# Reconstruction and Modernization of Novi Han Radioactive Waste Repository

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## 1. Introduction

The objectives of the preliminary study, performed by EQE-Bulgaria [1], were the development of conceptual solutions for construction of the following new facilities in the Novi Han permanent Radioactive Waste Repository (NHRWR):

- An operational storage for unconditioned high level spent sources;
- New temporary buildings over the existing radwaste storage facilities;
- A rain-water draining system;
- A plant for conditioning of high level spent sources, and an interim storage;
- A fire-extinguishing water tank - 150 $m^3$ in volume.

In addition, the study includes the engineering solutions for conservation of the existing facilities, currently full with high level spent sources.

To meet the objectives the following tasks have been performed:
- Review of the existing documentation of the facilities, along with other previously developed preliminary studies. Comparison of the available documentation with the current status of the facilities as recorded during performed walkdowns.
- Review of regulatory documentation concerning the study.
- Review of the current and planned facility maintenance, performed repair works of some facilities on the site, and the activities planned in addition.

A "Program for Reconstruction and Modernization" has been created, including the analysis of some regulation aspects concerning this program implementation, as well as justification of the required additional analyses and studies, before starting the design activities. On approval of the program by the client the "Terms of Reference" for the conceptual design of reconstruction and modernization of NHRWR will be defined.

This report presents briefly the most important issues of the study [1].

# 2. Repository status and general concept for reconstruction and modernization

## *2.1 Input data for the study and facilities status*

### 2.1.1 Basic data for the site and its facilities

Currently, the main information available for the site and facilities at NHRWR is due to studies, carried out at a later time, during NHRWR's operation, as:

- Engineering-geological and hydro-geological survey on the site, performed by the Geotechnical Laboratory of the Bulgarian Academy of Science, 1991.
- "Terms of Reference" for the reconstruction and modernization of NHRWR, performed at a request of Committee of Usage of Atomic Energy for Peaceful Purposes (CUAEPP) by Energoproect, 1996 [8].

The drawings of the last document were used as basic information for the present study. They comprise:

- The updated layout of the site, showing to a high extent the correct locations of the main buildings and
- Cross-sections of the main storage facilities as recorded through walkdowns, or descriptions of the operation personnel.

### 2.1.2 Summary of the results obtained through site and facility walkdowns

Summary of findings by walkdowns and inspections performed by EQE-Bulgaria is as follows:

1. The site has two zones – "clean" and "contaminated" as required in accordance with Regulation 0-35. The sanitary pass area in the "Deactivation" building is not used for prescribed purposes and its current status makes doubtful its future utilization as an advanced sanitary and radiological-control facility.
2. Water has penetrated in some of the trench cells storage for solid radwastes. The source is not evident – the water penetrated either through the covered openings on the cells' ceiling or through the walls and the bottom of the facility.
3. The geometry of the openings on the ceiling of the storage has been changed in result of additional hydro-insulation works, made recently.
4. No data for the site underground structure and communications is available. The additional measures for the site upgrading, including a lot of the activities for newly buried cables, ditches, etc. performed in recent years at different site locations, is done without design drawings, following hand-made sketches.
5. Two drilled bore holes, made for the engineering-geological study in 1991, are still available at the site. They could be used for observations of underground water level. These observations would provide information, necessary to define the depth of the new facilities. The drilled holes are not enough to define the depth of the basic soil lager bellow back-fill soil in some zones, where the new facility foundations should

be arranged. There is not sufficient information to prepare vertical cross-sections of the site. In general, additional geological survey is required to provide information about the geological conditions of the site.

6. The existing "radiation-control shafts" along the storage trench for solid radwastes are shallow and not adequate for the purpose of efficient radiation monitoring.
7. The available geodesic mapping is good in showing the site vicinity, but the points of survey within the site are not sufficient for the existing difference in elevation. A detailed geodesic mapping of the site operational zone should be made before the landscape design is performed.
8. No documentation on the water-supply system and the water tanks is available. This deficiency will eventually be corrected by the contemporary reconstruction of the water-supply pipelines.
9. The road at the restricted zone of the site is too narrow (such findings were made by the CUAEPP [24]). The reconstruction should follow the recommended measures.

