out purification of contaminated water. The technology is developed by FSUE Radon and considers water filtration using two different type of filters (Fig.31)

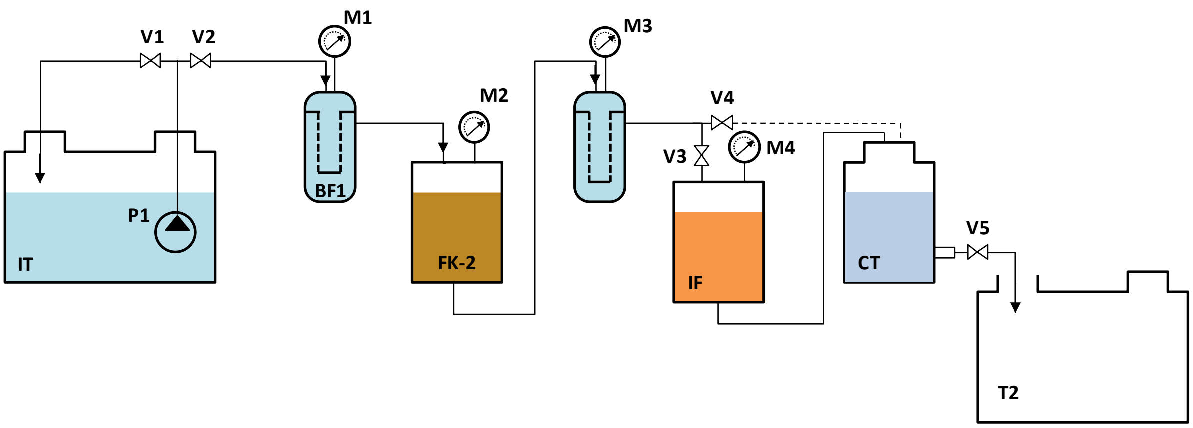

Fig.31 Hardware diagram of apparatus for water purification
IT – tank with the initial LRW; BF1 and BF2 – bag filter; FK-2 – filter - container with the selective inorganic sorbent MDM (based on oxide of manganese); IF – ion exchanger filter; CT – plastic control tank; P1 –pump; M1-M4 – manometers, V1-V5 – ball valves, T2 – tank

During the purification all filtered water was collected in to the control tank, where the samples were taken on periodic basis. The express chemical and radiological analyzes were conducted on the place. All samples were investigated by DRWM using HpGe detector and then rechecked by investigation in laboratory conditions. (Tab.4) In case of reducing of filtering effectiveness the filters ere replace by new ones. During the activity it was identified that real volume of contaminated water is 51m^3 (not 41m^3. Due to shape of the bottom of the tank). Whole water was purified and collected in the second tank.

Tab.4 Radionuclide concentration in one sample of purified water

Nuclide	Activity (Bq/kg)	Uncertainty U %
Na-22	0.85	73.1
Kr-88	0.98	81.6
Pb-214	12.17	2.6
Bi-214	3.26	2.9
Ra-226	6.89	111.8

The generated waste and contaminated objects were immobilized into the concrete matrix in three drums and sent CSF for storage.

At 2016 the surface of solid waste vault was covered by special water proof layer (Fig.32) and lightening system was established

Fig.32 New cover of solid waste vaults

Additionally the Saakadze site was guarded and video monitoring system was established. Internet connection to the site also was provide and arrangements were made (IAEA TC project GEO/9/013) to provide radiological static system for radiological monitoring (The system signal will be sent to DRWM office) (Fig.33).

Fig.33 View of radiological and video monitoring system at Saakadze site

The cementation facility also was constructed on site of Saakadze disposal (See Exiting facilities and Practices)

Section I. Transboundary Movement

Export, import and transit of radioactive sources are regulated by issuing of special permit (Art. 18 Law on Nuclear and Radiation Safety). The permit can be issued also for export of radioactive waste. Import and transit of radioactive waste are forbidden (Art.36 Law on Nuclear and Radiation Safety).

Georgia is transit country; therefore, the state had to pay great attention to illegal movement of radioactive materials through the country borders. During last years mainly slightly contaminated cars are detained at the borders, A number of different radioactive materials (including nuclear materials) were detected at the borders as smuggling materials during the past years.

To prevent the illegal movement of any radioactive materials across Georgian borders, the government of the country, in close collaboration with US DoE and IAEA, had taken appropriate action including the following:

- Establishing radiation checking portal monitors at Georgian border check points;
- Equipping Georgian border guards and customs officers with hand-held detectors and spectrometers to find, locate and identify radioactive sources;
- Training border guards and customs officers to operate the radiation detection system;
- Establishing a special framework for providing quick responses to emergency situations at the borders.

Georgian border checkpoints were equipped with special dual channel (gamma and neutron) portal monitors (Fig.34), which are connected to Central Alarm Stations (CAS). Now signal identification is possible to do by smartphone with especially installed programme. All emergency signals from border checkpoints are collected at the special center.

Fig. 34 View of portal monitor and report print out

Green borders are controlled by moving portal monitors. Patrol police (Border guards) and customs officers are equipped with hand-held detectors and spectrometers to conduct secondary investigations of suspected goods. They are properly trained by Georgian specialists. The training material is based on the IAEA standards [11-13] and on the case studies of the relevant incidents which have taken place at the border crossings of Georgia and other countries. The special practical guidebook for border guards and customs officials was also issued to provide recommendations for actions needed to check any suspicious consignment. The trainings for border workers are conducted periodically. The government resolution N397 was elaborated and approved to identify responsibilities of state organizations in case of fixing of illegal radioactive material at Georgian border.

Good illustrations of the effectiveness of the established system are the two following cases: the first at “Red Bridge” check point (east Georgia) and the second at Batumi naval port (west Georgia), when “orphan” radioactive sources were found. In the first case, two well logging Pu-Be sources (Fig.35) were found in scrap metal.

