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Abstract. The closed fuel cycle concept in relation to the WWER was adopted in the former USSR. The WWER-440 spent fuel assemblies (SFAs) were shipped to RT-1 plant (“Mayak” enterprise) for reprocessing. WWER-1000 SFAs were shipped to Krasnoyarsk-26 (Zheleznogorsk) for storage in the wet away-from-reactor (AFR) spent fuel storage facility (SFSF) of the prospective reprocessing plant. RBMK SFAs were transported to the wet AFR storage located on the NPP site. Reprocessing of RBMK spent fuel was considered inexpedient because of the low content of fissile nuclides. The closed fuel cycle for some countries at present and in the nearest decades is evaluated as economically unprofitable. Presently, Ukraine continuing to ship spent fuel to Russian reprocessing plants is developing the Intermediate Spent Fuel Dry Storage Program (deferred decision). The dry SFSF on the basis of VSC-24 casks designed by the American company Sierra Nuclear was put into operation at Zaporizhzhya NPP in September 2001. Spent fuel is planned to be stored during 50 years. The modular type (horizontal concrete modules “NUHOMS” designed by Framatome ATEA) SFSF (HOYAT-2) is being constructed near the Chornobyl NPP site. One of the key problems of the successful development of the Nuclear Power Industry undoubtedly is the management of radioactive waste arising both during nuclear power plant (NPP) operation and during NPP decommissioning. Decommissioning of NPPs, rehabilitation of the 30-kilometer Exclusion Zone territory, the former rocket–nuclear weapon complex storages elimination, maintenance of 8000 firms of the country’s economic complex using ionizing radiation sources, treatment of 6000 m3 of solid radioactive waste generated by 13 operating units at four Ukrainian NPPs - these are different aspects of the same problem – the problem of radioactive waste management. The problems of radioactive waste management including such specific ones as radioactive waste arisen at the destroyed Unit 4 of the Chornobyl NPP and radioactive waste arisen at the enterprises of the former military-industrial complex of the Soviet Union are multilevel.

1. Introduction

On April 20, 2000 the Parliament of Ukraine (Verkhovna Rada) adopted the Law of Ukraine “About ratification of the joint convention about safety management of spent fuel and radioactive wastes” (Convention). Therefore, by joining the Convention Ukraine has undertaken the obligations to respect its clauses during implementation of the state policy in the field of nuclear energy.

In order to implement the state policy in the field of spent nuclear fuel (SNF) and radioactive waste management (the main principles of which fully conform with the principles of the Convention) and to ensure the unified approach to its implementation the main activity directions in the area of spent nuclear fuel and radioactive waste management are defined. They are as follows:

- Provision of the SNF safe long-term storage in Ukraine. Advance accelerated investigation of spent fuel behaviour in hot cells are being performed (within 10 years) for forecasting spent fuel behaviour and safety justification under a long dry storage condition;
- Creation of the legislative base and of the financial mechanism for assurance of SNF reprocessing activity (in order to recycle valuable nuclear materials) and high-level radioactive wastes disposal or deep geological disposal of spent nuclear fuel after making an ultimate decision well-founded from economic and technical point of view safeguarding the interests of the country and the future generations;
- Allocations of duties, rights and responsibilities at all stages of the SNF and radioactive waste management to the subjects of legal partnership in this sphere;
- Provision of scientific and technical support of the SNF and radioactive waste management;
- Promotion of international cooperation and international experience to make SNF and radioactive waste management practice in Ukraine conform with the world economic and technical accomplishments and meet the international safety standards.

2. General situation of nuclear energy in Ukraine

There are thirteen power water-cooled reactors in operation (6 WWER-1000 at Zaporizhzhya NPP, 3 WWER-1000 at South Ukraine NPP, 1 WWER-1000 at Rivne NPP, 1 WWER-1000 at Khmelnitsky NPP, and 2 WWER-440 at Rivne NPP) with total installed capacity of 11,835 MWe in Ukraine. That is about 25% of the total installed capacity of the electric power plants. Unit # 3 with WWER-1000 at Rivne NPP and Unit # 2 with WWER-1000 at Khmelnitsky NPP are under the final stage of construction and will have been commissioned by the end of the year 2004. The construction of 2 WWER-1000 units at Khmelnitsky NPP was suspended, but not cancelled.