In brief, the storage facility is 30 years old and does not satisfy all current requirements for facility design [12, 14, 15, 16 18, 19 21, 22]. The lack of design or executive drawings of the original construction and of performed modifications is a serious impediment to define clear and applicable recommendations to the existing facilities. The first priority task of the reconstruction and modernization should be the creation, or updating of the documentation of the existing facilities, and a proper site survey for the facilities design.

## *2.2 Concept for reconstruction and modernization of NHRWR*

The analysis of the reviewed documentation on the history of NHRWR [2,4] and the proposed development of the repository in compliance with the "National Strategy" [7] lead to the following strategic objectives for the prospective site reconstruction and modernization:

- The short-term measures, apart from the construction of the new facilities for conditioning and the interim storage, should conform to the general concept.
- The long term measures, including the new facilities constructions, should to certain extent change the functions of NHRWR as a repository, to provide conditioning of sealed spent sources or solid and liquid radwastes, as well as their interim storage. The new configuration should take advantage from the available advanced conditioning technologies, as well as from the availability of existing facilities by fitting them in the general concept as elements of the new system.

The considered engineering solutions are:

- Partial conservation of the existing facilities, not limiting the option for retrieval of the stored radwastes, and partial change of facility functions to fit in the new conceptual configuration.
- Construction of new facilities for conditioning different types of radwastes and their interim storage.
- Modernization of the existing infrastructure.

# 3. Engineering solutions for the existing facilities

## *3.1 Temporary building structures over existing storage*

### 3.1.1 Scope and requirements

Temporary building structures over the existing storage are required for physical and rain protection. Temporary building structures would not provide radiological protection. Temporary building structures are presumed to protect the following facilities:

- Solid radwaste storage;
- Biological radwaste storage;
- Trench storage for solid radwastes.

The existing "Liquid radwaste storage" would not be possible to use in future, due to nonconformance to long-term storage regulations [12,14,16,21]. The reconstruction concept includes this facility as reservoir within the special sewage system of the contaminated zone.

The temporary buildings are foreseen to be light steel structures appropriate to provide future possible dismounting, in case the regulator takes decision for facility shut-down, or in case of its decommissioning after the stored radwastes have been retrieved and conditioned.

The temporary building structures do not need heating and other passive or active systems, required for operation. The light structure will not endanger to damage seriously the reinforced concrete storage during an earthquake. Their design should meet the civil codes requirements for seismic stability. Design parameters should provide stability for:

- Snow: s=0,5 kN/m2;
- Wind: w=0.38 kN/m2;
- Earthquake: kc=0,27 for IX degree on MSK [22].

### 3.1.2 Engineering solutions

The conceptual design for temporary building structures over existing facilities comprises structures with the following dimensions:

- Solid radwaste storage: foundation dimensions 11,0/17,0 m, h=5,16/3,96/ m in height, and b=6,0/5,50/ m distances between frames.
- Biological radwaste storage: foundation dimensions 9,0/9,55 m, h=4,97/3,96/ m in height, and b=4,775 m distance between frames.
- Solid radwaste trench storage: foundation dimensions 6,0/33,10 m, h=4,68/4,06/ m in height, and b=6,62 m distance between frames.

Other peculiarities of the proposed solutions are:

- No heating or heat-insulation is required. Due to potential possibility that gas vapors may appear, the building should provide common natural air convection (like wall openings covered with metal grids and roof deflectors to provide minimal twice air convection).

- The biological radwaste storage solution includes manually controlled roof ventilator for additional ventilation in summer time when people enter the building.
- Building draining is provided by special drain channels on the floor and a drain trench, that will take water to the South drain trench of the rain-water sewage system within the contaminated zone.
- Permanently closed windows, located over the metal doors on the North side of the building are recommended.

Water-proof and dust-proof light and phone systems should equip the buildings. Special equipment should provide the heavy covers lifting off the storage openings. As its usage will be rare, this equipment may be operated manually.

Radiation monitoring inside the building and the building access control should be performed by IAEA as usual.

