

State Agency of Ukraine on Exclusion Zone Management
SAEZ of Ukraine

State Corporation "Ukrainian State Association "Radon"
SC "UkrSA "Radon"

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CHNPP EXCLUSION ZONE

**INDUSTRIAL COMPLEX FOR DECONTAMINATION, TRANSPORTATION,
REPROCESSING AND DISPOSAL OF RADIOACTIVE WASTE
(CODE NAME "VECTOR")**

CONSTRUCTION OF THE INTERIM STORAGE FACILITY FOR HIGH-LEVEL WASTE WHICH ARE TO BE RETURNED FROM THE RUSSIAN FEDERATION AFTER REPROCESSING OF SPENT NUCLEAR FUEL OF UKRAINIAN NPPS

**ENVIRONMENT IMPACT ASSESSMENT OF THE STORAGE FACILITY IN
A TRANSBOUNDARY CONTEXT**

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ABBREVIATIONS

SC “UkrSA “Radon” – State Corporation “Ukrainian State Association “Radon”

SE “STC KORO” – State Enterprise “Science and Technical Centre of Decontamination and Complex Management of Radioactive Waste, Materials and Ionizing Radiation Sources”

SSE “CEMRW” – State Specialized Enterprise “Central Enterprise for the Management of Radioactive Waste”

EZ – Exclusion Zone

PPE – personal protection equipment

EGC – engineering-geologic component

IC – Industrial Complex

CL – control level

LLW, ILW – low-, intermediate-level waste

NRBU – radiation standards of Ukraine

EDR – equivalent dose rate

NRF – nature reserve fund

RAW – radioactive waste

GWL – groundwater level

CA – control area

vit-HLW – vitrified high-level waste

VIT-HLW ISF – interim storage facility for vitrified HLW

1 DESCRIPTION OF THE INDUSTRIAL COMPLEX "VECTOR"

A place for construction of vit-HLW storage facility is selected to be at the site of the Industrial Complex for decontamination, transportation, processing and disposal of radioactive waste from areas contaminated by the Chernobyl accident (complex "Vector") in the Exclusion Zone (EZ), which is located in the north of Kiev region.

Regulation of all activities in the EZ is based on the Law of Ukraine "On legal regime of the territory, which is radioactively contaminated by the Chernobyl accident."

With respect to radioactive contamination, the site chosen on the edge of the western radioactive trace, directly at the 10-km zone of extensive radiological control.

In order to improve radiation safety and to prevent the contamination distribution, both on the territory of EZ and beyond its boundaries, EZ territory is divided into three radiation-regime zones:

The first zone (10 km zone) is the territory within a 10-km radius around the Chernobyl NPP. At this territory the radiation-hazardous work is carried out on the basis of programs agreed with the regulatory authorities, in compliance with current laws and regulations on radiation safety in Ukraine. In this area the strict radiation monitoring is constantly carried out.

The second zone (the buffer zone) is the territory lying from the border of 10 km zone to the outer boundary of the Exclusion Zone (other than Chernobyl). Works within this zone are carried out according to a month schedule. In this zone is under the constant radiation monitoring.

The third zone (residential) combines a part of Chernobyl territory, where hostels and administrative structures are placed together with the surrounding areas, catering and trade, socio-cultural, health-care organizations and access roads to them.

The administrative center of the EZ is Chernobyl, where the State Agency of Ukraine on the Exclusion Zone Management is located. It coordinates all activities and manages the business activities of enterprises and organizations located within the zone. Workers of the EZ are classified as "staff", categorized as A according to NRB-97.

The activities in the Chernobyl EZ are implemented in two directions - decommissioning the Chernobyl nuclear power plant and works aimed at minimization of the consequences of the Chernobyl accident.

In Chernobyl EZ there are several research organizations located that conduct a large-scale study on contamination around the NPP.

There are also enterprises in the EZ to provide medical, commercial, municipal and transport services, catering services, fire protection, life and leisure activities (sports halls, library, club).

The main regions that provide EZ with the personnel are adjacent territories to the borders of the Chernobyl zone.

As of January 1, 2007 in Chernobyl EZ (excluding NPP staff) 3180 people have been working. As of today the only workers of organizations and enterprises of EZ (working in shifts) as well as self-settlers live in Chernobyl. Under the status of EZ habitation of population is not provided for.

Agrotechnical activities aimed at the production of commercial products, also is not provided for within the territory of the EZ.

The basic principle that should be followed when working in the exclusion zone is to ensure radiation safety of the human being.

The construction of the Industrial Complex "Vector" (IC "Vector"), which is an integral part of the industrial complex for processing of solid radioactive waste, the "Comprehensive Program of Radioactive Waste Management", approved by the Cabinet of Ministers of Ukraine №2015 dated December 25, 2002 and conditioned by the need of transfer the RAW generated as a result of the accident, in an environmentally safe controlled condition.

In addition, the construction of the IC "Vector" is conditioned by the need to meet the challenges of transportation, receiving, processing to reduce the volumes of RAW and

disposal/storage of solid RAW by the only one enterprise and at one centralized location, equipped with the necessary engineering software in accordance with applicable regulations.

The area for IC "Vector" is selected according to the act of choosing a site for the construction of Industrial Complex "Vector" dated March 9, 1991.

The territory of the Industrial Complex "Vector" is located at a distance of 13-17 km from the nearest northern borders of the Republic of Belarus - Fig. 1.1.

At present, the equivalent dose rate (EDR) in the vicinity of the site IC "Vector" is determined by the content of ^{137}Cs . EDR ranges from 0.1 mSv/year to 3 mSv/year. At the site of IC "Vector" the area have been decontaminating earlier.

The construction of the complex began in 1998. In 1998, in order to reduce the cost of construction as part of the I stage of IC "Vector" the starting complex has been defined, which provided for commissioning of top-priority facilities that ensure technological cycle.

Disposal facilities of the Stage I of the complex provide for the disposal of solid inorganic and non-combustible RAW of low and intermediate level (group I and II), which contain radionuclides with a half life of less than 30 years.

Facilities of type I are designed for disposal of waste in concrete containers (4668 containers with a total volume of 9800 m³ of waste).

Facilities of type II are designed for disposal of RAW in bulk. Storage facility capacity - 8600 m³ of waste.

The first stage of the complex was put into operation in late 2007.

IC "Vector" is closely related to the implementation of the international project on the TACIS program, according to which at the site of IC "Vector" engineered near-surface disposal facility for solid radioactive waste (Lot 3, Industrial Complex for Solid Radioactive Waste Management) was built.

The design of the Stage II of the Complex necessitated to create the advanced nationwide industrial complex for receiving RAW of all categories for long-term storage and/or disposal before the start of large-scale works on:

- decontamination (remediation) of radiation-contaminated natural or man-made facilities of EZ;
- transformation of the "Shelter" into an ecologically safe system;
- decommissioning of Chernobyl NPP;
- reburial of RAW from TRWSF and RWDS;
- restructured MSC UkrSA "Radon".