In 2003 NPPs generated $81.4 \times 10^9$ kW·h of electricity (44.9% of electricity in the country). In 2003 the average load factor reached 78.5%.

Units #1,2,3 with RBMK-1000 of Chornobyl NPP are under decommissioning.

3. Spent fuel management

3.1. The forecast for spent fuel generation

The forecast for spent fuel generation within 2004 - 2045 year period at Ukrainian NPPs is shown in figure 1. It is expected that the design operational life of the currently operated and commissioned in 2004 units at KhNPP and RNPP will be extended for 10 years.

![FIG. 1 The estimated spent fuel arising](image)

3.2. Current status

RBMK SFAs are stored in at-reactor (AR) spent fuel pools and in the wet AFR storage located on the NPP site.
WWER-440 SFAs are stored in AR spent fuel pools and then are shipped to RT-1 plant (“Mayak” enterprise) for reprocessing. WWER-1000 SFAs are stored in AR spent fuel pools and then are transported to RT-2 complex site for storage and reprocessing in future after completion of the fuel reprocessing plant construction. AR spent fuel pools were re-racked at all WWER-1000 power units to increase their storage capacity, except Zaporizhzhya -3, -4, -5. Since the year 2003 the WWER-1000 SFAs of Zaporizhzhya NPP have not been shipped to RT-2 complex site but are stored in the dry SFSF located at the NPP site. In total by the beginning of May, 2004 14 containers (330 SFAs/ 136 tU) were loaded.

After the dissolution of the Soviet Union in 1991, spent fuel from Ukrainian WWERs was not transported to reprocessing plants until 1995, follow-up the ban that was in force in Russia. Since 1995, spent fuel from WWERs-1000 and WWERs-440 has been transferred to RT-1 and RT-2 plants, under the contracts. One of the conditions of the contracts is the return of vitrified wastes to Ukraine after spent fuel reprocessing. General data on the spent fuel balance is shown in table 1.

### Table I. General data on the balance of spent fuel of Ukrainian NPPs (As of 01 January 2004)

<table>
<thead>
<tr>
<th>Spent Fuel</th>
<th>WWER-1000, number FAs/tU</th>
<th>WWER-440, Number FAs/tU</th>
<th>RBMK, number FAs/tU</th>
<th>Total, tU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spent fuel generation:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- during the whole period of NPP operation</td>
<td>8315/3435</td>
<td>4336/520</td>
<td>21284/2447</td>
<td>6402</td>
</tr>
<tr>
<td>Stored in spent fuel pools and in the wet AFR storage</td>
<td>3624/1497</td>
<td>593/71</td>
<td>21284(*)/2447</td>
<td>4015</td>
</tr>
<tr>
<td>Stored in the dry AFR SFSF</td>
<td>306/126</td>
<td></td>
<td></td>
<td>126</td>
</tr>
<tr>
<td>Shipped to reprocessing Plant:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- during the whole period of NPP operation</td>
<td>4385/1812</td>
<td>3743/449</td>
<td>-</td>
<td>2261</td>
</tr>
</tbody>
</table>

(*) 2375 FAs from them are being stored in reactor cores

### 3.2. Deferred decision rationale

The closed nuclear fuel cycle was evaluated as preferable for the option of large scale nuclear industry development involving fast breeder reactors into the nuclear fuel cycle. Nuclear energy has undergone essential changes during the last decades. The competitiveness of nuclear energy (NPPs) under the increased safety requirements, reliability of operation, was determined first of all by a nuclear fuel cycle cost reduction, NPPs construction terms reduction, and units’ unification degree increase. Evolutionary water-cooled reactors (including WWER) have appeared most adaptable and competitive under natural uranium price reduction and enrichment capacities excess. The commercial use of fast reactors was deferred.

The national nuclear utility “Energoatom” advances payments for spent fuel reprocessing the results of which it would probably never get because the strategic decision on the structure of the national nuclear fuel cycle is not made. Several circumstances hinder the decision-making:

- The program of nuclear energy development after the year 2010 and the program of operating reactors life extension are not developed in Ukraine;
- The possibility of the safe operation of WWER-1000 using MOX fuel is not demonstrated and WWER-1000 necessary modernization programs are not developed;
- WWER-1000 MOX fuel manufacturing is absent.
Since the nuclear fuel cycle strategy is not adopted in Ukraine a well-founded decision on long-term spent nuclear fuel storage is of paramount importance. The decision should give the time for the country’s long-term nuclear energy strategy development, appropriate nuclear fuel cycle creation and adoption, and be competitive in comparison with the existing practice of spent fuel dispatch to Russia.