In the second case at Batumi naval port, a truck loaded with scrap metal collected in Georgia was apprehended. Amongst the scrap, a large number of gun night-sights were found, each containing ^{226}Ra source (Fig.36)

Fig.35 Plutonium/beryllium source found in the scrap metal shipment at the “Red Bridge on the Georgia-Azerbaijan border

Fig.36 Truck with scrap metal and gun night sights containing ^{226}Ra radioactive source

Georgia has received the difficult heritage form Soviet era. As part of the Soviet Union, numerous military bases were established in Georgia to secure the border with NATO-member, Turkey; and, during the withdrawal of Soviet forces, following the collapse of the Soviet Union, many of the Sealed Radioactive Sources (SRS) used by the military troops were abandoned in Georgia. SRS were also widely used by different institutions and facilities, throughout Georgia, during the Soviet era. With the collapse of the Soviet Union, however, many institutions and facilities either ceased to function, or changed their activities. As a result, the control and records for many radioactive sources were lost, and many sources were forgotten or misplaced. State regulatory system also was weakened. So, the control of SRS, both within Georgia, and for sources' transport across Georgia's borders, became ineffective, and many sources were become disused or went outside any institutional control, (become "orphaned") - they have been lost, abandoned or stolen.

Georgia had some serious problems with "orphan" radioactive sources. More than 300 such sources have been found and recovered. A number of people had been exposed to radiation from these sources. Unfortunately, lethal events also were fixed. Among the "orphan" sources found, the most important are the RTGs (Fig.37). There were found and recovered 6 such sources. Each of them contains $^{90}Sr/^{90}Y$ with initial activity 1 295 TBq. These sources were used to produce electricity for radio antennas installed in the Enguri River gorge. Due to high energy loss in the form of radiation, the sources are very hot, and, by using thermocouples, enough electrical power could be produced to supply the antennas with energy. Usually, the sources were installed in special devices (Fig.38) [14].

Fig. 37 RTG sources found near the village Lia (Tsalendijkha)

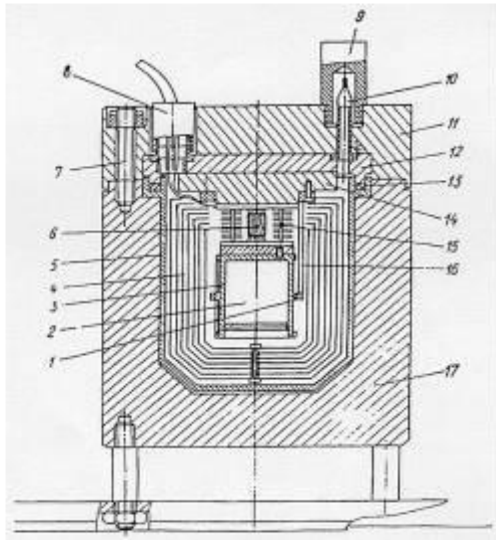

Fig.38 RTG device with $^{90}Sr/^{90}Y$ source

Two sources were usually used to supply electricity for one antenna.

Frequently found “orphan” sources comprise military devices containing ^{137}Cs radionuclides (Fig.39). Two types of high activity devices (special containers) have been found. The first contains one source with an activity ~10^{11}Bq, and the second containing two sources, each with an activity of ~10^{8}Bq . Fig.40 shows the proportions of all the different types of “orphan” sources which have been found and recovered.

Fig. 39 Military container with one 10^{11}Bq activity ^{137}Cs source

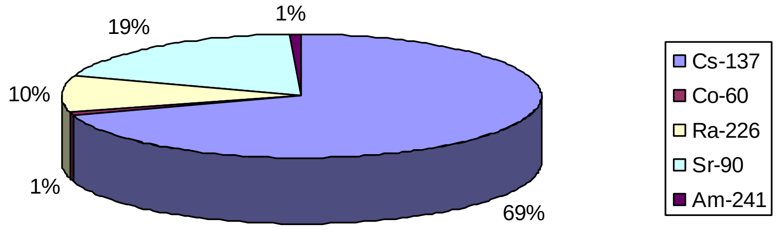

Fig. 40 Found and recovered "orphan" radioactive sources[7]

Several radiological accidents have occurred, in Georgia, since 1997. The first serious incident occurred at the military base in Lilo, when 11 soldiers were irradiated by ^{137}Cs ("orphan" ^{60}Co and ^{226}Ra sources also were found) [15]. As a result, the IAEA TC project GEO/9/004 "Radiological Emergency Assistance to Georgia", provided some analytical and monitoring equipment to Georgian specialists to enable them to locate any additional sources left behind by the former Soviet Army in Georgia. The next serious incident took place at the village of Matkhoji, in August 1998, when three powerful ^{137}Cs and one ^{60}Co sources were found. The same types of sources have also been found in different regions of Georgia. In 2009, orphan sources were found in western Georgia near the village of Ianeti (four ^{137}Cs sources with activity ~ 10^8Bq each) and elements contaminated by ^{137}Cs were found in Tbilisi.

It may be concluded that the main reason for the loss of control, leading to the problem of "orphan" sources, was financial [16]. When people found abandoned radioactive sources they tried to use them to earn money in a very difficult economic situation. The three main causes for the occurrence of "orphan" radioactive sources in Georgia are identified as follows:

- Temporary absence of regulatory control;
- Absence of a radioactive waste management system;
- Difficult economic situation.

To solve the problem with "orphan" radioactive sources the activity of RB was focused on the following main areas:

- Search and recovery of "orphan" radioactive sources;
- Establishment of legal basement for radioactive source management in the country;
- Collection of information and establishment of radioactive sources national inventory;

[7] Fig. 40 does not include RTG-s.