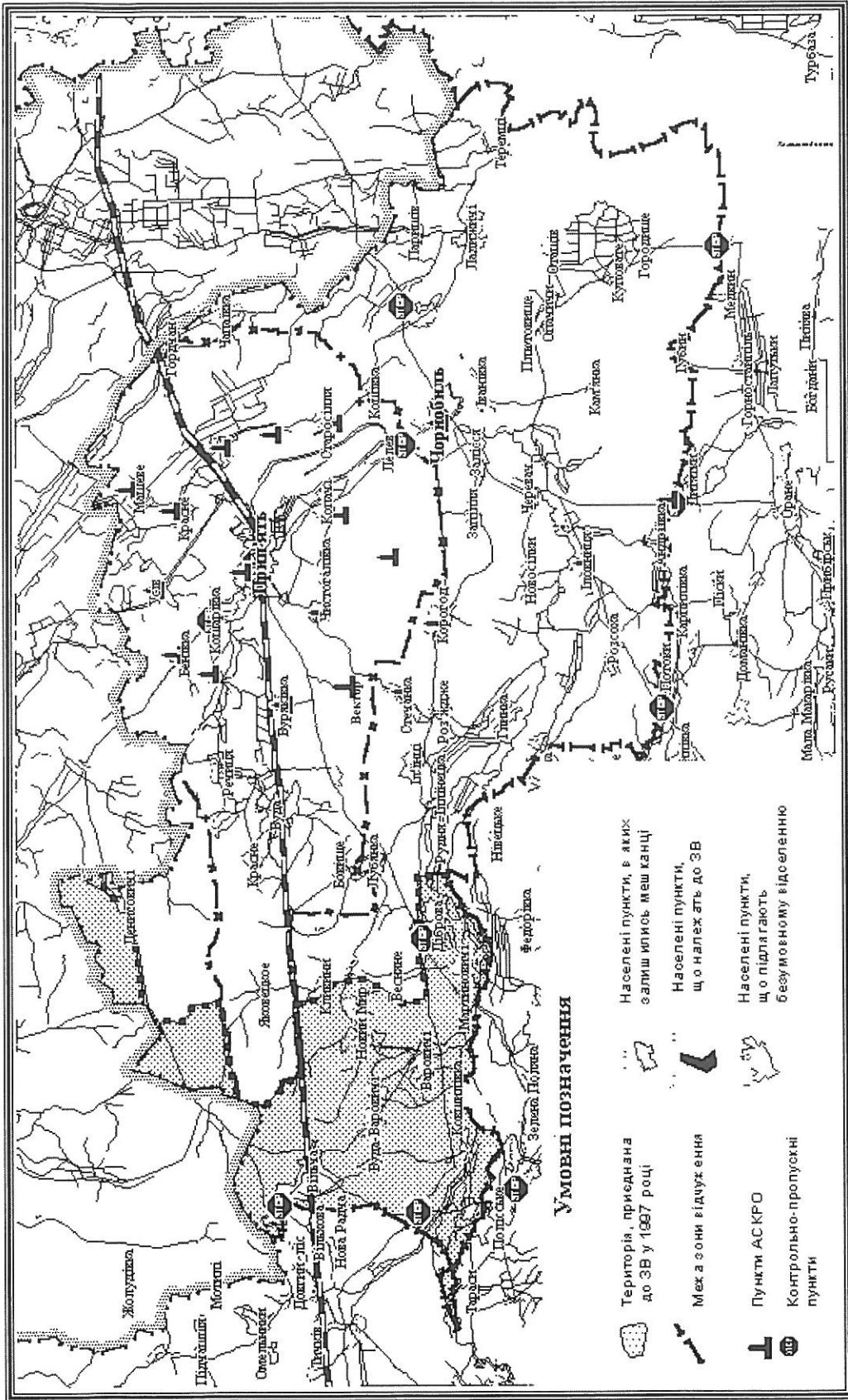


Fig. 1.1 – Administrative map of the Exclusion Zone and area of absolute (mandatory) resettlement (scale 1:440 000)

Feasibility Study of the Stage II of Industrial Complex "Vector" was developed by STC KORO (Zhovti Vody, Dnipropetrovsk region.) In accordance with the Resolution of the Cabinet of Ministers of Ukraine dated May 5, 1999 № 542 and the "Decision of the Scientific and Technical Council of the State Specialized Enterprise "Technocentre" dated December 26, 2000.

By the Resolution of the Cabinet of Ministers of Ukraine dated December 23, 2009 №1605-p-Feasibility Study of investment to the second stage of Industrial Complex "Vector" was approved.

Feasibility Study of Investment to the construction of the interim storage facility for HLW was performed in 2013 by SE "STC KORO" with the aim of construction of a repository for safe storage of the vit-HLW, generated as a result of reprocessing of spent nuclear fuel at the PA "Mayak", the Russian Federation.

The site for vit-HLW storage facility construction is located in the northern part of the IC "Vector" (Fig. 1.2).

In accordance with the current legislation of Ukraine a comprehensive state examination of the data of Feasibility Study of investment to the construction of interim storage facility for HLW was carried out, which includes, in particular, the state sanitary-epidemiological expertise, state nuclear and radiation safety and environmental impact assessment. All the examinations confirmed the desirability and feasibility of establishing a repository for intermediate storage of HLW, and showed that the basic design decisions can provide safety during the construction and operation of the repository (the report SE Ukrderzhbudekspertiza №00-1426-13/PB (00-0771-12/PB).

2 COMPLIANCE WITH THE REQUIREMENTS OF ANNEX II TO THE ESPOO CONVENTION AND EXISTING INFORMATION CONTAINED IN THE FEASIBILITY STUDY ON THE CONSTRUCTION OF INTERIM STORAGE FOR VITRIFIED HLW WHICH ARE TO BE RETURNED FROM RF

2.1 Description of planned activities and their objectives

According to the Law of Ukraine dated September 17, 2008 №516-VI on the "National Target Environmental Program of Radioactive Waste Management", it is planned further designing and construction of the Stage II of IC "Vector", including the design and construction of a repository for interim (100 years) storage of vitrified high-level waste vit-HLW, which are to be returned from the RF after reprocessing of spent nuclear fuel of Ukrainian nuclear power plants. The facility is to receive vit-HLW generated from processing of spent fuel reactors at PA "Mayak", the Russian Federation. After the end of the operation period of HLW repository the vitrified HLW should be transferred for disposal into the disposal facility specially engineered in stable geological formations.

