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PRESENTATION MEMORANDUM

„SITE EXTENSION OF THE INTERMEDIATE DRY SPENT FUEL STORAGE FACILITY AND CONTINUING TO BUILD THE MACSTOR 400 TYPE MODULES”

Owner: Societatea Naţională Nuclearelectrica S.A.

September 2016

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I. Project name

„SITE EXTENSION OF THE INTERMEDIATE DRY SPENT FUEL STORAGE FACILITY AND CONTINUING TO BUILD THE MACSTOR 400 TYPE MODULES"

Site extension of the Intermediate Dry Spent Fuel Storage Facility (IDSFS) and continuing to build the MACSTOR 400 type modules - covered by *GD 445/2009 on environmental impact assessment for certain public and private projects*, with subsequent amendments and additions, fitting in Annex 2 - List of projects subjected to the assessment of impact upon the environment, item 13. a) *„Any changes or extensions other than those listed in Annex. 1, item 22, of projects listed in Annex 1 or in this Annex, already authorized, executed or in the process of being executed, which may have significant environmental effects*".

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III. Project Description

This Presentation Memorandum was elaborated based on information provided by the Beneficiary.

We mention that the Presentation Memorandum was drafted according to the content of the written presentation framework in Annex 5 from Order No. 135 from 2010 *on approving the Methodology for the application of environmental impact assessment for public and private projects* and was taken into account also some requests from the Meeting minute held on 31.03.2014 at MMSC with register no. 115265 / OP / 16.04.2014.

III.1. Project Summary

This Memorandum is designed for **Site extension of the Intermediate Dry Spent Fuel Storage Facility (IDSFS) and continuing to build the MACSTOR 400 type modules**

The existent Intermediate Dry Spent Fuel Storage Facility – IDSFS is placed inside the NPP Cernavodă, on the extension of it, it was taken into account the existing location of the IDSFS, the optimal solution being obviously the extension of its surface, considering the available space

By implementing the new strategy for long-term development of IDSFS (in Romanian - DICA) and authorization in view the extension of the lifetime of Units 1 and 2 with another operating cycle of 30 years, are identified the following major changes compared to the technical documentation that formed the base of the Environmental Permit no. 2058 / 22.02.2002 issued by the Environmental Protection Inspectorate of Constanta:

- extending IDSFS site by the 4th row of modules intermediate dry spent fuel storage, respectively increase the surface to about 31,000 sqm
- increasing the number of modules of the type MACSTOR from 27-30 modules, including 9 modules type MACSTOR 200 and 21 modules type MACSTOR400;
- building modules MACSTOR type 400 instead of MACSTOR 200 modules from module no. 10 of the row 2;
- increasing the number of spent fuel bundles that can be stored in modules type MACSTOR from 324000 to 612000 spent fuel bundles.

  Access to extended IDSFS is made from existing access roads.

IDSFS site is surrounded by two fences placed at 8 m distance between them, is equipped with gateway for the trailer, with 4 rows of modules, Access Control Building and a transformers area. Besides the access road from the IDSFS platform are provided gates and entry / exit for personnel and vehicles.

The road network on the IDSFS platform includes both roads between rows of modules and connecting roads and platforms necessary to ensure traffic and manoeuvres of the trailer carrying to modules the container in which is found the basket with bundles of dry spent fuel.

On the IDSFS platform is positioned a gantry crane that services the first row of modules, following that the next rows of modules following to be constructed, to be set with a gantry crane to ensure the handling of the container in which is transported the spent fuel bundles basket, from the trailer to each module cylinders. MACSTOR modules are rectangular reinforced concrete buildings embedded with cylinders, containing spent fuel bundles baskets.

MACSTOR 200 modules have dimensions of 8.10 m x 21.6 m x 7.50 m and includes 20 cylinders arranged in 2 rows vertical.

MACSTOR 400 modules have dimensions of 12.95 m x 21.94 m x 7.60 m and includes 40 cylinders arranged in 4 rows vertical.

III.2. Justify the necessity of the project

This documentation is done for obtaining a new Environmental Permit to extend with 3 modules the 27 modules type MACSTOR 200 approved by the Environmental Permit No. 2058 / 22.02.2002 and replace modules type MACSTOR 200 with modules type MACSTOR 400, starting from module 10 to module 30 in order to accommodate the necessarry storage capacity for 2 cycles of operation for Units 1 and 2.

Spent fuel Bay capacity (SFB) was designed for approx. 10 years of plant operation, at an annual average load factor of 80%.

However, from the beginning, the plant has maintained a higher load factor and increased rate of accumulation of spent fuel has prompted the need for additional storage capacity.

In the period 1998-2000, were conducted analysis on the technologies used worldwide to supplement the storage capacity of spent fuel at the site of NPP. **It was concluded that, dry storage is the most advantageous technology for ensuring additional capacity for storing spent fuel**, using materials available locally.

The basic principle of dry storage systems comes down to**: "Storing the spent fuel for a minimum of 50 years in conditions of nuclear safety for both operating personnel and population, and the environment"** by:

- providing a fuel confinement barrier to the environment (outside the fuel sheath);
- removing the residual heat of the stored fuel, by natural air convection;
- ensuring the storage area against external events (natural and human induced);
- ensuring appropriate biological protection.

The Intermediate Dry Spent Fuel Storage Facility (IDSFS) has the role of extending the spent fuel storage capacity of the Cernavodă NPP beyond the capacity of the Spent Fuel Storage Bay (SFB) of the plant.

Commissioning of nuclear units at Cernavodă NPP - Unit no. 1 in 1996 and Unit no. 2 2007 - led to a need of achieving and commissioning of Intermediate Dry Spent Fuel Storage Facility (IDSFS) to provide intermediate storage of irradiated spent fuel from the reactor after the temporary storage of it in Spent Fuel Bay (SFB) existing in each unit, in accordance with regulations issued by the National Commission for Nuclear Activities Control (CNCAN), by the IAEA recommendations and international practices regarding the management of spent fuel resulting from the operation of CANDU nuclear units.

Currently, according to the initial project, on the location and authorized area for the construction of IDSFS, it is foreseen the location of a number of 27 modules type MACSTOR 200, arranged in three rows (7 modules on the first row and 10 modules on rows 2 and 3).

The intermediate solution of fuel storage in Cernavodă NPP is based on the dry storage system type MACSTOR (Modular Air-Cooled STORage) developed by AECL and built in NPP Gentilly, system based on the use of MACSTOR 200 storage module, which in 2000 represent one of the most modern and best storage solutions.

In October 2013 was issued by Cernavodă NPP the document code: IR-35370-006 / Rev.1 in which was established **long term development strategy of IDSFS and authorization in view of extension of lifetime of Units 1 and 2 with another operation cycle of 30 years, and the solution that must be implemented to increase the capacity of spent fuel storing.**

In this respect, **starting with module no. 10 - third on the row 2, is intended to build MACSTOR 400 type modules that have a double storage capacity for spent fuel bundles towards MACSTOR 200 type modules**. The document was approved by the National Commission for Nuclear Activities Control (CNCAN) on the letter no. 50620 / 22.11.2013.

The solution is based on the efficient use of the current site initially allocated to IDSFS with the change of the initial design that provide MACSTOR 200 storage modules and switching to alternative MACSTOR 400, developed as a

collaboration between AECL, Korea Hydro & Nuclear Co. (KHNP) and Nuclear Environment Technology Institute (NETEC).

Given the above, it is necessary to increase the existing storage by expanding the area initially allocated for MACSTOR 200 with an existing surface in the operational IDSFS area in, resulted from project for MACSTOR 400, including increasing the number of modules.

MACSTOR 200 – MACSTOR 400 comparative table

Parameter	**MACSTOR 200**	**MACSTOR 400**
Fuel Cooling Period in the irradiated fuel storage	6 years for the reference fuel	
Average residual heat per bundle, for the reference average burnup and minimum cooling period	6,08 W	
Residual power for the storage basket:		
Average basket	364,8 Watts	
"Hot"basket	390,6 Watts	
Designed Service Life of the Structure	50 years	
Dimensions		
Length(m)	21,64 m	21,95 m
Width (m)	8,13 m	12,95m
Parameter	MACSTOR 200	MACSTOR 400
Height(m)	7,5 m	7,60 m
Capacity:		
- Number of storage cilinders	20	40
Air circuit configuration	- 10 air inlets (5 at each side) - 12 air outlets (6 at each side)	
The heat dissipated by a module	73 kW (analyzed at 78 kW)	145,9 kW (analyzed at 146,7kW)
Environment temperature	40°C daily maximum temperature	40°C daily maximum temperature

As shown in the comparative table, it can be seen that besides the width and storage capacity of the module MACSTOR 400, there are no major differences compared with MACSTOR 200, resulting an identical operating mode by compatibility with existing equipment (gantry crane, transfer container, loading guide, etc.).

We mention that the dimensions and characteristics of the module, allow achieving the transition from module MACSTOR 200 to module MACSTOR 400 without imposing major changes in the current arrangements of modules rows within IDSFS.

III.3. Drawings representing the Project site boundaries, including any area to be temporarily used (situation and location plans)

In the image below is presented the IDSFS inside the Cernavodă NPP site.

FRAMING PLAN
SCALE 1 : 5000

S.C. RAMBOLL SOUTH EAST EUROPE S.R.L.

III.4. Physical aspects of the project (plans, buildings, other structures, construction materials, etc.).

Preliminary proposed arrangement of the extended IDSFS site

IDSFS related site, including extending the new configuration, will consist of 30 modules type MACSTOR.

All modules are reinforced concrete constructions. The initially provided modules were MACSTOR 200 type, size (lx L x h) 8.10 m x 21.60 m x 7.50 m and storage capacity of 12000 spent fuel bundles in each module.

To increase and improve storage capacity is proposed to build MACSTOR 400 modules, size (l x L x H) 12.95 m x 21,94 m x 7.60 m and double storage capacity compared to MACSTOR 200.

For placing the 30 modules 4 rows will be required.

Given that the current authorized location ensures construction of three rows of modules, it follows that for the construction of the fourth row of modules requires an increase in the site area.

From calculations, the IDSFS site area will increase by about 7,000 m^2, respectively from about 24,000 m^2 to 31,000 m^2 (area between the IDSFS outside fence limits).

Site extension will include an area in which the quota where the bedrock is - limestone Barremian, is high enough to achievment of foundations in good technical and economic conditions.

Storage module description

Storage module foundation

Storage modules are built on a reinforced concrete sub-base slab that provides necessary interface between concrete components and modules slab.

The sub-base slab is made of reinforced concrete 1 m thick, being 1 m larger and 1 m longer than the module itself and is provided with 4 shear keys, 2 on each direction. The slab ensures the necessary structural interface between sub-base slab and module and is equipped with four shear spurs, located in the sub-base slab keys / baffles, to achieve horizontal anchorage of the module from slipping, in the event of an earthquake. The shear key (baffle) / spur system allows also thermal longitudinal and lateral expansion of the module structure.

During construction and operation, it is periodically checked the module structure compaction.

The assembly module – sub-base slab is placed on the completion concrete massive, achieved in conditions resulted from geotechnical expertise, made on unveiled rock at the quotas indicated by the project (+ 7.00m + 8.00m + 9.00m).

Expertise of rocks allowed local characteristics setting on the bearing capacity of its and specific recommendations necessary for consolidation of the foundation area.

Following these recommendations, all cracks (fissures) were opened and cleaned to a depth of 50 cm and then filled with concrete C12 / 15 with aggregates up to 16 mm diameter; the foundation surface was covered with a layer of concrete C12/15 of 10 cm, the steps between different levels being processed at an 45°angle

Working of the entire area was achieved through a reinforcing net with square meches of 25/25, PC52, located about 30 cm above the surface of the rock; this reinforcement net is continuous, covering also transition areas. Over the net it was poured completion concrete, up to +15.30 mdMB quota, and further, sub-base slab modules up to +16.30 mdMB quota.

During the execution of the first modules was done the structure behaviour subsidence tracking, activity that takes place throughout the life of the storage, according to the Programme of tracking construction behaviour in time.

MACSTOR 400 storage module components

Storage modules are monolithic structure made from normal density reinforced concrete.

The storage cylinders are suspended from the upper plate of the module, in a shared cooling cavity. The passive cooling system of the module consists of this cavity, which is provided with a series of air inlets located on the lower part of the module and a series of air outlets located on the upper part of the module.

The other module components are: the reverification system of EURATOM / AIEA, drainage and ventilation pipes of cylinders, storage cylinder seismic restraints, sealing plugs, protection weather cover, handrail for operators safe and lightning system and grounding.

Storage cylinders

Storage cylinders are manufactured according to standard quality assurance NRAC-04 category IV for Cernavodă IDSFS - Phase I and, starting to Phase II have been carried out in accordance with NMC-07.

The storage cylinder is made of carbon steel protected against corrosion by having its interior and exterior metallized with zinc. The storage cylinder is embedded in the concrete top slab of the module and is suspended at a small distance above the module floor.

The top of the storage cylinder has a recess which, along with the shielding plug (carbon steel filled with reinforced concrete), a weather covers and the actual module, is designed to provide shielding for the operating personnel. Both the biological protection plug and the stainless steel weather cover are part of the storage cylinder accessories.

The weather covers and the top of the cylinder that is exposed to the atmosphere are made of stainless steel and are seal welded to each other after the cylinder has been filled with the storage baskets; this provides the second containment barrier of the storage system. The base plate of the storage cylinder provides a space for two holes in which the seismic restraints are located, preventing any lateral displacement of the cylinder.

Construction Materials

The CM-400 is made from normal density reinforced concrete. Type 50 Portland (low sulphate) cement is used with minimum 20% fly ash content, a low water-cement ratio of 0.37 to 0.39, a 6.5%±1.5%, air entrainment, a 7 days moist curing resulting in a 28-days minimum compressive strength of 30 MPa.

The reinforcing bars are typically made from carbon steel and supplied in accordance with CSA A23.1 and CSA A23.2 and have minimum yield strength of 400 MPa.

All construction joints are waterproof, stepped to prevent radiation streaming and located at a position that is not aligned with a row of storage cylinders.

Shielding

The main material used to shield the CM-400 is normal density concrete. A concrete wall thickness of 0.985 m, which, according to the reference document, provides a reduction of the dose rate at contact up to 25 μSv/h. (ref. doc. 79D-01320-SAR-001).

Evaluation of this dose rate was made considering the design value of the average degree of burning for all the fuel bundles(7800 MWd/MTU), higher than the value recorded by now at Cernavoda NPP.

This algorithm has been validated for the MACSTOR200 module from Cernavoda NPP after measuring the gamma dose rate (maximum value measured of 3,3 μSv/h).

Gamma dose rate will register the maximum value when all the spent fuel baskets are loaded into the storage cylinders and protective plug is being descending.

The maximum dose rates around a completely loaded MACSTOR 400 module is estimated to be within the limit of 25 μSv/h[1].

Upper Deck Shielding

The upper deck concrete shielding thickness for the CM-400 is currently designed to be 1.14m.

Shielding of the upper deck is characterized by the presence of the storage cylinder shield plugs that are inserted in the superior portion of the storage cylinders. The shield plugs are made conical to minimize the insertion gap and facilitate insertion of the shield plug; loading operations are made remotely. Even with a conical shape, the gap can still generate some shine, particularly when manufacturing tolerances and ovality of the shield plug and storage cylinder add up. To minimize the dose rate from the insertion gap, a steel shield ring is added to the storage cylinder body, at the location where the shield plug is deposited. Figure 3-5 indicates the location of the shield ring with respect to the shield plug and storage cylinder body. The shield ring is made of a number of segments that are welded to the storage cylinder body during manufacture. The design feature minimizes the dose rate at the upper deck.

When shield plugs are exchanged with the loading plug assembly and when the loading plug is removed to position the transfer flask, a direct shine from the top of the storage cylinder occurs.

The intensity of this shine varies with the number of fuel baskets stored in the storage cylinder.

Before those operations are carried, the operators stand behind the transfer flask and at a safe distance from the storage cylinder being loaded. Those plug transfer and fuel loading operations last only for a short period, resulting in a

[1] 25 μSv/h is the base design value, and also the authorization limit

minimal dose to the operators. Several thousand fuel baskets have been safely stored using this method.

Wall Shielding

The air inlet and outlet circuits are shaped as a labyrinth to minimize streaming of radiation to the outside.

The dose rate due to gamma scattered radiation was evaluated for the air inlet opening and it has a maximum value of 10 μSv/h.

The total dose rate (scatter radiation + direct radiation) is ~19 μSv/h.

III.5. Characteristic elements specific to the proposed project

III.5.1. Production type and capacities

IDSFS objective consists of new construction and adaptations of existing infrastructure at Cernavodă NPP in the spent fuel handling area, allowing the achievement of all specific activities for intermediate storage of spent fuel, an important stage of the closing program of the nuclear fuel cycle.

The basic principle of dry storage systems comes down to**:**

"Storing the spent fuel for a minimum of 50 years in conditions of nuclear safety for both operating personnel and population, and the environment" by:

- providing fuel confinement barrier to the environment (outside the fuel sheath);
- removing the residual heat of the stored fuel, by natural air convection;
- ensuring the storage area against external events (natural and human induced);
- ensuring appropriate biological protection.

IDSFS objective involves three main activities taking place in three different places on the Cernavodă NPP site, as follows:

- at the Spent Fuel Bay (SFB), room *S1-126 (S2-126) from the Services Building U1 (U2)*, in a space of about 3,0 m along row A is done the loading of spent fuel in storage baskets;
- at Shielded Work Station (SWS) from U1 or U2, located in a new building adjacent SFB, specially built for this purpose is done loading of storage baskets in the transfer flask and of the transfer flask on the mean of transport;
- at the Intermediate Dry Spent Fuel Storage Facility (IDSFS) is done the spent fuel baskets storage; these modules are built in stages, to ensure the storage capacity for periodically discharged spent fuel from the SFB, Unit 1 and Unit 2.

The main activities specific to IDSFS objective are presented below.

a) Spent fuel preparation for dry storage - run in SFB (*rooms S1-126, S2-126*) and its extension – Extension SFB Building. Spent fuel is transferred from SFB in the storage basket, equipment made of stainless steel 304L. The spent fuel bundles are transferred one by one from the existing storage trays (horizontal) and placed vertical in the storage basket. Loading is done under water, stand on a turntable, after which the basket is positioned on a trolley placed underwater on another turntable for transfer in Shielded Work Station (SWS).

SWS consists of an enclosure secured with gamma and neutron biological protection which receives the full storage basket, it is decontaminated with demineralized water under pressure, it is dried, sealed by making two welds and is visually checked. The storage basket thus sealed provides the first confinement barrier to the environment, without considering the sheath of the fuel.

In SWS is made the lifting and blocking of the basket so prepared in the transfer flask (TF), which will be transported to IDSFS. The transfer flask provides protection of the spent fuel basket during transfer operations until lowering the basket into the cylinder. Inspection, monitoring and settlement of TF on the transport trailer are performed in the adjacent room built in extension of *S1- 126 (S2-126).*

b) Transfer of the spent fuel from NPP to IDSFS - is done with a trailer that takes the transfer flask containing a storage basket and carry it to IDSFS, on a specific route, which is not related to public road.

c) Intermediate spent fuel storage - is made in the storage itself (IDSFS). This is modular type, allowing phased construction, as the spent fuel must be transferred from the SFB.

The storage was designed to serve Units 1 and 2 of Cernavodă NPP and is authorized at this moment for placement of 27 modules MACSTOR 200, on 3 unequal rows, each row being provided with an access road and served by a gantry crane.

Through this project it is proposed to extend IDSFS both by increasing the number of modules stored, from 27 (arranged in 3 rows) to 30 arranged in 4 rows, and using, starting module no. 10, modules type MACSTOR 400 with a double storage capacity.

According to the Informative Report IR - 35370 - 006, Rev. # 4, **Long term strategy of development of Intermediate Dry Spent Fuel Storage Facility and licensing in the perspective of extending the life of Units 1 and 2, harmonized with CNCAN and MECC (Ministry of Environment and Climate Change– now Ministry of Environment, Water and Forests) observations** is mentioned:

To ensure the storage space for spent fuel bundles obtained from operation of the units U1, U2, U3 and U4 with 2 life cycles will be necessary 53 MACSTOR modules, respectively 9 MACSTOR200 modules and 44 MACSTOR400. So for the storage of the spent fuel resulting from operation of U3 and U4 (if they will be

realized) and extension of their lifetime, there is the possibility of extension on site, through a possible future extension project of IDSFS.

Considering the nature of the foundation soil and the space required it is possible to build a number of 49 MACSTOR modules from the 53, and for the rest of 4 modules that are not included within the good foundation area there is enough space in the close vicinity of the extended IDSFS site. In this situation, a new geological study will be necessary, and if necessary a new foundation solution will be designed.

NOTE: In the event that Units 3 and 4 will not be built, or whether for storing spent fuel from these, the entity that will provide operating of the U3 and U4 units will propose alternative solutions, this document will be revised as to reflect the situation at that moment (total number of modules will be reduced accordingly the situation)."

The report documents the development strategy on long-term of the Intermediary Dry of Spent Fuel Storage Facility and is for showing to CNCAN and MECC (now MEWF) of how the SNN S.A. is considering solving the problem of intermediate spent fuel storage, resulting from the operation of Units 1 and 2, and the storage version of spent fuel resulting from the operation of Units 3 and 4.

IDSFS extension strategy has been developed taking into account two assumptions:

1. All spent fuel results during the entire two cycles of operation, of 210.000 EFPH, is stored on IDSFS site;

2. Starting with 2061 the fuel stored in IDSFS until then, will be transferred gradually in the Final Geologic Deposit.

The Informative Report IR - 35370 - 006, Rev. # 3 and Rev. 4, Long term strategy of development of Intermediate Dry Spent Fuel Storage Facility and licensing in the perspective of extending the life of Units 1 and 2, harmonized with CNCAN and MECC (now MEWF) observations it was approved after review by CNCAN and by the Technical - Economic and Scientific Council of National Company NUCLEAR ELECTRICA S.A.

III.5.2. Description of facility and on site technological flows (as the case)

MACSTOR storage system, chosen for the storage of spent fuel from Cernavodă NPP, consists of storage modules located on site and of a series of equipment used for preparing of storage and transfer of spent fuel at IDSFS. The main activities of preparation, transfer and storage itself of the fuel, and also the main equipment used during the technological process will be described hereinafter.

Preparing fuel for storage

Preparatory activities for the storage of fuel are made in the SFB. The fuel bundles are transferred from the storage trays from bay to the basket. Fuel handling

equipment used to transfer operations consists of the turntables of bays, various tools for handling and equipment and lifting equipment.

Once filled, the basket is inspected, moved under the cone terminal of Shielded Work Station (SWS) and raised from SFB in SWS. In SWS, the fuel is dried and the basket is sealed by welding.

During preparation operations of fuel for storage are used these next equipment and fuel handling tools:

- Spent Fuel Storage Basket
- Gantry crane of SFB
- Support components in SFB (worktable in SFB, tipping device, turntable, etc.)
- Fuel Handling Equipment
- Shielded Work Station (SWS), complete with conical terminal at the bottom, a panel of command and control and auxiliary systems (ventilation system and dry fuel, electric power supply system).

For all these operations, conducted both in SFB and in SWS, they are used also auxiliary systems such as: power supply, compressed air supply, control system of operation taking place at SWS, demineralized water supply.

In what follows, Spent Fuel Storage Basket and SWS will be described in more detail.

Spent Fuel storage basket

Design parameters of the spent fuel basket

POSITION	**PARAMETER**
Material	stainless steel 304 L type
Total height of the basket	556 mm
The outer diameter of the weather cover	1040 mm
The outer diameter of the bottom and upper plate	1,07 m
Sheet thickness: • at the upper part • lateral • at the basket base	 9,5 mm 9,5 mm 19,1 mm
Weight (empty)	424 kg
Amount of residual heat released by a basket	365 W (reference) 390,5 W (maximum residual power)
The gas inside the basket	Air
Relative humidity of the air	40% at 40°C 1% at 137°C 19 g water / 1 kg air
Maximum intern pressure	34 kPa(r) or 5 psig

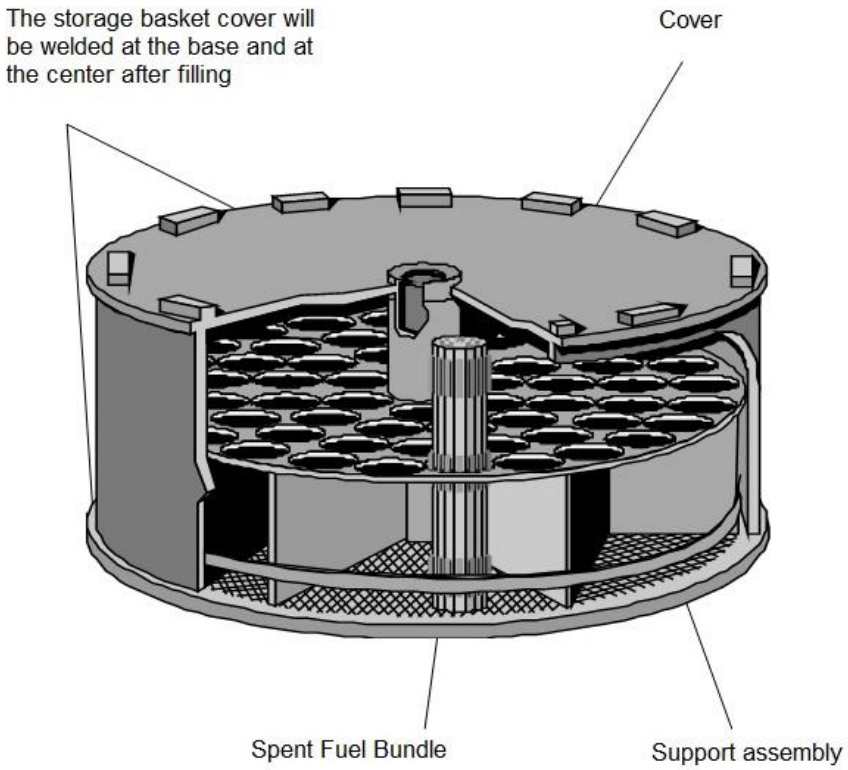
The spent fuel storage basket functions are:

- holding the spent fuel bundles;
- providing the first containment barrier of the spent fuel bundles.

The basket is made up of sub-assembly support and sub-assembly cover, designed to be assembled by sealed welding after the basket is filled and its content is dry.

The support assembly is constituted by a circular base plate, thick, to which is welded a strong central post. On it is fixed a sleeve, where the hanging device of the basket is mounted. The central post has six radial feather, which will be attached to the base plate. At the central post is fixed a positioning plate with holes for placing in vertical position the spent fuel bundles. An expanded steel plate is fixed on the bottom of the base plate to facilitate draining and drying of the fuel bundles.

The cover assembly comprises a horizontal plate, a cylindrical wall and a set of spacers welded to the top of the plate.



Spent fuel storage basket

The spent fuel that is stored in Cernavodă IDSFS consists of bundles of natural uranium. Given the geometrical configuration of place, the lack of sustained production of neutrons and the storage environment strong absorber of neutron (non-moderator), there is no possibility that this fuel to become critical.

Since the loading operation of the fuel basket is done under water, fuel cooling is provided by the cooling system of the plant storage basin. Once the basket is transferred to the dry storage, cooling is ensured, effective by the passive cooling system of the MACSTOR module.

The fuel basket loads is designed for loads due to all handling operations, internal and external pressures and also for stresses due to accidental drops.

The pressure inside the basket is resulting from increased air temperature remained indoors after drying operation of the basket. Analyses show that at a temperature of 159 ° C of the basket, the basket air pressure is less than 34 kPa (g).

This pressure was considered in the design of the basket; basket does not need to be classified as a pressure vessel.

Loadings due to accidental drops represent the largest stresses applied to the basket structure. The basket must maintain its general structural integrity and also must be maintained its recovery capacity from the storage cylinder, after an accidental drop.

The most severe of all the possibilities of basket drop is its fall over the top of the only basket already placed in the bottom of the storage cylinder. Dynamic stress analysis shows that loads the welds are subject of, remain below acceptable

limits; the fuel basket maintains its structural integrity and is ensured recovery capacity from the storage cylinder, after an accidental drop.

The containment barrier integrity of the fuel basket is performed by two sealing welds executed and controlled in SWS (besides the main welds made at the basket prefabrication).

Welds of the basket structure made during prefabrication are executed and controlled by qualified workers, in accordance with procedures approved by manufacturer, the assurance level of quality for execution and control of these welds is NRAC-04, Category IV for IDSFS Phase I and NMC-07 starting with Phase II.

Integrity and quality of welds sealing chimney executed in SWS are provided by a qualified welding process executed by trained and qualified welders.

The quality and integrity of sealing welds made on basket in SWS are provided by a qualified welding process executed by trained and qualified welders.

The materials, the geometry of the joint areas to be welded, surface preparation and cleaning are strictly controlled. The welding process is automated through the rotary table, through the positioning device of the burner tip, by a modern system of inert gas supply and through continuous electrode cleaning. The level of assurance of quality for execution and non-destructive control of these welds is NRAC-04, Category IV for IDSFS Phase I and NMC-07 starting with Phase II.

Sealing welds are visually monitored by the operator via closed video circuit and also welding parameters are recorded for each basket, for future reports. Checking weld (for acceptance) is done by visual inspection according to the procedure IDP-NDE-010 (*Procedure for visual examination of sealing welds of spent fuel storage baskets*) and the acceptance criteria of the *Canadian standard CSA W59-M1989* (R2001) "*Welded Steel Construction (Metal Arc Welding*). Regular control of the welding process stability is ensured by performing a welding sample every 10 baskets welded (frequency that provides a set of samples for each storage cylinder).