- Conducting regulation and control of radioactive source application;
- Establishment of export-import control for radioactive sources
- Establishment of waste storage facility in respect of management of Disused Sealed Radioactive Sources (DSRS).

The corresponded steps were taken on above-mentioned areas: A number of searching (pedestrian, car and airborne searching) and recovery operations were conducted; basic legal basement was established and regulatory control activity was started; the inventory of all sources of ionization radiation (including radioactive sources) was created; export-import control system was established; as a first step of radioactive waste management system, CSF was commissioned where all DSRS can be kept safely.

According to the existing current data the greatest number of sealed sources are disused and mainly kept in the CSF. Repackaging company or them in initial phase (as mentioned above. See Sitting of Proposed Facilities)

A number of sources are also kept in Sukhumi, which is not controlled by Georgian government (see Section D)

All existed DSRS have Soviet origin. In case of import of new source, importer will receive the permit only in case if he warranties sending of the source back when it becomes unused to avoid appearance any new DSRS.

As it was mentioned abode small activity DSRS (see Section D) were transferred to CSF and consolidated under 46 packages with corresponded regulatory numbers. Another case of source recovery operation is transferring of high activity ^{226}RaBe source, which is kept at local storage room of Tbilisi State University (TSU) not in proper condition – source is shielded by constructed housing (Fig.41).

Fig 41 Housing for RaBe source in the corner of the storage room

The radailogical survey of place (including identificataion of poassible hot spots) is already conducted. The acativity plan is elaborated. US colleagues helped by sending special gamma container, which should be used to modify existing S100 container (Fig.42)

 

Fig.42 Containers (s.c gamma and S100) for recovering of the source

Gamma gontainer will be put inside S100 to shield gamma radaition. The specialadeveice to cath source and keep distance with vide control of the source position (s.c “fishing rod”) ws developed. The receovery operation wa conducted successfully and source are stored at CSF.

Section K. General Efforts to Improve Safety

Georgia implements the tasks defined by National Strategy to develop its radioactive waste management system. The great attention is paid to radiation safety. The activities are conducted mainly in the following directions:

- ***Upgrading of legal base***

As it was mentioned above (see Section E) the activity for upgarading of Law on Nuclear and Radiation Safety and national BSS is already started. Working for elaboration of WAC is going. New regulation for decommissioning activity is already drafted.

- ***Develop of RAW infrastructure***

According to the goals and tasks defined by National Strategy the site for allocation of new Raw management facilities is selected, general designs of storage and processing facilities are issued. The activity for issuing detail design and obtaining official authorization for construction is started.

- ***Public outreach company***

Under support of Swedish SSM and Sida the public outreach company is started. Georgian specialists conduct investigation to identify public opinion and attitude of stockholders to existing Raw management system and conducting upgrades.

- ***Building capacity***

Under support of Swedish SSM and Sida implementation of new project is already started. The project considers conducting of self-assessment, identifying and analyzing of existing gaps and elaboration of plan for building capacity.

- ***Enhancing safety of existing facilities***

To enhance the safety of existing facilities a number of activities are already conducted or planning to conduct. For instance, CSF and Saakadze disposals site were equipped with video and additional radiological monitoring system, RFID system was installed at CSF. New whole body contamination monitor will be installed at CSF. The DSRS repackaging company is in initial phase. DSRS allocation to CSF is going. New TC project for 2022-2025 tears was designed and submitted to IAEA officially.

- ***Transport safety***

New regulation for safety requirements during the transport of radioactive substances is adopted. Georgia has received new car equipped with update installations for safe and secure transport of radioactive waste. The truck was already used in umber of operations.

- ***Remediation activity***

Remediation of the contaminated soils at the former Anaseuli Institute of Tea and subtropical cultures is going. The site was investigated and situation assessed. Under support of Swedish SSM the remediation plan for the first phase of the remediation activity is elaborated. The activity is planned to conduct soon.

- ***Environmental safety***

Under EU support new STCU project was designed for providing of mobile radiological laboratory to conduct on field radiological investigations (Fig.43) The project implementation is already going. The laboratory will be equipped with mobile and portative devices to conduct alpha, beta, gamma and neutron assessment, evaluation of different materials, searching the radioactive sources, taking samples, conducting gamma spectrometric and other analyzes. Additionally, some stationery equipment will be provided to support the investigation activity of the mobile laboratory. In case of finding some radioactive sources, providing of transport containers are also considered. A number of tenders are already conducted and purchased equipment were supplied to DRWM.