3.4. Interim dry SFSF implementation on Zaporizhzhya NPP site.

It should be noted that the construction of the dry SFSF at the Zaporizhzhya NPP site was foreseen by the design. It was understandable that when the fifth and the sixth units of the Zaporizhzhya NPP would be put into operation the difficulty with spent fuel shipment would arise. Primarily the spent fuel storage was planned at the NPP site in the TK-13 containers. But spent fuel was not shipped to Russia from 1993 until 1995, due to that the situation became complicated and the decision concerning the construction of dry SFSF which is capable of long-term storage of all spent fuel from Zaporizhzhya NPP was made.

After the proposals from different companies were addressed, the decision was made to build the SFSF on the design basis of VSC-24 casks of the American company Sierra Nuclear. Zaporizhzhya NPP signed an agreement with the engineering company Duke Engineering & Services to perform the design of the container to store spent fuel from WWER-1000 and escort the design of SFSF. The designing of the rest of the components was carried out by the Kharkiv Design Institute “Energoproject”. The full design capacity of the SFSF of Zaporizhzhya NPP is 380 containers. Each container can consist of 24 SFAs.

The dry SFSF on the basis of VSC-24 casks was put into operation at Zaporizhzhya NPP in September 2001. Spent fuel is planned to be stored during 50 years. In total by the beginning of May, 2004 14 containers (330 SFAs/ 136 tU) were loaded. The first 14 baskets, equipment for container sealing-in and spent fuel transportation were manufactured and procured by the company Duke Engineering & Services. The rest of the containers will be manufactured in Ukraine.

The average capital component of the specific cost of spent fuel storage counting on the complete storage facility fill up (380 containers) is estimated to be not more than 40 $/kg U. The running costs of the container storage in the specific cost of spent fuel storage during 50 years will be insignificant because the NPP will be at the stage of operation and afterwards at the stage of decommissioning and practically there won’t be any need in additional personnel.

Fig. 2 shows the Zaporizhzhya NPP dry SFSF. In figure 3 the cask transportation is shown.
FIG. 2 the Zaporizhzhya NPP dry SFSF

FIG. 3 Zaporizhzhya NPP dry SFSF. (Cask transportation)
3.5. RBMK-1000 spent fuel long term dry storage implementation

It was admitted that the wet AFR SFSF at the Chornobyl NPP site didn't meet the safety requirements and has to be reconstructed or decommissioned. Further on, the existing storage facility design life time expires in 2016. It was decided to construct the new dry storage "HOYAT-2" in the area of Chornobyl NPP site instead of the wet storage "HOYAT-1".

The project financial support was provided by the Grant Agreement signed by the Ukrainian Government, EBRD and Chornobyl NPP. The Grant would be available if Ukraine provides:
- Financing related to licensing;
- Construction site;
- Construction of roads;
- Power supply lines;
- Administrative office and so on.

The choice of the interim dry SFSF project was put out to the international tender (bid) in 1999. The modular type (horizontal concrete modules “NUHOMS” designed by Framatome ATEA) SFSF (HOYAT-2) is being constructed near the Chornobyl NPP site. The NUHOMS modules are being built in two parallel lines. Each module contains 1 canister. According to the design each canister contains 196 spent fuel bundle cartridges (98 RBMK FAs divided into halves). The new storage capacity is planned for 21,356 RBMK SFAs and approximately for 2,000 discharged absorber rods for 100 years. The transport of all spent fuel from the wet SFSF to the dry SFSF should be completed during 7 – 8 years. Fig. 4 shows the Chornobyl NPP modular type SFSF.

In April of the year 2003 HOYAT-2 construction works were suspended on the customer’s (Chornobyl NPP) request to specify and co-ordinate the changes in the design documentation. Currently contract negotiations with the Contractor are under way concerning introduction of the changes into the design and the spent fuel management technology revision. During the year 2004 it is intended to issue a new preliminary version of the Safety Analysis Report. Subsequently the Safety Analysis Report will be submitted to the State Nuclear Regulatory Committee for agreement. HOYAT-2 construction works resumption is planned for the beginning of the year 2005.
One of the major reasons for the necessity of the HOYAT-2 design revision is as follows: the actual changes in the size and geometry of a number of SFAs after their discharge from the reactor and loading into the spent fuel pool were not taken into account. The greater part of SFAs has damaged spacer grids. As a result, apparently, it would be necessary to increase the bundle cartridge diameter, to improve the Radioactive Waste Management, ventilation system and so on. In figure 5, as an example, the SFA with the damaged spacer grid is shown.