These welding samples are visually inspected also by non-destructive control procedures, subject if necessary, to destructive testing to verify if the welding installation is still in parameters.

Since the beginning of the first operation of AECL dry storage deposit in 1980 and until now, it has not reported any basket that may have lost containment barrier integrity.

Shielded Work Station (SWS)

SWS is used to dry spent fuel and for sealing welding of the storage basket.

SWS is composed of a steel structure included in steel panels filled with lead, to ensure radiation protection. It is installed on a base plate anchored to the SFB wall, and allows entry of air pipes, of electric cables and instrumentation pipes to ensure the conduct of operations within SWS.

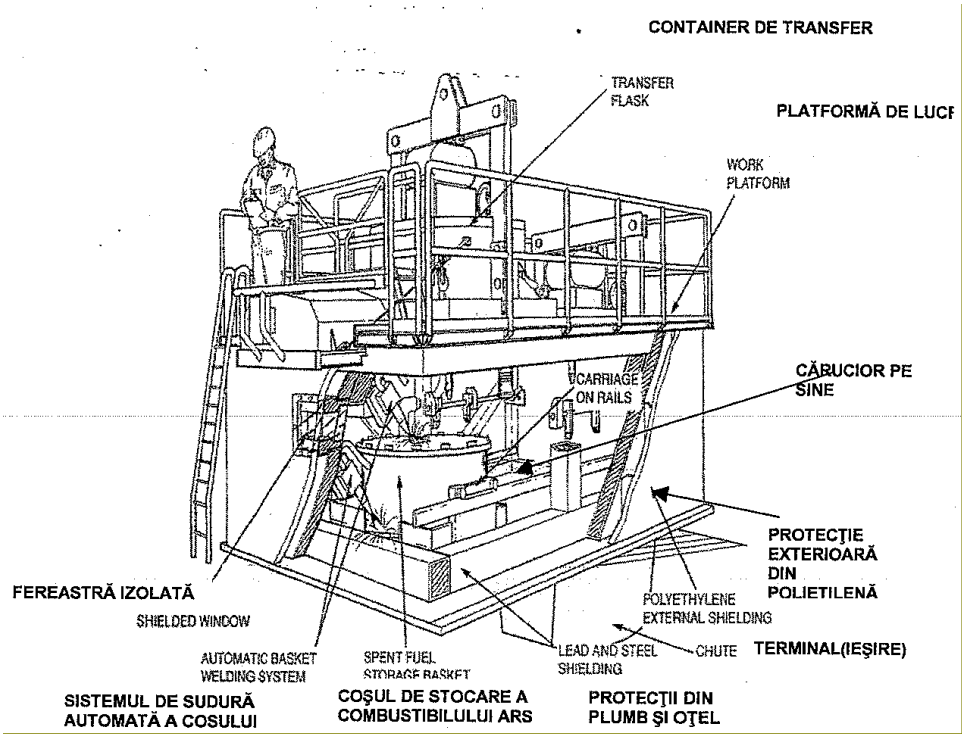
To dry the spent fuel, a drying system is provided, with two operation stages, who provides hot air and maintain negative pressure in SWS.

SWS has an opening at the top through which the sealed (welded) basket is hoisted in the transfer flask, to be transferred to the storage modules.

Lower terminal of SWS is conical shape, stainless steel plated, filled with lead, to ensure radiation protection and is placed under SWS above SFB. The terminal is partially submerged in water from the basin, to ensure radiation protection for operators, when the fuel storage basket is hoisted from water in SWS.

In this terminal there is a decontamination system with demineralized water splash of the spent fuel basket and of the handling tool of it, at the basin lifting.

Shielded Work Station (SWS) is shown in the following figure.



Fuel Transfer

Transport of the transfer flask loaded with fuel storage basket from SWS tp the storage modules is made using a means of transport. For loading of the fuel transfer flask in transportation, is provided a adjacent building SFB. The transfer flask, positioned on SWS, is used for transferring the basket out of SWS. The transport of the flask from SWS to the means of transport is made using a crane from the Adjacent Building.

For Unit 1, the transfer flask lead thickness is 17.8 cm, and steel walls have 2.5 cm; lead panels are covered with high density polyethylene panels, having a thickness of 5.1 cm.

The result of the shielding calculations showed that, on the wall surface consisting of lead, steel and polyethylene, radial dose rate (gamma plus neutrons) is 15 μSv / h and axial dose rate is 15-17 μSv / h (therefore lower than the design value of 25 μSv / h). The calculations were based on the reference fuel, cooled for 6 years.

For Unit 2 for shielding of the transfer flask resulted a lead screen with a thickness of 17.78 cm, a 1.27 cm steel panel and also a polyethylene panel of 5.04 cm.

The radiation dose rates on the transfer flask wall surface, resulted from the analysis, are lower than 25 μSv / h.

Gantry crane

Gantry crane is used for handling the transfer flask at the storage itself.

The gantry crane runs on rails and includes a storage module throughout its length. The gantry crane guide rails extend along a row of modules. The gantry crane has a larger opening than the module, so as to allow positioning of the transport vehicle under the crane at the end of a module. The crane has a profile structure type A and is equipped with two tackles: a main tackle of 30t and a 10t auxiliary tackle. The two tackles are used to lift the transfer flask and also for lifting the temporarily sealing plug (loading plug) during its positioning on the storage cylinder that will be loaded with spent fuel, thus preserving an almost continue shielding during these short operations. The auxiliary tackle is also used for handling the final shield (protection) plug of the storage cylinder, while its replacement with temporary plug, and for moving the charging guide of the transfer flask.

The gantry crane is designed according to ISCIR R1-87 prescriptions and manufactured according to quality assurance standard NRAC-04 category IV (NMC-07). The gantry crane is equipped with anti-derailment clamps, applied manually by the operator, so to ensure the crane in the working position (during operation) and safe parking outside the modules during periods when not working. These clamps prevent the possible derailing and overturning during an earthquake DBE level.

The gantry crane for the first row of modules is seismic qualified at a PGA (Peak ground acceleration) of 0.3g (according to 79D-76 140-SQR-003, rev.0 "Seismic Report Gantry Cranes 30T-28M" reference 4-35).

To calculate the overturning forces, a safety factor (2.4) was used, in addition of the prescription ASME NOG-1-2004, "Rules for Construction of Overhead and Gantry Cranes " (para.4130; 4136; 4140), which shows that the crane has a robustness which ensures a seismic edge up to HCLPF (High Confidence of Low Probability of Failure) = 0.3 x 2.4 = 0.72g. In addition, the anti-derailment mechanisms mounted does not let the crane to jump from rails in case of an earthquake.

For Modules 8 and 9 (on the second row of module) is provided through project a new gantry crane, that will be purchased to withstand an earthquake reflecting an horizontal acceleration on ground level of 0.3 g (similar to seismic data for the crane on first row), providing an seismic edge of HCLPF> 0.4g.

According to the Chapter 8 "Accident Analysis", the gantry crane collapse is possible only in case of an event well beyond design basis and therefore classified in the category of severe accidents. If this event would occur, the impact on the gantry crane loss on module is smaller than that produced by missiles generated by tornadoes and would not have radiological consequences. The repairs would be particularly common in construction works.

Loading plug assembly and positioning guide

Each storage cylinder is closed at its upper part with a taper shielding plug, plug made of steel filled with reinforced concrete.

To improve shielding during loading fuel storage baskets, it is used a loading plug assembly (provisional). Before starting the loading operations, the final shielding plug assembly will be replaced with this provisional loading plug assembly. The assembly consists of a loading guide and a loading plug. The loading guide has an inner diameter large enough to allow passage of fuel storage basket. The loading guide is made from steel filled with concrete at its lower part and lead at the top. The loading plug is attached to the loading guide through screws. To allow loading of fuel storage baskets, the provisional plug must be disassembled from the guide by removing the screws.

The permanent cylinder plugs and the loading plug assembly were performed according to the quality assurance norm NRAC-04 category IV for

Cernavodă IDSFS - Phase I and starting Phase II will be executed according to NMC-07.

Positioning guide consists of a steel frame used for guiding the transfer flask, providing an additional shielding to operators and ensuring proper positioning of the transfer flask during loading operations.

Positioning guide and provisional loading plug assembly are moved from one storage cylinder to another, when necessary. Positioning guide used in Cernavodă IDSFS was executed in Canada, according to ISO 9001-94 norm, accepted by AECL as equivalent of the CSAZ299.4 norm.

At the top of the storage module is provided a handrail that protects operators against falling. A section of the handrail is open temporarily to allow lateral entry of the transfer flask over the module.

Means of transport

The mean of transport is a mean of commercial transport, with a transport surface suitable to the settlement and anchoring of the flask. The mean of transport is equipped with decontamination possibilities. The mean is designed to transfer the transfer flask loaded with fuel storage basket from NPP (Adjacent Building) to the Storage Modules, and to transfer the empty flask back to the Adjacent Building.

Spent Fuel Storage

The spent fuel storage area is a fenced enclosure, and will be extended to include the proposed storage modules arranged in a network of four rows.

Given the proposed extension, an increase of the site area is required, that from calculations it appears that will increase by about 7,000 m^2, respectively from about 24,000 m^2 to about 31,000 m^2 (the area between the exterior fence boundaries of the objective).

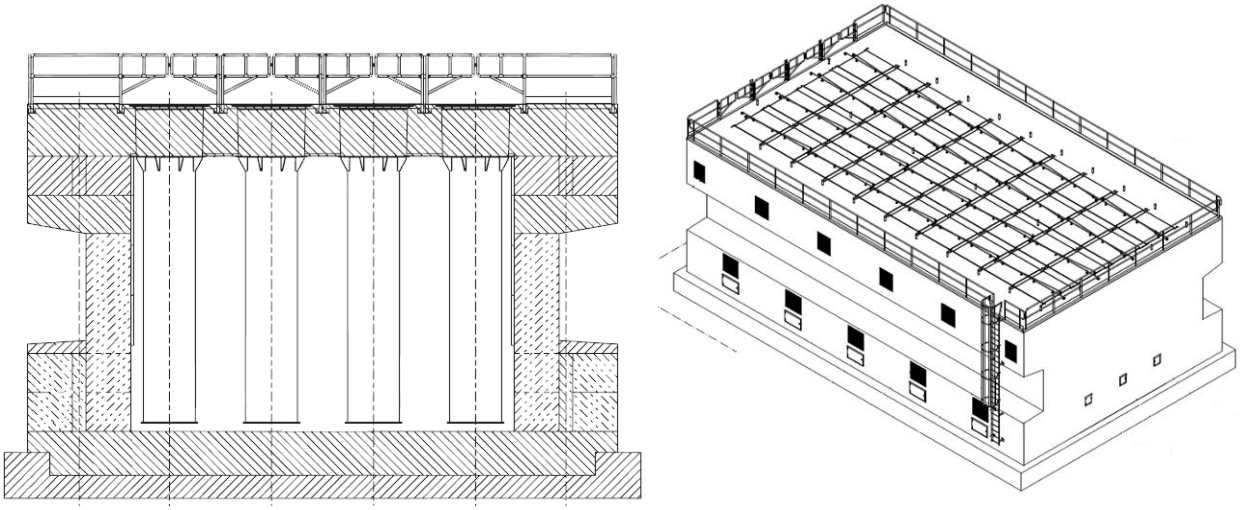
Site extension will include an area in which the quota where the bedrock is - limestone Barremian, is high enough to achievment of foundations in good technical and economic conditions.

In the storage area, the transfer flask is hoisted from the mean of transport with the gantry crane, above the storage module. The sealing plug, initially positioned on the storage enclosure, will be removed, the transfer flask will be positioned above the cavity and the basket will be lowered into the storage enclosure. The cycle is repeated until the storage enclosure is filled. The sealing plug is then positioned at the end of the storage enclosure, welded, the cover is installed and welded, completing the transfer operations.

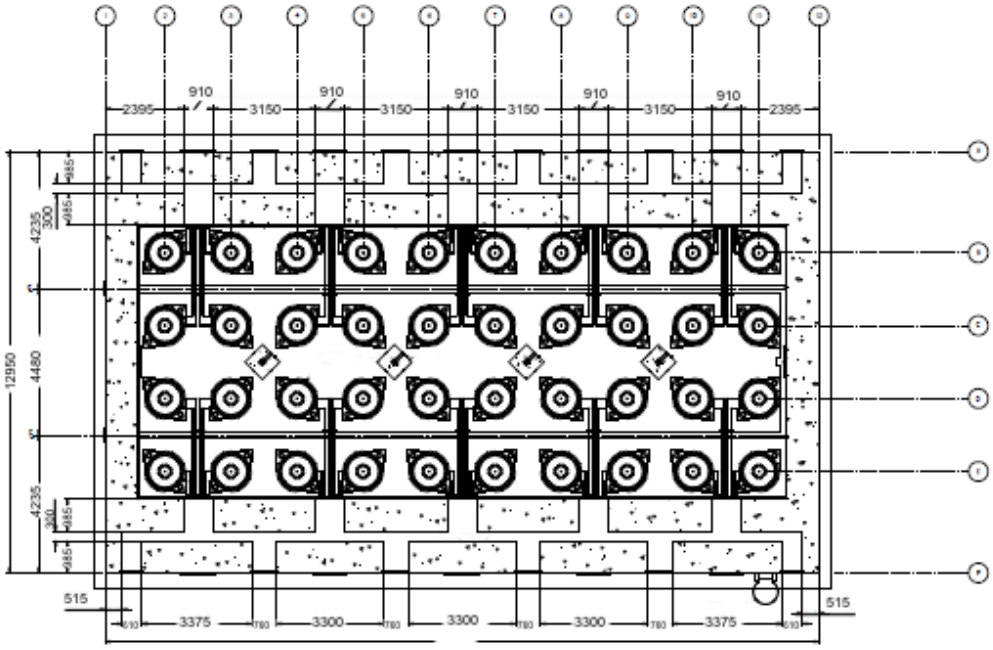
The fences that surround the storage area are located at such distance from storage modules, that the dose caused by direct radiation, outside the fence, not to exceed allowed limit values for the population.

For the physical protection of the module is provided a surveillance system and access control, interconnected with similar system on the Cernavodă NPP Platform.

Storage module is shown in the following figure:



MACSTOR 400 Module



IDSFS - MACSTOR 400- Storage cylinder arrangement

Loading operations at IDSFS

In the storage area, preparation is done first to achieve the actual operation. Thus, the auxiliary tackle of the gantry crane is used to position the transfer flask above the storage cylinder that will be loaded. Before starting the loading operations, the protection plug of the storage enclosure will be replaced by a temporary plug. The loading ring is removed to release the plug. Ventilation and drainage lines of the storage enclosure are kept open in order to ensure that the storage cylinder is drained. After these preparatory information will be made the main loading operations.

Operation of Spent Fuel Storage System

During storage period, the main operations consist of sampling at each storage cylinder to demonstrate that both the basket and the enclosure preserve its barrier capacity. The cover plate of the reinforcements enclosure is open and the re-circulation pump is connected to the drain and ventilation lines. Air from storage enclosures will be recirculated through a filter package. Filters are analysed for determination of presence of artificial radioactivity. Once completed the sampling operations, the monitoring system is disconnected, the reinforcements closed and sealed with caps and the cover plate is placed over the reinforcements enclosure.

Removal of the residual heat from the storage module

The heat produced by the fuel bundles is transmitted by conduction, convection and radiation to the external surfaces of the storage basket, and then transferred to the storage cylinder, mainly by convection and radiation. The storage cylinder heat is dissipated by convection in the air inside the cavity module and by radiation to the inner surfaces of the storage module concrete. A set of input and output air holes, arranged in the form of a maze to reduce the spread of radiation, ensure circulation by natural convection, of the cooling air that enters at the bottom and exits at the top of the cooling cavity.

Air circuit is projected ensuring redundancy and diversity, so as to be available more interconnected openings on both sides of the module, to maintain an adequate cooling of stored spent fuel; the air inlets and outlets are protected with grilles to prevent entry of foreign bodies and / or small organisms.

At Cernavodă IDSFS, the maximum temperature of the fuel in the storage module has the following estimated values (air temperature 40°C):

i) normal conditions:

157°C + 1,5°C (residual power: 390,5 W/cos)

ii) when blocking the air openings on the same side of the module:

158,5°C + 10°C = 168,5°C

At Cernavodă IDSFS this situation represents a severe accident. Even in this case, the maximum design temperature (180 ° C) is not exceeded.

The MACSTOR module project ensure the effective evacuation of heat from the stored spent fuel and from the storage structures, both in normal operating conditions and in case of accident.

To monitor the evolution of structure temperatures during the storage of spent fuel, at module 2 (considered representative for MACSTOR 200) was implemented a system for temperature measurement.

The integrity of containment barriers (storage cylinder and storage basket) and protection against degradation

Storage cylinders and fuel storage baskets are the two engineering barriers for containment of fuel.

The storage cylinder is a structure from carbon steel plates welded and designed to withstand degradation. The storage cylinder is completely protected from corrosion by applying, on manufacturing, of a metal coating layer, resistant to corrosion. The storage cylinder is protected against precipitation by the storage module; it is heated internally by the stored spent fuel, thus reducing the corrosion rate (due to air that forms the internal ambient environment) of the cylinder surfaces. Ventilation and drainage pipelines from the storage cylinder are also protected from corrosion by the use of carbon steel pipes with thick walls and protective coating resistant to corrosion in the area near the storage cylinder and pipelines made of stainless steel in sections embedded in concrete or external parts of these pipelines.

To verify the integrity of containment barriers (storage cylinder and spent fuel baskets stored in it) was provided a system for monitoring the atmosphere from the storage cylinder and was established an operational limit: "*The integrity of containment barriers* ".

The atmosphere monitoring system in the cylinder is composed of a vessel of water capture, an air pump, a particulate filter, an active carbon filter and a drying unit (desiccant filter silica gel) and of pipes and necessary fittings. Each cylinder is equipped with a ventilation and drainage pipe with termination outside the protective screen, in a fitting box, where the valves that close pipes are located.

Through this system, air samples are taken from the cylinder atmosphere for detecting presence of humidity or radionuclides, according to standard operating sequence SSO-35370-1, periodically (with the frequency approved by CNCAN). For air sampling, the air pump and filters are connected to the vent and drainage fittings of the storage cylinder cavity and is recycled 1 m^3 of air from the cylinder atmosphere. Filters and retained water after sampling are analysed in the Dosimetry Laboratory.

In case of humidity or artificial radionuclides presence, sampling is repeated for confirmation and evaluation in order to decide. After confirming leakiness of the containment barriers, will act according to specific procedures for this situation.

Humidity detection could indicate that outside air entered the storage cylinder, which has lost the ability of confinement. In this case, all welds of the protection cover and shielding plug of the cylinder will be checked; if the confinement conditions can not be restored by repairing welds, baskets of stored spent fuel will be moved to another cylinder, and the inadequate cylinder is abandoned.

If laboratory tests indicate the presence of artificial radionuclides in the air in the cylinder, it is suspected that a basket containment barrier from the storage cylinder is no longer intact. Radionuclides present may come from the surfaces of fuel elements from defect basket or from diffusion of the fuel interstitium - sheath of these fuel elements. These radionuclides are iodine (retained on active charcoal filter) and aerosols (retained on the particles filter).

Checking baskets in the cylinder in order to confirm the defect and the defect basket isolation is made according to specific procedure for this situation.

Visual check of each basket and repair by additional welding of the suspect basket will be made in SWS. If the defects can not be repaired, the defect basket will be returned to the SFB and reopened for fuel bundles transferring in a new basket.

Biological protection of storage modules

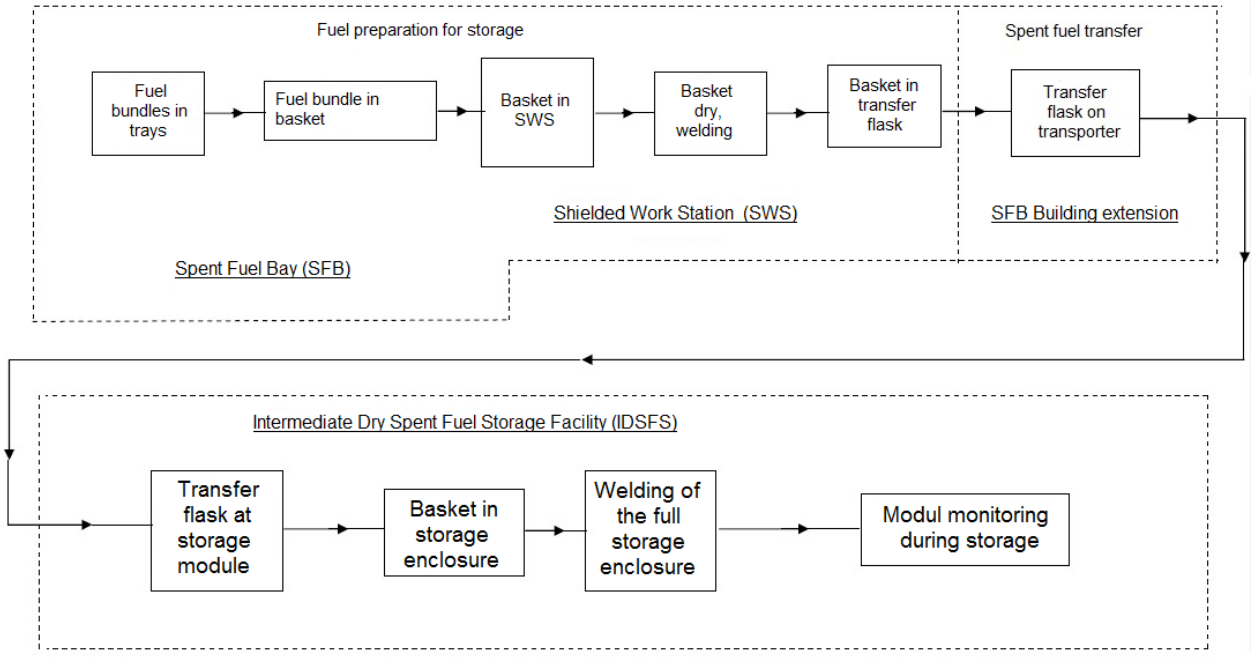
Storage modules are provided with a thick layer of concrete with biological protection role of 965 mm minimum thickness. The thickness chosen for this concrete layer for normal density ensure complete neutron mitigation, the dose rate at the outer surface of the module being caused only by gamma radiation.

The storage module is designed to reduce dose rate at less than 25 μSv / h. If the measurements indicate higher values of doses rates than maximum project value, protective measures are taken by local temporary shielding and appropriate operating procedures.

Regarding shielding penetrations storage module, external parts of the inlet and outlet air circuit are equipped with two thin axial shielding plates, that ensure the reduction of the dose rate below 25 μSv / h for the fuel cooled 6 years in SFB.

III.5.3. Description of production processes of the proposed project, depending on the investment specific, products and by-products, size, capacity

In the image below is represented a block diagram of the main activities required to transfer spent fuel from Cernavodă NPP *Unit 1 and Unit 2* at IDSFS.



Next will be described various stages of fuel loading and preparation for storage, namely welding of the storage basket, transfer to the deposit and loading storage baskets into the storage module.

The estimated duration of the technological process

Processing time for a fuel basket for storage is 4 hours, as indicated in the following table.

The estimated time for fuel preparing and transferring

TECHNOLOGICAL PROCESS STEPS	**Estimated medium time**
Loading operations of the storage cylinder	2 hours
Storage basket drying in SWS	0,5 hours
Other operations in SWS (position placement of the transfer flask, welding, checks and documentation)	0,5 hours
Transfer to IDSFS	1 hour

Loading operations of the basket with fuel bundles in SFB requires about 2 hours with 2 operators. Operations in SWS takes less than an hour; fuel drying operation lasts 30 minutes and the remaining time is used for welding, placing the transfer flask on positions, checks and documentation. Transfer to the storage, loading of the basket in the storage module and return the transfer flask in Building Extension SFB takes less than an hour.

Operations in Spent Fuel Bay (SFB U1 / U2)

The sequence of operations required for preparing spent fuel for storage is:

1) the empty basket with cover is brought in the SFB building. The cover is separates from the support subassembly, using the handling tool of the cover outside of the bay, suspended from monorail hook. The subassembly support basket is lowered on th rotary table in the bay using the long manual handling basket tool.
2) the tray that will be transferred into the basket is identified, in accordance with the inventory bundles of specific records to confirm the storage characteristics.
3) the tray is brought from SFB, where it was stored and is placed on the working table, in the tilter device, using the trays handling tool and the gantry crane.
4) the odd row of bundles are raised in the unloading position, until the 12 bundles reach the vertical position. The bundle series are checked, using the underwater telescope and compare with the inventory records from the approved list for transfer. Then the bundles are hoisted one by one from the tilter device and loaded in the basket, using the bundle manipulation device, which is hooked into a pneumatic balance. The rotary table is manually rotated to optimize the distance between the tilter device and the empty place from the basket, where the next bundle must be loaded.

5) When all 12 bundles were transferred into the basket, by using the handling tool of trays, the tray is raised and rotated with 180°, then sits back on the tilter device. The second set of 12 bundles is rotated upright and loaded into the basket, after confirming that the identification numbers of the bundles are in agreement with inventory records from the approved list for transfer.
6) The empty tray is moved from the tilter device, another loaded tray is brought, and the cycle repeats until the basket is filled (2.5 trays). Empty trays are moved to a predetermined location, or are transfered to Reception Basin S-124 for reuse.
7) After the basket was loaded with bundles, it is inspected. Identification numbers of bundles are independently checked and compared with inventory records from the approved list for transfer. Gamma dose rate can be checked to ensure they were not included in the basket bundles with gamma dose rate too high (bundles that have a lower cooling period than nominal). EURATOM / IAEA / CNCAN staff can inspect the basket using their own equipment, to ensure that in each bundle is really the fuel that has been irradiated in the reactor.
8) the cover is put over the basket, then the basket is moved from the rotary table on the transfer table. The basket is carried up under the SWS airlock using the transfer table, and thus, the basket is brought in the position to be raised in SWS, for fuel drying and basket welding.

Depending on the operation stages, the fuel loaded basket can be temporarily stored in SFB, awaiting transfer in SWS. In this case, handling of the basket loaded with fuel in SFB is done using pneumatic hanging tool, suspended from the new gantry crane.

Bundle inspection is possible at any time during these operations. All these operations are done at minimum 4.3 m underwater. Keeping a layer of water of at least 4.3 m above the work tables from SFB is an operating limit, established to ensure radiological protection function.

Registration of fuel bundles is performed according to the plant procedures, to meet the requirements of EURATOM / IAEA on safeguards control.

SWS operations

To prepare the fuel in SALA, following preliminary operations are necessary:

- put into operation drying fuel system
- check the welding system
- check the transfer flask functionality.

The main operations occurring at SWS are:

1) the empty transfer flask is lowered on SWS, using the Extension Building SFB gantry crane; the correct positioning is checked using position limiter. then the flask roof opens fully.
2) The hanging tackle device SWS is lowered using remote, to lift the basket on the transfer table. The basket is hooked and raised in SWS airlock. There takes place the basket decontamination, of the handling chain, of the hanging head and of the outer surfaces, with a spray system with demineralized water. Fuel basket remains above the bay water until leak of from the components.
3) The basket is raised in SWS, and the trolley / rotary table of SWS is brought under the basket. The basket is then lowered (inside SWS) on the trolley / rotary table and the hanging tool is detached of the basket.
4) The trolley / rotary table of SWS is moved to the position of drying inside SWS. The basket cover is raised and the drying sequence begins, by rotating the basket. During drying, the heated air passes over fuel bundles and then, before being evacuated to the ventilation system of SFB, is passed through a filter system. Upon completion of the drying sequence, using video system, the part of the base of the basket is inspected, which must be dry and free of water traces, if the basket drying is complete.
5) Once dried, the basket is moved into position for welding inside SWS. It achieves first the lower peripheral welding, followed by brief high welding, according to specific procedures. Welding operations are manually adjusted and then are made automatically. Working parameters during welding are registered. The welder visually inspects, using video cameras, each sealing weld, to check the quality of welds, according to specific procedures.
6) The storage basket is then placed under the transfer flask, is lifted in flask and the roof of the flask is closed. The basket is lowered and placed on the roof, and power supply and compressed air of the transfer flasks are disconnected.

Following these operations, the fuel basket, placed in a safe position in the transfer flask, may be transferred to the storage deposit.

Most of the operations above are performed remotely. Checking the weld (for acceptance) is done by visual inspection according to specific procedures and acceptance criteria. Quality assurance of welding is performed by using an approved welding procedure and authorized operators, and by providing and visual examination of welding samples (rings). Welding samples are taken every 10 baskets (frequency that provides a set of samples for each storage cylinder) and are examined to confirm the quality of welds made to predetermined parameters. Registrations for the inspection of welding are kept for further checks.

AECL projects for the storage basket and for the welding system of teh basket proved to be extremely reliable, with a cumulative rate of 100% success at over 1,000 baskets made. It has not recorded any defect, showing the performance

of 100% containment barrier integrity of the basket. However, there is an additional possibility of checking the integrity of the basket: once 10 baskets are loaded in storage cylinder and this is welded (for sealing), the integrity of stored baskets (for detecting possible leaks) is checked by using the sampling system from the storage cylinder.

Inspection activities of the EURATOM / IAEA can occur at any time during fuel handling progress operations in SFB. Inspection requirements for fuel that will be transferred to dry storage depends on the site and EURATOM / IAEA policy.