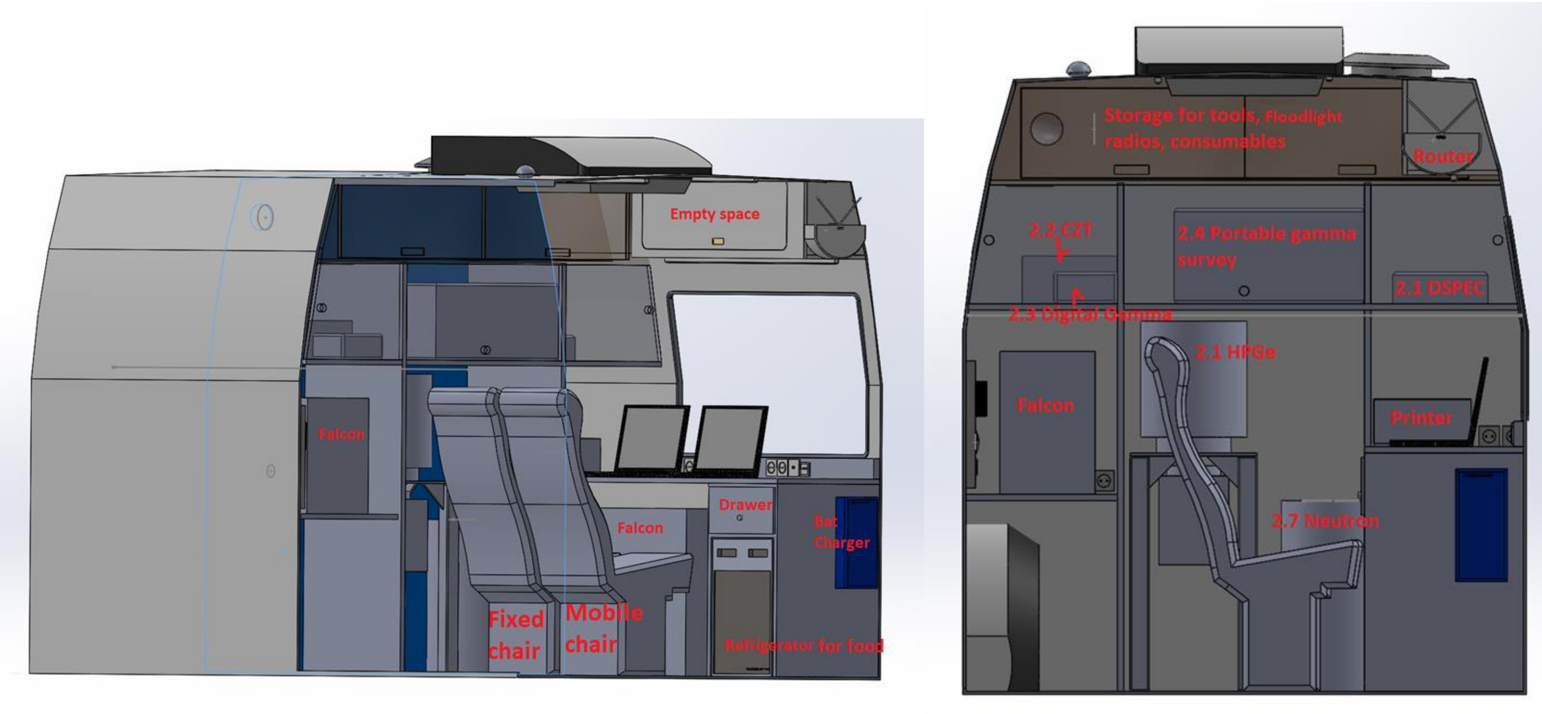

Fig.43 General layout of the mobile laboratory

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Section L. Annexes

Annex. 1
The radioactive waste generated during of the project GEO/3002

Tab1 Radioactive waste concreted in iron drums

By means of sand and cement solution the following are concreted in iron drums (№ 1-B - № 18-B):

- fragments of pipeline of Primary cooling system made of stainless steel (Ø 8 mm ÷ 80 mm);
- fragments of low-temperature test equipment made of stainless steel (Ø 8 mm ÷ 80 mm);
- fragments of retarding capacity of Primary cooling system made of stainless steel (Ø 8 mm ÷ 80 mm);
- pulse tubes made of stainless steel connected with testing instruments.

- *By means of sand and cement solution (№ 19-B - № 22-B) the following is concreted in iron drums :*
- Ion exchange resin of the filter of purification of Primary coolant which is placed in special interim container made of stainless steel

Drum #	Weight of the contents, kg	Total weight of the drum, kg	Radioactivity of the contents, mCi	Specific radioactivity of the contents, mCi/kg	Specific radioactivity of the drum, mCi/kg
#1-B	90	430	(Co-60) 0.04	0.00044	0.00010
#2-B	110	440	(Co-60) 0.02 (Cs-137) 0.08	0.00091	0.00023
#3-B	110	420	(Co-60) 0.09	0.00082	0.00021
#4-B	90	430	(Co-60) 0.08	0.00089	0.00019
#5-B	120	460	(Co-60) 0.07 (Cs-137) 0.03	0.00083	0.00022
#6-B	130	490	(Co-60) 0.10 (Cs-137) 0.03	0.00100	0.00027
#7-B	120	460	(Co-60) 0.08	0.00067	0.00017
#8-B	110	440	(Co-60) 0.04	0.00036	0.00009
#9-B	90	430	(Co-60) 0.05 (Cs-137) 0.03	0.00089	0.00019
#10-B	130	490	(Co-60) 0.06	0.00046	0.00012
#11-B	120	460	(Co-60) 0.05	0.00042	0.00011
#12-B	110	440	(Co-60) 0.05	0.00046	0.00011
#13-B	90	430	(Co-60) 0.06	0.00067	0.00014
#14-B	130	490	(Co-60) 0.06	0.00123	0.00033
#15-B	150	520	(Co-60) 0.04 (Cs-137) 0.10	0.00093	0.00027
#16-B	110	440	(Co-60) 0.05 (Cs-137) 0.04	0.00082	0.00021
#17-B	110	440	(Co-60) 0.07 (Cs-137) 0.02	0.00082	0.00021
#18-B	120	460	(Co-60) 0.04 (Cs-137) 0.03	0.00058	0.00015
#19-B	60	420	(Co-60) 5 (Cs-137) 55	1.00	0.15
#20-B	60	420	(Cs-137) 80	1.33	0.19

#21-B	60	420	(Co-60) 6 (Cs-137) 64	1.17	0.17
#22-B	60	420	(Co-60) 5 (Cs-137) 65	1.17	0.17
#23-B	60	420	(Co-60) 0.02 (Cs-137) 0.08	0.001	0.0002
#24-B	60	420	(Co-60) 0.02 (Cs-137) 0.08	0.001	0.0002
#25-B	100	140	(Co-60) 0.13 (Cs-137) 0.37	0.5	0.004
#26-B	--------	50	(Co-60) 0.017 (Cs-137) 0.022	--------	0.0008

Tab. 2 Hermetically sealed up radioactive pumps of Primary cooling circuit of the reactor