Vitrified HLW are loaded into cans. Cans with vit-HLW are to be placed in a specially made steel cases with a diameter of 630 mm. The height of the case depending on the assembly can be 2300 mm (case for two cans) or 3400 mm (case for three cans). Cases are hermetically sealed. In fact, the heat generation of vit-HLW from VVER-440 reactors at the time of their return to Ukraine is less than 2 kW/m³. Containers for storage and transportation of vit-HLW from VVER-440 reactors are suitable for such heat generation and are cooling naturally by the air flow. The volume of the vit-HLW makes up 550 m³.

The matrix material is a glass melt (a mixture of oxides of the elements), the density - $(2650 \pm 50) \text{ kg/m}^3$. The maximum temperature in the center of the can, seasoned over 20 years of glass melt, is not more than 60°C.

2.2 Description of reasonable alternatives, including no-action alternative

Chernobyl Exclusion Zone for the construction of storage facilities for safe storage (vit-HLW) is selected based on the following factors:

- the site of IC "Vector" is placed on the boundary of the watershed of the river Pripjat and Uzh and has a deep groundwater occurrence;
- Chernobyl Exclusion Zone (its western part) has the necessary geological formations at its basis, in particular long-standing granitoids of Kirovograd-Zhitomir complex, which lies at a depth of 200,0-400,0m and can be used in case of the corresponding decision, to create a separate repository in deep geological formations (geological repository) and disposal of vit-HLW in it without reprocessing;
- population of the Exclusion Zone is resettled;
- nearby passes the railway Chernigov-Ovruch, Semihody station, Yanov station, crossroad Buryakovka. At a small distance there are located SSE "CHNPP" and Slavutych;
- the extensive road network is laid to the construction site, which is updated to a large degree;
- there is qualified staff and sufficient human resources in Slavutych, Chernihiv, Ivankiv, Kyiv, etc.

The site is located at the Pripjat and Uzh river interflaves, nearby the settlement Buryakovka, 11 kilometers south-west of ChNPP, 12 km north-west of the Chernobyl town, 53 km south-west of Slavutich town, and about 110 km north-west of Kiev. Distance from the Pripjat River is 8 km, from the Uzh river is 18 km.

In respect of physical geography, the district territory of the site is located in the south-western part of the East European Plain, in Polesie, which is adjacent to the west of the Dnieper lowland.

In the Exclusion Zone there are two towns (Chernobyl and Pripjat) and 74 rustic units.

The construction site for the interim storage facility for vitrified high-level waste is near RWDS "Buryakivka", in the north of the Kiev region within the borders of Kiev Polesie, in the northeastern part of the Kiev moraine outwash plain, which is part of the Polesie lowlands, directly into river Pripjat and Uzh interflaves at a distance of 10 km from the Pripjat river and 8-9 km from the Uzh river.

In October 2012, in accordance with the requirements of DBN A.2.1-1-2008 the control geological engineering survey was made and a report "On additional geological engineering survey 12-45" prepared.

In accordance with the requirements of DBN A.2.1-1-2008 (amendment Zh) the survey site refers to the category II according to the complexity of engineering-geological conditions.

Feasibility Study considers two options for the structural construction of storage facility modules:

- frame-type cells (option 1). For this option, the wall and the bottom of the module are made of reinforced concrete, and there is a frame made from stainless steel with the cells, construction is overlapped by monolithic slab with holes over the cells that are closed by "plugs";
- cells in the monolithic reinforced concrete mass (option 2). This reinforced concrete mass with the cells that are closed by "plugs".

According to the analysis results of the proposed structural configuration of storage facility modules as for nuclear and radiation safety, reliability, durability and effectiveness of investments into the project of construction of vit-HLW storage facility the Employer have been selected the frame-type cells option, where the walls and the bottom of the module are made of

reinforced concrete, with placement of the frame stainless steel cells inside and overlapping of the building by monolithic slab with holes over the cells that are closed by "plugs".

Thereafter, two options of ventilation were considered: natural and mechanical.

The selected option of storage facility is designed for storage of 1008 cases, which are placed in 8 sections, 126 cases in each one, and which ensure the acceptance for storage of about 550.0 m³ of vit-HLW. In addition, the Feasibility Study provides for reserve areas that allow further acceptance up to 160.0 m³ vit-HLW.

Vit-HLW storage facility is a one-storey building with planed dimensions 222.0x36.0 m. The height to the bottom of roof trusses is 21.5 m. Built-up area - 8064.0 m³.

Foundations are the reinforced concrete columnar.

The frame is made of metal structures. Resistance of the facility enables communication through the columns and trusses. Covering - metal sandwich panels with metal girders laid through the steel trusses. Roof is gable with built outside gutter and electrical curing. Protection of steel structures against corrosion is provided with enamel paint twice under the layer of primer; metal bearing elements (columns, trusses, communication) covered with flame-resistant paint.

Storage facility consists of 2 separate modules with dimensions 50.20x27.80 m, 4 storage section for each, dimensions 12,00x27,80m, number of cells - 126 pieces in each section. Cell diameter is 850 mm, the distance between the centers of the cells is 1.4 m. Each section has a slot for loading the cases, which are closed by "plugs" of reinforced concrete. Cooling of cases installed in the cells is carried out by air, which flows between the cases.

The site for reloading of the cases with vit-HLW is arranged between module 1 and 2.

Explosion and flame category - "D".

The walls of the storage facility are made of sandwich panels, the cladding panels layer - enamel paint. The building is equipped with bridge cranes that are of 60 and 120 tons.

Floor is concrete and impregnated, linoleum and ceramic, depending on the functional purpose. Interior finish – plastering of brick walls, followed by painting of walls and ceiling with the oil paint.

"Hot" cell is made of reinforced concrete, with a wall thickness of 1100 mm.

Vit-HLW storage facility provides for areas of receiving, unloading, handling and decontamination of transport and packaging set (TUK), locks, line for loading of cases ("hot" cell), a area for reloading of cases of vit-HLW, reserve area and access crane platform. The layout of the facility provides for access for equipment maintenance personnel, convenience and mechanization of repair work, compliance with the rules of fire and radiation protection, labour protection.

Feasibility Study provides for the construction of new facilities: Check point, railway track for transportation of transport and packaging set, ventilation systems, substation with two transformers, concrete and mesh fence, site for car inspection, car roads.

To ensure the operation of the proposed vit-HLW storage facility Feasibility Study provides for the use of the existing infrastructure of Stage I of the IC "Vector", and engineering networks and communication systems, radiation monitoring and environmental monitoring systems.

Vit-HLW delivery is planned to be executed by railway transport. For transportation of vit-HLW around territory of the IC "Vector" the construction of the approach roads, adjacent to existing roads is considered.

In designing of structural elements of the storage facility to ensure safe interim storage of cases there are developed schemes of transportation and delivery process of vit-HLW, technology of work and methods of case storage, arrangement of the ventilation system inside the storage facility, engineered barriers and staff radiation safety system.