To check the identification numbers of fuel bundles and baskets, in SFB was provided an underwater telescope. In addition, the existing cameras in SFB can also be used as backup to ensure that there has been no unauthorized transfer of fuel or other disruption of operations. All fuel handling operations allow inspection and registration, in accordance with safeguards requirements of EURATOM / IAEA of each fuel bundle transferred.

When fuel transfer operations are planned, EURATOM / IAEA are notified and can decide to provide the presence of an inspector during transfer operations, or give further instructions.

Fuel transfer operations

After completing operations at SWS, fuel can be transferred to the storage module.

Transfer flask is loaded on the transport mean using the gantry crane of the Building Extension of SFB. For this purpose, the M3 door between SFB and Building Extension of SFB opens, while the main door of the Building Extension of SFB (to outside) is kept closed. An interlock prevents the simultaneous opening of these two doors. An air curtain starts in the M3 doorway, when it opens, maintaining a barrier between potentially contaminated air from the SFB and SFB Expansion clean air. The flask, after being checked in terms of contamination and radiation dose, and is located on the transporter platform and anchored to the mean of transport. SFB Building Extension main door is then opened, and the mean of transport loaded with transfer flask starts to the deposit.

Maintaining physical separation between the SFB and SFB Building Extension atmosphere is a technical condition established to limit the consequences of a possible radiological incident in SFB.

The flask transfer to the deposit takes place under certain conditions:

- any transfer to IDSFS will only be allowed in compliance with all conditions of the CNCAN permits
- before a transfer of spent fuel to IDSFS, the Physical Protection Service must confirm that the route has been inspected and is accessible
- transfer to IDSFS require verbal authorization of the Head Chief Dispatcher of the unit where the transfer is made;

- the flask transfer to the deposit is allowed only during the day (with a speed of max. 10 km / h) and in favourable weather conditions to avoid incidents with radiological consequences.

Loading operations at the storage itself

In the storage area, preparatory activities are done first:

- the loading guide of the transfer flask is positioned above the storage cylinder that will be loaded, using the auxiliary tackle of the gantry crane;
- before the start of loading operations, the protection plug of the corresponding cylinder is replaced by a temporary plug assembly. The screws securing the temporary plug from the loading ring are loosen, releasing the provisional plug.

After these preparatory activities, the main loading operations follows, namely:

1) The mean of transport is positioned near the storage module.
2) The gantry crane is moved over the transfer flask, which is lifted on the storage module using the main tackle of the crane (for this purpose, teh handrail opens). Transfer flask is positioned with the storage cylinder cavity that loads, using the loading guide of the transfer flask.
3) The auxiliary tackle of the crane is used to lift the temporary plug of the storage cylinder, so as to release the enclosure inlet. The transfer flask and the temporary plug are displaced laterally (in the same time but in opposite directions) with the main tackle of the crane, to bring the transfer flask over the storage cylinder cavity. Removal of the temporary plug and positioning the transfer flask are executed remotely using the control panel of the gantry crane.
4) Power and air supply of transfer flask is connected, storage basket is lifted from the flask roof and the hatch is open. The basket is then lowered into the storage cylinder using the electric powered tackle of the transfer flask. Once the basket is placed into storage cylinder or the last basket already in the cylinder, the pneumatic head of basket hanging is separated from the basket and raised into the transfer flask.
5) The hatch of transfer flask is closed and the flask is disconnected from the power supply and compressed air. The flask is moved laterally from the storage cylinder while the temporary plug of the enclosure will be simultaneously reinstalled in its cavity, performing, in reverse order, the operations described above.
6) Transfer flask is lowered from the module, placed back on the mean of transport and returned to SWS for another work cycle.
7) Once the cylinder is loaded with 10 fuel baskets, the temporary plug is bolted by its ring and is replaced by the cylinder shielding plug. The temporary plug assembly is moved on the cylinder to be filled next. This change of plugs is done remotely, similarly to settlement / movement of transfer flask on / from

the storage cylinder. The protection plug of the storage enclosure and protective cover are then welded according to the procedure [5-7]. Up to total filling of the storage cylinder, EURATOM / IAEA temporary seals are applied. Then, permanent seals are applied.

8) The operator then starts drying storage cylinder cavity. To this end, it connects air recirculation pump to the drainage and ventilation lines, and air is circulated through one or more absorbent filters, until all humidity is removed. Once the enclosure is dry, ventilation and drainage lines are enclosed with isolation fittings, and also is closed the protection cover of the reinforcement dock.

Staff requirements and dry storage operation at Cernavodă IDSFS

At Cernavodă IDSFS the team carrying out fuel transfer activities consists of 5 people, plus team leader.

The responsibilities of the team members are:

- team leader: supervising and planning works
- a qualified welder: automatic welding of baskets in SWS and manual welding of the plug to the storage cylinder
- 2 operators: handling trays with spent fuel bundles, filling and handling storage baskets
- 2 operators: transfer basket in the transfer flask and then to the storage and loading storage modules.

Other staff involved:

- Radioprotection technician
- EURATOM / IAEA inspector
- CNCAN inspector.

Additionally, are also used the driver for driving trailer with transfer flask, crane driver to drive the gantry crane, etc.

Summary of the activities described above is as follows:
Activity 1: Fill baskets
Activity 2: Transfer the basket from the bay at SWS
Activity 3: Drying and welding the basket
Activity 4: Loading baskets into the storage modules
Activity 5: Welding the storage cylinder (every 10 baskets)

Routine operation of spent fuel storage system

Storage modules being passive components, requires no routine maintenance.

During storage period, the main operations consist of taking periodic (frequency approved by CNCAN) air samples from the cylinder atmosphere according to the specific procedure, for checking basket and storage cylinder

capacity, to maintain the containment barrier of radioactive isotopes from spent fuel. For this purpose, the cover plate of the fitting dock is opened and the recirculation pump is connected to the drain and vent lines.

The air inside the storage cylinder is recirculated through a particulate filter, an active carbon filter and a drying unit which condenses the water vapour. The particle filter retains solid contaminants, the activated carbon one is analysed for the presence of I-131 and the water may contain tritium. Once completed sampling operations, the monitoring system is disconnected, the fittings closed and sealed with covers and the cover plate placed over the fittings dock.

III.5.4. Raw materials, used energy and fuels, how to ensure them

Given the nature of the project, which involves intermediate storage of spent fuel derived from nuclear units U1 and U2, at the site is not carried out a production process, thus raw materials term is not applicable to IDSFS Extension.

Materials used in the construction of MACSTOR 400 modules are presented in **Chapter III.5.8. Natural resources used during construction and operation**.

Regarding energy and fuels used we make the following clarifications.

At this moment are conducted electrical installations related to IDSFS platform (Access Building and seven modules M1 ÷ M7) and related facilities to the initially set perimeter for two rows of modules namely: perimetral lighting installations and external grounding belt following the route through the ditch of the power cable of normal lighting perimeter.

Power supply of existing facilities on the IDSFS platform, related to Gate Building and existing modules (7 modules arranged in a single row), is made from the general panel 5435-TG1, located in Gate Building.

Energy is provided by the Own Commune Services Station by two 0.4kV power lines, namely:

- the main supply line of panel 5435 - BUJ / J2, via secondary panel 1-5435-TF1, located in the Hydro Node of NPP platform. (Circuit 01 of 5435-TG1)
- reserve line ensured from the transformer point of New Office Building objective (PT-NOB), from the 54370-TGD1 panel / circuit 8 (circuit 13 in 5435-TG1)

Also, the supply of consumers which do not allow interruptions in power supply or admit short interruptions, is made from the safety panel rods 5435-TG2, connected to a Diesel group 90kVA and a UPS group 10kVA, installation placed also in the Gate Building.

At the level of M1 ÷ M7 modules, on each module are provided two circuits of three-phased sockets / outlets (two sockets / circuit) and a separate single phase circuit for the control installations related to the module.

The circuits 05 and 06 of the general panel 5435 -TG1, are allocated to supply of the sockets for the first row of modules.

Power supply of sockets related to M2 ÷M7 modules is achieved curly, from the first module.

The power supply of the Gantry Crane of 30t that services this first series of modules is made also from the general panel 5435 -TG1 through a separate circuit (circ. 03).

To extend IDSFS Facility will be provided similar solutions to ensure electricity supply.

Regarding fuels, similar to the previous stage of expansion of the IDSFS Facility, will use Diesel fuel for the following activities:

- transport spent fuel basket to the modules on IDSFS site by auto-transporter
- realization of the construction works of the MACSTOR modules - machinery and transport means involved in the building process of modules
- Diesel group functioning in the event of any interruption in power supply

Diesel fuel will be provided by suppliers approved by NPP / filling stations.

III.5.5. Connection to existing utility networks in the area

The existing situation of water supply connections / sewerage at Cernavodă NPP

a) Water supply

a1) Drinking water supply

Currently drinking water supply from underground of Cernavodă NPP industrial platform is regulated by Water Management Authorisation No. 131 from 01.06.2016, issued by the "Romanian Waters" National Administration (ANAR).

Source of drinking water supply is underground, power being achieved through 3 deep wells, two wells located inside and 1 located in the NPP Campus, respectively:

- **Fj1** H = 700 m Nhs = 4 m; Nhd = 10 m; Q = 16 l/s
- **Fj2** H = 700 m Nhs =3,1 m; Nhd = 5 m; Q = 28,5 l/s
- **Fj3** H = 700 m Nhs = 5,17 m; Nhd = 5,92 m; Q = 21,2 l/s (NPP Campus area)

The reserve is ensured from the drinking water supply system of Cernavodă town - operated by RAJA SA Constanta.

Drilling water supply from underground in the NPP area are connected by two HDPE pipelines provided with Dn 180 mm at the main pipe of adduction of NPP, made of HDPE tubes diameter Dn 250 mm, ensuring supply of two storage tanks made of reinforced concrete provided with V = 1500 m^3 each.

Of the two storage tanks, one is in service and the other one is kept clean, isolated, drained. Passing from one tank to the other is made at maximum six months or whenever needed.

The drinking water network is common to the classical and nuclear side.

a2) Technological water supply

The water source is the Danube River – Section I of the Danube-Black Sea (DBS) Channel, through the derivation canal. The degree of usage assurance is

97% and is regulated by Water Management Authorisation No. 305 from 17 December 2013, issued by the "Romanian Waters" National Administration.

The Danube River can provide the required flow for cooling. For a nuclear plant, the maximum flow is 53.8 m^3 / s, flow formed of condensers cooling water and service technical water.

Chemical Water Treatment Plant (WTP) produces, stores and delivers demineralized water to be used in different systems of Unit 1 and Unit 2.

For operation with two (2) units, corresponding to a maximum flow of 108 m^3/ s, outlet and adduction system of water to the plant are capable of providing flows of cooling water specific operating mode at maximum power or maintain the two units in stopped state, safely guaranteed.

a3) Firefighting water supply

The water source for firefighting is the Danube, taken either from the derivation canal after passing through a 5mm mesh filter, or after its passage through the rotary screens of the technical service water system and the Brassert filters of the firefighting water system.

Current household of firefighting water covers the need for Cernavodă NPP site, according to fire risk scenarios under the NPP documents, underlying CNCAN authorization (RFS U1 / U2; RPS DICA; RFS DICA).

The analysis of fire danger made for units of Cernavodă NPP has demonstrated that, for all the appearance of a fire, combined capability of fire protection systems, and intervention of mobile teams of firefighters are sufficient to not reach to a generalized fire to all targets at the site. This result is the natural consequence of design principles used in nuclear facilities that provide sufficient safeguards to prevent the spread of fire and fire sources separation from combustible materials, whose storage is done under strict administrative control.

b) Sewage, rainwater and technology wastewater circuit

b1) Domestic wastewater sewer

Currently, not-contaminated radioactive domestic wastewater coming from Units 1 and 2 are discharged into the sewerage system of the Cernavodă city, based Water Management Authorisation No. 131 from 01.06.2016, issued by the "Romanian Waters" National Administration.

b2) Rainwater and technology wastewater sewer

Currently, drainage of rainwater, including underground drainage, inactive drains in the turbine building, U1 and U2 reactors buildings, buildings SDG U1 and U2, siphoning pool 1(2), CTP, water resulting from cleaning mechanical filters WTP, wastewater from oil separator, meteoric on the surface of hydrogen deposit and water coming from splashing hydrogen reservoirs, is made in the distribution basin of Cernavodă NPP.

Intermediate Dry Spent Fuel Storage Facility (IDSFS) and continuing to build the MACSTOR 400 type modules

Intermediate Dry Spent Fuel Storage doesn't require connection to water supply network (Drinking water, Technological water, Firefighting water) nor to the sewage network for domestic or technology wastewaters.

The only necessary utilities on IDSFS site are the pluvial sewerage and electricity supply.

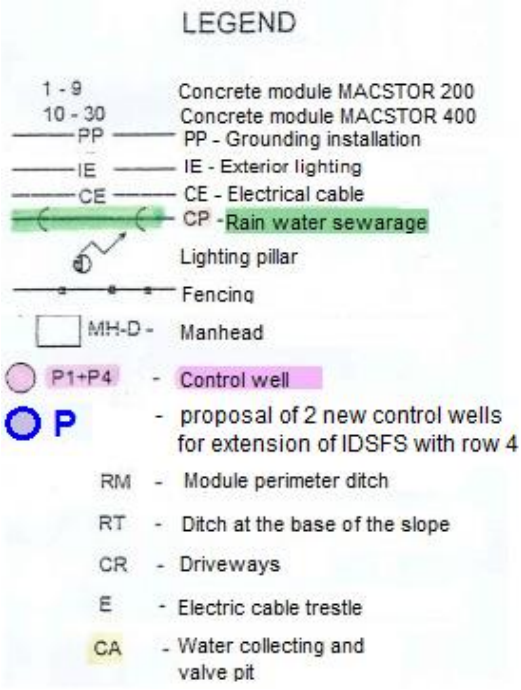
Cernavodă NPP has the Water Management Authorisation No. 267 from 11.11.2013 for Cernavodă Intermediate Dry Spent Fuel Storage (I.D.S.F.S) which grants to the authorization holder, S.N. NUCLEARELECTRICA S.A., Cernavodă NPP branch, the right to use the hydraulic structures and receptors for drainage of rainwater from the surface of Intermediate Dry Spent Fuel Storage, in compliance with the structural and functional parameters, discharged water quality indicators and all the obligations and conditions established by the authorization.

For the drinking water consumption, necessary for the staff, will be provided bottled water.

It is not necessary to extend the existing utility networks of the power plant (electricity supply and rainwater sewer), the connection of proposed modules on the site of extended IDSFS will be made to existing networks, that has been designed from the beginning to support future extensions of IDSFS.

The following image shows the route networks of the IDSFS site - rain sewer, electrical wires, piezometric wells, etc. (Drawing no. DI-08230 - SF01 – GA – 2 - 2).


SIR 1
SIR 2
SIR 3
SIR 4
DRUM ACCES
ACCES PRINCIPAL DICA
ECUNDAR
P
P



Rain water sewer – Rain sewer network related to the storage facility

Rain sewer network related to IDSFS site consists of concrete ditches covered with metal carriageway grills, sewers from HOBAS type tubes made of reinforced with glass fibre polyester (PAFS), on which are located manholes HOBAS type and inlets fitted with HOBAS type grills.

The total estimated flow of water from rainfall for the entire surface of the storage platform is approx. 300 l / s determined in accordance with STAS 4273-83 (Importance class I-exceptional significance construction) STAS 1846-90 (rain with calculation frequency of 1/5 years) and STAS 9470-73.

Roads and platforms inside IDSFS are designed so that through considered slopes, water from rain to be properly evacuated to ditches and sewers related to IDSFS platform. The remaining land of the IDSFS site – green spaces, is arranged so as to solve drainage from rainfall, with drainage slopes toward adjacent roads.

Rain water from the perimetral embankment of the platform are taken through concrete ditches and discharged into a pit located outside the IDSFS enclosure, close to it. The ditches are positioned at the base of the embankment, in the space provided between the enclosure embankment foot and the inner fence route of physical protection.

On the first row of modules type MACSTOR 200 are executed three water collecting and valves pits.

At the group consisting of 2 (two) modules (modules 1 and 2, namely 3 and 4) MACSTOR 200 type is made a ditch (with a length of about 120.00 m), perimetrical, with cross section of about 50 x 50 cm covered with metal carriageway grills, and between modules is executed a ditch, covered also with metal carriageway grills, having also a cross section of about 50 x 50 cm

connecting to a water collection pit, with volume of approx. 2.00 m^3 and a pit of valves, located between modules.

In the group of three (3) modules (modules 5, 6 and 7) MACSTOR 200 type is made a ditch (with a length of about 200.00 m), the perimetrical, with cross section of about 50 x 50 cm covered with metal carriageway grills, and between modules is made a ditch (namely 2 ditches), also covered with metal carriageway grills, having also a cross section of about 50 x 50 cm connecting to a water collection pit, with the volume about 2.00 m^3 and a pit of valves.

To prevent the penetration of rainwater through the visiting opening in the pit of valves, starting from module 2 was provided bordering of the opening with an L 70x70x7 angle.

Upon completion of each odd module, until commissioning of the even pair module, the perimeter ditch is partially made, and is closed by the corresponding section of the unexecuted even module.

Collector pit along with the ditch are able to collect and confine the maximum volume of water, resulted in 24 hours of rain, with return period of 5 years, from the platform related to both modules between which are placed.

This protection measure provides a sufficient time for verification of water thus retained and discharge accordingly without allowing possibly contaminated water spreading. The operating conditions are described below.

In the collector pit was installed a level indicator, and the alarm of the maximum level of water from the pit (from rainwater and water from washing platform) is transmitted in the Main Control Room (MCR).

Drainage of water collected in the pit is made gravitational at the meteoric sewage collector of the platform, through a valve pit located adjacent to the collector pit.

The valve pit is equipped with 2 (two) valves, one on service and one on reserve; these valves are located on a pipeline of high density polyethylene, with D_{ext} 160 x 6.2 mm, which takes water from the collection pit.

For quality control and water levels in groundwater on the IDSFS relevant platform, four (4) drilled wells (piezometric wells - P1, P2, P3, P4) were placed. Drillings are made of high density polyethylene (HDPE) pipe, PE80, being composed of a protective column with D_{ext} 400 x 22.8 mm and a filtering column with D_{ext} 110 x 6.3 mm and have a depth of approx. 14.00 m.

Once the construction of 4th row of modules will start, will be executed another 2 additional drilled wells that will ensure the control of quality and water levels in the groundwater from the entire extended IDSFS platform.

Frequency of measurements, types of analysis, required detection limits are detailed in the latest revisions of documents SI-01365-RP06 and SI-01365-RP15.

During a storage campaign of irradiated fuel, the valve from the valve pit for the module being loaded is in closed position, in order to retain water from rainfall from related platform.

From the collecting pit water samples are taken to check possible radioactive contamination.

Water is released only after through laboratory analysis is confirmed that the water is not contaminated with artificial radionuclides, according to the procedure SI-01365-RP06.

If the water collected, resulting in rainfall from the platform is radioactively contaminated, it is loaded into trucks and transported to the NPP, where is taken by the Liquid Radioactive Waste System.

If this water is not radioactive contaminated, the valves from the valve pit opens, and the water collected is gravitational discharged in the sewage collector from rainfall from IDSFS platform.

Between storage campaigns, the valve is put in the open position, only after confirming the lack of contamination of the platform.

To prevent seepage from ditches and pit of collected water possibly radioactively contaminated, they are protected waterproof.

Waters from rainfall from the rest of the IDSFS platform and water coming from rainfall on the perimeter embankment of the arranged platform, will be discharged by gravity through a collector tube, HOBAS type, made of polyester reinforced with fiberglass (PAFS), on which are located manholes HOBAS type, in Cismelei Valley.

By extending IDSFS Facility, the rainwater sewer network will expand suitable for all surface that will be occupied under the expansion project, using the same technical solutions described above, the sewer of rainwater being achieved similar to the previous stage of extending the facility. Also, as mentioned before, 2 additional drilled wells will be made once the construction of 4th row of modules will start.

Following the extension of IDSFS, the total number of necessary manifolds pit and valves will be 25, of which 3 are executed.

Further, the instrumentation and control system will perform the role of signalling in MCR of the high level in rainwater pits associated to modules, in total by extending the facility, will be required a total number of 22 signals. The instrumentation and control system also performs the function of measuring temperature in various locations of the module no. 10 (representative of all the modules MACSTOR 400).

Waters from rain on the perimetral embankment of the IDSFS platform will be taken also by concrete ditch, that will ultimately have a total length of approximately 655.00 m (350.00 m of which is already completed), and discharged into a manhole located outside the enclosure of IDSFS, in the immediate vicinity.

Waters from rainfall from the rest of the IDSFS platform (as detailed above) and water coming from rainfall on the perimeter embankment of the arranged platform, will be discharged by gravity, in Cismelei Valley.

Power supply - electricity supply system of the storage facility

Ensure power supply to consumers of class IV, 0.4 kV (consumers that admit indefinitely interruptions in power supply), that are on IDSFS Facility platform and a UPS equipment that provide uninterrupted power for physical protection systems and safety lighting (220 Vac).

The system components are:

- Distribution panel 1-54350-TF1, 400/230 V, 50 Hz located outside the transformer cabin 5325-T20
- Distribution panel 1-54350-TG1, 400/230 V, 50 Hz located in the IDSFS Access Building, Electrical Station
- Distribution panel 1-54350-TG2, 400/230 V, 50 Hz located in the IDSFS Access Building, Electrical Station
- Distribution panel 1-56840-TS, 400/230 V, 50 Hz located in the IDSFS Access Building, Weak Current Room
- Distribution panel 1-56740-TL, 400/230 V, 50 Hz located in the IDSFS Access Building, Electrical Station
- Distribution panel 1-54350-PDG, 400/230 V, 50 Hz located in the IDSFS Access Building, Electrical Station
- UPS equipment, 5435-UPS, 60 kVA @ 1 hour, located in the IDSFS Access Building, Weak Current Room
- Diesel Group generator, 54350-DG, 400 V, 50 Hz, 90 kVA, located on a concrete platform, adjacent to the IDSFS Access Building
- Distribution panels, 54350-TD for supplying the Gantry Crane, 30 tf
- Distribution panels, 54350-CD for supplying welding installations
- Electrical cables of 0.4 kV, from reinforced and unreinforced copper, with PVC insulation, with high resistance to flame propagation. The cables will follow the route on the rastel in Access Building and canal, outside, to consumers from the platform
- Installations for grounding and lightning protection

The main electricity supply of IDSFS consumers is guaranteed from Unit 0 of the plant, transformer point 0-54350-BUJ / J2 and the reserve power is provided in the transfer point for the New Office Building, 54370-TGD1 panel.

From PT 0-54350-BUJ/J2 is fed the 54350- TF1 panel, which ensure electricity supply to the general panel 54350-TG1. Reserve power is connected to this panel also.

From **54350-TG1** is supplied 54350-TG2, the gantry crane, the welding installations and 56740-TL.

54350-TG2 distribution panel ensure normal supply for UPS and 56840-TS.

56740-TL distribution panel ensure normal supply of interior and exterior lighting, and sockets circuits.

56840-TS panel is supplied normally from 54350-TG2, and until complete start of the Diesel generator, from 54360-UPS. From TS is powered the outdoor safety lighting and consumers related to physical protection systems.

543520-PDG distribution panel is fed normal from TG1 and at the loss of this supply, from the Diesel generator. From this panel major consumers are supplied, consumers that not accept large interruptions in power supply [UPS via TG2]. Diesel Group connection at the general panel rods is realized through a control panel, 5435-PDG, which provides interlocking and fast automatic release of the group, if the normal source is unavailable.

Grounding System - IDSFS Facility

For protection of personnel in the IDSFS Facility area from electrocution or electric shocks are provided:

- An earth connection consisting of a natural socket, using module foundations and utility networks (water, sewer etc.) and an artificial socket, made of galvanized steel band of 50 x 6 mm and vertical electrodes, which will be connected to the building belt and external metal parts that normally are not under tension, but accidentally may get under tension.
- An earthing belt of the gate building from galvanized steel band of 25 x 4 mm which will be connected to all metal parts that normally are not under tension but accidentally may get under tension.

Lightning protection system

Lightning protection system is intended to reduce the risk of damage buildings and external technological installations and the risk of persons' injury.

Lightning protection system consists of a capture facility, descents and earth connection (common for lightning protection and electrical protection system).

Signalling system of rainwater level

The signalling system of rain water level is designed to announce the operator from the command room of Unit 1 that, in the water pit between two modules, the water level has reached the set value, requiring its intervention.

Signalling mode is performed as follows:

- in the pit was installed an oil-gauge with float, which opens the signalling contact at the achievement of predetermined value
- circuit feeds an intermediate coil relay placed in the unworkable outline of command room
- after discontinuing the circuit, a contact will signal to the scanner the exceeding of water level in the pit.

Communication Systems

For the operative communication with the fuel storage is used mobile phones. Communications systems are provided between spent fuel facility and Unit 1 in order to ensure physical protection.

Control system and guarantees

The objective of the IAEA guarantee control is to ensure that all nuclear material are properly tracked through constant surveillance with a device installed by the IAEA or through a IAEA inspector, so any unauthorized movement to be detected.

III.5.6. Description of the rehabilitation works of the site in the area affected by the implementation of the Project

During construction and normal operation of the project objectives, these will not affect local flora and fauna and are therefore there are no ecological reconstruction works necessary.

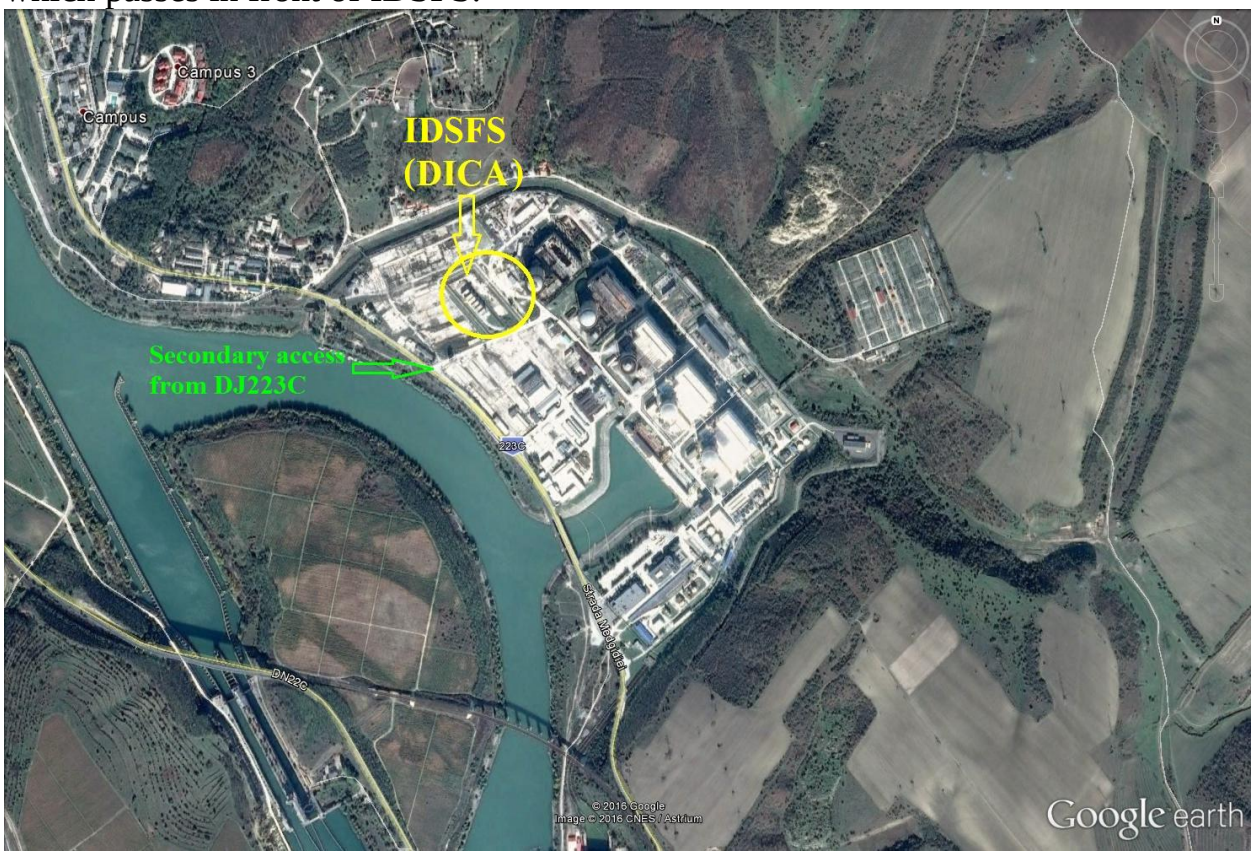
Upon completion of construction works of the investment no special recovery site / ecological reconstruction works are necessary, given that its site is located in an industrial area, inside the Cernavodă NPP.

Following decommissioning of the objective, depending on the potential existing radiation source, appropriate measures are necessary for decontamination and environmental protection.

Before starting the decommissioning works, the beneficiary will prepare a decommissioning plan, which will provide to the national authorities in nuclear safety, environmental protection, public health, needed information for issuing regulatory documents, necessary to implement for these activities (Technical documentation for obtaining the environmental permit for IDSFS operation, CITON, 2003).

III.5.7. New access roads or changes of the exiting ones

Access to IDSFS is achieved by the connection of the existing road from DJ223C on the secondary access road, concreted, interior Cernavodă NPP site, which passes in front of IDSFS.