3.6. Centralized dry WWER SFSF

Central dry SFSF is apparently the most economically viable decision for Ukraine [1].

Results of the preliminary performed assessments:
- The preferable spent fuel management strategy for South Ukraine NPP, Rivne NPP, Khmelnytsky NPP is centralized storage;
- The preferable technology for centralized spent fuel storage is modular or container storage;
- The preferable centralized SFSF site location is the Exclusion Zone of Chornobyl NPP, adjacent to SF-2 of ChNPP

One of the most important problems is spent fuel storage technology selection on the basis of option assessment and based on the utilization experience. The technology selection is carried out on the tender basis. The bid on WWER spent fuel interim storage technologies implementation in Ukraine to store 11,000 WWER-1000 SFAs and 3,300 WWER-440 SFAs is planned to be conducted by August 2004. According to the Plan the centralized SFSF construction may be realized during 2007-2008.
4. Advance investigation of spent fuel behaviour under a long dry storage condition, Maintaining FAs operation and irradiation database

4.1. The basis of the researches

Advance accelerated investigation of spent fuel behaviour in hot cells is required for forecasting spent fuel behaviour under a long dry storage condition. In the State Scientific Centre of Russia "Research Institute of Atomic Reactors" (RIAR, Dimitrovgrad, Russia) the advance investigations of three fuel assemblies from Zaporizhzhya NPP are being performed (within 10 years) under the contract between "Energoatom" and RIAR.

4.2. Research problems (tasks) [2]:

1. To evaluate the corrosion processes and their influence on properties of the fuel cladding and FAs structure materials.
2. To develop the methodology of forecasting of WWER -1000 SFAs condition after long term dry storage with the substantiation of safety criteria.
3. To define allowable fuel cladding temperatures in the beginning of storage.
4. To define allowable fuel cladding temperatures for emergency case and allowable time of overheating.
5. To evaluate FA behavior as an integrity under long term dry storage with the calculated codes.
6. To evaluate allowable term of spent fuel assemblies storage from the point of view of ensuring the possibility in the future to unload FAs from the storage facility and to load them in the transport container, then to transport, to reprocess or to dispose of.
7. To develop the recommendations for the option of the safe mode of spent FAs.

4.3. Developing and maintaining database on FAs operating conditions and irradiation history

It is very important while adopting and implementing the concept of spent fuel long-term interim storage to have the information on FAs operating conditions and FAs irradiation modes, cladding tightness test results as well as the conditions of SFAs storage in the spent fuel pools.
In 2004 the Ministry of Fuel and Energy of Ukraine issued an Order committing the operator – NAEK “EnergoAtom” to developing and maintaining the corresponding database on FAs operating conditions, FAs irradiation history and on the conditions of SFAs storage in the spent fuel pools. Data retention using reliable medium will help our future generations to resolve the problems of decision-making concerning further SF management.

5. Radioactive waste management

5.1. The problems of radioactive waste management

One of the key problems of the successful development of the Nuclear Power Industry undoubtedly is the management of radioactive waste arising both during nuclear power plant (NPP) operation and during NPP decommissioning. Decommissioning of NPPs, rehabilitation of the 30-kilometer Exclusion Zone territory, the former rocket–nuclear weapon complex storages elimination, maintenance of 8000 firms of the country’s economic complex using ionizing radiation sources, treatment of 6000 m$^3$ of solid radioactive waste generated by 13 operating units at four Ukrainian NPPs - these are different aspects of the same problem – the problem of radioactive waste management.

The problems of radioactive waste management including such specific ones as radioactive waste arisen at the destroyed Unit 4 of the Chornobyl NPP and radioactive waste arisen at the enterprises of the former military-industrial complex of the Soviet Union are multilevel.