NN	Pump type	Weight, kg	Activity, mCi	Specific activity, mCi/kg	Dose rate on the surface of package (container), μSv/h
AN-1	CNG-71	390	(Co-60) 0.42 (Cs-137) 0.48	0.0023	0.50
AN-2	CNG-71	330	(Co-60) 0.43 (Cs-137) 0.45	0.0027	0.35
AN-3	CNG-71	360	(Co-60) 0.28 (Cs-137) 0.40	0.0020	0.25
AN-4	CNG-71	390	(Co-60) 1.0 (Cs-137) 0.40	0.004	0.70
AN-5	CNG-71	280	(Co-60) 0.45 (Cs-137) 0.23	0.0024	0.50
AN-6	CNG-71	280	(Co-60) 0.33 (Cs-137) 0.22	0.0020	0.30

Tab.3 Hermetically sealed up radioactive cases of ion exchange filter of the water purification system of Primary cooling circuit of the reactor

NN	Length, mm	Diameter, mm	Weight, kg	Activity, mCi	Specific Activity, mCi/kg	Dose rate on the surface of package (container), μSv/h
F-1	1500	420	145	(Co-60) 7.6 (Cs-137) 3.3	0.075	3.0
F-2	1330	400	110	(Co-60) 3.82 (Cs-137) 2.25	0.055	1.5
F-3	1500	420	145	(Co-60) 5.9 (Cs-137) 4.47	0.072	3.0
F-4	1500	300	120	(Co-60) 3.80 (Cs-137) 30.44	0.285	3.5
F-5	1500	300	120	(Co-60) 3.9 (Cs-137) 21.3	0.21	3.0
F-6	1330	400	110	(Co-60) 0.3 (Cs-137) 0.1	0.0035	0.3

Tab.4 Hermetically sealed up pipeline valves of Primary cooling system of the reactor

NN	Diameter, mm	Weight, kg	Activity, mCi	Specific Activity, mCi/kg	Dose rate on the surface of package (container), μSv/h
A-7	150	80	(Co-60) 0.07 (Cs-137) 0.23	0.004	0.30
A-8	100	35	(Co-60) 0.065 (Cs-137) 0.084	0.004	0.28
A-9	150	80	(Co-60) 0.08 (Cs-137) 0.25	0.004	0.30
A-10	100	35	(Co-60) 0.062 (Cs-137) 0.075	0.004	0.26
A-11	150	80	(Co-60) 0.023 (Cs-137) 0.60	0.008	0.40
A-12	100	35	(Co-60) 0.066 (Cs-137) 0.079	0.004	0.27
A-13	150	80	(Co-60) 0.09 (Cs-137) 0.32	0.005	0.30
A-14	100	35	(Co-60) 0.075 (Cs-137) 0.084	0.005	0.38
A-15	150	80	(Co-60) 0.074 (Cs-137) 0.34	0.005	0.40
A-16	100	35	(Co-60) 0.074 (Cs-137) 0.080	0.0044	0.36
A-17	100	35	(Co-60) 0.078 (Cs-137) 0.122	0.006	0.30
A-18	100	35	(Co-60) 0.076 (Cs-137) 0.090	0.005	0.40
A-20	150	90	(Co-60) 0.08 (Cs-137) 0.16	0.003	0.35
A-21	150	90	(Co-60) 0.074 (Cs-137) 0.13	0.002	0.30
A-22	150	90	(Co-60) 0.070 (Cs-137) 0.13	0.002	0.30
A-23	150	90	(Co-60) 0.090 (Cs-137) 0.17	0.003	0.32

Tab.5 Hermetically sealed up heat exchangers of Primary cooling system of the reactor

NN	Material	Weight, kg	Inner surface, m^2	Activity, Ci	Specific Activity, mCi/kg	Dose rate on the surface of package (container), μSv/h

TO-33	Aluminium AD-1M	775	79.5	(Co-60) 0.7 (Cs-137) 0.5	1.5	8.5
TO-34	Aluminium AD-1M	775	79.5	(Co-60) 0.7 (Cs-137) 0.2	1.2	4.5

Tab. 6 Radioactively contaminated pipes of primary and secondary circuits of cooling system of the reactor IRT-M

#	Pipe diameter, mm	Pipe length, m	Pipe weight, kg	Total weight of the pipe with the contents, kg	Total radioactivity mCi Co-60	Specific radioactivity mCi/ кg Co-60	Dose rate on the surface of the pipe, μsv/h
1	280	0,77	37	61	6,4	0,105	2,0
2	280	1,52	72	175	4,1	0,023	1,8
3	280	1,72	95	190	3,46	0,018	1,7
4	280	1,57	90	170	7,46	0,044	2,5
5	459	0,8	70	135	10,5	0,078	2,8
6	280	1,58	75	140	1,65	0,012	1,5
7	280	1,92	95	210	1,58	0,0075	1,2
8	280	1.81	80	155	2.47	0.016	1.6
9	459	3.2	240	340	47.4	0.139	3.6
10	280	1.72	80	145	3.8	0.0262	1.3
11	280	1.23	50	120	3.73	0.031	1.6
12	280	1.4	55	150	13.8	0.092	3.6
13	280	3.05	160	295	2.88	0.0098	1.5
14	459	2.4	185	270	20	0.074	3.9
15	280	3.07	165	310	3.7	0.012	1.3
16	280	3.83		200	0.53	0.0017	0.4
17	220	2.43	140	180	0.85	0.0047	0.5
18	150	1.85	50	75	0.45	0.0053	0.5
19	220	2.08	105	170	0.57	0.0034	0.5
20	220	3.4	165	255	2.3	0.009	1.3
21	220	3.25	170	240	1.2	0.005	0.6
22	220	3.1	170	170	0.8	0.0047	0.5
23	220	3.03	160	160	0.72	0.0045	0.5
24	220	2.5	160	160	0.75	0.005	1.2
25	270	2.25	70	70	14	0.2	3.6
26	459	4.9	340	515	28.2	0.055	4.2
27	459	5.5	340	340	25	0.074	4
28	220	100	100	100	0.1	0.001	0.6
29	220	100	100	100	0.1	0.001	0.6
30	260	0.6	45	45	4.5	0.1	1.8
31	220	2.5	60	60	12	0.2	3.6