Access to the storage area is controlled from Access Building and follows the operating procedures of the plant.

The storage area is equipped with two fences. Exterior fence is built in order to prevent unauthorized access, while the interior fence ensure the physical protection of the facility.

III.5.8. Natural resources used during construction and operation

The implementation of the project is done for sustainable development, in the sense that neither construction nor operation involves the use of materials from the depleting natural resources category.

The renewable natural resources used are:

- river stone, sand, wood - resources used in construction - will be provided by the contractor will not be exploited by the Project site
- soil - land on which the building is placed
- water, air - resources used both in construction and in operation.

III.5.9. Construction methods

Constructions works will be done in compliance with:

- Law no. 111/1996 (R2) on the safe deployment, regulation, authorization and control of nuclear activities
- Law no. 10/1995 on construction quality
- Regulation on management and quality assurance in construction - approved by GD no. 261/1994.

For the IDSFS Extension the following works are needed:

- increasing the area occupied by roads and internal platforms
- relocation of physical protection and perimetral ditch and their recovery on the sides of reactor 5 building and from Cismelei Valley
- extension of existing rails and execution of new ones.

Site extension requires also increasing the area occupied by roads and internal platforms. From calculations, results that IDSFS site area will increase by about 7,000 m^2, respectively from about 24,000 m^2 to about 31,000 m^2 (area between the exterior fence boundaries of the objective).

Site extension will include an area in which the quota where the bedrock is - limestone Barremian, is high enough to achievment of foundations in good technical and economic conditions.

Part of the physical protection fence must be remaked on the new site position, namely the one with 4 rows, the average length of fencing that will run in this version is about 330.00 m.

The secondary gateway that provides entering of heavy machinery required to build the modules and arrangement of row 3 and 4 of modules will be located in the right of row 4 on the opposite side of the one containing the main gate at the IDSFS site.

From the point of view of needed facilities of electrical installations to related to construction, they are provided for construction 6 main drag manhead and 23 new connection manholes, one for each module.

9 new additional columns will be needed, fully equipped and 5 existing columns will require disassembly and reassembly. Total number of columns arranged will be 27.

Regarding the rain water sewer network for extension of IDSFS, the total number of necessary manifolds pit and valves will be 25, of which 3 are executed.

The length of the sewerage network in the enclosure will increase from the existing 160 m to approx. 616 m and the length of rainwater drainage network, the perimetral to modules will increase from 440 m as is currently performed at approx. 2060 m.

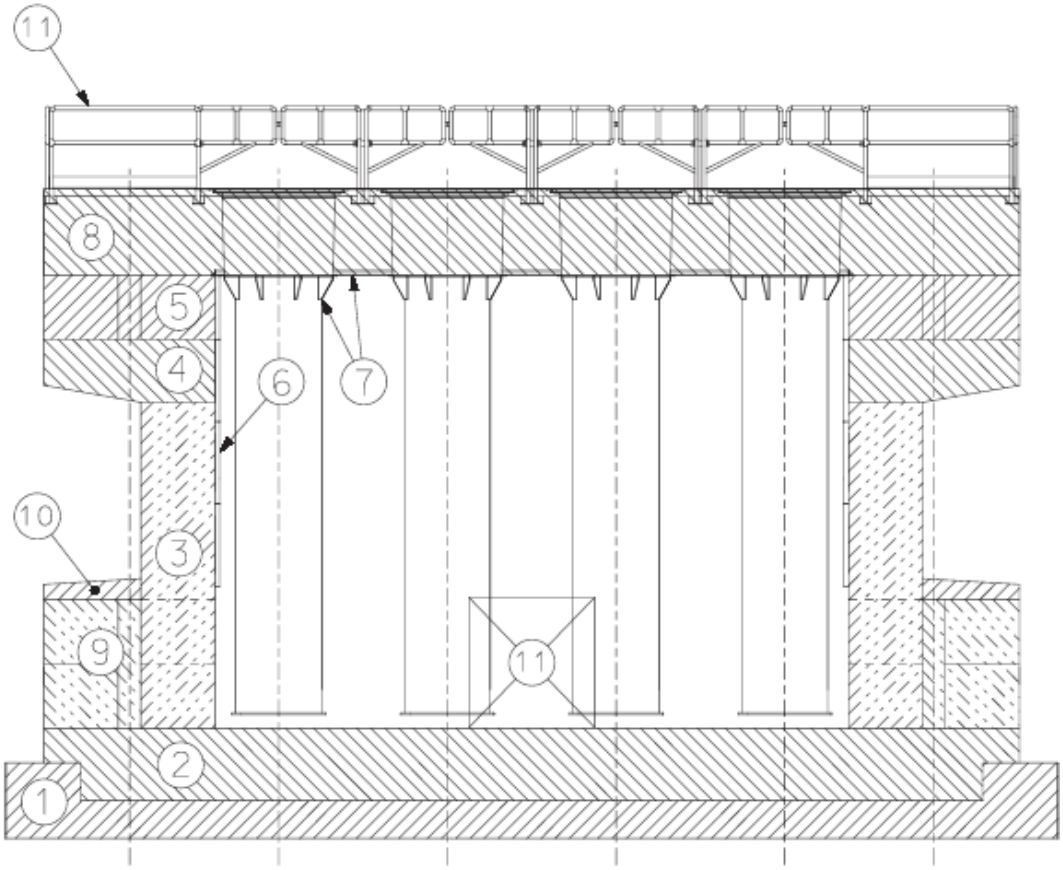
The concrete ditch which takes rainwater from rainfall on the perimetral embankment of the IDSFS platform which currently has a length of 350 m, will be increased and will finally have a length of 655 m.

Regarding the construction of MACSTOR 400 modules are described below stages and methods used construction.

The CM-400 is constructed following the general sequence of operations listed below. This sequence covers only the principal equipment and does not cover all the embedded parts necessary for construction. This following sequence is provided only as general guidance and input to the site installation contractor's civil engineer, who is responsible for achieving the design intent of the drawings and for the development of the detailed construction plan.

The module is subdivided in 3 longitudinal sections that are poured separately, the two extremity ones first, followed by the central portion.

Once foundations are completed, construction typically proceeds with the following steps.



Step # 1. The base slab is poured, accounting for the shear key gap; The base slab is built directly on top of the lean concrete foundations. The base slab size is 1 meter thick and extends slightly beyond the module walls, as per the drawings. The base slab holds the shear key holes that are fitted with Styrofoam laid on two of the four sides, to provide space for thermal expansion of the module following fuel loading. In order to retain the same Top of Concrete (T.O.C.) elevation as the existing MACSTOR 200 modules (for compatibility with the existing gantry crane), the starting elevation has been lowered when compared to the MACSTOR 200;

Step # 2. The module's floor is poured over a polyethylene sheet deposited on the base slab. This pour forms the drains inside the module. This

step has the embedded portion of the storage cylinder seismic restraints installed in the top portion of the floor; in addition to the dowels for the walls; and the embedded anchors for the central reverification columns plates;

Step # 3. The sidewalls and the reverification columns are then poured up to approximately 4.6 m. One of the extremity walls includes a temporary construction opening. Embedded portions of the vent, drain lines and SEGM tubes are installed in longitudinal walls, and the base plate, and the inner steel columns inside the reverification columns is placed;

Step # 4. Embedded portions of the vent, drain lines and SEGM tubes are installed in longitudinal walls, and the inner steel columns inside the reverification columns is placed, from 4.6 m to 6.420 m top of concrete (TOC);

Step # 5. The walls are poured up to the top of the air outlets; and the verification columns up are placed to elevation (6.420 m T.O.C). The air circuits, the module floor and the drain linesare thoroughly cleaned to remove any wood and concrete debris. The surfaces are then vacuum cleaned following construction activities;

Step # 6. The TIPs for the upper portion of the 4 walls to be installed;

Step # 7. The upper deck TIPs and storage cylinders are installed. Vertical tolerance for the entire length of the cylinders to be installed vertically is maximum 20 mm. The flask guide pin locating jig (79D-25529-4009-1-SA-1) can be used to locate the centerline of the cylinder top opening and to support a laser plumb bob or another instrument. The centerline of the drain hole in the bottom plate represents the storage cylinder centerline datum at the bottom plate;

Step # 8. The upper deck is poured in a single step over a polyethylene sheet deposited on the TIPs, using the panels as the bottom formwork. Weight of upper deck is supported by temporary supports, and the 16 SEGM tubes and 4 central column tubes need to be placed prior to concrete placing;

Step # 9. The bottom air openings are poured, together with the sampling boxes for storage cylinders;

Step # 10. The air inlet concrete pouring is completed. This specific pour is separate to facilitate formwork removal;

Step # 11. This final step has the storage cylinder vent and drain lines welded to embedded sections, the miscellaneous steel installed, the internals of the module and air circuit are cleaned and the construction opening poured, completing the civil construction of the module.

The MACSTOR 400 module is a reinforced concrete structure holding 40 storage cylinders laid in four rows of ten storage cylinders.

Prior to storage in MACSTOR, the fuel bundles are cooled in the fuel storage pool at Cernavodă NPP site for a minimum period of 6 years. With this cooling, the fuel bundle average heat release is reduced to 6.08 Watts. This reference value of the heat released by CANDU 6 bundles is also used for the MACSTOR 400 module's thermal design. The fuel bundles are loaded under-water in storage baskets.

The baskets are then dried and seal welded at the shielded work station.

The fuel baskets are transferred to the dry storage modules area in a shielded transfer flask that is carried by transport trailer.

Loading operations into the modules consist of lifting the transfer flask by a gantry crane and positioning above the storage module. The shield plug at the top of the storage cylinder is exchanged with the loading plug assembly to facilitate operations and enhance shielding. The loading plug assembly consists of a shielded annulus and a loading plug. The transfer flask hoist is used to load the fuel baskets inside the storage cylinder. When the tenth basket has been loaded, the storage cylinder is closed with the permanent shield plug and a metallic weather cover, both of which are welded to the top portion of the storage cylinder.

Storage Cylinder

The Module storage cylinder is made of zinc-coated carbon steel. Once filled with spent fuel baskets, the shield plug, made from steel lined concrete, is installed at the top of the storage cylinder and its top welded to the storage cylinder.

The storage cylinders are encased in the upper deck with the portion holding the fuel hanging within the inside plenum. The bottom section of the storage cylinder interfaces with seismic restraints to allow free thermal expansion of the storage cylinder in the vertical direction, while restraining movements in the horizontal direction. The top of the storage cylinder is covered with a weather cover to protect the shield plug from elements.

Cooling of the storage cylinders is achieved by natural convection and infrared radiation from the storage cylinder surface and by conduction to the module's upper deck. The cooling air enters the module at the bottom through a set of air inlets, reaches the inside plenum where the storage cylinders are located and then exits the module near the top through a set of air outlets.

The air inlet and outlet ducts are designed as labyrinths and are located at the bottom and top of each of the two sidewalls. The labyrinth arrangement minimizes radiation streaming and provides a low impedance air circuit that maximizes air flow. The air inlets are positioned above the ground to minimize the likelihood of blockage from snow or debris.

The MACSTOR 400 dry storage system provides two containment barriers to the fuel bundles the fuel basket and the storage cylinder. Those barriers thus provide a passive isolation system with controlled restraint, to safely prevent the

release of radionuclides to the environment. The spent fuel storage basket is seal-welded closed and the weld is inspected prior to transferring the basket to the MACSTOR 400 module.

Provision for sampling air within each storage cylinder is provided to detect leaks from either the baskets or the storage cylinder itself. Each storage cylinder is equipped with a drain pipe at the centre of the storage cylinder's bottom plate and a vent pipe located at the side of the storage cylinder near the top. Both pipes are extended to the side of the module near the base, so that air sampling equipment may be connected as required. Each line has a normally closed valve, terminated by seal caps, at its extremity.

Storage Module

The storage cylinders extend into the module's upper deck providing an opening that enables loading of the fuel baskets. Each opening has a shield plug made from steel lined concrete that provides shielding and closes the storage cylinder containment at its top portion. During transfer operations the shield plug is replaced by the loading plug assembly to reduce radiation streaming and help meet radiation protection requirements during loading. Once loading of the storage cylinder is complete, the shield plug is repositioned onto the opening.

The MACSTOR 400 is designed to withstand credible natural and man-made hazards. It is made from reinforced regular-density concrete that provides both structural integrity and shielding.

The concrete is protected from direct infrared heating from the storage cylinders by thermal insulation panels covering the internal ceiling below the upper deck and the upper portion of the walls of the module down to above the air inlets.

The MACSTOR 400 has no moving parts. Structures with such a static operation have no failure mode in normal operation and can only degrade slowly over time. To compensate for slow degradation of the external surfaces over time, repairs to the concrete surfaces are possible when required. The external surfaces of the storage cylinder are directly exposed to the cooling air while the internal surfaces are only exposed to the dry air inside the storage cylinder. To minimize the oxidation rate of the carbon steel internal and external surfaces, the internal and external surfaces are metallized with an appropriate thickness of Zinc. The storage cylinders are self-heated and protected from direct rain by the module. Their external surfaces are thus infrequently wetted, further reducing corrosion by ambient air.

Safeguard Receptacles for use by the International Atomic Energy Agency (IAEA)

The MACSTOR 400 module provides a number of receptacles for IAEA's seals that enable IAEA personnel to safeguard the stored materials.

The module is also provided with 24 re-inspection pipes (also termed re-verification tubes) located along the longitudinal and extremity walls of the

module, to enable profiling or fingerprinting of the radiation signal of each irradiated fuel basket once the storage cylinders are loaded with fuel baskets. These tubes run inside the module walls for the 24 peripheral storage cylinders and are similar in to the ones used for MACSTOR-200. The 16 central storage cylinders are served by four shielded re-verification columns each column housing one re-verification tube that looks at four neighbour storage cylinders. The shielded re-verification columns are provided with 40 collimators each one looking at the position occupied by the fuel basket.

CM-400 MODULE DESIGN PARAMETERS	**PARAMETER**
Designed Service Life of the Structure	50 years
Reference design	Qinshan and Wolsong 400 MACSTOR storage modules
Dimensions of the storage module: -Length (m) -Width (m) -Height (m)	21.9 m 12.93 m 7.58 m1
Structural material	reinforced concrete of normal density
Distance from the Exclusion Zone Boundary	Minimum of 800 m
Fuel Cooling Period	6 years
Average Residual Heat per Bundle (for the reference burnup and cooling period)	6.08 W
Permitted Fuel Temperature during Storage	160°C
Fuel Integrity	Designed both for intact bundles and bundles with defective sheathing.
Fuel Bundle Containment	Via the storage cylinder and the storage basket
Cooling	Via multiple air inlets and outlets located on both sides of the modules (see Section 3.2.1.5.1)
Monitoring	Via drain and vent pipes for sampling the gas between the cavities of the storage cylinders
Air circuit: Number of air inlets Number of air outlets	10 (5 at bottom of each longitudinal side) 12 (6 in top portion of each longitudinal side; 4 full size and two half size)
Maximum/minimum average peak air temperature during the day and during the night	-26°C/ +40°C
Maximum fuel temperature estimated for a storage basket filled with six-year-cooled reference fuel bundles	149.5°C (with a peak ambient air temperature of 40°C during the day and 24°C at night, for a month
Minimum thickness of the concrete wall (for shielding and structural reasons)	985 mm
Maximum wind speed during a tornado (storm)	420 km/hour (no tornadoes occur at Cernavodă)
Design wind pressure	1.0 kPa
Seismic (horizontal) acceleration	0.3 g
Design code for dry storage	CSA N292.2
Main design code for Structural Analysis	CSA N291

Design Basis Events Considered for the	Earthquake, strong winds, tornadoes

Summary Description of CM-400 Storage Cylinder

The CM-400 storage cylinder is designed to hold 10 baskets. The storage cylinder height is set to have all fuel baskets located within the modules inside plenum to maximize cooling.

The storage cylinder is made of carbon steel protected against corrosion by having its interior and exterior metallized with zinc. The storage cylinder is embedded in the concrete top slab of the module and is suspended at a small distance above the module floor.

The top of the storage cylinder has a recess which, along with the shielding plug (carbon steel filled with reinforced concrete), a weather covers and the actual module, is designed to provide shielding for the operating personnel. The MACSTOR-400 cylinders are provided with a shielding ring to enhance shielding between the shield plug and the storage cylinder. Both the biological protection plug and the stainless steel weather cover are part of the storage cylinder accessories.

The bottom section of the storage cylinder is located at a sufficient distance to the floor to access the drain pipe and provide sufficient space for thermal expansion of the storage cylinder. This arrangement also reduces heat transfer from the storage cylinders to the floor. In the unlikely event of a basket drop event inside the cylinder - from a height of 7.5 m, the impact analysis confirmed that stresses are kept under allowable limits and that:

1. Upper deck of MACSTOR 400 module retains the storage cylinder in place;
2. The storage cylinder maintains its structural integrity; and
3. The fuel basket can be retrieved after the drop event.

The weather covers and the top of the cylinder that is exposed to the atmosphere are made of stainless steel and are seal welded to each other after the cylinder has been filled with ten storage baskets; this provides the second containment barrier of the storage system. The base plate of the storage cylinder provides a space for two holes in which the seismic restraints are located, preventing any lateral displacement of the cylinder.

Following are presented the conclusions of the **Study on geological and hydrogeological characteristics of the IDSFS site to approve the foundation soil** conducted in 2000 by GEOTEC S.A.:

The present study shows an alternative location of the spent fuel facility (IDSFS), the only one possible in the given geologic conditions, where the calcareous relief was used as foundation soil for the other nuclear objectives.

The only unused portion remained is the western extension of it, which was recommended by GEOTEC.

The investigation works executed confirmed and detailed the old data allowing exact shaping of the calcareous relief buried. Also by geophysical

investigation were evaluated and confirmed the values of the main geotechnical parameters, previously obtained in adjacent areas.

Measurements of underground water level made over two years in drillings especially made for the Barremian aquifer in the entire area around the barremiene platform, filled with those on main natural river arteries (Danube) or artificial (Danube-Black Sea Channel) which works alternately as suppliers or dischargers of the Barremian aquifer, have allowed obtaining a complete picture in hydrogeological terms. Thus, variations up to 7-9 m (maximum accidental values 1% = 12.10 mdMB and extraordinary 1 ‰ = 14.13 mdMB) of the Danube levels induce a movement type tide with seasonal frequency and amplitude up 3-3,5 m of underground water level from the barremiene limestone, between 7-7.5 and 10-10.5 mdMB quotas.

Seasonal variations like written above on the covering deposits quaternary inhomogeneous sometimes loess or fillers made uncontrolled to even out the initial land greatly diminishes their geotechnical characteristics after repeated changes of humidity status, making them unsuitable for direct foundation.

When choosing a foundation solution is necessary to take into account those described above, to ensure avoidance of construction settlement on these deposits and unloading loads given by the facility building on the rocky limestone massif, at reasonable depths (0-6 m above the current level of land) in an area larger than that required for the actual construction.

To achieve the final quota required by the project in implementation of platform construction is necessary to create a controlled filling of local materials between the current land surface and the above mentioned quota.

It is necessary a permanent consultation between geologists, designer and builder, then in detail execution phases of a permanent geological supervision.

The monitoring system of the site in terms of hydrology is presented in the current study phase by 5 observance drillings: D2, D6, D7, D8, D9, plus 101 drilling previously executed (drills from the Cernavodă NPP platform site). Their location is shown in Annex No.11. These drills have already been tested chemical and radiometric both on samples from cores extracted by drilling, and on water samples from these wells through a program agreed between GEOTEC, ICIM and Cernavodă NPP. In general, these wells can remain outside perimeter of the building, being used in the future during construction or in operational stage. It is possible to include them in an extensive network to the entire area of Cernavodă. A monitoring program is required for these phases through the contribution of the three units mentioned above.

III.5.10. The execution plan including the construction phase, commissioning, operation, rehabilitation and subsequent use

The Intermediate Dry Spent Fuel Storage Facility is a modular construction **allowing phased building, over an extended period as the spent fuel, intermediate stored in SFB should be transferred to IDSFS.**

The development sequence for IDSFS has been described in Information report on long-term strategy of IDSFS development (IR-35370-006, Rev. 3) aiming to ensure the availability of the storage capacity according to the needs.

In these circumstances, taking account of the period necessary to design, drafting documents required for agreements / approvals / authorizations and other considerations related to obtaining agreements / approvals / authorizations (environmental permit, sanitary permit and water management and CNCAN building permit) is proposed to continue the construction of another 2 MACSTOR 200 type modules on the second row (namely, modules no. 8 and 9), and from module 10, to be built only MACSTOR 400 type modules. This provides a grace period (additional) of about 2 years to complete all the legal steps necessary to build MACSTOR 400 type modules.

Scoreboard of the investment – IDSFS expansion is structured so as to accommodate the time needed for design, obtaining permits and authorizations and the time for the actual construction in a manner to avoid certain situations under which Cernavodă NPP could face difficulties in operation due to lack of available storage space.

Scheduling of the investment (INV/Construction + Assembly works)

	Investment			Construction + Assembly		
Activity	**Start date**	**Finish date**	**Months No.**	**Start date**	**Finish date**	**Months No.**
Module 8 type MACSTOR200	**3/6/2015**	**15/1/2017**	20	15/4/2016	15/12/2016	8
Module 9 type MACSTOR200	**3/6/2015**	**31/8/2017**	26	01/12/2016	31/7/2017	8
Module 10 type MACSTOR400	**1/3/2017**	**28/9/2018**	18	01/8/2017	29/8/2018	13
Module 11 type MACSTOR400	**29/6/2018**	**9/3/2020**	21	7/12/2018	6/2/2020	14
Module 12 type MACSTOR400	**9/12/2019**	**17/8/2021**	20	18/5/2020	16/7/2021	14
Module 13 type MACSTOR400	**18/5/2021**	**25/1/2023**	20	26/10/2021	26/12/2022	14
Module 14 type MACSTOR400	**26/10/2022**	**4/7/2024**	21	5/4/2023	4/6/2024	14
Module 15 type MACSTOR400	**4/4/2024**	**16/1/2026**	21	12/9/2024	17/12/2025	15
Module 16 type MACSTOR400	**17/10/2025**	**12/7/2027**	21	27/3/2026	10/6/2027	15
Module 17 type MACSTOR400	**12/4/2027**	**19/12/2028**	20	27/2/2029	29/4/2030	14
Module 18 type MACSTOR400	**19/9/2028**	**29/5/2030**	20	27/2/2029	29/4/2030	14
Module 19 type MACSTOR400	**27/2/2030**	**6/11/2031**	21	7/8/2030	7/10/2031	14
Module 20 type MACSTOR400	**7/8/2031**	**15/4/2033**	20	15/1/2032	16/3/2033	14
Module 21 type MACSTOR400	**14/1/2033**	**25/9/2034**	20	24/6/2033	24/8/2034	14
Module 22 type MACSTOR400	**26/6/2034**	**4/3/2036**	21	4/12/2034	1/2/2036	14
Module 23 type MACSTOR400	**4/12/2035**	**12/8/2037**	20	13/5/2036	13/7/2037	14
Module 24 type MACSTOR400	**13/5/2037**	**3/2/2039**	21	21/10/2037	4/1/2039	15
Module 25 type MACSTOR400	**4/11/2038**	**13/7/2040**	20	14/4/2039	13/6/2040	14
Module 26 type MACSTOR400	**13/4/2040**	**23/12/2041**	20	21/9/2040	21/11/2041	14
Module 27 type MACSTOR400	**23/9/2041**	**2/6/2043**	21	3/3/2042	1/5/2043	14
Module 28 type MACSTOR400	**3/3/2043**	**9/11/2044**	20	11/8/2043	10/10/2044	14
Module 29 type MACSTOR400	**10/8/2044**	**19/4/2046**	20	18/1/2045	20/3/2046	14
Module 30 type MACSTOR400	**18/1/2046**	**27/9/2047**	20	28/6/2046	28/8/2047	14
TOTAL	**3/6/2015**	**27/9/2047**	380			***312***

In order to definitive storage of high active waste, constituted mostly of spent nuclear fuel (considered radioactive waste, in Romania), Romania is considering the construction of a Geological deposit of great depth, until 2060.

Underlying this election state that, internationally, after 30 years of research, has demonstrated sufficient that geological storage is currently the safer option and more durable in terms management of high activity waste on long-term and on nuclear spent fuel.

On the assumption that the Geological deposit will be completed in 2060, and considering the pace of production of the spent fuel, during the two life cycles of U1, U2, it can be seen that some of the spent fuel stored in IDSFS can be transferred to the Final Geological Deposit. In this way it will still provide storage space in IDSFS for the fuel produced by operational units in at that time.

The lifetime of modules to be emptied and used further for storing spent fuel, will be established after a technical expertise of them.

III.5.11. The relation with other existing or planned projects

Currently, IDSFS serves unit U1 and U2 for spent fuel storage resulting from them.

After commissioning of the U3 and U4 Units, IDSFS will serve also these units, being necessary to extend its surface.

The operation of the four units, after two cycles of life, will end as follows:

- Unit 1 at the end of 2050;
- Unit 2 at the end of 2061;
- Unit 3 at the end of 2076;
- Unit 4 at the end of 2076.

Regarding the relation between expanded IDSFS and Unit 5 we mention that the change of Unit 5destination made possible the expansion of IDSFS, by increasing its surface.

Following are presented other future projects, that may be related to the project, respectively:

- **Destination change of Unit 5** was approved by the EGMS Decision of SNN No. 1 of March 11, 2015.

  National Energy Strategy in force on this date, does not provide completion of Unit 5 as required, specifically, completion of Units 3 and 4. The only mention about Unit 5 is: *"Development of a study on capitalization of work performed at this facility"*. Indirectly, therefore, the National Energy Strategy provides the ceasing of works at the object of investment. Meaning those mentioned above, at the SNN SA. level, was contracted the development of „Feasibility study on the opportunity of continuing the works at Unit 5 from Cernavodă NPP in order to use it as a nuclear power", study developed in March 2012.

  The study author, CITON branch from the Autonomous Administration Technologies for Nuclear Energy (RATEN) recommends the use of existing buildings and spaces, by changing destination of buildings and their equipment in order to ensure operation of Units 1 and 2 and subsequently Units 3 and 4, in safe conditions and nuclear security.

  On 13/11/2014, was taken the Decision no 163 of the Board of SNN S.A., according to which the Board of Directors of National "Nuclearelectrica" Company S.A. decided that is approved the commitment to the investment project "*Changing the destination of Unit 5 and use of spaces and structures already achieved, related to Unit 5, to other activities*

related to the safe operation of Units 1 and 2 and subsequently Units 3 and 4".

Following remediation, closure, modification and finishing the construction and division of *Integrated Building*, it will also include the following items:

- Emergency Shelter
- Emergency Control Centre on site (CCUA)
- Fire station house PSI, appropriate to its purpose;
- Making an Administrative Area for intervention personnel in case of emergency
- Manage Technical Areas necessary sanitary equipment, electrical, ventilation and security
- Establish Thermal point in Cernavodă NPP Platform in Integrated Building
- Garage with adequate maintenance requirements of the mobile intervention groups (mobile diesel generators for a total loss of power supply - Station Black Out (SBO).

Regarding the *Reactor Building*, given that this building is made of massive concrete elements, with thicknesses of over 1 m, provides a space for further destinations indefinite at this date, being still carried out repairs and closing, achievement of rough finishes and achieve propensity to connect to utilities, to the limit building without interior compartment.

- Also, the beneficiary has a number of small scale investment projects for 2016 that may have a direct or indirect connection with new integrated project, this list is given below:

No. item	Name of the project
1	Extending the coverage area of the monitoring system of tritium in air U1 / U2
2	Installing a backup extractor on the steam seal labyrinth turbine system at U1 and U2
3	Improving operation of LISS System (Liquid Injection Shutdown System) by replacing the associated valves with another type of valves - MPA - 658
4	Improving the live steam system at U1 by replacing discharge steam valves into the atmosphere (ASDV) with another type of valves -MPA - 581
5	Modernization and expansion of Physical Protection System
6	Rehabilitation and planning of roads, platforms and underground pipelines (including decommissioning of inner CF, of unloading black oil ramp and of ABA boiler. Rearrangement of land and CLU discharge outlets from tankers)
7	Replacement of stationary batteries of 48 Vcc, 220 Vcc and 400 Vcc at U1
8	Replacement of excitation system 1-41220-PL743/3501 GENNEREX from U1 due to the impossibility of buying components with SPV character
9	Increasing operational safety of the power discharge system from Cernavodă NPP, by revamping power discharge transformers and providing a backup trafo for two units
10	Arrangement of support intervention centre at the simulator
11	Installing an "on-line" LEM sub-system at Unit 2 and uniform integration with current LEM system
12	Fitting of 1-5144-T03/T04 and 1-5134-T05/T06 transformers with explosion and fire prevention system
13	Installing filtration systems upstream of the water chambers of U1 and U2 condensers and revamping of the balls cleaning system of U1 condenser
14	Upgrading the compressed air system from U1by replacing the instrument air service and breathing compressors with new generation high performance compressors
15	Installation of online measuring systems of concentration of dissolved gases in the insulating oil of power transformers corresponding 5144-T03 / T04, 5134-T05 / T06 at U1 and U2 and 0-5134- T1 / T2 and 0-5135-TC01 / TC02 at U0
16	Optimizing the sampling of chemical system from the U1 / U2 plant
17	Revamping fire detection systems installed in NSP-U1 and Pavilion 2
18	Replacement of ventilation and air conditioning system for Pavilion 2
19	Rehabilitation and modernization of the equipment of Fire Engine Station – FES
20	GEM Spectrometer of noble gases to ensure monitoring of gaseous emissions from U 2 similar to the one installed at U1
21	Replacement of ventilation and air conditioning system for Pavilion 6 NOB
22	Placing on the suction pipe of the U1reactor building ventilation system, before 1-7312-ACU1, of an air dehumidification system with adsorbent wheel
23	Weather Tower Revamping

III.5.12. Details on the alternatives taken into consideration

Alternative 0 - project non - implementation, keeping current configuration of 27 MACSTOR 200 type modules

Intermediate storage capacity required

Determination of dry intermediate storage capacity is based on technical considerations regarding the number of fuel bundles that are burned annually in each reactor. CANDU 6 reactors have a life cycle estimated at a total number of 210.000 EFPH[2] operating, limited by active area pressure tubes condition.