5.2. The structure of Ukraine’s radioactive waste management complex

Ukraine’s radioactive waste management complex (except NPPs) is represented by the following enterprises of the Ministry on the Problems of Emergency Situations and Protection of the Public against the Consequences of the Chornobyl Accident (MES) and the Ministry of Fuel and Energy (MFE)

An Enterprises of the MES:
- The nuclear instrument-making plant “Etalon”, Belaya Tserkov;
- The association “Radon” includes 6 specialized industrial complexes which service the industrial complex on the whole territory of Ukraine. Besides, this association includes the enterprises of the Exclusion Zone – the State Specialized Enterprise “Complex”, the State Specialized Enterprise “Technocenter” and the operating low-level radioactive waste storage facility “Buryakovka”.
- The radioactive waste treatment and disposal complex “Vector” is being constructed in the Exclusion Zone.

An Enterprises of the MFE:
- The liquid radioactive waste treatment plant is being constructed on the Chornobyl NPP industrial site.
- Besides, on the Chornobyl NPP industrial sites and outside the NPP territory in the Exclusion Zone the construction of other three solid radioactive waste treatment plants is being completed:
  - Chornobyl radioactive waste extraction plant;
  - Radioactive waste sorting and treatment plant;
  - Low- and intermediate-level radioactive waste storage facility which belongs to the MES.

5.3. Sources of radioactive waste.

Ukraine’s NPPs generate approximately 6000 m$^3$ of solid low-level radioactive waste per year. Uranium mining and milling is accompanied by arising of a great amount of low-level long-lived radioactive waste. The area of the industrial sites occupied by this type of radioactive waste is more than 8,000 hectares, their total activity - 140,000 curie (5*10$^{15}$ Bq), the volume – 70 million m$^3$. 
The country’s industrial complex (without NPPs) has got more than 8000 enterprises which use radioactive materials with total activity of 2.5 million curie ($10^{17}$ Bq).

The third source of radioactive waste is the military-industrial complex.

And finally, the fourth source of radioactive waste is the 30-kilometer Exclusion Zone. The total activity (excluding "Shelter" facility) is estimated at 230,000 curie ($8.5 \times 10^{15}$ Bq). The total amount of radioactive waste is estimated at 2.5 million m$^3$, of those during Chornobyl NPP decommissioning - 55,000 m$^3$.

### 5.4. NPPS Radioactive Waste Management

In general at WWER NPPs there are facilities for solid radioactive waste sorting, drying and pressing. However, integrated complexes which allow to prepare and dispatch solid radioactive waste to the specialized enterprises with the purpose of subsequent disposal have not been introduced.

Concentration by evaporation design facilities for liquid radioactive waste treatment are available at NPPs. Besides concentration by deep evaporation facilities which transform liquid waste into a fusion cake are being introduced in addition. In figure 6 Ukraine’s NPP intermediate-level and low-level solid and liquid waste storages infill status is shown.

High-level waste storages are filled on average not more than by 10% and are designed for the whole operational life of NPPs.

**Objectives of the industry NPP radioactive waste management system:**

- Radioactive waste collection;
- Radioactive waste sorting;
- Radioactive waste treatment (to the condition suitable for intermediate storage);
- Radioactive waste interim storage;
- Radioactive waste final treatment (to the condition suitable for transfer to the long-term storage/disposal specialized enterprise);
- Radioactive waste transfer to the long-term storage/disposal specialized enterprise.

Taking into account the existence of the Chornobyl Exclusion Zone, the land which is put out of economical activity for hundreds of years, the existence of decommissioning Chornobyl NPP infrastructure and Exclusion Zone Radioactive waste management enterprises in operation and under construction (Fig.8) the following variants of the industry NPP radioactive waste management system are being considered:

#### VARIANT 1

**NPP**

- Collection
- Sorting
- Treatment
- Interim storage

**Specialized Enterprise of the MES**

- Final treatment
- Disposal/long-term storage
FIG. 6 Solid and liquid waste storages infill status

VARIANT 2

NPP
- Collection
- Sorting
- Treatment
- Interim storage
- Final treatment

Specialized Enterprise of the MES
- Disposal/long-term storage

VARIANT 3

NPP
- Collection
- Sorting
- Treatment
- Interim storage
- Final treatment

Central Enterprise (on the basis of the Chornobyl NPP infrastructure)
- Final treatment (processing)
- Interim storage (if necessary)
Specialized Enterprise of the MES
- Disposal/long-term storage

Radioactive Waste Treatment (to the condition suitable for intermediate storage)