Radioactively contaminated pipes of primary and secondary circuits of cooling system of the reactor IRT-M
(The external storage for utilized fuel)

#	Pipe diameter, mm	length, m	Pipe weight, kg	Total weight of the pipe with the contents, kg	Total radioactivity mCi Co-60	Specific radioactivity mCi/ кg Co-60	Dose rate on the surface of the pipe, μsv/h
32	220	5.75	145	145	22	0.152	4.0
33	459	6.2	450	450	24	0.053	3.8
34	459	5.5	440	440	48	0.109	4.5

Annex 2

Tab.1 The radioactive waste concreted during the first phase of IRT-M reactor decommissioning (Project GEO/4/002)

No	Item	Location	Amount	Dimensions (cm)	Material (wt %)	Mass total (kg)	Induced Activity (Bq)	Contamination (Bq/cm^2)	Remarks
1	Reactor tank	Inside biological shield	1	Height: 7600 Cross section perimeter: 1090 Thickness: 0,3	Stainless steel X18H10T 100%	1900	Lower part is highly activated with 10^{11} of ^{60}Co	Contaminated with ^{60}Co, ^{137}Cs, ^{90}Sr	Lower part. Concreted
2	Bottom of the tank	Inside biological shield	1	Area: $7.2\cdot10^4$ Thickness: 0.6	Stainless steel X18H10T 100%	337	$5\cdot10^{10}$ ^{60}Co	Contaminated with ^{60}Co, ^{137}Cs, ^{90}Sr	Concreted
3	Upper part of reactor core casing	In reactor tank	1	Length: 43.0 Width: 50.0 Height: 88.0	Al alloy: AD-1	10	$1\cdot10^{10}$ ^{60}Co	Contaminated ^{60}Co, ^{137}Cs, ^{90}Sr	Concreted in the tank
4	Lower part of reactor core casing	In reactor tank	1	Length: 66.8 Width: 45.0 Height: 20.0	Stainless steel X18H10T 100%	36	$1\cdot10^{10}$ ^{60}Co	Contaminated ^{60}Co, ^{137}Cs, ^{90}Sr	Concreted in the tank
5	Ejection pump with diffusor	In reactor tank	1			47	$1\cdot10^{8}$ ^{60}Co	Contaminated ^{60}Co, ^{137}Cs, ^{90}Sr	Will be concreted in the tank
6	Supporting grid	In reactor tank	1	Length: 66.8 Width: 45.0 Thickness: 7.0	Stainless steel X18H10T 100%	30	10^{11} ^{60}Co	Contaminated ^{60}Co, ^{137}Cs, ^{90}Sr	Concreted in the tank
7	Protective shield	In reactor tank	1	Length:85.0 Width: 64.0 Thickness: 7.0	Cladding: Stain. Steel, Lead Thickness: 5.4	420	10^{10} ^{60}Co	Contaminated ^{60}Co, ^{137}Cs, ^{90}Sr	Concreted in the tank
8	Hold up grid	In reactor tank	1	Length:150.0 Width: 190.0 Thickness: 0.2	Al alloy: AD-1	95	$2\cdot10^{10}$ ^{60}Co	Contaminated ^{60}Co, ^{137}Cs, ^{90}Sr	Concreted in the tank

No	Item	Location	Amount	Dimensions (cm)	Material (wt %)	Mass total (kg)	Induced Activity (Bq)	Contamination (Bq/cm^2)	Remarks
9	Hold up tank	In reactor tank	1	Height:500 Length: 130 Max thickness: 100 Wall thickness: 0.5	Stainless steel X18H10T 100%	1700	Not activated	Contaminated ^{60}Co, ^{137}Cs, ^{90}Sr	Concreted in the tank
10	Parts of horizontal experimental channels	In reactor tank	10	Diameters: 110 (8), 159 (1), 410 (1) Wall thickness: 0.3-0.5	Stainless steel X18H10T 100%	100	$2.5 \cdot 10^{12}$ ^{60}Co	Contaminated ^{60}Co, ^{137}Cs, ^{90}Sr	Concreted in the tank
11	Pressure pipeline of th primary cooling circuit	In reactor tank	1	Length: 1000 Diameter:27.0 Wall thickness: 1.0	Al alloy: AD-1	230	Low activation	Contaminated ^{60}Co, ^{137}Cs, ^{90}Sr	Concreted in the tank
12	Suction pipeline of the primary cooling circuit	In reactor tank	1	Length: 2.500 Cross section: 40.0 x 40.0 Wall thickness: 1.0	Al alloy: AD-1	160	Low activation	Contaminated ^{60}Co, ^{137}Cs, ^{90}Sr	Concreted in the tank
13	Control rods with channels	In reactor tank	9	Length of channels: 740, rods: 660, Diameters of channel: 2.7 x 0.15, rods: 23.0	Al alloy: SAV-1, B-Al		Not activated	Not contaminated	Removed
14	Vertical experimental channels	In reactor tank	2	Length: 740 Diameter: 2.4 x 0.1	Al alloy: SAV-1		Not activated	Not contaminated	Removed