Systems for monitoring and process control ensures maximum centralization of remote control of technology operations and equipment support systems.

Automated systems and communication is integrated into similar systems of IC "Vector".

2.3 Description of the environment elements which are likely to be significantly affected by the planned activity and its alternatives

Deleterious effect on the environment (groundwater, air, soil, plants, animals) is excluded. Planned activities will not blight the environment.

During normal operation, at all stages of the process vit-HLW management direct contact of personnel with radioactive substances is practically eliminated, as well as adverse effect on the environment.

2.4 Description of the types of possible environmental impact of the planned activity and its alternatives and an assessment of the extent of influence

As a part of the Feasibility Study of construction a preliminary assessment of the impact on staff, public and environment was conducted. The assessment shows compliance with the applicable law.

Radiation exposure during the construction of the storage facility (the formation of radioactive dust) is not essential, since the construction is carried out at the decontaminated territory.

During operation of vit-HLW storage facility it was considered only radiation influence (external radiation) associated with the accumulation of radioactive waste.

Calculations of protective shields show that the thickness of the concrete of 110 cm will provide non-exceeding of annual dose for the staff. Calculated near-surface concentrations of pollutants in the air at the boundaries of residential buildings (at a distance of 20 km from the IC "Vector") do not exceed 0.00001 shares of MPC during the transfer of steel cases of HLW into the case made of stainless steel and welding to cover it in a "hot" cell. The risk of non-carcinogenic effects is of $4,5 \cdot 10^{-7}$. Carcinogenic risk of the combined action amounts to $7 \cdot 10^{-12}$, and is classified as an acceptable level. Social risk of proposed works for a group of people who live on the border of the 30-km zone, amounts to $5 \cdot 10^{-8}$ and is classified as an acceptable level of social risk.

During operation of the vit-HLW storage facility the emission of harmful substances into the environment is not provided for. It is provided for post-treatment of sewage and rainwater in accordance with the existing collection system at the site of the IC "Vector".

The condition of the hydrosphere is controlled through monitoring of wastewater and groundwater. Sewage and rain water according to the existing collection system and wastewater at the site of IC "Vector" after cleaning is offered to throw into the river Maryanovka. The place of collection of the treated wastewater is defined in the Deed of siting of IC "Vector" dated March 15, 1994, with the participation of representatives from the Ministry of Health of Ukraine. This decision is agreed with sanitary-and-epidemiologic institution of the Exclusion Zone (decision #26 dated January 31, 1994). Post-treated wastewater is dumped into the river Maryanovka with indicators of suspended solids not greater than 15 mg/l, BOD - no more than 15.0 mg/l COD - no more than 80 mg/l, which meets the requirements for the composition of the water of a water body (Maryanovka) used for fishery purposes - in accordance with the 'protection of surface waters from sewage pollution. "The project is not provided for release of radioactive substances into the environment.

Planned work does not provide for the release of radioactive substances into the environment. For the monitoring of the airspace condition the continuous monitoring of emissions from the ventilation system of storage facility is planned.

Formation of secondary radioactive emissions is of low-probability. Secondary waste with high radioactivity can be represented by:

- personal protective equipment, which are not subject to decontamination;
- rags and other cleaning materials;

- tools and equipment which are not subject to decontamination.

Secondary RW stacked in the container KT-02 for temporary storage prior to disposal in storage SRW-1 and SRW-2 Stage I of the IC "Vector".

Residual impact on the environment during the construction and operation of the vit-HLW storage facility is not envisaged. During construction there is no harm to the environment, therefore special rehabilitation measures for the normalization of the components of the environment and of compensatory measures for the improvement of the equivalent natural and social environment in the Feasibility Study is not provided for.

Influence of the proposed facility in the region can be characterized so that is not a threat of environmental pollution and public exposure from areas adjacent to the EZ.

2.5 Description of preventive measures aimed to minimization of the harmful effects of environment

The main technical measures to ensure radiation safety in handling the vit-HLW are measures aimed at protecting the environment and personnel:

- multi-level principle of physical protection and access;
- the use of special technical means to ensure the non-distribution of radionuclides from "hot" cell; sealed containers for vit-HLW management;
- works on decontamination of equipment, facilities and clothing;
- continuous radiation monitoring;
- arrangement of alarm system and communication.

According to the presented technology, the impact of radioactive substances on the air environment during the operation of vit-HLW storage facility is not expected because

- transportation, reloading and storage of the vit-HLW is carried out in sealed cases (double protection)
- reloading of the case with vit-HLW into a protective case made from stainless steel is carried out in a "hot" cell the design of which is intended to eliminate the dispersion of radionuclides;
- ventilation and air purification system using filters eliminates the emission of harmful substances during the welding of stainless steel in a "hot" cell

2.6 The specific value of forecasting events and assumptions that are based on them, as well as, respective data on the environment, which are implemented

Analysis of the possibility of occurrence and prognosis of emergencies during the operation shows that the planned operation can not cause any significant impact on the environment. Planned work does not provide for a release of radioactive substances into the environment. For the monitoring of the airspace condition the continuous monitoring of emissions from the ventilation system of storage facility.

2.7 Description of the gaps in knowledge and uncertainties that have been identified in the preparation of the necessary information

Storage facility for long-term storage is intended for long-term safe isolation of vit-HLW (a period of not less than 100 years).

Due to the lack of initial data on the processing of spent nuclear fuel of reactors VVER-1000, the storage facility is designed only for the vit-HLW from reactors VVER-440. The facility is to receive vit-HLW, generated as a result of reprocessing spent nuclear fuel from reactors VVER-440 of Ukrainian NPPs at PA "Mayak" (the Russian Federation).

Forecasting the impact at the stage of Feasibility Study is facing with the uncertainty of possible technical solutions, which will be developed on the project stage. The problem is amplified by the fact that there is no examined analogue activity in domestic practice. All projected levels of exposure are identified by computational methods without the use of test data and measurements made by accredited laboratories at analogue facilities.

The second source of uncertainty is the restriction of the modeling results (simulation of pollutant dispersion) for accurate prognostication of the magnitude and distribution of influence. The uncertainty is associated with the conditions of the initial design stage, when there is no design decisions necessary for accurate calculations.

In order to reduce these uncertainties, the evaluation of the planned activities is usually was carried out for the cases of the maximum possible impact. Thus, in the EIA a conservative approach was approved to determine the importance of the influence. The EIA procedure will be continued in the next design stages. It should be expected that the majority of the EIA projected estimates are to be specified and adjusted to the specifics of design and technical solutions and the results of engineering and environmental studies.

2.8 Summary of the monitoring and management programs, all plans for post-project analysis

Storage facility will be fully released from the vit-HLW a maximum in a 100 years. After the end of operation term of the repository vit-HLW should be transferred for disposal to the disposal facility equipped in a stable geological formations.