Quantifying the calendar years of operation is based on the capacity factor achieved in operation. For a CANDU 6 plant with average performance, the total number of spent fuel bundles resulting from the operation, during a life cycle of 210,000* EFPH, at a capacity factor of 80% (equivalent to 30 years of operation) is estimated to be around approx. 144.000 bundles/unit. (288000 for both units)

Since 27 MACSTOR 200 modules accommodate 324000 bundles it is obvious that alternative 0 will ensure the storage capacity needed for only 1 cycle for both units (with a contingency capacity).

From the above considerations and calculations, it is clear the need to extend the capacity of dry storage of spent nuclear fuel, compared to the initial version of the project which provided 27 MACSTOR 200 modules, so Alternative 0 is not a viable solution.

Alternative 1

The solution underlying this scenario is to make better use of the allocated IDSFS site by modifying the current project which provides storage of spent fuel in MACSTOR 200 modules and switching to alternative MACSTOR 400 of them developed as a collaboration between AECL (Atomic Energy of Canada Limited), Korea Hydro & Nuclear Power Co. (KHNP) and Nuclear Environment Technology Institute (NETEC).

In this alternative, IDSFS site would contain: **9 MACSTOR 200 type modules** and **21 MACSTOR 400 type modules** on **4 parallel rows.**

Basically, this would significantly increase the storage density per area unit, fully use utilities and terrain features.

The 30 modules are arranged on an area of land characterized by average rate of limestone bathymetrics + 9.05 mMB (quotas between - 2.0 ... + 12.0 mMB) and foundation quota to an average depth of 4,95 m (including 1.0 m embedding in bedrock) from ground level + 13.0 mMB.

Each row of modules will be provided with their own gantry crane of 30t / 10t-28m, the same type of gantry crane that currently serves row 1 of MACSTOR 200 modules, so 4 gantry cranes will be needed.

[2] EFPH = effective full power hours – total number of operation hours at 100% power

MACSTOR 400 type module is a more compact version of module, having a double storage capacity (24.000 bundles) compared to the storage capacity of MACSTOR 200 module.

MACSTOR 200 – MACSTOR 400 comparative table

Parameter	**MACSTOR 200**	**MACSTOR 400**
Fuel Cooling Period in the irradiated fuel storage	6 years for the reference fuel	
Average residual heat per bundle, for the reference average burnup and minimum cooling period	6,08 W	
Maximum bundle heat power	9,76 W	
Residual power for the storage basket:		
Average basket	364,8 Watts	
Designed Service Life of the Structure	50 years	
Dimensions		
Length(m)	21,64 m	21,95 m
Width (m)	8,13 m	12,95m
Height(m)	7,5 m	7,60 m
Capacity:		
- Number of bundles that can be stored in one module	12.000 bundles	24.000 bundles
Air circuit configuration	- 10 air inlets (5 at each side) - 12 air outlets (6 at each side)	
The heat dissipated by a module	73 kW (analyzed at 78 kW)	145,9 kW (analyzed at 146,7 kW)
Environment temperature	40°C daily maximum temperature	40°C daily maximum temperature

As shown in the comparative table, it can be seen that besides the width and storage capacity of the module MACSTOR 400, there are no major differences compared with MACSTOR 200, resulting an identical operating mode by compatibility with existing equipment (gantry crane, transfer container, loading guide, etc.). Very small difference in length (300 mm) does not bother the use of the same type of gantry crane of 30 / 10t with 28m opening, allowing also the transport trailer access.

The dimensions and characteristics of the module allow achieving a smooth transition from module MACSTOR 200 to module MACSTOR 400 without imposing major changes in the current arrangements of modules rows within IDSFS.

In these circumstances, taking account of the dimensions provided in the comparative table above and considerations about obtaining agreements / approvals / authorizations (environmental permit, sanitary permit and water

management and CNCAN building permit) is proposed to continue the construction of another 2 MACSTOR 200 type modules on the second row (namely, modules no. 8 and 9), and from module 10, to be built only MACSTOR 400 type modules. This alternative provides a grace period (additional) of about 2 years to complete all the legal steps necessary to build MACSTOR 400 type modules.

The storage capacity that result from this proposed alternative would be of 612.000 bundles.

Given that the current authorized location ensures construction of only three rows of modules, it follows that for the construction of the fourth row of modules of the Alternative 1, the site requires an increase in the area.

From calculations results that IDSFS site area will increase by about 7,000 m^2, respectively from about 24,000 m^2 to about 31,000 m^2 (area between the exterior fence boundaries of the objective).

It should also be noted that, this alternative 1, ensures an area of land that would allow construction in the future, of new modules required for the storage of fuel resulting from the operation of Units 3 and 4.

For the IDSFS Extension the following works are needed:

- demolition of physical protection and perimetral ditch and their recovery on the sides of reactor 5 building and from Cismelei Valley
- increasing the area occupied by roads and internal platforms
- extension of existing rails and execution of new ones.

In this alternative, the secondary gateway that provides entering of heavy machinery required to build the modules and arrangement of row 3 and 4 of modules will be located in the right of row 4 on the side of the fencing which contains the main gate at the IDSFS site.

From the point of view of needed facilities of electrical installations to related to construction, this alternative 1provides construction of 6 main drag manhead and 23 new connection manholes, one for each module.

In the Access Building area, the underground space that communicates with the platform enclosure, is very crowded and it is practically impossible to design a battery of pipes, for output wiring was adopted the solution of practice penetrations on the upper level of the room that houses the electrical installations of class IV from Gate Building and cabling works on the existent rack and outside, on the trestle crossing the inside physical protection fence in the vicinity of Diesel group, crosses all aboveground the rain ditch, then descends through pipes in the first drag manhead (MH-1D), continuing underground the route to modules.

New designed cable routes are fitted with capacity to take all new wires (power, control and instrumentation, physical protection, etc.)

In this way are avoided repeated excavations on the ancient paths, or on new trails, avoiding damage of cables already laid, avoiding crowded routes in the gate area.

In these alternative of platform configuration, 9 new additional columns will be needed, fully equipped and 5 existing columns will require disassembly and reassembly. Total number of columns arranged in this alternative will be 27.

The rainwater network (meteoric), corresponding to IDSFS site, consists of collecting sewers from tubes, Dn 500 mm, made of polyester reinforced with fiberglass (PAFS), on which are located PAFS manholes. Sewers are located underground, beneath the depth of frost.

Rainwater channels, for each row of modules, is disccharging by gravity the waters collected in the rainwater sewer ditch located at the base of the IDSFS embankment platform.

In this alternative, the total number of necessary manifolds pit and valves is 25, of which 3 are executed.

From the collector pit water samples are taken to check possible radioactive contamination.

In the collector pit was installed a level indicator, and the alarm of the maximum level of water from the pit is transmitted in the Main Control Room (MCR).

In alternative 1, the instrumentation and control system will perform the role of signalling in MCR of the high level in rainwater pits associated to modules from 8 to 30, located on the 2,3 and 4 rows. In total will be required a total number of 22 signals. Also, the instrumentation and control system also performs the function of measuring temperature in various locations of the module no. 10, MACSTOR 400 type.

Waters from rain on the perimetral embankment of the IDSFS platform will be taken also by concrete ditch, that will ultimately have a total length of approximately 655.00 m, from which 350.00 m is already completed, and discharged into a manhole located outside the enclosure of IDSFS, in the immediate vicinity.

Waters from rainfall from the rest of the IDSFS platform (as detailed above) and water coming from rainfall on the perimeter embankment of the arranged platform, will be discharged by gravity, in Cismelei Valley.

Site extension requires also increasing the area occupied by roads and internal platforms.

The surface of roads and platforms that will be achieved is 4.550,00 m^2.

In alternative 1, part of the physical protection fence must be remade on the new site position, namely the one with 4 rows, the average length of fencing that will run in this version is about 330.00 m.

Alternative 2

To ensure a total of 612 000 spent fuel bundles that can be stored in alternative 1, the number of MACSTOR 200 modules needed in Alternative 2 is 44 modules providing the same reserve of space as in Alternative 1.

Result that, to ensure storage of spent fuel bundles obtained from the operation of Units 1 and 2, with two life cycles will be necessary in Alternative 2, 51 MACSTOR 200type modules.

In this alternative, IDSFS site would contain 51 MACSTOR 200 modules on 6 parallel rows.

To accommodate the additional storage capacity determined for the units U1 and U2, two operation cycles, in the prospect of extension of lifetime for units U1 and U2 with another operational cycle of 210.000 EFPH, in the situation of maintaining MACSTOR 200 module, would be necessary to extend the current IDSFS site (the one with 27 modules on three rows) with another row of 10 modules, a row of 11 modules, and a third row of 3 modules, finally resulting 6 rows of modules.

Each row of modules will be provided with their own gantry crane of 30t / 10t-28m, the same type of gantry crane that currently serves row 1 of MACSTOR 200modules, so six gantry cranes will be needed in this scenario.

The 51 modules are arranged on an area of land characterized by average rate of limestone bathymetrics + 8.90 mMB (quotas between - 2.0 ... + 12.0 mMB) and foundation quota to an average depth of 5.10 m (including 1.0 m embedding in bedrock) from ground level + 13.0 mMB.

Land feature requires the version that would opt for this alternative, the extension site IDSFS to Unit 5, lane 6 modules to be built into the perimeter unit 5, the contempt units 1, 2, 3, and 4, this is the only area where the bedrock is found at a rate feasible to build modules.

Land feature would impose, in the version that would choose for this alternative, **the extension of IDSFS site to Unit 5, the row 6 of modules being built into the Unit 5 perimeter, on the side of Units 1, 2, 3, and 4, this is the only area where the bedrock is found at a feasible rate to build modules.**

From calculations results that IDSFS site area will increase by about **14,000 m^2, respectively from about 24,000 m^2 to about 38,000 m^2** (area between the exterior fence boundaries of the objective).

From the point of view of needed facilities of electrical installations related to construction, this alternative provides construction of 8 main drag manhead and 44 new connection manholes, one for each module. In this alternative are necessary 52 manholes.

In terms of the changes needed to achieve the construction of electrical wiring routes, this alternative, at he level of Access Building, is not different from Alternative 1.

The cable routes to the module, in alternative 2, imposes additional construction works to the one necessary in alternative 1. This is due to the higher number of rows: 6 instead of 4 and higher number of modules: 51 instead of 30, and therefore, a higher number of drag manhead.

In the alternative 2 of platform configuration, 12 new additional columns will be needed, fully equipped and 5 existing columns will require disassembly and reassembly. Total number of columns arranged on IDSFS site, in this alternative 2, will be 30.

It is obvious that the configuration of alternative 2, in terms of outdoor lighting system, leads to a higher cost compared to alternative 1.

Rainwater channels, for each row of modules, is discharging by gravity the waters collected in the rainwater sewer ditch located at the base of the IDSFS embankment platform.

In this alternative are necessary 6 collecting rain water sewers, with a total length of approximately 860.00 m, from which 160.00 m is already completed. On these sewers will be located about 28 manholes.

Rain water sewer network of the modules from ISDFS site is made of concrete ditches covered with metal carriageway grills.

At the group consisting of 2 (two) MACSTOR 200 modules is made a ditch (with a length of approximately 120.00 m).

In the group of three (3) modules (on the first, 5^{th} and 6^{th} row of modules) MACSTOR 200 type is made a ditch (with a length of about 200.00 m), perimetrical, covered with metal carriageway grills, and between modules is made a ditch / namely 2 ditches, also covered with metal carriageway grills.

In this alternative, the total number of necessary manifolds pit and valves is 24, of which 3 are executed.

Waters from rain on the perimetral embankment of the IDSFS platform will be taken also by concrete ditch, with a total length of approximately 710.00 m, from which 350.00 m is already completed,

Site extension requires also increasing the area occupied by roads and internal platforms.

The surface of roads and platforms that will be achieved in alternative 2 is 6.700,00 m^2.

Currently the fencing, which constitutes the physical protection of the IDSFS site is executed and includes rows of modules 1 and 2.

In alternative 2, the fence must be demolished and remade on the new site position, namely the one with 6 rows.

The average length of fencing that will run in this version is about 375.00 m.

CONCLUSIONS - Choosing Alternative 1

Given the limited space of the IDSFS site and the existence of neighbourhoods which have an influence on the expansion and authorization of

this objective (public road, Unit 5, Cismelei Valley, secondary access road and not least the geological characteristics of the land - dramatic collapse of limestone, etc.) an increase in the storage density per unit area, more particularly help to find a solution to extend IDSFS.

The solution underlying this alternative is to make better use of the allocated IDSFS site by modifying the current project which provides storage of spent fuel in MACSTOR 200 modules and switching to alternative MACSTOR 400 of them developed as a collaboration between AECL (Atomic Energy of Canada Limited), Korea Hydro & Nuclear Power Co. (KHNP) and Nuclear Environment Technology Institute (NETEC).

In this alternative, IDSFS site would contain: 9 MACSTOR 200 type modules and 21 MACSTOR 400 type modules on 4 parallel rows.

Basically, by implementing MACSTOR 400 module starting module 10, would significantly increase the storage density per area unit, fully use utilities and terrain features.

The 30 modules are arranged on an area of land characterized by average rate of limestone bathymetrics + 9.05 mMB (quotas between - 2.0 ... + 12.0 mMB) and foundation quota to an average depth of 4,95 m (including 1.0 m embedding in bedrock) from ground level + 13.0 mMB.

Each row of modules will be provided with their own gantry crane of 30t / 10t-28m, the same type of gantry crane that currently serves row 1 of MACSTOR 200 modules, so 4 gantry cranes will be needed.

MACSTOR 400 type module is a more compact version of module, starting from the project of MACSTOR 200 storage module, having a double storage capacity (24.000 bundles) to the storage capacity of MACSTOR 200 module.

As shown in the comparative table presented in Alternative 1, it can be seen that, besides the width and storage capacity of the module MACSTOR 400, there are no major differences compared with MACSTOR 200, resulting an identical operating mode by compatibility with existing equipment (gantry crane, transfer container, loading guide, etc.). Very small difference in length (300 mm) does not bother the use of the same type of gantry crane of 30 / 10t with 28m opening, allowing also the transport trailer access.

Mentioned that the dimensions and characteristics of the module, allow achieving the transition from module MACSTOR 200 to module MACSTOR 400 without imposing major changes in the current arrangements of modules rows within IDSFS.

In Alternative 1, taking account of the dimensions provided in the comparative table above and considerations about obtaining agreements / approvals / authorizations (environmental permit, sanitary permit and water management and CNCAN building permit) is proposed to continue the

construction of another 2 MACSTOR 200 type modules on the second row (namely, modules no. 8 and 9), and from module 10, to be built only MACSTOR 400 type modules. This scenario provides a grace period (additional) of about 2 years to complete all the legal steps necessary to build MACSTOR 400 type modules.

It should also be noted that the alternative I shall ensure an area of land that would allow construction in the future, of new modules required for the storage of fuel resulting from the operation of Units 3 and 4.

Achieving a new spent fuel storage facility inside or outside the Cernavodă NPP site cannot be considered from environmental protection considerations and cost efficiency, such as:

- Achieving of an additional area for which additional resources for security and protection, monitoring, transport distance should be allocated, creating additional a new sensitive point from the environment point of view
- Location outside the Cernavodă NPP enclosure was originally studied as an alternative for site selection, and reached the conclusion that a location outside the plant would require special transport with spent fuel radioactive waste for a long distance, on public roads, an inopportune version in terms of environmental protection.

III.5.13. Other activities that occur as a result of the project (for example, extraction of aggregates, providing new sources of water, sources or energy transport lines, increase housing, sewage and waste disposal)

Regarding the storage of spent fuel it is created a need to build a geological deposit of great depth, given that, following internationally research, it has been shown that in a sufficient way, that geological storage is currently, the safest and most durable option, in concerning to long-term management of high activity waste and spent nuclear fuel. So, some of the spent fuel stored in IDSFS will be transferred to the Final Geologic Deposit, ensuring continuous storage space in IDSFS of the fuel produced by units in operation at that time.

III.5.14. Other permits required for the project

In order to obtain the Building Permit for the project **„ Site extension of the Intermediate Dry Spent Fuel Storage Facility and continuing to build the MACSTOR 400 type modules",** permit to be obtained under the provisions of Law No. 111/1996 (with subsequent additions and republishing) on nuclear activities, in compliance with in force legislation, it is necessary to obtain permits, approvals, authorizations from the competent authorities, such as:

- Sanitary Permit
- Water Management Permit / Authorization
- Sanitation Permit
- Permit of custodians of protected areas in the vicinity of the site, if necessary, depending on the requirements of the competent authority for environmental protection
- The regulatory act of the competent authority for environmental protection
- CNCAN Building Permit

Authorisation of operation and decommissioning involves other approvals, permits and specific authorizations.

The project shall be authorized in accordance with *Law no. 111/1996 regarding on the safe deployment, regulation, authorization and control of nuclear activities* with amendments and additions in force, the nuclear regulatory authority (CNCAN) following to issue the specific Location and Construction Authorisation to allow the construction and installation works.

As regarding the environmental protection, the project is subject mainly to the following regulations:

- Emergency Ordinance no. 195/2005 on environmental protection, amended and approved by Law no. 265/2006 with subsequent amendments and completions
- Governmental Decision No. 445/2009 on environmental impact assessment for certain public and private projects as amended

- Order No. 135/76/84/1284 of 10 February 2010 approving the methodology for applying of environmental impact assessment for public and private projects
- Governmental Emergency Ordinance No. 57/2007 on the status of natural protected areas, conservation of natural habitats, wild flora and fauna, as amended and supplemented
- Order No. 19/2010 for the approval of methodological guidelines for appropriate assessment of the potential effects of plans or projects on protected natural areas of community interest
- Water Law No. 107/1996 with amendments and additions in force and subsequent legislation applicable
- Other subsequent legislation, specific to environmental protection.

According to the provisions of Art. 37 (3) of Law no. 111/1996 with subsequent amendments and completions, and of the Governmental Emergency Ordinance no. 195/2005 approved by Law no. 265/2006 with subsequent amendments and completions, obtaining the Environmental Approval for the Project is one of the preconditions for issuance of the Building Permit by CNCAN.

In the Environmental Approval no. 2058 of 22.04.2002 are imposed the following conditions:

- IDSFS will never transform into a regional storage for radioactive wastes, not even for temporary storage;
- IDSFS will never transform into a permanent storage;
- On this objective will never be stored materials coming from other nuclear technologies;
- To restrict urban development to this area as well as other urban activities;
- To be foreseen a bilateral accepted manner regarding data transmission about radioactive constants, at predetermined time intervals and especially during the periods when the radioactive materials are taken over in the storage;
- The material that the IDSFS storage site will be made of, must allow the takeover of the elastic deformation of construction and the foundation land
- Informing the environmental authority on execution stages of works
- Obtaining all permits and approvals, according to law;
- Prohibition to place temporary storage of fuel and lubricants on the site organization, where losses may occur on the ground
- Prohibition to make repairs of machinery and transport equipment on the site organization, which usually cause fuel and lubricants leaking to the ground;
- Execution of fenced premises or rooms for temporary storage of certain industrial wastes, not be possible their spreading outside the premises of the site organization;

- Obligating the constructors to use only those transport means for materials and wastes that will be evacuated from the site organization, that will be equipped with protection means against their dispersion on traffic routes
- Taking the adequate means not to pollute with mud or debris from the site organization, the communication means where the machinery and transport means of the constructors are circulating
- The materials needed to execute works will be stored in well-established places, properly arranged, to prevent pollution of soil and / or subsoil, dirtying public roads;
- Upon the completion of the works, the executor is obliged to clean the affected areas of any materials and wastes, and the recyclable wastes resulted are delivered only to units authorized for taking this type of wastes;
- Respecting the project routes according to the sketch and the memorandum from the documentation, keeping the appropriate distances to the networks and pipelines in the area;
- The executor is obliged to perform the works without causing pollution or insalubrity phenomena in the area;
- The leftover materials resulting after performing the works will be submitted only to units authorized to take such wastes.

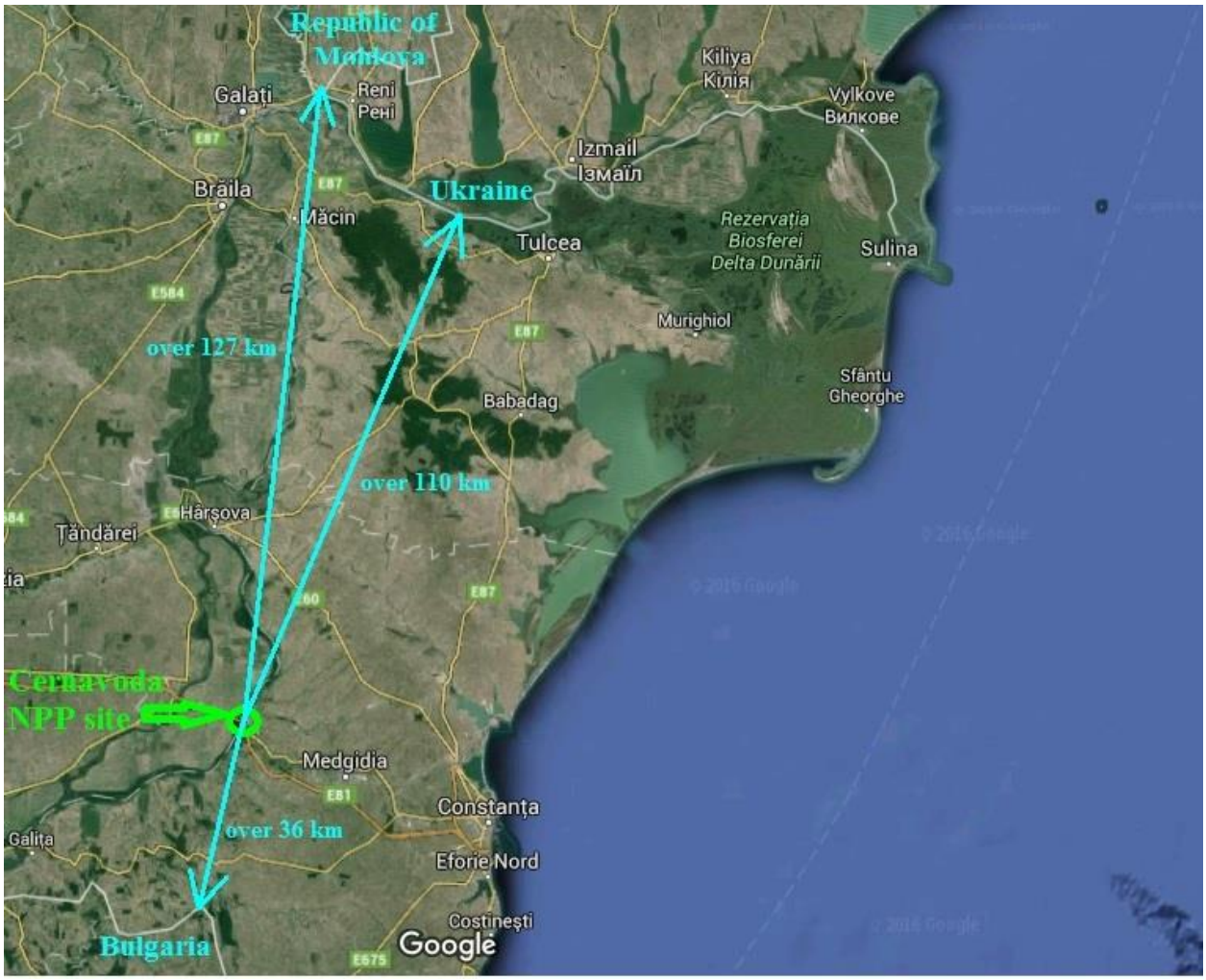
According to information and documents provided by the beneficiary, the conditions imposed by the Environmental Approval no. 2058 of 22.04.2002 are totally respected.

III.6. Project location

III.6.1. Distance from the borders for projects that fall under the Convention on Environmental Impact Assessment in a transboundary context, adopted on Espoo at 25 February 1991, ratified by Law no. 22/2001

The distances from the extended IDSFS on the Cernavodă NPP site - to borders are:

- Over 36 km from Bulgaria – the distance is measured in a straight line from IDSFS site boundary to the nearest border point
- Over 110 km from Ukraine – the distance is measured in a straight line from IDSFS site boundary to the nearest border point
- Over 127 km to the Republic of Moldova – the distance is measured in a straight line from IDSFS site boundary to the nearest border points



III.6.2. Maps, photographs of the site who can provide information on the physical characteristics of the environment, both natural and artificial, and other information on:

III.6.2.1. Current and projected land use, both on site and on adjacent areas

The location of Cernavodă nuclear power plant inside of which will be located the project is located on the platform resulting from excavations of the former limestone quarry Ilie Barza, at approx. 2 km south-east of the Cernavodă town and approx. 1.5 km north-east of the first sluice of the Danube-Black Sea navigable channel, bordered to the north by Cismelei Valley and south-west by DJ223C.

Intermediate Dry Spent Fuel Storage Facility (IDSFS) is located on the Cernavodă NPP.

The link between nuclear units of related services buildings no. 1 and 2 find in operation, and other nuclear power units currently in preservation (in various stages of construction / assembly) and IDSFS location, is done on existing acces roads within the platform Cemavodă NPP, so: road liaises between all units of NPP platform, from Unit 1 to Unit 5, and a secondary access road (with connection way related to the IDSFS site).

Currently on the IDSFS site are authorized for operation 7 storage modules MACSTOR 200 type, and there is allocated and authorized an area of 24.000m^2 for construction of 27 storage modules MACSTOR 200 type.

The current authorized site ensures the construction of only three rows of modules; it follows that for the construction of the fourth row of modules, an increase of the surface site is required.

As a result of calculations, IDSFS site surface will be increased by about 7,000 m^2, respectively from about 24.000 m^2 to approx. 31.000 m^2 (surface between exterior fence boundaries of the objective).

III.6.2.2. Zoning and land-use policies

According to the Urbanism Certificate no. 347 from 21.10.2015 the land where the new integrated project will be located is:

- Located in the urban part of Cernavodă Town, Constanta County, according to General Urban Plan (PUG) approved by Local Council Decision (H.C.L.) no. 242/2014
- Found in the U.T.R. A3 – sub-area of production units related to N.P.P.

The legal status of the land where is going to place the new integrated project has been established by the State Council Decree No. 31/27.01.1986 (for building Cernavodă NPP Units 1 - 5), the land being expropriated.

The land is owned by SNN SA according to the Certificate of land ownership, Series M03, No. 5415 / 25.04.2000 issued by the Ministry of Industry and Resources.

According to legislation on nuclear domain in force, the lands of the Cernavodă NPP site shall only be used with the assent of the National Commission for Nuclear Activities Control (CNCAN) and of Cernavodă NPP, being allowed only constructions associated to NPP operation.

It was approved the cessation of works on object Unit 5 from the investment objective: "Cernavodă nuclear power plant 5 x 700 MW and the change of destination and space use and already achieved structures, related to Unit 5"; for the project "Works needed for changing the destination of existing buildings on the site of Unit 5 from nuclear power plant to the destination of other support objectives useful during the lifetime of operational Units 1 and 2 and the future Units 3 and 4 of Cernavodă NPP in order to ensure their operation in conditions of nuclear safety and fulfilling all legal requirements" proposed to be realized on NPP precinct – it was issued the Decision of framing stage no.6983RP/08.11.2016 by APM Constanta – Environmental Protection Agency of Constanta.