No	Item	Location	Amount	Dimensions (cm)	Material (wt %)	Mass total (kg)	Induced Activity (Bq)	Contamination (Bq/cm^2)	Remarks
15	Vertical experimental Channels	In reactor tank	2	Length: 600 Diameter: 3.4 x 0.2	Stainless steel X18H10T 100%		Not activated	Not contaminated	Removed
16	Source of supercold neutrons	Horizontal experimental channel 1	1	Height: 30 Width: 50 Length: 50	Al alloy: AD-1 Beryllium rods	60	10^{10} ^{60}Co	Low Contamination	Concreted in the tank
17	Imitators of fuel assemblies	In reactor core	42	Height: 7 Width: 7 Length: 88	Al alloy: AD-1	126	Not activated	Not contaminated	Removed

Tab.2 The Waste Generated during the implementation of the Project GEO/3/004

Container							Content							Total Weight, kg	Total Activity of the Container with the Content, MBq	Specific Activity of the Container with the Content MBq/kg	Dose Rate on surface of the Container µsv/h
No	Length, m	Diameter, mm	Weight, kg	Type of Steel	Activity, MBq	Specific Activity, MBq/kg	Length (Length of Cut Pice), m	Diameter of cut piece, m	Weight, kg	Type of Steel	Quantity	Activity, MBq	Specific Activity, MBq/kg				
1	4.7	630	800	Ст3	15.9248	0.01990	92.0 (4.6)	52	400	Ст3	20	13.024	0.0326	1200	28.9488	0.024124	1.0
2	4.7	630	800	Ст3	15.9248	0.01990	55.2 (4.6)	52	240	Ст3	12	13.4976	0.0330	1210	29.4224	0.02430	1.0
							36.8 (4.6)	57	176	Ст3	8						
3	4.7	630	800	Ст3	15.3920	0.01924	92.0 (4,6)	52	400	Ст3	20	11.8400	0.0296	1200	27.2320	0.02267	0.97
4	4.7	630	800	Ст3	14.8592	0.0186	92.0 (4.6)	52	400	Ст3	20	11.2480	0.0281	~1200	26.1072	0.0218	0.97
5	4.7	630	800	Ст3	14.6224	0.0183	92.0 (4,6)	52	400	Ст3	20	10.6560	0.0266	~1200	25.2784	0.0210	0.92
6	4.7	630	800	Ст3	13.2904	0.0166	92.0 (4,6)	52	400	Ст3	20	10.0640	0.0252	~1200	23.3544	0.0194	0.83
7	4.7	630	800	Ст3	12.7576	0.0160	92.0 (4,6)	52	400	Ст3	20	9.4720	0.0237	~1200	22.2300	0.0185	0.80
8	4.7	630	800	Ст3	13.2608	0.0166	92.0 (4,6)	52	400	Ст3	20	10.0640	0.0252	~1200	23.3248	0.0194	0.83
9	4.7	630	800	Ст3	13.0832	0.0164	92.0 (4,6)	52	400	Ст3	20	9.4720	0.0237	~1200	22.5552	0.0183	0.83
10	4.7	630	800	Ст3	13.0240	0.0163	85,6 (2.5)	52	376	Ст3	33	8.2880	0.0220	~1176	21.3120	0.0178	0.82
11	4.7	630	800	Ст3	16.4576	0.0206	23 (4.6)	133	450	нж	5	2.8120	0.0062	1250	19.2696	0.0154	0.67
12	4.7	630	800	Ст3	16.1912	0.0202	41.4 (4.6)	100	450	нж	9	3.1968	0.0071	1250	19.3880	0.0155	0.67

13	4.7	630	800	Ст3	15.9248	0.0200	41.4 (4.6)	100	450	нж	9	2.6640	0.0059	1250	18.5888	0.0149	0.64
14	4.7	630	800	Ст3	13.5568	0.0170	23.0 (4.6)	100	300	Ст3	5	8.8800	0.0164	1340	22.4368	0.0166	о.92
							13.8(4.6)	133	240	Ст3	3						
							3.3	275	190	Ст3	1						
15	4.7	630	800	Ст3	10.3896	0.0130	4.6	275	260	Ст3	1	15.3920	0.0342	1250	25.7816	0.0206	0.92
							3.3	275	190	Ст3	1						
16	4.7	630	800	Ст3	10.0936	0.0126	4.6	275	265	Ст3	1	16.0432	0.0373	1230	26.1368	0.0213	0.63
							2.9	275	165	Ст3	1						
17	4.7	630	800	Ст3	10.5672	0.0132	4.6	275	265	Ст3	1	16.1320	0.0343	1270	26.6992	0.0210	0.66
							3.6	275	205	Ст3	1						
18	4.7	630	800	Ст3	10.1528	0.0127	4.6	275	260	Ст3	1	15.5400	0.0243	1440	25.6928	0.0178	0.64
							13.8 (4.6)	133	240	Ст3	3						
							9.2 (4.6)	100	120	Ст3	2						
							1.8	100	20	Ст3	1						
19	4.7	630	800	Ст3	9.5608	0.0120	9.2 (4.6)	133	160	Ст3	2	13.5272	0.0200	1480	23.0880	0.0156	0.60
							4.0	133	70	Ст3	1						
							2.0	275	150	Ст3	1						