After that it is considered to be the demolition of the building and dismantling of the equipment. After expert review the structures of the building and equipment, can be possibly used for other purposes later. It is envisaged that the building and equipment will have no radioactive contamination after the operation, since the Feasibility study provides for as follows:

- handling of the vit-HLW at the storage facility in a hermetically sealed equipment;
- radiation monitoring of radioactive contamination of premises and equipment;
- decontamination of surfaces of work places, tools and equipment.

Vit-HLW storage facility is located at the site of the Industrial Complex "Vector", which has the infrastructure.

Environmental monitoring during operation of the storage facility should be included into the monitoring program for the IC "Vector".

The operator of the designed vit-HLW storage facility is State Specialized Enterprise "Central Enterprise for the Management of Radioactive Waste" (SSE "CEMRW").

The organization will provide

- safe operation in accordance with applicable regulations of Ukraine and legislative documents;
- appropriate management structure;
- non-exceeding of permissible and proposed levels of radioecological impact on the environment.

In case of violation of conditions of normal operation SSE "CEMRW" is fully responsible for the consequences.

Non-technical summary - see. Annex 2.

Notification on the design and construction of interim storage facility for vitrified high-level waste (vit-HLW), which are to be returned from the Russian Federation

Assessment of the factors that are relevant to the site and may affect the safety of the storage facility during its lifetime

According to the "National Target Environmental Program of Radioactive Waste Management", approved by the Supreme Council of Ukraine dated September 17, 2008 №516-VI, the subsequent design and construction of Stage II of the industrial complex "Vector" is provided for, including the design and construction of interim storage for facility vitrified high-level waste (vit-HLW) that are to be returned from the Russian Federation after the reprocessing of spent nuclear fuel of Ukrainian nuclear power plants. At the end of the life of the vit-HLW storage facility the vitrified HLW should be transferred for disposal into disposal facility equipped in a stable geological formations.

Vitrified HLW (vit-HLW) and part of the ILW by 20-40% are subject to returning.

Vitrified HLW are loaded into cans. Cans with vit-HLW are to be placed in a specially made steel cases with a diameter of 630 mm. The height of the case depending on the assembly can be 2300 mm (case for two cans) or 3400 mm (case for three cans). Cases are hermetically sealed. In fact, the heat generation of vit-HLW from VVER-440 reactors at the time of their return to Ukraine is less than 2 kW/m³. Containers for storage and transportation of vit-HLW from VVER-440 reactors are suitable for such heat generation and are cooling naturally by the air flow. The volume of the vit-HLW makes up 550 m³.

The matrix material is a glass melt (a mixture of oxides of the elements), the density - (2650 ± 50) kg/m³.

The maximum temperature in the center of the can, seasoned over 20 years of glass melt, is not more than 60°C.

Development of Feasibility Study (FS) of investment to the construction of interim storage facility for HLW is performed in order to build a repository for safe and secure storage.

FS identified that the best place for location of storage facility is at the site of the Chernobyl Exclusion Zone.

The site is located in 30-km Exclusion Zone and directly at the 10-km zone of enhanced radiological control.

Chernobyl Exclusion Zone for the construction of storage facilities for safe interim storage of vitrified high-level radioactive waste (vit-HLW) is chosen based on the following factors:

- the site of IC "Vector" is placed on the boundary of the watershed of the river Pripjat and Uzh and has a deep groundwater occurrence;
- Chernobyl Exclusion Zone (its western part) has the necessary geological formations at its basis, in particular long-standing granitoids of Kirovograd-Zhitomir complex, which lies at a depth of 200,0-400,0m and can be used in case of the corresponding decision, to create a separate repository in deep geological formations (geological repository) and disposal of vit-HLW in it without reprocessing;
- population of the Exclusion Zone is resettled;
- nearby passes the railway Chernigov-Ovruch, Semihody station, Yanov station, crossroad Buryakovka. At a small distance there are located SSE "CHNPP" and Slavutych;
- the extensive road network is laid to the construction site, which is updated to a large degree;
- there is qualified staff and sufficient human resources in Slavutych, Chernihiv, Ivankiv, Kyiv, etc.

The site is located at about 110 km north-west of Kiev, 11 kilometers south-west of ChNPP and 12 km north-west of the Chernobyl town.

The construction site for the interim storage facility for vitrified high-level waste is near RWDS "Buryakivka", in the north of the Kiev region within the borders of Kiev Polesie, in the northeastern part of the Kiev moraine outwash plain, which is part of the Polesie lowlands, directly into river Pripyat and Uzh interfluves at a distance of 10 km from the Pripyat river and 8-9 km from the Uzh river.

Up to the depth of 73.50m the geological structure has soils of the Eocene epoch of the upper Paleogene (sands of Buchaks and Kanev suite and chalky clay of Kiev suite), which are overlapped by the Quaternary system deposits. Quaternary blankets are represented by lower- and mid-Quaternary alluvial and fluvioglacial deposits, mid-Quaternary fluvioglacial and moraine deposits. In respect of lithology these are the sands mainly of a small and medium grain with lenses and layers sandy loam and pulverescent sands.

In October 2012, in accordance with the requirements of DBN A.2.1-1-2008 the control geological engineering survey was made by the private enterprise "Engineering and technical firm AIF" and a report "On additional geological engineering survey 12-45" was prepared.

In accordance with the requirements of DBN A.2.1-1-2008 (amendment Zh) the survey site refers to the category II according to the complexity of engineering-geological conditions.

Construction area is located in the building and climate zone II (DSTU-NB V.1.1-27: 2010). The climate of the area - temperate continental, formed under the influence of the western and eastern offshore continental climatic factors, has the following characteristic values:

- The weight of snow cover - 1800 Pa.
- The wind pressure - 450 Pa.
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Seismically site is in zone of 6-point activity at 1% of probability. The soil seismic properties relate to category II (DBN V. Table 1.1.-12-2006. 1.1 Annex A, B)

Description of the proposed facility

Feasibility Study considers two options for the structural construction of storage facility modules:

- frame-type cells (option 1). For this option, the wall and the bottom of the module are made of reinforced concrete, and there is a frame made from stainless steel with the cells, construction is overlapped by monolithic slab with holes over the cells that are closed by "plugs";
- cells in the monolithic reinforced concrete mass (option 2). This reinforced concrete mass with the cells that are closed by "plugs".

Thereafter, two options of ventilation were considered: natural and mechanical.

According to the analysis results of the proposed structural configuration of storage facility modules as for nuclear and radiation safety, reliability, durability and effectiveness of investments into the project of construction of vit-HLW storage facility the Employer have been selected the frame-type cells option, where the walls and the bottom of the module are made of reinforced concrete, with placement of the frame stainless steel cells inside and overlapping of the building by monolithic slab with holes over the cells that are closed by "plugs".