Map with location of MACSTOR module in relation to U5

III.6.2.3. Sensitive areas

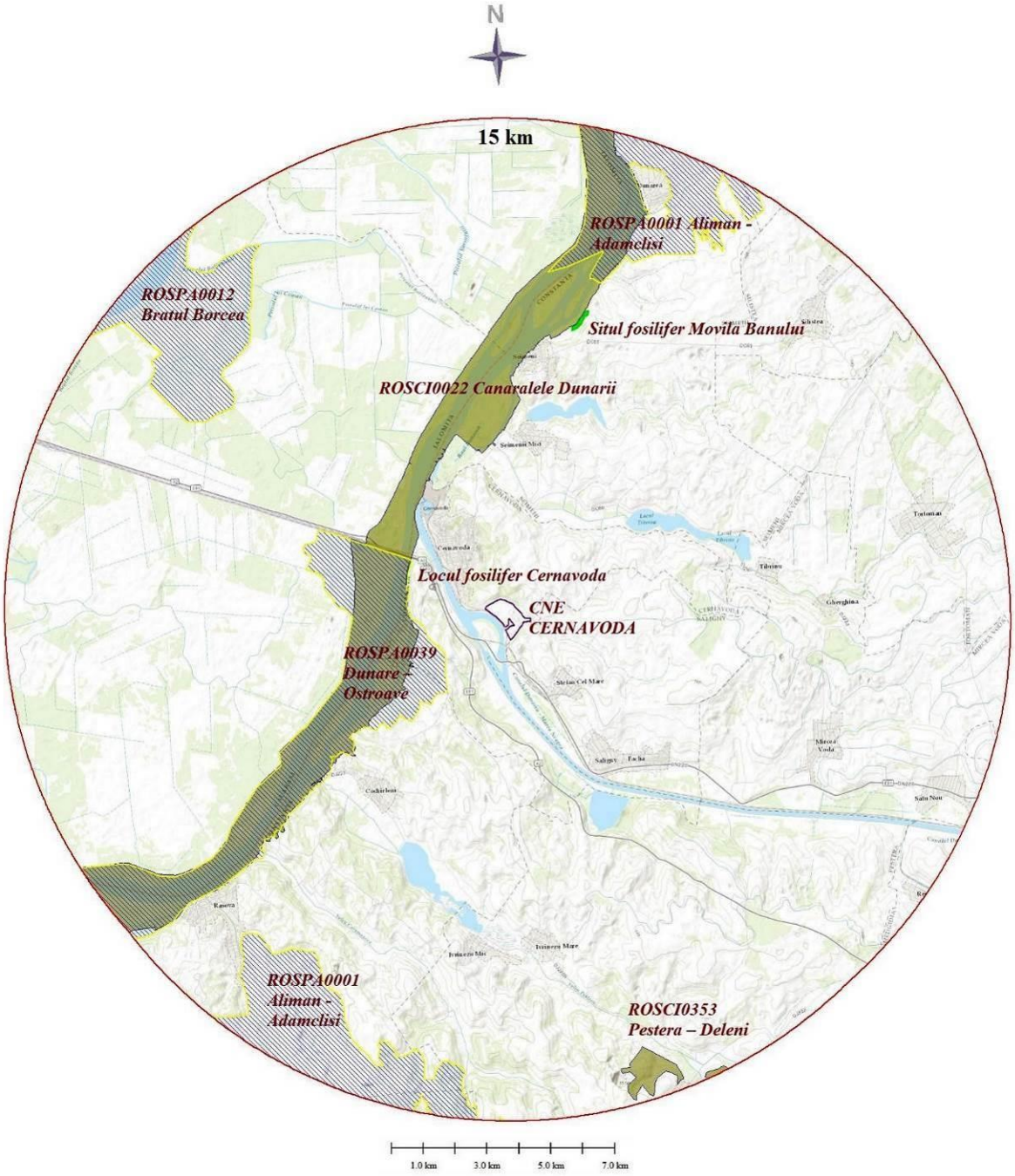
The analysed project is placed on the Cernavodă NPP platform, outside of protected natural areas of national and community interest.

Project is located in the vicinity of Natura 2000 sites, natural monuments, nature reservations and localities.

On a radius of 15 km from the NPP, we can find these next protected natural areas of national and community interest:

- ***ROSPA0039 Dunare - Ostroave*** (approx.1,8 km up to NPP)
- ***ROSCI0022 Canaralele Dunarii*** (approx. 2,2 km up to NPP)
- ***Locul fosilifer Cernavodă*** (approx. 2,6 km up to NPP)
- ***Situl Fosilifer Movila Banului*** (approx. 8,6 km up to NPP)
- ***ROSPA0012 Bratul Borcea*** (approx. 10,06 km up to NPP)
- ***ROSPA0002 Allah Bair - Capidava*** (approx. 10,3 km up to NPP)
- ***ROSPA0001 Aliman - Adamclisi*** (approx. 11,5 km up to NPP)
- ***ROSCI0353 Pestera - Deleni*** (approx. 13,4 km up to NPP)

Thus, near Cernavodă NPP, on a 15 km radius, there are 6 protected natural areas of community interest among which 2 sites of Community importance, 4 special protection areas for avifauna and 2 protected areas of national interest (2 nature monuments).



Cernavodă NPP platform location towards protected natural areas of national and community interest.

We present you a brief description of the six Sites of Community Interest (**ROSCI0022 Canaralele Dunarii**, **ROSCI0353 Pestera- Deleni**, **ROSPA0002 Allah Bair-Capidava, ROSPA0039 Dunare – Ostroave, ROSPA0001 Aliman - Adamclisi, ROSPA0012 Bratul Borcea**), based on information contained in the standard forms, approved by national legislation (Government Decision no. 1284/2007, as amended and supplemented by Government Decision no. 971/2011 and the Ministry of Environment and Sustainable Development Order no. 1964/2007, as amended by Ministry of Environment and Forests Order no. 2387/2011).

ROSCI0022 Canaralele Dunarii

ROSCI0022 Canaralele Dunarii (map source: openstreetmap)

Relationships with other Natura 2000 sites: ROSPA0054 Lacul Dunareni, ROSPA0039 Dunare-Ostroave, ROSPA0017 Canaralele de la Harsova, ROSPA0002 Allah Bair-Capidava, ROSPA0012 Bratul Borcea

Region – Muntenia and Dobrogea
County – 22% Ialomita, 51% Constanta, 27% Calarasi
Biogeographical region - Steppe
Site center location - N 44° 24’ 36”; E 28° 4’ 41”
Altitude (m): min. 0; max. 133; med. 14
Site area (ha): 25.943
Custodian: RNP ROMSILVA- Constanta Forest Direction
Management plan: Under approval

Ecological information

Table 1. Habitat types present on the site and assessment for them

Code	Habitat name	%	Repres.	Rel. Surf.	Conserv.	Global
3130	Oligotrophic to mesotrophic standing waters with vegetation of *Littorelletea uniflorae* and / or *Isoeto-Nanojuncetea*	0,5	B	C	B	B
3140	Hard oligo-mesotrophic waters with benthic vegetation of *Chara* species	0,1	B	C	B	B
3270	Rivers with muddy banks with *Chenopodion rubri* and *Bidention vegetation*	1	B	B	B	B
40C0*	Ponto-Sarmatic deciduous thickets	1	B	B	B	B
62C0*	Ponto-Sarmatic steppes	10	B	B	B	B
6430	Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels	1	B	C	B	B
6510	Lowland hay meadows (*Alopecurus pratensis, Sanguisorba officinalis*)	1	B	C	B	B
91I0*	Euro - Siberian steppic woods with*Quercus spp.*	0,38	C	C	B	C
91M0	Pannonian-Balkanic turkey oak –sessile oak forests	0,19	B	C	B	C
91AA	Eastern white oak woods	0,76	B	B	B	B
92A0	*Salix alba* and *Populus alba* galleries	38	B	B	A	A
92D0	Southern riparian galleries and thickets (*Nerio-Tamaricetea* and *Securinegion tinctoriae*)	0,02	C	C	B	C
6440	Alluvial meadows of river valleys of the *Cnidion dubii*	0,5	B	C	B	B
91F0	Riparian mixed forests of *Quercus robur, Ulmus laevis, Fraxinus excelsior* or *Fraxinus angustifolia*, along the great rivers (*Ulmenion minoris)*	1	B	B	B	B
3150	Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition* type vegetation	0,01	B	C	B	B

LEGEND

REPRESENTATIVENESS	RELATIVE SURFACE	CONSERVATION STATUS	GLOBAL EVALUATION
A – excellent representativeness	A - 100 ≥ p > 15 %	A – excellent conservation	A – excellent value
B – good representativeness	B - 15 ≥ p > 2 %	B – good conservation	B – good value
C – significant representativeness	C - 2 ≥ p > 0 %	C – medium or low conservation	C – considerable value
D – insignificant presence			

Table 2. Mammal species listed in Annex II of Council Directive 92/43/CEE

Code	Species	Population: Resident	Reproduction	Wintering	Passage	Pop.Sit.	Conserv.	Isolation	Global
1355	*Lutra lutra*	P?				D			

Table 3. Amphibians and reptiles listed in Annex II of Council Directive 92/43/CEE

Code	Species	Population: Resident	Reproduction	Wintering	Passage	Pop.Sit.	Conserv.	Isolation	Global
1188	*Bombina bombina*	P				B	B	C	B
1220	*Emys orbicularis*	P				C	B	C	B
1219	*Testudo graeca*	P				C	B	C	B
1993	*Triturus dobrogicus*	P				C	B	C	B

Tabel 4. Fishs listed in Annex II of Council Directive 92/43/CEE

Code	Species	Population: Resident	Reproduction	Wintering	Passage	Pop.Sit.	Conserv.	Isolation	Global
4125	*Alosa immaculata*	P	R			C	B	B	B
1124	*Gobio albipinnatus*	P				C	B	C	B
1157	*Gymnocephalus schraetzer*	P				B	B	B	B
1145	*Misgurnus fossilis*	P				B	B	C	B
2522	*Pelecus cultratus*	P				B	B	C	B
1134	*Rhodeus sericeus amarus*	P				B	A	C	A
1160	*Zingel streber*	P				B	B	C	B
1159	*Zingel zingel*	P				B	B	C	B
1130	*Aspius aspius*	P				B	B	C	B
2511	*Gobio kessleri*	P				C	B	C	B
4127	*Alosa tanaica*	P	R			C	B	B	B
2555	*Gymnocephalus baloni*	P				B	B	B	B
1149	*Cobitis taenia*	P				C	B	C	B
2484	*Eudontomyzon mariae*	P				C	C	C	C
1146	*Sabanejewia aurata*	P				C	C	C	C

Tabel 5. Invertebrate species listed in Annex II of Council Directive 92/43/CEE

Code	Species	Population: Resident	Reproduction	Wintering	Passage	Pop.Sit.	Conserv.	Isolation	Global
4056	*Anisus vorticulus*	R				D			

Tabel 6. Plant Species listed in Annex II of Council Directive 92/43/CEE

Code	Species	Population: Resident	Reproduction	Wintering	Passage	Pop.Sit.	Conserv.	Isolation	Global
2079	*Moehringia jankae*	V				B	B	A	B
2236	*Campanula romanica*	R				B	A	A	B

LEGEND

STATUTE	UICN	POPULATION	ISOLATION	CONSERVATION	GLOBAL
F - frequent	EN - Endangered	A - 100 p > 15%	A – isolated population (almost)	A – excellent conservation	A – excellent value
R - rare	NT - Near Threatened	B - 15 p > 2%	B - non isolated population, but to the limit of the distribution area	B – good conservation	B – good value
RC – relatively common	VU - Vulnerable	C - 2 p > 0%	C - non isolated population with an extended spreading area	C – medium or low conservation	C – considerable value
P – present	LC - Least concern	D – unsignificant population			
C - common					
A - abundant					
i - individuals					
p – pairs					

IUCN - International Union for Conservation of Nature

POPULATION - population size and density of species present in the site in relation to the populations present within national territory. This criterion aims relative size assess or relative density of the population in the site with the nationwide.

CONSERVATION – degree of conservation of the habitat features that are important for the concerned species: A - excellent conservation = elements in excellent condition (i I), regardless of classification of recovery possibilities; B - good conservation = elements well preserved b (i II), regardless of classification of recovery possibilities = elements in average or partially degraded condition (i III) and easy to rebuilt (ii I); C - average or reduced conservation = all other combinations

ISOLATION - the degree of isolation of present population on site compared to normal species distribution area

GLOBAL - Global assessment of the site value for conservation of that species

Tabele 7. Other important species of flora and fauna

Cat.	Species	Population	Reason	Cat.	Species	Population	Reason
P	*Allium saxatile*		A	P	*Asparagus verticillatus*		A
P	*Campanula romanica*		C	P	*Celtis glabrata*		A
P	*Festuca callieri*		A	P	*Gagea bulbifera*		A
P	*Iris suaveolens*		A	P	*Jasminum fruticans*		A
P	*Koeleria lobata*		A	P	*Muscari neglectum*		A
P	*Ornithogalum amphibolum*		C	P	*Paliurus spina-christi*		A
P	*Paronychia cephalotes*		A	P	*Periploca graeca*		A
P	*Thymus zygioides*		A				

LEGEND	
Population	**motivation**
C= common; R= rare; V= hardly ever; P= present	A = Red List national data; B = endemic; C international conventions (including Berne, Bonn and the biodiversity one); D = other reasons

Site description

General characteristics of the site
(Based on information provided by Corine Land Cover project)

Code	%	CLC	Habitat class
N06	31	511, 512	Rivers, lakes
N07	5	411, 412	Swamps, turbaries
N12	2	211-213	Crops (arable land)
N14	2	231	Meadows / Pasteures
N16	57	311	Deciduous forests
N26	3	324	Forest habitats (forest in transition)

Other Site Characteristics: rockery habitats are well represented (limestone) and the edges of waters vegetation. Danube waters are a determining factor in the presence of a rich and diverse fauna associated to habitat types. On the site is located the Carsium fortress archaeological reserve (founded by Traian in 103 year d.I.H),the reserves Locul Fosilifer Cernavodă, Movila Banului Fossil Point and geological and paleontology reserve Neojurasic Reef from Topalu.

Quality and importance :

The site features a great variety of protected habitats, from hydrophilic to the xerophilic, including lawns, bushes, forests, etc.. Among these habitats, the most representative, both as area occupied within the site (30%), and at a national level (11%) is the **92A0 Salix alba and Populus alba galleries** habitat. This habitat includes significant surfaces of young trees excluded from forestry interventions, which can be considered as virgin forests (located mainly on holms), as well as old trees (especially poplars), on tens of hectares (eg. Ostrovul Turcesc).

The second place in terms of importance belongs to the priority habitat **62C0* Ponto-Sarmatian steppes**, which accounts for approximately 2,5% of the national surface of the habitat, represented in some areas by primary steppes, including petrophile steppes on reef limestone, with many endangered species included in the national Red List.

The most important of these is the species of Community Importance *Campanula romanica*, and the most important area of the site is the natural reserve Calea Mare – Ene Valley. From the endemic steppe associations of petrophile steppe, the presence of the coenotaxa *Sedo hillebrandtii - Polytrichetum piliferi* and *Agropyro brandzae - Thymetum zygioidi*, must be noted, which are found predominantly in the North of the site, between Ghindaresti and Harsova.

The habitat **40C0* Ponto - Sarmatian deciduous shrubs** includes two rare associations at a national level, with high conservative value, respectively *Rhamno catharticae - Jasminietum fruticantis* and *Paliuretum spinae - christi*, endemic to Dobrogea.

Although reduced in terms of surface, the xerothermic forests included in habitats **9110* Euro-Siberian silvosteppe vegetation with Quercus sp., 91 M0 Balkan-Pannonian Turkey oak and oak forests, 91AA* Forest vegetation with oak**, have a significant importance, including from a paleontology standpoint. This is due to the fact that they represent the last vestiges of the coastal forests which were on the route of migration of the Balkan forest species towards the massifs in Northern Dobrogea. Most of these forests are protected in reserves such as Bratca Forest, Cetate Forest, and Calea Mare – Valea lui Ene.

Although they are not a protected habitat, the *Celtis glabrata (Gymnospermio altaicae - Celtetum glabratae association*) forest stand has a great scientific importance, as it is very rare and endemic for Dobrogea.

The site is on the main migration pathway of all bird species (eg. *Periploca graeca*) – not just of forest birds – travelling from the Balkan Peninsula towards Northern Dobrogea and the Danube Delta, being located on one of the main bird migration routes, for which it was proposed as a SPA. At the same time, the site is a vital area for the reproduction and migration of sturgeons and another fish species. Including the Danube River course in the site is essential for continuity and for the water transport of the reproductive organs (seeds, shoots, etc.) of different plant species, which favors their propagation towards the North of Dobrogea and the Danube Delta.

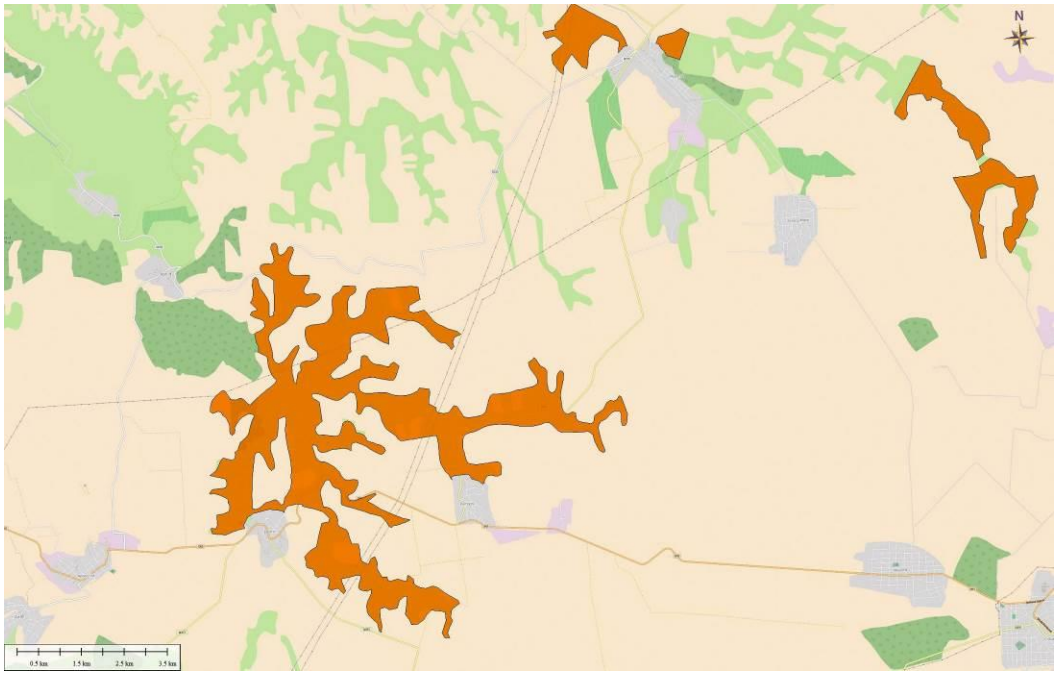
Vulnerability:

The site is especially threatened by:

- plantations within habitats 92A0, 62 CO *, and less in habitats 91AA and 40 C0*; the intensity of this factor is average;
- forest exploitation and other forest works in habitats 92A0 and 91AA, including invasive or difficult to eliminate allochthonous species (eg *Eleagnus angustifolia*, *Robinia pseudoacacia*); all these interventions have a low capacity;
- Danube water pollution, especially with hydrocarbons (potential radioactivity or heavy metal pollution) - low intensity;

- Dredging of Danube sectors (eg Cochirleni, Cernavodă) and the prospect of performing such operations in other sectors, followed by the discharge in secondary cesspools, or on the banks;
- Prospects of installing wind turbines within the site and in the vicinity.

ROSCI0353 Pestera- Deleni



ROSCI0353 Pestera- Deleni (map source: openstreetmap.ro)

Relationships with other Natura 2000 sites: ROSPA0001 Aliman-Adamclisi

Region – Dobrogea
County –100% Constanta
Biogeographical region - Steppe
Site center location - N 44° 6’ 36”; E 28° 1’ 36”
Altitude (m): min. 26; max. 149; med. 92
Site area (ha): 2.508
Custodian: It has no management structure.
Management plan: it is not elaborated.

Ecological information

Tabel 1. Mammalian species listed in the Annex II of the Council Directive 92/43/CEE

Code	Specie	Population: Residents	Nesting	Wintering	Passage	Pop. Sit.	Conservation	Isolation	Global
1335	*Spermophilus citellus*	p				C	B	B	B
2609	*Mesocricetus newtoni*	p				C	B	B	B

LEGEND					
STATUS	**UICN**	**POPULATION**	**ISOLATION**	**CONSERVATION**	**GLOBAL**
F - frequent	EN - Endangered	A - 100 p > 15%	A - isolated population (almost)	A – excellent conservation	A – excellent value
R - rare	NT - Near Threatened	B - 15 p > 2%	B – non-isolated population, but to the limit of the distribution area	B - good conservation	B – good value
RC – relatively common	VU - Vulnerable	C - 2 p > 0%	C - non-isolated population with an expanded spreading area	C – medium or low conservation	C - considerable value
P – presence specie	LC - Least concern	D - unsignificant population			
C - common					
A - abundant					
i - individuals					
p –pairs					
IUCN - International Union for Conservation of Nature					
POPULATION - population size and density of species present in the site in relation to the populations present within national territory. This criterion aims relative size assess or relative density of the population in the site with the nationwide.					
CONSERVATION - degree of conservation of the habitat features that are important for the concerned species: **A** - excellent conservation = elements in excellent condition (i I), regardless of classification of recovery possibilities; **B** - good conservation = elements well preserved b (i II), regardless of classification of recovery possibilities = elements in average or partially degraded condition (i III) and easy to rebuilt (ii I); C - average or reduced conservation = all other combinations					
ISOLATION - the degree of isolation of present population on site compared to normal species distribution area					
GLOBAL - Global assessment of the site value for conservation of that species					

Site description

General characteristics of the site
(based on information provided by Corine Land Cover project)

Code	%	CLC	Habitat class
N14	100	231	Pasteures

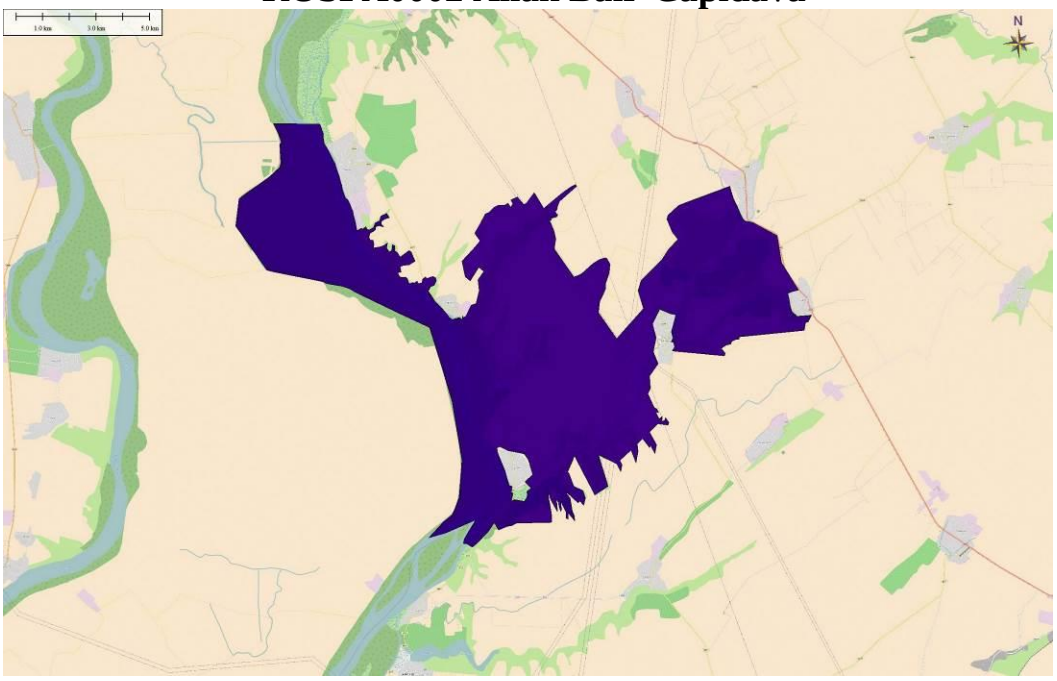
Other site characteristics: The cave located near the biogeographic steppe region at the limit to the contact with the Black Sea biogeographical region, representing species-specific habitat *Mesocricetus Newtons*.

Qualiy and importance:

Characteristic habitat of the species of conservation interest-*Mesocricetus newtoni.*

Vulnerability: Tourism.

ROSPA0002 Allah Bair-Capidava



ROSPA0002 Allah Bair -Capidava (map source: openstreetmap)

Relationships with other Natura 2000 sites: ROSCI0053 Dealul Alah Bair, ROSCI0022 Canaralele Dunarii

Region – Muntenia si Dobrogea

County- 23% Ialomita, 77% Constanta

Biogeographical region - Steppe

Site center location - N 44° 29’ 5”; E 28° 7’ 31”

Altitude (m): min. 0; max. 217; med. 54

Site area (ha): 11.645

Custodian: RNP – The Forestry Directorate of Constanta

Management plan: Under approval.

Ecological information

Table 1. Bird species listed within Annex I of the Council Directive 2009/147/EC

Code	Specie	Resident population	Nesting	Wintering	Passage	Pop. Sit.	Conservation	Isolation	Global
A397	*Tadorna ferruginea*		6-8 p			B	B	C	B
A402	*Accipiter brevipes*		3-5 p		>30i	C	B	C	B
A229	*Alcedo atthis*		70-80 p			C	C	C	C
A133	*Burhinus oedicnemus*		20-30 p			B	B	C	B
A243	*Calandrella brachydactyla*		100-120 p			C	A	C	B
A224	*Caprimulgus europaeus*		110-120 p			C	C	C	B
A083	*Circus macrourus*				15-20 i	C	B	C	A
A231	*Coracias garrulus*		90-100 p			C	A	C	B
A238	*Dendrocopos medius*		15-18 p			D			
A236	*Dryocopos martius*		15-20 p			D			
A321	*Ficedula albicollis*				C	D			

A320	*Ficedula parva*				C	D			
A338	*Lanius collurio*		1200-1300 p			D			
A339	*Lanius minor*		120-130 p			C	B	C	A
A177	*Larus minutus*				400-600 i	C	B	C	B
A246	*Lullula arborea*		120-150 p			C	B	C	C
A533	*Oenanthe pleschanka*		12-15 p			C	A	C	B
A234	*Picus canus*		20-30 p			D			
A403	*Buteo rufinus*		2-3 p			C	A	C	B
A021	*Botaurus stellaris*			2-5 i		D			
A215	*Bubo bubo*	1p				C	B	C	B
A379	*Emberiza hortulana*		150-200 p			C	B	C	B
A073	*Milvus migrans*		0-1 p			C	B	C	C
A429	*Dendrocopos syriacus*		15-20 p			D			
A097	*Falco vespertinus*		14-22 p			C	B	C	B
A196	*Chlidonias hybridus*				2000-3000 i	C	B	C	B
A393	*Phalacrocorax pygmeus*			420-500 i		C	B	C	B
A031	*Ciconia ciconia*				18000-50000 i	B	B	C	B
A030	*Ciconia nigra*				1500-3000 i	B	B	C	B
A080	*Circaetus gallicus*		1-3 p		80-130 i	B	B	B	A
A081	*Circus aeruginosus*				680-1780 i	D			
A084	*Circus pygargus*				140-220 i	C	A	B	A
A089	*Aquila pomarina*				2500-5000 i	C	B	C	B
A072	*Pernis apivorus*				340-775 i	D			
A092	*Hieraaetus pennatus*				40-90 i	C	B	C	A
A019	*Pelecanus onocrotalus*				300-600 i	C	B	B	B
A255	*Anthus campestris*		800-1200 p			C	B	C	B
A307	*Sylvia nisoria*		40-60 p			C	B	C	C
A242	*Melanocorypha calandra*		500-700 p	200-400 i		C	A	C	B
A075	*Haliaeetus albicilla*		P	4-8 i	4-6 i	C	A	B	B
A082	*Circus cyaneus*			10-15 i	40-82 i	C	B	C	B
A197	*Chlidonias niger*				400-600 i	C	B	C	B
A193	*Sterna hirundo*		P		2000-3000 i	C	B	C	B

LEGEND				
STATUS	**POPULATION**	**ISOLATION**	**CONSERVATION**	**GLOBAL**
F - frequent	A - 100 p > 15%	A - isolated population (almost)	A - excellent conservation	A - excellent value
R - rare	B - 15 p > 2%	B - non-isolated population, but to the limit of the distribution area	B – good conservation	B – good value
RC – relative common	C - 2 p > 0%	C - non-isolated population with an expanded spreading area	C – medium or low conservation	C – considerable value
P - present	D - unsignificant population			
C - common				
A - abundant				
i - individuals				
p - pairs				

POPULATION - population size and density of species present in the site in relation to the populations present within national territory. This criterion aims relative size assess or relative density of the population in the site with the nationwide.