### *3.2 Conservation of the spent source storage*

The spent source storage, called the "gamma well", presently is considered full. In principle, it is assumed that the spent sources will not be retrieved. That means that the storage is not considered interim. A considerable amount of long life isotopes have been stored in contradiction to the requirements for a surface storage. This conclusion was made by a PHARE study [2], recommending retrieval, sorting and conditioning of the sources and decommissioning of the facility.

The retrieval of spent sources from the storage is the best variant from the point of view of ecological and population protection in the long run. But it will cost much and the radiation doses of the operation personnel, performing dangerous operations, will be high. The proposed solution is to put the facility under conservation temporarily, until available funding or new high technologies will make possible facility decommissioning.

In compliance with the available information, the study of EQE-Bulgaria recommends the following measures as necessary and adequate:

- Creating horizontal filter screens under the storage facilities (in two stages) by drilling sloping holes and vertical holes and injecting two-component polyurethane clays under pressure. The injections should be located at a distance of 1.5-2 m from the storage foundations (as there is not information about clay behavior under radiological impact). Clays will fill in all soil pores and will perform as a water-proof barrier.

Some preliminary drilling works should be made to find out the specific parameters of the soil profile under the facilities, in order to define the specifications for the injection works .

Once the filter screens are created, the vertical drilling holes may be used for storage status remote control.

- Creating vertical filter screens surrounding the facility by reinforced concrete walls, which may follow different technology using different machines. The technology could be selected after study of the soil profile and depending on machine dimensions.
- Creating a water-proof reinforced concrete plate around the storage that drains surface water away from the area within the filter screens.

# 4. Engineering solutions for the new facilities

## *4.1 Location concept*

Within the presented study, performed by EQE Bulgaria, some new facility engineering solutions are planned for implementation through both a short-term and a long-term program. The location of these facilities is shown on the NHRWR site layout.

### 4.1.1 Fire-extinguishing reservoir

The facility should supply with water the fire-extinguishing car. In compliance with the national regulations the facility should be located no further than 150 m away from any of the serviced buildings. Its volume is 150 m3.

Considering the new facilities location in the contaminated zone and the existing facilities location at the site entrance, the reservoir is proposed to be located on the slope over the parking area, opposite the "Deactivation" building. This location is convenient for car access to the reservoir shaft. The location is convenient, if a fire-extinguish system with pumps and hydrants would be constructed.

### 4.1.2 New facilities locations in the contaminated zone

Proposed new facilities locations in the contaminated zone is based on the following considerations:

- Facilities communications should correspond to the technological integrity of processes and activities.
- Facilities within the contaminated zone, requiring most often personnel operations, should be located as near the "clear zone" barrier as possible (to diminishing the time of personnel presence within the contaminated zone and the corresponding dose loading).
- Places for shipping operations with vehicles, should be located as near the "contaminated zone" barrier as possible, to reduce the hazards of contamination and consequent deactivation activities.

## *4.2 Engineering solutions*

### 4.2.1 Fire-extinguishing reservoir

The feasibility study rejected the variant of an open fire-extinguishing pool for the reasons it may get dirty, freeze, etc. that will prevent its reliable operation. The reservoir is located within the "clean zone". The proposed conceptual solution is shown on Fig. 1. The reservoir is made out of reinforced concrete, it is water proof inside and hydro-insulated outside.

### 4.2.2 Operational storage of high level spent sources and a plant for conditioning of the high level spent sources

The proposed in the study variant [1] recommends a fast construction of the operational storage, which in future will be integrated within the plant for conditioning of high level spent sources. The building consists of 3 structures with gaps in-between, permitting their step-by-step construction. The facility is located in the "contaminated zone". The proposed conditioning technology follows the concept outlined in [19,20].

### 4.2.3 Plant for conditioning of the medium and low level spent sources

The proposed by the study technological process, performed by the plant, is shown on Fig. 2. The plant building is located within the "contaminated zone". Its foundation dimensions are 42 x 18 m and its height is h=5 m. The study presents the conceptual solutions and the equipment of the plant. The engineering solution sought the minimum internal transportation operations, planning the plant in conformance with the technological process. Main plant areas are:

- An inventory store;
- A shipping sector, and an adjacent to it sector for the input radwastes control, as well as an operational spent sources storage.
- A conditioning sector, divided in: a sorting area, a wet area, and a conditioning area for liquid radwastes and deactivation.
- An underground room with reservoirs for the sewage system and the operational reservoir of the conditioning installation for liquid radwastes.