The selected option of storage facility is designed for storage of 1008 cases, which are placed in 8 sections, 126 cases in each one, and which ensure the acceptance for storage of about 550.0 m³ of vit-HLW. In addition, the Feasibility Study provides for reserve areas that allow further acceptance up to 160.0 m³ of vit-HLW.

Vit-HLW storage facility is a one-storey building with planed dimensions 222.0x36.0 m. The height to the bottom of roof trusses is 21.5 m. Built-up area - 8064.0 m³.

Foundations are the reinforced concrete columnar.

The frame is made of metal structures. Resistance of the facility enables communication through the columns and trusses. Covering - metal sandwich panels with metal girders laid

through the steel trusses. Roof is gable with built outside gutter and electrical curing. Protection of steel structures against corrosion is provided with enamel paint twice under the layer of primer; metal bearing elements (columns, trusses, communication) covered with flame-resistant paint.

Storage facility consists of 2 separate modules with dimensions 50.20x27.80 m, 4 storage section for each, dimensions 12,00x27,80m, number of cells - 126 pieces in each section. Cell diameter is 850 mm, the distance between the centers of the cells is 1.4 m. Each section has a slot for loading the cases, which are closed by "plugs" of reinforced concrete.

Cooling of cases installed in the cells is carried out by air, which flows between the cases. The area for reloading of the cases of vit-HLW is arranged between module 1 and 2.

Explosion and flame category - "D".

The walls of the storage facility are made of sandwich panels, the cladding panels layer - enamel paint. The building is equipped with bridge cranes that are of 60 and 120 tons.

Floor is concrete and impregnated, linoleum and ceramic, depending on the functional purpose. Interior finish – plastering of brick walls, followed by painting of walls and ceiling with the oil paint.

"Hot" cell is made of reinforced concrete, with a wall thickness of 1100 mm.

Vit-HLW storage facility provides for areas of receiving, unloading, handling and decontamination of transport and packaging set (TUK), locks, line for loading of cases ("hot" cell), a area for reloading of cases of vit-HLW, reserve area and access crane platform. The layout of the facility provides for access for equipment maintenance personnel, convenience and mechanization of repair work, compliance with the rules of fire and radiation protection, labour protection.

Feasibility Study provides for the construction of new facilities: Check point, railway track for transportation of transport and packaging set, ventilation systems, substation with two transformers, concrete and mesh fence, site for car inspection, car roads.

To ensure the operation of the proposed vit-HLW storage facility Feasibility Study provides for the use of the existing infrastructure of Stage I of the IC "Vector", and engineering networks and communication systems, radiation monitoring and environmental monitoring systems.

Vit-HLW delivery is planned to be executed by railway transport. For transportation of vit-HLW around territory of the IC "Vector" the construction of the approach roads, adjacent to existing roads is considered.

In designing of structural elements of the storage facility to ensure safe interim storage of cases there are developed schemes of transportation and delivery process of vit-HLW, technology of work and methods of case storage, arrangement of the ventilation system inside the storage facility, engineered barriers and staff radiation safety system.

Systems for monitoring and process control ensures maximum centralization of remote control of technology operations and equipment support systems.

Automated systems and communication is integrated into similar systems of IC "Vector".

Environmental Impact and the expected impact during the operation of the proposed facility under normal and emergency conditions

As a part of the Feasibility Study of construction a preliminary assessment of the impact on staff, public and environment was conducted. The assessment shows compliance with the applicable law.

Radiation exposure during the construction of the storage facility (the formation of radioactive dust) is not essential, since the construction is carried out at the decontaminated territory.

During operation of vit-HLW storage facility it was considered only radiation influence (external radiation) associated with the accumulation of radioactive waste. Calculations of

protective shields show that the thickness of the concrete of 110 cm will provide non-exceeding of annual dose for the staff.

Calculated near-surface concentrations of pollutants in the air at the boundaries of residential buildings (at a distance of 20 km from the IC "Vector") do not exceed 0.0000001 shares of MPC during the transfer of steel cases of HLW into the case made of stainless steel and welding to cover it in a "hot" cell. The risk of non-carcinogenic effects is of $4,5 \cdot 10^{-7}$. Carcinogenic risk of the combined action amounts to $7 \cdot 10^{-12}$, and is classified as an acceptable level. Social risk of proposed works for a group of people who live on the border of the 30-km zone, amounts to $5 \cdot 10^{-8}$ and is classified as an acceptable level of social risk.

Analysis of the possibility of occurrence and prognosis of emergencies during the operation shows that the planned operation can not cause any significant impact on the environment.

In accordance with the current legislation of Ukraine a comprehensive state examination of the data of Feasibility Study of investment to the construction of interim storage facility for HLW was carried out, which includes, in particular, the state sanitary-epidemiological expertise, state nuclear and radiation safety and environmental impact assessment.

All the examinations confirmed the desirability and feasibility of establishing a repository for intermediate storage of HLW, and showed that the basic design decisions can provide safety during the construction and operation of the storage facility.

List of planned activities that ensure operation of the proposed facility in accordance with environmental regulations

To protect the environment during temporary storage of the vit-HLW there are the following basic activities provided for:

- arrangement of technological process with the use of special technical means in case of reloading and location of vit-HLW for storage;
- engineered barriers system during the storage;
- ventilation system with constant control of emissions;
- Radiation monitoring of the situation in the vit-HLW storage facility and environmental elements outside of the repository.

During normal operation, at all stages of the process vit-HLW management direct contact of personnel with radioactive substances is practically eliminated, as well as adverse effect on the environment

During operation of the vit-HLW storage facility the emission of harmful substances into the environment is not provided for. The condition of the hydrosphere is controlled through monitoring of wastewater and groundwater.

Planned work does not provide for the release of radioactive substances into the environment. For the monitoring of the airspace condition the continuous monitoring of emissions from the ventilation system of storage facility is planned.

Residual impact on the environment during the construction and operation of the vit-HLW storage facility is not envisaged. During construction there is no harm to the environment, therefore special rehabilitation measures for the normalization of the components of the environment and of compensatory measures for the improvement of the equivalent natural and social environment in the Feasibility Study is not provided for.

Obligations of the operator (employer) to ensure the operation of the vit-HLW storage facility in accordance with the environmental requirements

The operator of the designed vit-HLW storage facility is State Specialized Enterprise "Central Enterprise for the Management of Radioactive Waste" (SSE "CEMRW").

The organization will provide: safe operation in accordance with applicable regulations of Ukraine and legislative documents; appropriate management structure; non-exceeding of permissible and proposed levels of radioecological impact on the environment. In case of violation of conditions of normal operation SSE "CEMRW" is fully responsible for the consequences.