CONSERVATION - degree of conservation of the habitat features that are important for the concerned species: **A** - excellent conservation = elements in excellent condition (i I), regardless of classification of recovery possibilities; **B** - good conservation = elements well preserved b (i II), regardless of classification of recovery possibilities = elements in average or partially degraded condition (i III) and easy to rebuilt (ii I); C - average or reduced conservation = all other combinations

ISOLATION - the degree of isolation of present population on site compared to normal species distribution area
GLOBAL - global assessment of the site value for conservation of that species

Table 2. Regular migrating birds species which are not mentioned in Annex I of the Council Directive 2009/147/EC

Code	Specie	Resident Population	Nesting	Wintering	Passage	Pop. Sit.	Conservation	Isolation	Global
A244	*Galerida cristata*		120-140 p			C	A	C	B
A247	*Alauda arvensis*		C			D			
A041	*Anser albifrons*			300-400 i		C	B	C	C
A256	*Anthus trivialis*				C	D			
A221	*Asio otus*		C			D			
A366	*Carduelis cannabina*		R		RC	D			
A364	*Carduelis carduelis*		C		RC	D			
A363	*Carduelis chloris*		C		RC	D			
A365	*Carduelis spinus*				RC	D			
A207	*Columba oenas*		RC			D			
A113	*Coturnix coturnix*		>600 p			C	B	C	B
A208	*Columba palumbus*				C	D			
A212	*Cuculus canorus*		RC			D			
A253	*Delichon urbica*		RC			D			
A251	*Hirundo rustica*		C			D			
A340	*Lanius excubitor*			R		D			
A230	*Merops apiaster*		C			D			
A383	*Miliaria calandra*		C			D			
A262	*Motacilla alba*		RC			D			
A275	*Saxicola rubetra*				RC	D			
A276	*Saxicola torquata*		RC			D			
A210	*Streptopelia turtur*		RC			D			
A351	*Sturnus vulgaris*		C		C	D			
A311	*Sylvia atricapilla*		RC			D			
A310	*Sylvia borin*		RC			D			
A309	*Sylvia communis*		RC			D			
A286	*Turdus iliacus*				R	D			
A283	*Turdus merula*				C	D			
A285	*Turdus philomelos*				C	D			
A284	*Turdus pilaris*				RC	D			
A287	*Turdus viscivorus*				R	D			
A232	*Upupa epops*		C			D			
A179	*Larus ridibundus*				5000-10000 i	C	A	C	A
A459	*Larus cachinnans*				3000-5000 i	D			
A249	*Riparia riparia*		300-500 p			C	B	C	B
A086	*Accipiter nisus*				860-1370 i	D			
A087	*Buteo buteo*				5000-10000 i	C	B	C	B

LEGEND				
STATUS	**POPULATION**	**ISOLATION**	**CONSERVATION**	**GLOBAL**
F - frequent	A - 100 p > 15%	A - isolated population (almost)	A - excellent conservation	A - excellent value
R - rare	B - 15 p > 2%	B - non-isolated population, but to the limit of the distribution area	B - good conservation	B - good value
RC – relative common	C - 2 p > 0%	C - non-isolated population with an expanded spreading area	C - medium or low conservation	C - considerable value
P - present	D – unsignifiant population			
C - common				
A - abundant				
i - individuals				
p - pairs				
POPULATION - population size and density of species present in the site in relation to the populations present within national territory. This criterion aims relative size assess or relative density of the population in the site with the nationwide.				
CONSERVATION - degree of conservation of the habitat features that are important for the concerned species: **A -** excellent conservation = elements in excellent condition (i I), regardless of classification of recovery possibilities; **B** - good conservation = elements well preserved b (i II), regardless of classification of recovery possibilities = elements in average or partially degraded condition (i III) and easy to rebuilt (ii I); C - average or reduced conservation = all other combinations				
ISOLATION - the degree of isolation of present population on site compared to normal species distribution area				
GLOBAL - global assessment of the site value for conservation of that species				

Site description

General characteristics of the site

Code	%	CLC	Habitat classes
N06	8	511, 512	Rivers, lakes
N12	46	211-213	Crops (arable land)
N14	13	231	Pastures
N15	6	242,243	Other arable land
N16	22	311	Broadleaf forests
N19	3	313	Mixed forests
N21	2	221,222	Vineyards and orchards

Other site characteristics: The site is located in the steppe bioregion including at east the highest area of Central Dobrogea represented by Dealul Alah Bair (Baltagesti and La Cazemata) and the lower areas from west and southwest including the Danube islands from the next localities Topalu, Capidava and Danube. The relief is long wavy creases after Sarmatian limestones. The area has am arid climate, with medium and high temperatures (10-11 grade C), high temperatures in summer, low rainfalls (around 40mm/year), tropical days and frequent droughts, in winter the chill wind beats frequently. The continental area named as Special Bird Protection Area includes a mosaic of habitats dominated by arable areas and steppe grasslands that are intercalated between deciduous and coniferous forests (*Pinus nigra austrian*) but mixed foliage forests. The east part of the site includs the Danube and the islands which are, mostly, covered by willow and poplar plantations. On smaller areas are found willow and poplar natural water meadow. Particularly important for nesting, feeding and resting

aquatic birds are, also, the nude islands which are appearing at lower levels of Danube.

Quality and importance:

The site is important for bird species of European conservation interest characteristic of agricultural and steppe areas from Dobrogea as: *Anthus campestris, Burhinus oedicnemus, Calandrella brachydactyla, Emberiza hortulana* and *Melanocorypha calandra*. The site presents a large importance also for aquatic bird species such as: *Tadorna ferruginea, Phalacrocorax pygmeus, Sterna hirundo, Chlidonias hybridus, Chlidonias niger, Larus minutus, Alcedo atthis*. During migration is recordered some large flocks birds *Aquila pomarina, Ciconia ciconia, Ciconia nigra, Circus aeruginosus* and *Buteo buteo.*

Vulnerability:

- - Intensification of agriculture - changing methods of cultivation of the land from traditional one to intensive agriculture, with large monocultures, excessive use of chemicals
- Change of semi-natural habitats (meadows, pastures) beacause of stopping the pasture and the mowing.
- Poaching
- The draining of wetlands
- The destruction of nests,clutches and chicks
- Disturbing birds during the nesting (colonies of Corvus frugilegus and Falco vespertinus)
- Electrocution and collision in power lines
- Installation of wind generators
- Deforestation, forest works and cuts that has as a result the cutting trees on large areas.

ROSPA0039 Dunare – Ostroave

ROSPA0039 Dunare - Ostroave (map sourse: openstreetmap)

Relationship with other Natura 2000 sites: ROSCI0149 Padurea Eseschioi- Lacul Bugeac, ROSCI0172 Padurea and Valea Canaraua Fetii – Iortmac, ROSCI0022 Canaralele Dunarii, ROSCI0071 Dumbraveni- Valea Urluia-Lacul Vederoasa

Region – Muntenia and Dobrogea
County - 55% Constanta, 45% Calarasi
Biogeographical region - Steppe
Site center location - N 44° 13’ 32”; E 27° 45’ 48”
Altitude (m): min. 0; max. 133; med. 18
Site area (ha): 16.224
Custodian: RNP Romsilva-The Forestry Directorate of Constanta
Management plan: Under approval.

Ecological information

Table 1. Bird species listed within Annex I of the Council Directive 2009/147/EC

Code	Specie	Resident Population	Nesting	Wintering	Passage	Pop. Sit.	Conservation	Isolation	Global
A402	*Accipiter brevipes*		2p			C	A	C	A
A293	*Acrocephalus melanopogon*		R			D			
A229	*Alcedo atthis*		50 p			C	C	C	B
A029	*Ardea purpurea*		90-120 p			B	B	C	B
A024	*Ardeola ralloides*		90 p			C	B	C	B
A396	*Branta ruficollis*			120 i		C	B	C	B
A224	*Caprimulgus europaeus*		20 p			C	B	C	C
A196	*Chlidonias hybridus*		60 p		400-600 i	C	B	C	B
A197	*Chlidonias niger*				400 i	C	B	C	B
A031	*Ciconia ciconia*		22-34 p		1200-2400 i	C	B	C	B

A030	*Ciconia nigra*		4p			C	B	C	B
A081	*Circus aeruginosus*		14-20 p			C	B	C	B
A231	*Coracias garrulus*		70-80p			C	A	C	B
A236	*Dryocopus martius*		10 p			D			
A026	*Egretta garzetta*		320 p			B	B	C	B
A379	*Emberiza hortulana*		60 p			D			
A097	*Falco vespertinus*		18-21 p			C	B	C	B
A075	*Haliaaetus albicilla*		3-4 p		17i	B	A	B	A
A131	*Himantopus himantopus*				24 i	D			
A022	*Ixobrychus minutus*		40 p			C	B	C	B
A338	*Lanius collurio*		40 p			D			
A339	*Lanius minor*		54 p			D			
A177	*Larus minutus*				400 i	C	B	C	B
A073	*Milvus migrans*		3-4 p			C	A	B	A
A023	*Nycticorax nycticorax*		470-520 p			B	B	C	B
A094	*Pandion haliaetus*				20 i	C	B	C	B
A019	*Pelecanus onocrotalus*				50-150 i	C	B	B	B
A393	*Phalacrocorax pygmeus*		90-120 p	240 i	300 i	C	B	C	B
A234	*Picus canus*		30 p			D			
A034	*Platalea leucorodia*		144-160 p			B	B	C	B
A032	*Plegadis falcinellus*		120-130 p		230-400 i	B	B	C	B
A120	*Porzana parva*		12 p			C	B	C	B
A132	*Recurvirostra avosetta*				8 i	D			
A195	*Sterna albifrons*		25-30 p		400 i	B	B	C	B
A193	*Sterna hirundo*				1000-2000 i	C	B	C	B
A307	*Sylvia nisoria*		R			D			
A166	*Tringa glareola*				80 i	D			
A511	*Falco cherrug*				1-3 i	C	C	A	C
A020	*Pelecanus crispus*				20-50 i	C	C	C	C

LEGEND				
STATUS	**POPULATION**	**ISOLATION**	**CONSERVATION**	**GLOBAL**
F - frequent	A - 100 p > 15%	A – isolated population (almost)	A – excellent conservation	A – excellent value
R - rare	B - 15 p > 2%	B - non-isolated population, but to the limit of the distribution area	B – good conservation	B – good value
RC – relative common	C - 2 p > 0%	C - - non-isolated population with an expanded spreading area	C – medium or low conservation	C - considerable value
P - present	D –unsignificant population			
C - common				
A - abundant				
i - individuals				
p - pairs				
POPULATION - population size and density of species present in the site in relation to the populations present within national territory. This criterion aims relative size assess or relative density of the population in the site with the nationwide.				
CONSERVATION - degree of conservation of the habitat features that are important for the concerned species: **A -** excellent conservation = elements in excellent condition (i I), regardless of classification of recovery possibilities; **B** - good conservation = elements well preserved b (i II), regardless of classification of recovery possibilities = elements in average or partially degraded condition (i III) and easy to rebuilt (ii I); C - average or reduced conservation = all other combinations				
ISOLATION - the degree of isolation of present population on site compared to normal species distribution area				
GLOBAL - global assessment of the site value for conservation of that species				

Table 2. Regular migrating birds species which are not mentioned in Annex I of the Council Directive 2009/147/EC

Code	Specie	Resident Population	Nesting	Wintering	Passage	Pop. Sit.	Conservation	Isolation	Global
A053	*Anas platyrhynchos*		120 p			D			
A028	*Ardea cinerea*		50 p			D			
A059	*Aythya ferina*		80 p			D			
A099	*Falco subbuteo*		20 p			D			
A096	*Falco tinnunculus*	50 p				D			
A230	*Merops apiaster*		120 p			D			
A017	*Phalacrocorax carbo*		80-120 p		300 i	D			
A005	*Podiceps cristatus*			200 i		D			
A249	*Riparia riparia*		750-1100 p			C	A	C	B
A179	*Larus ridibundus*				10000-20000 i	B	B	C	B

LEGEND				
STATUTE	**POPULATION**	**ISOLATION**	**CONSERVATION**	**GLOBAL**
F - frequent	A - 100 p > 15%	A - – isolated population (almost)	A - excellent conservation	A - excellent value
R - rare	B - 15 p > 2%	B - non-isolated population, but to the limit of the distribution area	B - conservare buna	B - good value
RC – relative common	C - 2 p > 0%	C – non-isolated population with an extended spreading area	C - medium or low conservation	C - considerable value
P - present	D – unsignifiant population			
C - common				
A - abundant				
i - individuals				
p - pairs				
POPULATION - population size and density of species present in the site in relation to the populations present within national territory. This criterion aims relative size assess or relative density of the population in the site with the nationwide.				
CONSERVATION – degree of conservation of the habitat features that are important for the concerned species: A - excellent conservation = elements in excellent condition (i I), regardless of classification of recovery possibilities; B - good conservation = elements well preserved b (i II), regardless of classification of recovery possibilities = elements in average or partially degraded condition (i III) and easy to rebuilt (ii I); C - average or reduced conservation = all other combinations				
ISOLATION- the degree of isolation of present population on site compared to normal species distribution area				
GLOBAL - global assessment of the site value for conservation of that species				

Site description

General characteristics of the site

Code	%	CLC	Habitat classes
N06	32	511,512	Rivers, lakes
N07	5	411,412	Swamps, turbaries
N12	3	211-213	Crops (arable land)
N16	57	311	Deciduous forests
N26	3	324	Forest habitats (forests in transition)

Other site characteristics: Islands in the Danube meadow are represented by natural forests and plantations (with a share of over 50%), which includes several types of habitats of forest and scrub pastures.

In the perimeter of the site is the protected area Punctul fosilifer de la Cernavodă, a natural monument, where appear in day lower cretaceous deposits with a rich fossil fauna, represented by 72 species of corals, bivalves, gastropods, brachiopods.

Quality and importance:

This site houses important species of protected birds. According to the data we have the following categories:

a) number of species from Annex I of Birds Directive: 38

b) number of other migratory species listed in the annexes of the Convention on Migratory Species (Bonn): 36

c) number of globally endangered species: 5

The site is important for nesting populations of next species:

Coracias garrulus
Falco vespertinus
Aythya nyroca
Platalea leucorodia
Egretta garzetta
Nycticorax nycticorax
Plegadis falcinellus
Phalacrocorax pygmaeus
Ardea purpurea
Haliaaetus albicilla
Ardeola ralloides
Lanius minor
Caprimulgus europaeus
Milvus migrans

The site is important during migration for species:

Plegadis falcinellus
Phalacrocorax pygmaeus
Aythya nyroca
Sterna hirundo
Tringa glareola
Himantopus himantopus
Ciconia ciconia

The site is important for wintering for next species:
Branta ruficollis
Phalacrocorax pygmaeus

Vulnerability:

The site vulnerability is caused mainly by anthropogenic factors through activities river transport activities, extractive activities from Danube river bed, dredging, strengthening river banks, commercial fishing. Determinants are the natural factors with impact on natural and semi-natural habitats such as dramatic fluctuations of the Danube level erosion from natural causes of riverbanks.

ROSPA0012 Bratul Borcea

ROSPA0012 Bratul Borcea (map source: openstreetmap)

Relationship with other Natura 2000 sites: ROSCI0022 Canaralele Dunarii, ROSCI0278 Bordusani- Borcea, ROSCI0319 Mlastina de la Fetesti

Region – Muntenia
County - 61% Ialomita, 39% Calarasi
Biogeographical region - Steppe
Site center location - N 44° 17’ 12”; E 27° 40’ 3”
Altitude (m): min. 0; max. 64; med. 11
Site area (ha): 13.097
Custodian: The Ecologic Club UNESCO ProNature, Bucuresti
Management plan: It does not exist management plan.

Ecological information

Table 1. Bird species listed within Annex I of the Council Directive 2009/147/EC

Code	Specie	Resident Population	Nesting	Wintering	Passage	Pop Sit.	Conservation	Isolation	Global
A026	*Egretta garzetta*		320-340 p			C	B	C	B
A097	*Falco vespertinus*		18-21 p			C	B	C	B
A075	*Haliaeetus albicilla*		1-2 p		17 i	C	A	C	B
A022	*Ixobrychus minutus*		40-50 p			C	B	C	B
A338	*Lanius collurio*		RC			D			
A339	*Lanius minor*		R			D			
A177	*Larus minutus*				400 i	C	B	C	B
A073	*Milvus migrans*		3-4 p			C	A	B	A
A193	*Sterna hirundo*				1000-2000 i	C	B	C	B
A307	*Sylvia nisoria*		R			D			
A024	*Ardeola ralloides*		90 p			C	B	C	B
A196	*Chlidonias hybridus*		R		400-600 i	C	B	C	B
A197	*Chlidonias niger*				400 i	C	B	C	B
A231	*Coracias garrulus*		70-80p		P	C	A	C	B
A023	*Nycticorax nycticorax*		470-520 p			B	B	C	B
A019	*Pelecanus onocrotalus*				50-150 i	C	B	B	B
A393	*Phalacrocorax pygmeus*		P	240 i	300 i	C	B	C	B
A034	*Platalea leucorodia*		144-160 p			B	B	C	B
A032	*Plegadis falcinellus*		120-130 p		230-400 i	B	B	C	B
A120	*Porzana parva*		RC			C	B	C	B
A060	*Aythya nyroca*		100-120 p		300-400 i	C	B	C	B
A031	*Ciconia ciconia*		64-77 p		4000-7000 i	C	B	C	B
A081	*Circus aeruginosus*		12-14 p			C	B	C	C
A402	*Accipiter brevipes*		2-2p			C	B	C	B
A396	*Branta ruficollis*			4500-7000 i		A	B	C	B
A131	*Himantopus himantopus*		P		200-500 i	C	B	C	C
A030	*Ciconia nigra*		1-3p		200-500 i	B	B	C	B
A166	*Tringa glareola*				800-1000 i	C	B	C	B
A195	*Sterna albifrons*				400-400 i	C	B	C	B
A132	*Recurvirostra avosetta*		P		200-500i	C	B	C	B
A234	*Picus canus*	R				D			
A236	*Dryocopus martius*	R				D			

LEGEND				
STATUTE	**POPULATION**	**ISOLATION**	**CONSERVATION**	**GLOBAL**
F - frequent	A - 100 p > 15%	A - – isolated population (almost)	A - excellent conservation	A - excellent value
R - rarE	B - 15 p > 2%	B - - non isolated population, but to the limit of the distribution area	B - good conservation	B - good value
RC–relatively common	C - 2 p > 0%	C - populatie ne-izolata cu o arie de raspandire extinsa	C - medium or low conservation	C - considerable value
P - present	D - unsignificant population			
C - common				
A - abundant				
i - individuals				
p - pairs				
POPULATION - population size and density of species present in the site in relation to the populations present within national territory. This criterion aims relative size assess or relative density of the population in the site with the nationwide.				
CONSERVATION - degree of conservation of the habitat features that are important for the concerned species: A - excellent conservation = elements in excellent condition (i I), regardless of classification of recovery possibilities; B - good conservation = elements well preserved b (i II), regardless of classification of recovery possibilities = elements in average or partially degraded condition (i III) and easy to rebuilt (ii I); C - average or reduced conservation = all other combinations				

ISOLATION- the degree of isolation of present population on site compared to normal species distribution area
GLOBAL - global assessment of the site value for conservation of that species

Table 2. Regular migrating birds species which are not mentioned in Annex I of the Council Directive 2009/147/EC

Code	Specie	Resident Population	Nesting	Wintering	Passage	Pop.Sit.	Conservation	Isolation	Global
A296	*Acrocephalus arundinaceus*		RC			D			
A297	*Acrocephalus scirpaceus*		RC			D			
A295	*Acrocephalus schoenobaenus*		RC			D			
A247	*Alauda arvensis*		P			D			
A053	*Anas platyrhynchos*		P			D			
A055	*Anas querquedula*		R			D			
A041	*Anser albifrons*			13.000-300.000		C	B	C	B
A028	*Ardea cinerea*		50 p			D			
A221	*Asio otus*		C			D			
A059	*Aythya ferina*		RC			D			
A099	*Falco subbuteo*		20-30 p			D			
A096	*Falco tinnunculus*	20-40 p				C	B	C	B
A359	*Fringilla coelebs*	RC			P	C	B	C	C
A299	*Hippolais icterina*		R			D			
A251	*Hirundo rustica*		C			D			
A459	*Larus cachinnans*				RC	D			
A311	*Sylvia atricapilla*		RC			D			
A310	*Sylvia borin*		RC			D			
A309	*Sylvia communis*		RC			D			
A285	*Turdus philomelos*				RC	D			
A232	*Upupa epops*		C			D			
A373	*Coccothraustes coccothraustes*		RC			D			
A207	*Columba oenas*				RC	D			
A208	*Columba palumbus*		RC		P	D			
A212	*Cuculus canorus*		RC			D			
A179	*Larus ridibundus*				P	D			
A292	*Locustella luscinioides*		RC			D			
A271	*Luscinia megarhynchos*		RC		C	D			
A230	*Merops apiaster*		120p			D			
A383	*Miliaria calandra*	P			RC	D			
A262	*Motacilla alba*		RC			D			
A260	*Motacilla flava*		P			D			
A319	*Muscicapa*		RC		RC	D			

	striata								
A214	*Otus scops*		R			D			
A017	*Phalacrocorax carbo*		80-120 p		300 i	C	B	C	B
A273	*Phoenicurus ochruros*				RC	C	B	C	C
A005	*Podiceps cristatus*			200 i		D			
A336	*Remiz pendulinus*		RC			D			
A249	*Riparia riparia*		750-1100 p			C	A	C	B
A275	*Saxicola rubetra*				RC	C	B	C	C
A351	*Sturnus vulgaris*	RC			C	D			
A337	*Oriolus oriolus*		C		C	D			

LEGEND				
STATUTE	**POPULATION**	**ISOLATION**	**CONSERVATION**	**GLOBAL**
F - frequent	A - 100 p > 15%	A - isolated population (almost)	A - excellent conservation	A - excellent value
R - rare	B - 15 p > 2%	B - non isolated population, but to the limit of the distribution area	B – good conservation	B - good value
RC – relatively common	C - 2 p > 0%	C - non isolated population with an extended spreading area	C - medium or low conservation	C - considerable value
P - present	D – unsignificant population			
C - common				
A - abundant				
i - individuals				
p - pairs				
POPULATION - population size and density of species present in the site in relation to the populations present within national territory. This criterion aims relative size assess or relative density of the population in the site with the nationwide.				
CONSERVATION- degree of conservation of the habitat features that are important for the concerned species: A - excellent conservation = elements in excellent condition (i I), regardless of classification of recovery possibilities; B - good conservation = elements well preserved b (i II), regardless of classification of recovery possibilities = elements in average or partially degraded condition (i III) and easy to rebuilt (ii I); C - average or reduced conservation = all other combinations				
ISOLATION - the degree of isolation of present population on site compared to normal species distribution area				
GLOBAL - global assessment of the site value for conservation of that species				

Site description

General characteristics of the site

Code	**%**	**CLC**	**Habitat classes**
N06	24	511,512	Rivers, lakes
N07	2	411,412	Swamps, turbaries
N09	2	321	Natural pastures, steppes
N12	39	211- 213	Crops (arable land)
N16	33	311	Deciduous forests

Other features of the site: the Danube river, which separates to the E the county, flows through two branches: Borcea, on the left (besides Fetesti,

Bordusani, Facaieni, Vladeni) and Old Danube on th eright, this coming together in one course at 3 km S of Giurgeni. Between these branches are Balta Borcei or Ialomitei, initially with reeds, lakes, forest, today used for agricultural and only on the edges with forests. The soils were formed on alluvium deposited by the Danube waters during repeatedly floods, their genesis and evolution being influenced by regime flooding, groundwater depth, micro-relief forms, etc. The most common type of soil is typically alluvial protosoil (38%). The climate is excessive continental type characterized by warm summers and cold winters.

The average annual temperature is 11.5 gr C. Average annual rainfall of 550.5 mm, and during April-October period being 288.1 mm; dominant wind is North Wind causing temperature drops in winter. Being located on the great Eastern route of migration path, territory is visited during passage periods, being a feeding and resting place for rare and very rare species.

Quality and importance:

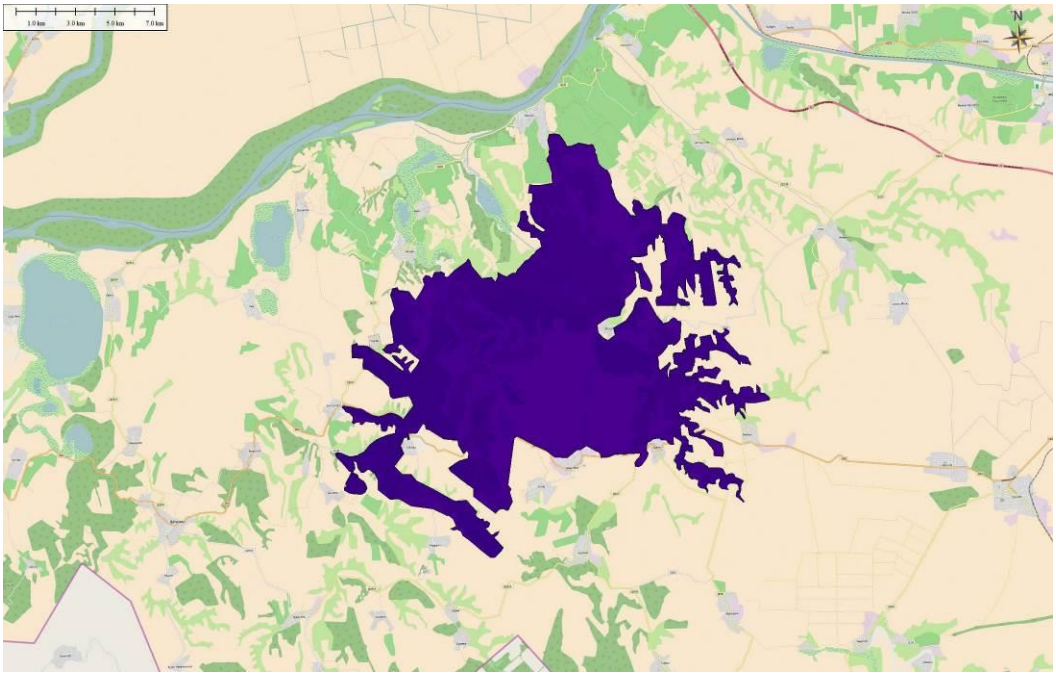
This site houses important species of protected birds. The site is important for breeding populations of the following species: *Aytya nyroca*, *Milvus migrans*, *Haliaetus albicilla*, *Falco vespertinus* and *Coracias garrulus*; Ardeidae and Threskiornithidae colonies.

The site is important for species during migration for: *Ciconia alba* si *Ciconia nigra*, *Plegadis falcinellus*, *Platalea leucorodia*, *Sterna hirundo*, geese and ducks. In winter, both wetlands and agricultural areas of the perimeter of the site are particularly important habitats for feeding and resting of *Branta ruficollis* flocks. During migration the site is hosting more than 20.000 specimens of aquatic birds, being a possibly canditat as a Ramsar site.

Vulnerability:

- poaching – hunting in rest and feeding areas for flocks of *Branta ruficollis* – destruction of nests, the clutch or chickens - disturbing birds during nesting (colonies)
- clearing forest areas where there are nests of *Haliaeetus albicilla* and *Ciconia nigra*.

ROSPA0001 Aliman- Adamclisi



ROSPA0001 Aliman- Adamclisi (map source: openstreetmap)

Relationships with other Natura 2000 sites: ROSCI0071 Dumbraveni- Valea Urluia- Lacul Vederoasa, ROSCI0353 Pestera- Deleni
Region – Dobrogea
County - 100% Constanta
Biogeographical region - Stepica
Site center location - N 44° 8' 21"; E 27° 56' 45"
Altitude (m): min. 11; max. 181; med. 110
Site area (ha): 19.468
Custodian: RNP ROMSILVA- Constanta Forest Direction
Management plan: Under approval

Ecological information

Table 1. Bird species referred to in Annex I of the Council Directive 2009/147/EC

Code	Species	Population: Resident	Nesting	Wintering	Passage	Pop.Sit.	Conserv.	Isolation	Global
A402	*Accipiter brevipes*		15-18 p		>30 i	B	B	C	B
A255	*Anthus campestris*		3600-4000 p			C	A	C	B
A133	*Burhinus oedicnemus*		30-32 p			B	B	C	B
A243	*Calandrella brachydactyla*		600-650 p			B	A	C	B
A082	*Circus cyaneus*			20-50 i	80-100 i	C	B	C	B
A084	*Circus pygargus*		1-3 p		120-130 i	B	A	B	A
A097	*Falco vespertinus*		36-41 p		200-400 i	B	B	C	B
A242	*Melanocorypha calandra*		2200-2500 p			B	B	C	B
A533	*Oenanthe pleschanka*		24-26 p			B	A	B	B
A224	*Caprimulgus europaeus*		120-130 p			C	B	C	B
A083	*Circus macrourus*				60-80 i	B	B	C	B
A231	*Coracias garrulus*		120-130 p			B	A	C	B
A238	*Dendrocopos medius*		20-22 p			D			

A511	*Falco cherrug*		>1 i			B	A	C	B
A321	*Ficedula albicollis*				200-300 i	D			
A320	*Ficedula parva*				800-1000 i	D			
A092	*Hieraaetus pennatus*		3-4 p		15-20 i	C	B	C	A
A338	*Lanius collurio*		700-1000 p			D			
A339	*Lanius minor*		210-220 p			C	B	C	B
A246	*Lullula arborea*		800-1000 p			C	A	C	B
A072	*Pernis apivorus*		6-7 p			C	B	C	C
A234	*Picus canus*		20-25 p			D			
A080	*Circaetus gallicus*		9-10 p			B	A	B	A
A103	*Falco peregrinus*				>4i	D			
A215	*Bubo bubo*		1-2 p			C	B	C	B
A403	*Buteo rufinus*		12-14 p			B	A	C	A
A404	*Aquila heliaca*		1-2 i			A	B	C	B
A089	*Aquila pomarina*		1-2 p		150-200 i	C	C	C	C
A081	*Circus aeruginosus*		2-4 i			D			
A429	*Dendrocopos syriacus*		30-40 p			C	B	C	C
A073	*Milvus migrans*		1-2 i		5-8 i	C	B	C	C
A379	*Emberiza hortulana*		200-300 p			C	B	C	B
A307	*Sylvia nisoria*		200-300 p			C	A	C	B

LEGEND				
STATUS	**POPULATIE**	**ISOLATION**	**CONSERVATION**	**GLOBAL**
F - frequent	A - 100 p > 15%	A – isolated population (almost)	A – excellent conservation	A – excellent value
R - rare	B - 15 p > 2%	B - non isolated population, but to the limit of the distribution area	B – good conservation	B – good value
RC – relatively common	C - 2 p > 0%	C - non isolated population with an extended spreading area	C – medium or low conservation	C – considerable value
P – present	D - unsignificant population			
C - common				
A - abundant				
i - individuals				
p – pairs				
POPULATION - population size and density of species present in the site in relation to the populations present within national territory. This criterion aims relative size assess or relative density of the population in the site with the nationwide.				
CONSERVATION – degree of conservation of the habitat features that are important for the concerned species: **A** - excellent conservation = elements in excellent condition (i I), regardless of classification of recovery possibilities; **B** - good conservation = elements well preserved b (i II), regardless of classification of recovery possibilities = elements in average or partially degraded condition (i III) and easy to rebuilt (ii I); **C** - average or reduced conservation = all other combinations				
ISOLATION - the degree of isolation of present population on site compared to normal species distribution area				
GLOBAL - Global assessment of the site value for conservation of that species				

Table 2. Bird species with regular migration, unmentioned in Annex I of the Council Directive 2009/147/EC

Code	Species	Population: Resident	Nesting	Wintering	Passage	Pop.Sit.	Conserv.	Isolation	Global
A260	*Motacilla flava*		P			D			
A435	*Oenanthe isabellina*		R			D			
A310	*Sylvia borin*		RC			D			
A244	*Galerida cristata*		300-320 p			C	A	C	B
A247	*Alauda arvensis*	P				D			
A221	*Asio otus*		C			D			

A373	*Coccothraustes coccothraustes*		RC			D			
A207	*Columba oenas*		RC			D			
A113	*Coturnix coturnix*		>600 p			C	B	C	B
A208	*Columba palumbus*		P			D			
A212	*Cuculus canorus*		RC			D			
A096	*Falco tinnunculus*	>70 i				D			
A299	*Hippolais icterina*		R			D			
A251	*Hirundo rustica*		C			D			
A341	*Lanius senator*		R			D			
A271	*Luscinia megarhynchos*		RC			D			
A230	*Merops apiaster*		C			D			
A383	*Miliaria calandra*		P			D			
A262	*Motacilla alba*		RC			D			
A277	*Oenanthe oenanthe*		RC			D			
A337	*Oriolus oriolus*		P			D			
A214	*Otus scops*		RC			D			
A273	*Phoenicurus ochruros*		R			D			
A249	*Riparia riparia*		C			D			
A276	*Saxicola torquata*		RC			D			
A210	*Streptopelia turtur*		RC			D			
A311	*Sylvia atricapilla*		RC			D			
A309	*Sylvia communis*		RC			D			
A232	*Upupa epops*		RC			D			

LEGEND				
STATUS	**POPULATIE**	**ISOLATION**	**CONSERVATION**	**GLOBAL**
F - frequent	A - 100 p > 15%	A – isolated population (almost)	A – excellent conservation	A – excellent value
R - rare	B - 15 p > 2%	B - non isolated population, but to the limit of the distribution area	B – good conservation	B – good value
RC – relatively common	C - 2 p > 0%	C - non isolated population with an extended spreading area	C – medium or low conservation	C – considerable value
P – present	D - unsignificant population			
C - common				
A - abundant				
i - individuals				
p – pairs				

POPULATION - population size and density of species present in the site in relation to the populations present within national territory. This criterion aims relative size assess or relative density of the population in the site with the nationwide.