Rooms for auxiliary systems are designated (like electrical, ventilation, etc. systems), as well as laboratories, stores, etc.

### 4.2.4 Interim storage for conditioned radwastes

The Interim storage of low and medium conditioned radwastes is considered. Drums, made out of reinforced concrete, will be stored and be accessible at all times to provide eventual drums transportation to a permanent storage.
The study presents conceptual drawings of the storage building. Variants of drum distribution are shown.

The building is located in the "contaminated zone". Its foundation dimensions are 15x48 m and height of h=5 m. Wall thickness is calculated in compliance with the radiological protection requirements. Natural air convection is provided by square openings on the walls, covered with grids.

## 5. Engineering solutions and infrastructure improvement

The study provides analysis for the required site infrastructure modifications, along with the engineering solutions for the new facilities. The additional issues include:

- New landscape design;
- Internal communications;
- Special sewage system modifications in the contaminated zone;
- Surface-water sewage modifications;
- Radiological monitoring and dose control system upgrading;
- Physical protection system;
- Inter-site communication system;
- Operational and emergency electric supply;
- Information system

The expanding of NHRWR functions should take into account the following issues as well:

- All existing laboratories are located in buildings, older than their life-time, are not seismically qualified.
- The existing sanitary pass does not conform to the current requirements for personnel dose-control.
- No lab for radiological monitoring, no probe store, or cleaning wash-room, etc. are available.

The study recommends a new sanitary-lab building to be constructed, which will solve these problems. The sanitary-lab building location is shown on the site layout, which lies at the border of the "clean" and "contaminated" zones.

## 6. Program for reconstruction and modernization

### *6.1 General principles*

As a result of the study, performed by EQE Bulgaria, the Program for restructuring and modernization defined two approaches for reconstruction and modernization of NHRWR:

- Reconstruction of the existing facilities and construction of new infrastructure, required for site modernization, even if no new facilities are to be constructed on this site.

  This approach is called a "small" reconstruction and corresponds to the first strategic objective of the concept for reconstruction and modernization of NHRWR. The activities for this reconstruction may be performed independently from the construction of the new facilities..

- Construction of new facilities for conditioning and storage of spent sources and radwastes.

  This approach is called a "large" reconstruction and corresponds to the second strategic objective of the concept for reconstruction and modernization of NHRWR. The activities for this reconstruction should be performed in relation with the site infrastructure modifications.

  Both Program approaches group the activities in three steps:
  - Study;
  - Design;
  - Implementation.

### *6.2 Small reconstruction*

The "small" reconstruction comprises the following amount of works:
- New landscape design;
- Mounting of a new system for rain sewage in the contaminated zone;
- Modernization of the existing sanitary pass in "Deactivation" building;
- Application of a computer-aided system for site radiological control;
- Construction of temporary buildings over existing facilities - Solid radwaste storage, Biological radwaste storage, Trench storage for solid radwastes;
- Construction of a drain system to reduce the level of underground water;
- Creation of a new security strip around the site;
- Construction of a fire-extinguishing reservoir.

### *6.3 Large reconstruction*

The amount of works for the "large" reconstruction are described in 4.2.2 to 4.2.4, including their integration (internal communications) with the other systems and facilities on the site.

### *6.4 Fast construction of operational spent sources storage*

The variant of fast construction of operational spent sources storage includes also this minimum amount of new infrastructure works, which should be carried out and in compliance with in the next stages of the NHRWR reconstruction. Construction of operational spent sources storage is obligatory nevertheless which one "small" or "large" reconstructions would be performed.

## 7. Conclusions

The engineering problems of NHRWR are clear and appropriate solutions are available. They can be implemented in both cases of "small" or "large" reconstruction. The reconstruction project anyway should start with the construction of a new site infrastructure. Reconstruction and modernization of NHRWR is the only way to improve the management and safety of radwastes from Medicine, Industry and Research in Bulgaria.

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