Comments and propositions should be sent within 30 days after receipt of the notice to the State specialized enterprise "Central Enterprise for the Management of Radioactive Waste" (SSE "CEMRW") to the following address: 07270 Chernobyl Ukraine, 52 Kirova str., E-mail: cembrw@ukr.net

SC "UkrSA "Radon" General Director –
SSE "CEMRW" Director

V. Melnychenko

General designer:
SE "STC KORO" Director

A. Panchenko

NON-TECHNICAL SUMMARY OF THE DESIGN AND CONSTRUCTION OF INTERIM STORAGE FACILITY FOR VITRIFIED HIGH-LEVEL WASTE (VIT-HLW), WHICH ARE TO BE RETURNED FROM THE RUSSIAN FEDERATION

Brief description of the planned activities (facility)

According to the "National Target Environmental Program of Radioactive Waste Management", approved by the Supreme Council of Ukraine dated September 17, 2008 №516-VI, the subsequent design and construction of Stage II of the industrial complex "Vector" is provided for, including the design and construction of interim storage for facility vitrified high-level waste (vit-HLW) that are to be returned from the Russian Federation after the reprocessing of spent nuclear fuel of Ukrainian nuclear power plants. At the end of the life of the vit-HLW storage facility the vitrified HLW should be transferred for disposal into disposal facility equipped in a stable geological formations.

Vitrified HLW (vit-HLW) and part of the ILW by 20-40% are subject to returning.

Vit-HLW storage facility is a near-surface building, which is designed for safe storage of vitrified high-level waste during the whole period of storage having relevant protective barriers, power supply, water supply, sanitation, ventilation, video surveillance, air purification and radiation monitoring

Vitrified HLW are loaded into cans. Cans with vit-HLW are to be placed in a specially made steel cases with a diameter of 630 mm. The height of the case depending on the assembly can be 2300 mm (case for two cans) or 3400 mm (case for three cans). Cases are hermetically sealed. In fact, the heat generation of vit-HLW from VVER-440 reactors at the time of their return to Ukraine is less than 2 kW/m³. Containers for storage and transportation of vit-HLW from VVER-440 reactors are suitable for such heat generation and are cooling naturally by the air flow. The volume of the vit-HLW makes up 550 m³.

The matrix material is a glass melt (a mixture of oxides of the elements), the density - (2650 ± 50) kg/m³.

The maximum temperature in the center of the can, seasoned over 20 years of glass melt, is not more than 60°C.

Development of Feasibility Study (FS) of investment to the construction of interim storage facility for HLW is performed in order to build a repository for safe and secure storage.

Alternatives to technological solutions and location of the planned activities (facility)

FS justifies that the best place for location of storage facility is at the site of the Chernobyl Exclusion Zone.

The site is located in 30-km Exclusion Zone and directly at the 10-km zone of enhanced radiological control.

Chernobyl Exclusion Zone for the construction of storage facilities for safe interim storage of vitrified high-level radioactive waste (vit-HLW) is chosen based on the following factors:

- the site of IC "Vector" is placed on the boundary of the watershed of the river Pripyat and Uzh and has a deep groundwater occurrence;
- Chernobyl Exclusion Zone (its western part) has the necessary geological formations at its basis, in particular long-standing granitoids of Kirovograd-Zhitomir complex, which lies at a depth of 200,0-400,0m and can be used in case of the corresponding decision, to create a separate repository in deep geological formations (geological repository) and disposal of vit-HLW in it without reprocessing;
- population of the Exclusion Zone is resettled;

- nearby passes the railway Chernigov-Ovruch, Semihody station, Yanov station, crossroad Buryakovka. At a small distance there are located SSE "CHNPP" and Slavutyeh;
- the extensive road network is laid to the construction site, which is updated to a large degree;
- there is qualified staff and sufficient human resources in Slavutyeh, Chernihiv, Ivankiv, Kyiv, etc.

The site is located at about 110 km north-west of Kiev, 11 kilometers south-west of ChNPP and 12 km north-west of the Chernobyl town.

FS considers two options for the structural construction of storage facility modules:

- frame-type cells (option 1). For this option, the wall and the bottom of the module are made of reinforced concrete, and there is a frame made from stainless steel with the cells, construction is overlapped by monolithic slab with holes over the cells that are closed by "plugs";
- cells in the monolithic reinforced concrete mass (option 2). This reinforced concrete mass with the cells that are closed by "plugs".

Thereafter, two options of ventilation were considered: natural and mechanical.

According to the analysis results of the proposed structural configuration of storage facility modules as for nuclear and radiation safety, reliability, durability and effectiveness of investments into the project of construction of vit-HLW storage facility the Employer have been selected the frame-type cells option, where the walls and the bottom of the module are made of reinforced concrete, with placement of the frame stainless steel cells inside and overlapping of the building by monolithic slab with holes over the cells that are closed by "plugs".

The selected option of storage facility is designed for storage of 1008 cases, which are placed in 8 sections, 126 cases in each one, and which ensure the acceptance for storage of about 550.0 m³ of vit-HLW. In addition, the Feasibility Study provides for reserve areas that allow further acceptance up to 160.0 m³ of vit-HLW.

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Vit-HLW storage facility is a one-storey building with planed dimensions 222.0x36.0 m. The height to the bottom of roof trusses is 21.5 m. Built-up area - 8064.0 m³.

Foundations are the reinforced concrete columnar.

The frame is made of metal structures. Resistance of the facility enables communication through the columns and trusses. Covering - metal sandwich panels with metal girders laid through the steel trusses. Roof is gable with built outside gutter and electrical curing. Protection of steel structures against corrosion is provided with enamel paint twice under the layer of primer; metal bearing elements (columns, trusses, communication) covered with flame-resistant paint.

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The site for reloading of the cases with vit-HLW is arranged between module 1 and 2.

Explosion and flame category - "D".

The walls of the storage facility are made of sandwich panels, the cladding panels layer - enamel paint. The building is equipped with bridge cranes that are of 60 and 120 tons.

Floor is concrete and impregnated, linoleum and ceramic, depending on the functional purpose. Interior finish – plastering of brick walls, followed by painting of walls and ceiling with the oil paint.

"Hot" cell is made of reinforced concrete, with a wall thickness of 1100 mm. Vit-HLW storage facility provides for areas of receiving, unloading, handling and decontamination of transport and packaging set (TUK), locks, line for loading of cases ("hot" cell), a area for reloading of cases of vit-HLW, reserve area and access crane platform. The layout of the facility provides for access for equipment maintenance personnel, convenience and mechanization of repair work, compliance with the rules of fire and radiation protection, labor protection.

Feasibility Study provides for the construction of new facilities: Check point, railway track for transportation of transport and packaging set, ventilation systems, substation with two transformers, concrete and mesh fence, site for car inspection, car roads.

To ensure the operation of the proposed vit-HLW storage facility Feasibility Study provides for the use of the existing infrastructure of Stage I of the IC "Vector", and engineering networks and communication systems, radiation monitoring and environmental monitoring systems.