							23.0	100	300	Ст3	5						
20	4.7	630	800	Ст3	9.5312	0.0120	73.6 (4.6)	38	128	ss	16	1.0064	0.0071	941	10.5376	0.0112	0.32
							7.2 (2.4)	38	13	ss	3						
21	4.7	630	800	Ст3	8.2584	0.0103	92.0 (4,6)	57 (27)	400	ss	18	2.6048	0.0065	1200	10.8632	0.0091	0.35
22	4.7	630	800	Ст3	7.9920	0.0100	92.0 (4,6)	57 (27)	400	ss	18	2.6640	0.0067	1200	10.6560	0.0089	0.35
23	4.7	630	800	Ст3	8.4952	0.0106	-	-	300	Ст3	200	14.2080	0.0474	1100	22.7032	0.0206	0.45
24	4.7	630	800	Ст3	8.9392	0.0112	-	-	-	-	-	-	-	800	8.9392	0.0112	0.32
25	4.7	630	800	Ст3	8.7024	0.0109	-	-	-	-	-	-	-	800	8.7024	0.0109	0.30
26	4.7	630	800	Ст3	8.6136	0.0108	-	-	-	-	-	-	-	800	8.6136	0.0108	0.30
27	4.7	630	800	Ст3	8.5544	0.0107	-	-	-	-	-	-	-	800	8.5544	0.0107	0.30
28	4.7	630	800	Ст3	8.5248	0.0107	-	-	-	-	-	-	-	800	8.5248	0.0107	0.30
29	4.7	630	800	Ст3	8.4360	0.0105	-	-	-	-	-	-	-	800	8.4360	0.0105	0.30
30	4.7	630	800	Ст3	8.6728	0.0108	-	-	-	-	-	-	-	800	8.6728	0.0108	0.30
31	4.7	630	800	Ст3	8.4064	0.0105	-	-	-	-	-	-	-	800	8.4064	0.0105	0.30
32	4.7	630	800	Ст3	8.6136	0.0108	-	-	-	-	-	-	-	800	8.6136	0.0108	0.30
33	4.7	630	800	Ст3	8.3768	0.0105	-	-	-	-	-	-	-	800	8.3768	0.0105	0.30
34	4.7	630	800	Ст3	8.4952	0.0106	-	-	-	-	-	-	-	800	8.4952	0.0106	0.30
35	4.7	630	800	Ст3	8.4952	0.0106	-	-	-	-	-	-	-	800	8.4952	0.0106	0.30
36	4.7	630	800	Ст3	8.2584	0.0103	-	-	-	-	-	-	-	800	8.2584	0.0103	0.30
37	4.3	630	730	Ст3	7.6960	0.0105	-	-	-	-	-	-	-	730	7.6960	0.0105	0.30

38	4.7	630	800	Ст3	7.9920	0.0100	-	-	-	-	-	-	-	800	7.9920	0.0100	0.30
39	2.77	630	482.0	Ст3	3.2859	0.0068	-	-	-	-	-	-	-	482.0	3.2859	0.0068	0.20
40	2.54	630	442.0	Ст3	3.0192	0.0068	-	-	-	-	-	-	-	442.0	3.0192	0.0068	0.20
41	2.49	630	433.0	Ст3	2.9526	0.0068	-	-	-	-	-	-	-	433.0	2.9526	0.0068	0.20
42	2.30	630	400.0	Ст3	2.7306	0.0068	-	-	-	-	-	-	-	400.0	2.7306	0.0068	0.20
43	2.30	630	400.0	Ст3	2.7306	0.0068	-	-	-	-	-	-	-	400.0	2.7306	0.0068	0.20
44	2.30	630	400.0	Ст3	2.7306	0.0068	-	-	-	-	-	-	-	400.0	2.7306	0.0068	0.20
45	2.30	630	400.0	Ст3	2.7306	0.0068	-	-	-	-	-	-	-	400.0	2.7306	0.0068	0.20
46	2.30	630	400.0	Ст3	2.7306	0.0068	-	-	-	-	-	-	-	400.0	2.7306	0.0068	0.20
47	2.30	630	400.0	Ст3	2.7306	0.0068	-	-	-	-	-	-	-	400.0	2.7306	0.0068	0.20

Tab.3 The Waste Generated during the implementation of the Project GEO/9/012

№	β-contamination Bq/cm^2	γ-contamination µSv/h	date	Note
1.	2.0	0.22	11.04.2016	Separated and put into pipe-container
2.	2.4	0.28	11.04.2016	Separated and put into pipe-container*)
3.	2.8	0.33	11.04.2016	Separated and one piece is put into C-1 ml container, and the second one is put earlier in 5T elbow cleaned within the previous project C-2
4.	4.25	0.13	12.04.2016	Separated and put into pipe-container*)
5.	2.15	0.24	13.04.2016	Separated and put into pipe-container
6.	11.5	1.8	27.05.2016	Cleaned on the equipment of abrasive jet Background value
7.	7.0	0.15	25.04.2016	Put into pipe-container
8.	3.1	0.14	25.04.2016	Put into pipe-container
9.	2.03	0.16	18.05.2016	Put into pipe-container
10.	2.08	0.2	18.05.2016	Put into pipe-container
11.	2.3	0.23	25.04.2016	Put into pipe-container
12.	1.82	0.18	18.05.2016	Put into pipe-container
13.	6.32	0.16	25.04.2016	Put earlier in 5T elbow cleaned within the previous project C-2
14.	9.0	0.23	05.05.2016	Separated and put into pipe-container
15.	8.0	1.2	05.05.2016	Separated and put into pipe-container
16.	1.31	0.1	18.05.2016	Put into pipe-container
17.	1.4	0.11	18.05.2016	Put into pipe-container
18.	1.0	0.9	05.05.2016	Put into pipe-container
19.	1.91	0.14	05.05.2016	Put into pipe-container
20.	3.8	0.2	25.04.2016	Put into pipe-container
21.	2x1.15	2x0.12	25.04.2016	Put into pipe-container
22.	4.2	0.9	13.06.2016	Cleaned on the equipment of abrasive jet Background value

№	β-contamination Bq/cm^2	γ-contamination μSv/h	date	Note
23.	2.1	0.2	13.06.2016	Cleaned on the equipment of abrasive jet Background value
24.	2.5	0.25	13.06.2016	Put into pipe-container
25.	2.0	0.12		Put into pipe-container
26.	3.4	0.41	17.106.2016	Put into pipe-container
27.	3.2	0.4	17.106.2016	Put into pipe-container
28.	2.6	0.15	17.106.2016	Put into pipe-container
29.	2.4	0.14	17.106.2016	Put into pipe-container