<table>
<thead>
<tr>
<th>SRAW</th>
<th>LRAW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drying</td>
<td>Concentration by evaporation</td>
</tr>
<tr>
<td>Prepressing</td>
<td>Concentration by deep evaporation</td>
</tr>
<tr>
<td>Burning</td>
<td>Rectification, burning of radioactive oil</td>
</tr>
<tr>
<td>Containerization</td>
<td>Drying of resins, sorbents</td>
</tr>
<tr>
<td>?????</td>
<td>Containerization</td>
</tr>
</tbody>
</table>

Radioactive Waste final treatment
(to the condition suitable for transfer for the long-term storage/disposal)

<table>
<thead>
<tr>
<th>SRAW</th>
<th>LRAW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superpressing</td>
<td>Vitrification</td>
</tr>
<tr>
<td>Burning</td>
<td>Cementing</td>
</tr>
<tr>
<td>Cementing</td>
<td>Burning of radioactive oil, resins, sorbents</td>
</tr>
<tr>
<td>Metallic radioactive wastes treatment (Fermentation, decontamination, remelting)</td>
<td>Containerization</td>
</tr>
<tr>
<td>Containerization</td>
<td>?????</td>
</tr>
</tbody>
</table>

That is why technical and economical studies are to be performed to identify the optimum alternative for the industry NPP radioactive waste management system creation and to define the structure of radioactive waste treatment complexes at NPPs as well as the structure of the Central enterprise if its creation will be considered expedient.

It is necessary to define the acceptance criteria for radioactive waste long-term storage/disposal.
At present the research is being performed and the technology is being developed in the area of the concentrated salt solution treatment after concentration by evaporation of liquid radioactive waste, the saline fusion cake, ion-exchange resins.

The technology developed by the research-and-production enterprise "Strum" is based on efficient methods of natural raw sorbents processing into dry grinded blends (with increased interaction chemical activity with regard to liquid radioactive waste) and, as a result, solid end product formation in normal conditions. In figure 7 the characteristics of the existing technologies and the results of solidified salt solution investigations according to the technology developed by the research-and-production enterprise "Strum" are presented. In the investigated solidified concentrated salt solution: salt content is 400-600 g/l, including borates 40 mass.%. At that, the end product amount increases up to two times and the leaching comes to $10^{-4} – 10^{-5}$ kg/m$^2$×day.

Advantages of the Technology:
- Low level of leaching;
- Cheap natural sorbents and additives are used;
- Solidification process is performed in normal conditions without additional energy consumption;
5.5. Ukraine’s Spent Fuel Reprocessing Radioactive Waste Management

According to the Contract on WWER-440 Spent Fuel (SF) reprocessing SF radioactive waste (SFRW) have to be returned to Ukraine. To resolve the problem of SFRW restitution a joint Russian – Ukrainian expert group was created which has to develop:
- Methods of accounting (calculation) of restituted WWER-440 SFRW (on the basis of the waste treatment technology selected by «MAYK» enterprise);
- The procedure of restitution of the vitrified radwaste generated during WWER-440 SF reprocessing;
- The requirements to the form of radioactive waste and transport packaging sets (packaging, physical form, radioactivity, etc.);
- The radioactive waste acceptance-transfer criteria;
- The requirements to ensure the safety of radioactive waste transportation.

The expert group also has to evaluate and analyze normative and legislative base in the area of SF management and radioactive waste treatment and prepare the recommendations on normative and legislative documents improvement.

5.6. Comprehensive radioactive wastes program

According to the comprehensive radioactive Wastes Program [3], adopted by the Cabinet of Ministers of Ukraine the centralized geological storage (repository) conception has to be created.

- Long-lived and high-level vitrified wastes which were generated during reprocessing of Ukrainian WWER spent FAs in Russian reprocessing plants;
- Long-lived and high-level wastes and fuel containing materials of the "Shelter" facility;
- Long-lived and high-level wastes arisen as the result of the Chornobyl accident and temporary localized in the Chornoby Exclusion Zone;
- Long-lived and high-level wastes generated as the result of Ukrainian NPP units decommissioning;
- Long-lived and high-level wastes which are being stored at specially equipped sites of the "Radon" enterprise;
- Long-lived wastes of the Ministry of Defence enterprises which are subject to long – term storage and/or ultimate disposal in deep geological formations.

FIG 8. Exclusion zone radioactive management facility (Under construction)

REFERENCES