Vit-HLW delivery is planned to be executed by railway transport. For transportation of vit-HLW around territory of the IC "Vector" the construction of the approach roads, adjacent to existing roads is considered.

In designing of structural elements of the storage facility to ensure safe interim storage of cases there are developed schemes of transportation and delivery process of vit-HLW, technology of work and methods of case storage, arrangement of the ventilation system inside the storage facility, engineered barriers and staff radiation safety system.

Systems for monitoring and process control ensures maximum centralization of remote control of technology operations and equipment support systems.

Automated systems and communication is integrated into similar systems of IC "Vector".

Assessment of the current conditions of the environment in the region of the planned activity

The construction site for the interim storage facility for vitrified high-level waste is near RWDS "Buryakivka", in the north of the Kiev region within the borders of Kiev Polesie, in the northeastern part of the Kiev moraine outwash plain, which is part of the Polesie lowlands, directly into river Pripyat and Uzh interfluves at a distance of 10 km from the Pripyat river and 8-9 km from the Uzh river.

Up to the depth of 73.50m the geological structure has soils of the Eocene epoch of the upper Paleogene (sands of Buchaks and Kanev suite and chalky clay of Kiev suite), which are overlapped by the Quaternary system deposits. Quaternary blankets are represented by lower- and mid-Quaternary alluvial and fluvioglacial deposits, mid-Quaternary fluvioglacial and moraine deposits. In respect of lithology these are the sands mainly of a small and medium grain with lenses and layers sandy loam and pulverescent sands.

In October 2012, in accordance with the requirements of DBN A.2.1-1-2008 the control geological engineering survey was made by the private enterprise "Engineering and technical firm AIF" and a report "On additional geological engineering survey 12-45" was prepared.

In accordance with the requirements of DBN A.2.1-1-2008 (amendment Zh) the survey site refers to the category II according to the complexity of engineering-geological conditions.

Construction area is located in the building and climate zone II (DSTU-NB V.1.1-27: 2010). The climate of the area - temperate continental, formed under the influence of the western and eastern offshore continental climatic factors, has the following characteristic values:

- The weight of snow cover - 1800 Pa.
- The wind pressure - 450 Pa.

- The maximum depth of seasonal soil freezing 120.0 cm.

Seismically site is in zone of 6-point activity at 1% of probability. The soil seismic properties relate to category II (DBN V. Table 1.1.-12-2006. 1.1 Annex A, B)

With respect to radioactive contamination, the site chosen on the edge of the western radioactive trace.

At present, the equivalent dose rate (EDR) in the vicinity of the site IC "Vector" is determined by the content of ^{137}Cs . EDR ranges from 0.1 mSv/year to 3 mSv/year. At the site of IC "Vector" the area have been decontaminating earlier. The average levels of air pollution is much less than allowable concentrations. Recently, due to the overall stabilization of the radiation situation in the Chernobyl Exclusion Zone, a narrow range of concentrations of radionuclides in the near-surface air was established.

Improvement of the environment is mainly due to the ongoing process of fixing of radioactive aerosols in the ground surface.

The site for vit-HLW storage facility construction is located in the northern part of the IC "Vector".

Environmental Impact and the expected impact during the operation of the proposed facility under normal and emergency conditions

As a part of the Feasibility Study of construction a preliminary assessment of the impact on staff, public and environment was conducted. The assessment shows compliance with the applicable law.

Radiation exposure during the construction of the storage facility (the formation of radioactive dust) is not essential, since the construction is carried out at the decontaminated territory.

During operation of vit-HLW storage facility it was considered only radiation influence (external radiation) associated with the accumulation of radioactive waste.

Calculations of protective shields show that the thickness of the concrete of 110 cm will provide non-exceeding of annual dose for the staff. Calculated near-surface concentrations of pollutants in the air at the boundaries of residential buildings (at a distance of 20 km from the IC "Vector") do not exceed 0.00001 shares of MPC during the transfer of steel cases of HLW into the case made of stainless steel and welding to cover it in a "hot "cell. The risk of non-carcinogenic effects is of $4,5 \cdot 10^{-7}$. Carcinogenic risk of the combined action amounts to $7 \cdot 10^{-12}$, and is classified as an acceptable level. Social risk of proposed works for a group of people who live on the border of the 30-km zone, amounts to $5 \cdot 10^{-8}$ and is classified as an acceptable level of social risk.

Analysis of the possibility of occurrence and prognosis of emergencies during the operation shows that the planned operation can not cause any significant impact on the environment.

Assessment of changes of social and economic conditions as a result of the implementation of planned activity

The administrative center of the EZ is Chernobyl, where the State Agency of Ukraine on the Exclusion Zone Management is located.

Regulation of all activities in the EZ is based on the Law of Ukraine "On legal regime of the territory, which is radioactively contaminated by the Chernobyl accident."

Under the status of EZ habitation of population is not provided for. Agrotechnical activities aimed at the production of commercial products, also is not provided for within the territory of the EZ.

The activities in the Chernobyl EZ are implemented in two directions - decommissioning the Chernobyl nuclear power plant and works aimed at minimization of the consequences of the Chernobyl accident.

Influence of the proposed facility in the region can be characterized so that is not a threat of environmental pollution and public exposure from areas adjacent to the EZ.

Positive social factor in the implementation of the planned activity is the creation of new job positions.

List of planned activities that ensure operation of the proposed facility in accordance with environmental regulations

To protect the environment during temporary storage of the vit-HLW there are the following basic activities provided for:

- arrangement of technological process with the use of special technical means in case of reloading and location of vit-HLW for storage;
- engineered barriers system during the storage;
- ventilation system with constant control of emissions;
- Radiation monitoring of the situation in the vit-HLW storage facility and environmental elements outside of the repository.

During normal operation, at all stages of the process vit-HLW management direct contact of personnel with radioactive substances is practically eliminated, as well as adverse effect on the environment

During operation of the vit-HLW storage facility the emission of harmful substances into the environment is not provided for. The condition of the hydrosphere is controlled through monitoring of wastewater and groundwater.

Planned work does not provide for the release of radioactive substances into the environment. For the monitoring of the airspace condition the continuous monitoring of emissions from the ventilation system of storage facility is planned.

Residual impact on the environment during the construction and operation of the vit-HLW storage facility is not envisaged. During construction there is no harm to the environment, therefore special rehabilitation measures for the normalization of the components of the environment and of compensatory measures for the improvement of the equivalent natural and social environment in the Feasibility Study is not provided for.

Assessment of possible hazardous transboundary impact of the proposed activity

Based on a preliminary identification and assessment of potential environmental and related social and economic and other impacts of the proposed activity, taking into account the criteria stated in Annex I and Annex III to the Convention on Environmental Impact Assessment in a Transboundary Context, the hazardous transboundary impact is not foreseen.