CONSERVATION – degree of conservation of the habitat features that are important for the concerned species: **A** - excellent conservation = elements in excellent condition (i I), regardless of classification of recovery possibilities; **B** - good conservation = elements well preserved b (i II), regardless of classification of recovery possibilities = elements in average or partially degraded condition (i III) and easy to rebuilt (ii I); **C** - average or reduced conservation = all other combinations

ISOLATION - the degree of isolation of present population on site compared to normal species distribution area

GLOBAL - Global assessment of the site value for conservation of that species

Site description

General site character

Code	%	CLC	Clase de habitate
N09	2	321	Dry grassland, Steppes
N12	12	211-213	Crops (arable land)
N14	2	231	Grasslands
N15	11	242, 243	Other arable lands
N16	40	311	Deciduous forests

Other site Characteristics: The site is in a bioregion steppe containing a representative area of western South Dobrogea Plateau, with elevations below 200m. It is widely, wavy after the Sarmatian calcareous folds and shows a slight slope from east to west. The valleys have a strong endorheic character. The area has an arid climate, with high average temperatures (10-11 degrees C), high temperatures in summer, low rainfall (around 400 mm / year), tropical days and frequent drynesses; in the winter frequently beats the North Wind. The area designated as a Bird Special Protection Area covers a mosaic of habitats dominated by arable areas and steppe grasslands between that are intercalated bodies of forest with different specie of trees.

Quality and importance:

This site houses important species of protected birds. The site is important for breeding populations of species characteristic of agricultural land and steppe of south-eastern Romania as: *Anthus campestris, Calandrella brachydactyla, Melanocorypha calandra, Coracias garrulus, Burhinus oedicnemus* and *Falco vespertinus.* It represents an important nesting and feeding area for *Buteo rufinus*. It is also one of the areas that register the presence of the Imperial Eagle and Danube hawk.

Vulnerability:

The site is subject to human pressure, especially by traditional grazing activity, through tourism practiced mostly in the Trophaeum Traiani monument and Roman-Byzantine ruins of Adamclisi and surface mining (quarries). In areas covered with forest vegetation hunting is performed.

Near the Cernavodă NPP are also two protected areas of national interest:

SITUL FOSILIFER MOVILA BANULUI

Reservation type: mixed geological and paleontological.
Area: 0,50 ha in Law no. 5/2000, 9,90 ha in Forest Management of Cernavodă Forest District
Location: at 1,5 km in NE of Seimeni village
Reservation access: on DJ 223 Cernavodă - Topalu.
Custodian: Constanta Forest Direction

Situl Fosilifer Movila Banului – *source Constanta County Council*

General characterization

The oldest of miocene fossil site discovered in Dobrogea. Fossil Point was declared protected area due to its richness in fossils, extremely well preserved, represented by ammonites, bivalves, gastropods, brachiopods and echinoderms.

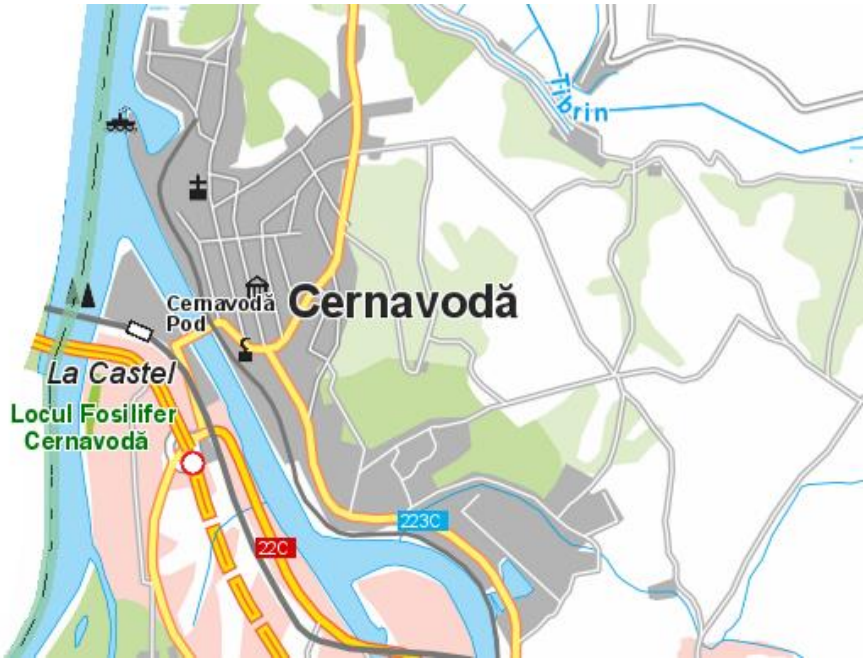
The great scientific importance is that here it could be paleontological argued that for the first time that lower miocene sea extends over Southern Dobrogea and Ostra bench marks the coastal area of this sea.

Across this fossil site are the oldest fossils from the miocene age on Dobrogea territory, covered by Cambria chernozioms, humic and regosoils.

Limestone layers with fossils date from the early miocene to the superior Miocene and the preserved fossil marine fauna is extremely rich in forms of tropical climate. The layers dating from the miocene are rich in ammonites (of genres as *Hysteroceras* and *Acanthoplites*) and belemnites and different types of Ostreid bivalve, and the layers dating from the superior miocene are dominated by pectinidae bivalve as *Chlamys domgeri*. Alongside these dominant forms (only ammonites described here fall into more than 60 different species) appears a large number of fossils of bivalves, gastropods, brachiopods and echinoderms.

LOCUL FOSILIFER CERNAVODĂ

Reservation type: geological and paleontological.
Area: 3 ha
Location: on the right shore of Danube, S from Carasu valley, near the Cernavodă road bridge
Reservation access: from Cernavodă city, on the Danube shore, upstream
Custodian: Constanta Forest Direction



Locul fosilifer Cernavodă- – source Constanta County Council

General characterization

The geological importance of the Locul Fosilifer Cernavodă results in the fact that here appear up to date lower cretaceous deposits with a rich fossil fauna which allowed the possibility of establishing clear boundaries between levels of lower cretaceous and correlation of these deposits with similar ones in other parts of Europe (France Spain, Portugal), North Africa and Asia Minor.

Locul Fosilifer Cernavodă, is one of the few places in the country where it can be seen, in a continuous succession of lower cretaceous reef deposits, especially those belonging to the lower and upper Valanginian. The richness of fauna fossils, consists mainly of gastropods, bivalves, brachiopods, pycnodont fishes, sponges, hexacore, foraminifera, algae and ostracods include geological reservation at Cernavodă in the richest fossil point in the country, and integrated in the South Dobrogea level, fossil fauna specific to facies carbonated lower cretaceous, in this part of the country, estimated at over 400 taxons, is situated on a place close to that occupied by the famous site fossil jurassic from Solnhofen, Germany, where they were identified over 600 taxons.

In terms of litho-stratigraphic, deposits which crop out in the geological reserve Locul Fosilifer Cernavodă belong to Carbonate formation of lower Cretaceous from Cernavodă, as part of the sedimentary layer of Moesian Platform.

III.6.2.4. Details of any site alternatives taken into consideration.

Regarding the Intermediate Dry Spent Fuel Storage Facility (IDSFS), the project provides only an extension of the site already approved and in use.

At the time of initial choice of location, other locations outside the Cernavodă NPP were studied, but it was considered as the most reliable, the location inside Cernavodă NPP, mainly due to safety.

III.7. Characteristics of potential impact, to the extent that such information is available

III.7.1. Impact on population and human health

The dry storage area is equipped with a system of fences consisting of an interface external fence (protection) and an interior fence for Security, which forms an isolated area between them. The security fence is located approximately 16 m away from the storage module. Distance and low dose rates from structures provide a level of radiation dose flow at the boundary fence of the site, below of the project value of 2.5μSv / h (one tenth of the dose rate at the surface of storage structures).

Beyond the external fence of the storage area, dose rates will thus be small enough to allow free access of plant personnel. Storage area is also located at a distance of about 0.8 km from the limit of exclusion zone of the plant (Unit 5), to west. At this distance, the radiation that comes from the dry storage area will not contribute to dose for the population during normal operation.

The impact on operating personnel

During transfer operations to storage area and during filling of the basket, equipment design, their location and operating procedures are conceived that workers to be placed away from flask, to limit additional doses received by them.

In case of the fuel cooled for 6 years, individual dose is estimated at 20 μSv. At Cernavodă NPP the maximum individual dose received in the transfer of a basket of fuel is 10 μSv.

During storage operations, there are transitional periods very short (less than a minute at each loading operation) in which the storage cylinder plug is lifted and moved laterally to allow installation of transfer flask over that cylinder, for storing a fuel basket (plug is moved backwards and reinstalled on the cylinder after storage). In this short periods, the transient radiation dose rate near the module exceeds the normal value of project. In this case, scattering contribution due to ambient air (effect "sky shine") is more important than the contribution of direct radiation through the shielding concrete.

Dose rates due to the effect of "sky shine" in case of the uncovered storage enclosure (during charging of the 10th basket) were calculated with the MCNP[3] code and compared with those measured at Point - Lepreau.

For irradiated fuel cooled for 6 years, it was achieved a maximum dose rate of 93.5 ± 2.06% μSv / h at 1 m above the ground, at a distance of 7.5 m lateral

[3] MCNP code – Monte Carlo N-Particle - represents a software package for simulating nuclear processes, being a general purpose code, which can be used for the transport of neutrons, protons, electrons or coupled transport of neutrons / protons / electrons. Specific areas of application include, but are not limited to: radiation protection and dosimetry, radiation shielding, radiography, medical physics, critical nuclear safety, detectors design and analysis, decontamination and decommissioning, etc.

from the enclosure, which corresponds with the measured value of 80 ÷ 100 μSv / h (at ground level).

At the top of the enclosure, gamma radiation measurements during this 1minute period, showed the following values:

- 8.4 mSv / h - in the work platform area from the transfer flask;
- 0.41 mSv / h - in the top of an adjacent covered enclosure.

It should be mentioned though that, the storage enclosure remains open (with the shielding plug suspended) for maximum 1 minute, which would lead to a maximum annual dose for the same operator (100 baskets / year and 1 minute / basket) of 14 mSv.

In order to determine the gamma dose rates due to the effect of "Sky shine" at Cernavodă NPP measurements were made on a height from 0.4 m to 2 m above the working platform and at a distance of 1 m from the edge of a cylinder.

They have obtained values of gamma dose rate between 2.1 mSv / h ÷ 4.15 mSv / h at a height of 0.4 m and a maximum of 19.6 mSv / h at a height of 1.5 m.

Individual dose during the construction of a new module

According to records from environmental thermos-luminescent dosimeters, the gamma dose rates outside the storage structure is at the level of natural background radiation.

Preventively, while building a new module will be implemented specific radiation protection measures from CNE Cernavoda, to ensure that the individual dose for the staff involved in the construction shall not exceed the dose constraint approved by CNCAN for IDSFS site (50 μSv / year):

- Maintaining a proper distance from the sources in the vicinity of the working site (by building a temporary fence)
- Monitoring the radiation fields in the working area
- Reduction of stationary time in the working area
- Evacuation of personnel who perform construction works during the transfer of spent fuel from SFB
- Installation of additional biological protection shields

III.7.2. Impact on fauna and flora

Intermediate Dry Spent Fuel Storage Facility (IDSFS) was put into operation in June 2003.

Radioactivity monitoring programs did not detect gaseous and liquid effluent emissions.

On the outside wall of the modules, the gamma radioactivity of air is at the natural background level.

In normal operating conditions of IDSFS extended site there are no radioactive materials released into the environment in liquid, gaseous or solid phase.

Regarding IDSFS, radiation dose to non-human living environment is limited by the fact that no animal lives on the site. The inlets and exhaust of air wherewith is equipped the storage module are covered with a grill to prevent entry of birds and mammals, and through visual inspection of inlets and exhaust of air, shall ensure that insects or insect swarms not obstruct air circulation. If there will be such blockages, there will be temporarily provided materials to stop the entry of this kind of insects.

There are 2 closing fences, situated 8 m form each other, which prevent entry of large terrestrial animals in the IDSFS area.

In conclusion, in normal operation conditions at the IDSFS extended site, with storage of spent fuel in the new MACSTOR400 modules, the impact on flora and fauna is predicted to be insignificant.

III.7.3. Impact on soils / subsoil, uses, material assets

The impact on soil and subsoil produced during use of the deposit is insignificant. Liquid radioactive effluents which could constitute indirect sources of pollution of soil or subsoil are treated and conditioned in the related technological systems of the facility.

Access roads are concreted and personnel access is limited and subject to the procedures of Cernavodă NPP site.

At IDSFS it is provided a drainage system that allows the collection of leaks and is provided their monitoring. If these leaks are radioactive, is provided their treatment at the plant.

In these conditions it can not be considered rationally contamination of soil and subsoil and therefore, environmental impact of these factors is practically null.

III.7.4. Impact on quality and quantitative regime of water

Under normal operation of extended IDSFS there are no pollutant emissions produced to affect surface water and groundwater.

The only possible sources are rainwater and water from washing platform.

Rainwater from the extended storage site and resulted from washing the platform are collected and discharged into a drain pit. The discharge of these waters to emissary is made through a channel of concrete tubes. Crossings under roads and concrete plaatforms, channels will be protected in a concrete sleeve.

Drainage pit is from reinforced concrete, fitted with a sluice type valves. In case that the platform is washed, sluice valve is closed.

From this pit, water samples are taken to check a possible radioactive contamination.

If the water is radioactive, it is loaded into tankers and transported to the plant where it is taken by the radioactive liquid waste system.

If the water from washing is not radioactive, it is discharged by gravity to the emissary.

Under the concrete platform related to the storage a drainage network is placed, that aims to collect leaking on the platform in case of accidents by destroying the concrete platform, and groundwater, if it accidentally touches the placement quota of the drainage tubes.

In normal operation, practically there is no possibility that the seepages from gutters or platforms to reach the underground water.

To the adjacent Building is provided an active drainage system linked to the plant system, which would take water resulted from eventual decontamination operations of transfer container, trailer. This water is processed according to plant procedures and facilities provided to it.

For tracking the groundwater quality, systematic measurements are done in four (4) piezometric wells specially arranged for this work.

For extension of IDSFS site with the 4th row of modules, will be made additionally 2 drilled wells, that will ensure the control of quality and water levels in the groundwater from the entire extended IDSFS platform

III.7.5. Impact on air quality and climate

Spent fuel bundles, transferred for dry storage, are usually intact because the operating procedures establish that non-intact bundles will be left in the spent fuel bay. After 6 years of cooling, radiological inventory of these bundles is 1000 times smaller than when the bundles were unloaded from the reactor.

MACSTOR system uses a dual confining of fuel bundles which ensures three very efficient barriers of retaining of gaseous radionuclides contained in spent fuel: fuel sheath, fuel basket and storage enclosure of storage module.

Normal operation of the storage for spent fuel coming from Cernavodă NPP does not involve pollutant air emissions, so there will be no impact on air quality caused by pollutant radioactive emissions.

III.7.6. Impact of noise and vibrations

Cernavodă NPP is located in an industrial area, and by ensuring the exclusion areas of Units U1 and U2, dwellings are not permitted at less than 1000 m.

For an enterprise located in an industrial area, in accordance with STAS 10009-88, sound pressure levels, equivalent continuous, A-weighted, will be lower than the permitted limit of 65 dB (A).

Noise sources within Cernavodă NPP site are located mostly at more than 20 m inward from the site boundary (fence that borders the territory of the plant). The

noise levels are at least 3 dB (A) lower than the limit of 65 dB (A) settled by legislation.

Project-specific noise sources, on the IDSFS site, are represented by activities of building modules, and during operation by gantry crane operation and spent fuel auto-transporter.

In rest of the time, when are not done loading operations on MACSTOR modules or their construction, there is no noise generated on site.

Noise at workplaces not exceed the level of 90 dB (A) that could produce acoustic exposure levels above accepted norms.

Regarding the vibration, considering the quality of special foundations, the submitted vibration levels are estimated to be very low. Given the low levels of vibration during operation and objective remoteness toward inhabited areas, there is not expected environmental pollution vibration.

Compared to the current situation, there is not expected an increase of noise and vibration level, given that the activities carried out are similar to those currently, IDSFS expanding and MACSTOR 400 modules carrying out does not require changes in the technological processes currently undertaken on the IDSFS site.

III.7.7. Impact on landscape and visual environment

Around the site, the landscape and visual environment are those characteristic to industrial platforms, having dispersion stacks, production halls and headquarters of NPP Cernavodă (offices, workshops and laboratories type ground and first floor), etc.

Given the location of the project inside the Cernavodă NPP site, and that the project provides the extension of an existing storage, it is estimated that the project will have no additional impact on landscape and visual environment.

III.7.8. Impact on historical and cultural patrimony

Given the location of the project inside the Cernavodă NPP site, the project will not have an impact on the historical and cultural patrimony of the area.

III.7.9. The cumulative impact

III.7.9.1. Environment factor water

Intermediate Dry Spent Fuel Storage doesn't require connection to water supply network (drinking water, technological water, firefighting water) nor to the sewage network for domestic or technology wastewaters.

The only necessary utilities on IDSFS site are the pluvial sewerage and electricity supply.

Cernavodă NPP has the Water Management Authorisation No. 267 from 11.11.2013 for Cernavodă Intermediate Dry Spent Fuel Storage (I.D.S.F.S) which grants to the authorization holder, S.N. NUCLEARELECTRICA S.A., Cernavodă NPP branch, the right to use the hydraulic structures and receptors for drainage of rainwater from the surface of Intermediate Dry Spent Fuel Storage, in compliance with the structural and functional parameters, discharged water quality indicators and all the obligations and conditions established by the authorization.

Once the construction of 4th row of modules will start, will be executed another 2 additional drilled wells that will ensure the control of quality and water levels in the groundwater from the entire extended IDSFS platform.

Rainwaters coming from IDSFS platform / site, collected through drainage channels in collection pits are analysed in terms of radioactive contamination. In the emissary, Valea Cismelei, are only discharged the uncontaminated rainwaters. If after the analysis performed it is ascertained that the rainwaters are contaminated, they are taken over and transferred to the liquid radioactive wastes system of the nuclear units.

Operating regime is described more detailed in Chapter III.

There are no physical or functional connections between the rainwater sewer system of IDSFS and rainwater sewer system of the nuclear units.

In these conditions, the cumulative impact on the environmental factor water arising from the extension of IDSFS and the one produced by nuclear units can be estimated as insignificant.

III.7.9.2. Environment factor air

Exhaust gases emissions and dust from machinery and vehicles used for building will have local effects, temporary and small scale. Details regarding impact on air during construction works, can be found in chapter VII.3.

Noise and vibration from transport and construction machinery manifests at close range, especially in site timeshare, so it can be estimated that the impact on human settlements will be insignificant. Moreover, Cernavodă city is protected by the hill that separates it from the site.

Diesel generators are practically in standby, their operation only being need on loss of energy supply situations and only on limited time. Diesel generators use as fuel as Euro 3 Diesel with a sulphur content of about 0.05%. Pollutant concentrations in flue gas total flow of 13,000 m^3 / h, are within allowable limits

for emissions. Diesel generators only work for short periods of time (when tested) and therefore they do not influence the systematic air quality or other environmental factors.

Relating to the IDSFS storage, it does not produce any kind of emissions into the atmosphere. Under normal operation conditions may not occur any leakage of radioactive substances in the air, the storage unit having three barriers from the environment, highly effective for retention of gaseous radionuclides contained by the spent fuel: fuel sheath, fuel basket and storage enclosure of the storage module.

Given what was presented results that extended IDSFS doesn't bring any significant impact on air, so the cumulative impact of extended IDSFS and the nuclear units in operation, from Cernavodă NPP, can be estimated as insignificant from the point of view of quantitative emissions of gas / contaminated air.

III.7.9.3. Environment factor soil, groundwater, subsoil

Details regarding impact on soil, groundwater, subsoil during construction works, can be found in chapter VII.3.

In operation, extended IDSFS doesn't produce any impact on soil, groundwater and subsoil.

Extension of IDSFS do not produce a significant impact on soil and subsoil, so **the cumulative impact with the impact of all nuclear units in operation can be estimated as being insignificant.**

III.7.9.4. Environment factor flora and terrestrial fauna

Construction activities for extension of IDSFS will not have as a result further reduction of species diversity of plants and animals in the area, because there will be no loss of habitat and / or their movements.

The site currently does not contain any critical or productive habitat, and execution activities will have no impact on terrestrial flora and fauna.

Since the project and administrative measures lead to non-radioactive emission limiting into the air to insignificant quantities, results that their impact on terrestrial vegetation and fauna will not be significant.

Cumulative impact produced by extended IDSFS and the operational nuclear units on flora and fauna can be estimated as being insignificant.

III.7.9.5. Cumulative impact on landscape

During operation of nuclear units, the measures to prevent adverse effects on landscape, will consist of maintenance activities of surface buildings and facilities.

Extended IDSFS is small sized, both in volume and as height, compared to the buildings made for U1, U2, U3, U4 and U5 which has already created a visual

impact and on landscape more than 30 years ago and practically can not alter the impact produced.

In conclusion, extended IDSFS together with the buildings of units U1, U2, U3, U4 will have an insignificant cumulative visual impact on the existing landscape.

III.7.9.6. Cumulated radiological impact

IDSFS ensures the intermediate storage of nuclear spent fuel from nuclear units, in terms of nuclear safety both for operating personnel and population, and for the environment, it's extension and using MACSTOR400 modules being necessary in perspective of lifetime extension of the units 1 and 2 for another operating cycle.

IDSFS contribution to the dose received by an individual who lives on the limit of the exclusion zone of the site, according to calculations from project, is insignificant, given it's extremely small value, of 21 µSv/year (79D-01320-SAR-001 page.7-24 chapter.7).

Regarding nuclear units, according to Fundamental Norms for radiological safety, release into the environment of liquid or gaseous radioactive effluents can be done only with respecting the derived emission limits (LDE) approved by CNCAN in the authorization process.

According to studies provided by beneficiary, from comparison between emissions reported to Cernavodă NPP for U1 and the derived emission limits it is found that the emissions reported for U1 are well below the LDE.

Considering the dose constraints for each nuclear unit in operation, (0.1 mSv/year for U1, 0.1 mSv/ year for U2 and 0.05 mSv/ year for IDSFS MACSTOR 200), the cumulative radiological impact for Cernavodă NPP site this moment is 0.25 mSv/year.

If the project of Units 3 and 4 will be realized and CNCAN will authorize the same dose constraints as the ones for Units 1 and 2 of 0.1 mSv/year/unit, than the cumulative radiological impact for the site with 4 units and IDSFS will be of 0.45 mSv/an, value situated below the legal limit of 1 mSv/year.

III.7.10. Avoidance, reduction or alleviation measures of significant environmental impacts

III.7.10.1. Environment factor water

Avoidance and reduction measures of the impact on the environment factor water are:

- constructive nature (design / technical solutions applied) and is aimed at sealing surfaces and adequate water collecting on the IDSFS and MACSTOR module surface, namely:
  - on the IDSFS site roads and platforms are concreted
  - roads and platforms inside IDSFS are designed so that through considered slopes, water from rain to be properly evacuated to ditches and sewers related to IDSFS platform.
  - the remaining land of the IDSFS site – green spaces, is arranged so as to solve drainage from rainfall, with drainage slopes toward adjacent roads.
  - MACSTOR modules are perimetral serviced with ditches (1 ditch to 1 and 2 module group; 1 ditch to 3 and 4 module group; and 1 ditch to 5, 6 and 7 module group) as well as by ditches between modules, all covered with metal carriageway grills, ditches that connect to water collection pit and pit valves, placed between modules. Similarly, following the expansion of the IDSFS site, MACSTOR modules will be served perimeter and between modules, by covered metal carriageway grills that will connect to water collection pit and pit valves
  - to prevent the penetration of rainwater through the visiting opening in the pit of valves, starting from module 2 was provided bordering of the opening with an angular.
  - upon completion of each odd module, until commissioning of the even pair module, the perimeter ditch is partially made, and is closed by the corresponding section of the unexecuted even module.
  - the collector pit along with the ditch are able to collect and confine the maximum volume of water, resulted in 24 hours of rain, with return period of 5 years, from the platform related to both modules between which are placed. This protection measure provides a sufficient time for verification of water thus retained and discharge accordingly without allowing possibly contaminated water spreading.
  - in the collector pit was installed a level indicator, and the alarm of the maximum level of water from the pit (from rainwater and water from washing platform) is transmitted in the Main Control Room (MCR); totally, by IDSFS extension, will be necessary a number of 22 signalling devices

- to prevent seepage from ditches and pit of collected water possibly radioactively contaminated, they are protected waterproof.
- for quality control and water levels in groundwater on the IDSFS relevant platform, four (4) drilled wells (piezometric wells - P1, P2, P3, P4) were placed.
- once the building of the 4th row of modules starts, will be made additionally 2 drilled wells, that will ensure the control of quality and water levels in the groundwater from the entire extended IDSFS

- measures applied during the technological process of storing of the irradiated spent fuel:
  - during a storage campaign of irradiated fuel, the valve from the valve pit for the module being loaded is in closed position, in order to retain water from rainfall from related platform.
  - from the collecting pit water samples are taken to check possible radioactive contamination.
  - Water is released only after through laboratory analysis is confirmed that the water is not radioactively contaminated with artificial radionuclides, according to the procedure SI-01365-RP06.
  - if the water collected, resulting in rainfall from the platform is radioactively contaminated, it is loaded into trucks and transported to the NPP, where is taken by the Liquid Radioactive Waste System.
  - if this water is not radioactive contaminated, the valves from the valve pit opens, and the water collected is gravitational discharged in the sewage collector from rainfall from IDSFS platform.
  - between storage campaigns, the valve is put in the open position, only after confirming the lack of contamination of the platform.

III.7.10.2. Environment factor air

Normal operation of the storage for spent fuel coming from Cernavodă NPP assumes no emissions into the air, so do not require special measures to reduce the impact on the environmental factor air due to pollutant emissions.

Regarding radiation, MACSTOR system uses a dual confining of fuel bundles which ensures three very efficient barriers of retaining of gaseous radionuclides contained in spent fuel: fuel sheath, fuel basket and storage enclosure of storage module.

Also IDSFS is equipped with a sampling system, in order to monitor fuel state by sampling air within the storage enclosure and filters analysis in the laboratory. This monitoring is done one week after filling the enclosure and then biannually.

III.7.10.3. Environment factor soil / subsoil

Mitigation measures on soil / subsoil are also constructive nature, namely protect soil and subsoil of the site area by building concrete platforms, module design solutions of MACSTOR modules, and measures relating to operation:

- create confinement barriers of radioactive materials (basket and storage enclosure)
- barriers protect against degradation
- monitoring containment barriers
- prevention of barriers damage
- collection and controlled disposal of waters

Also, protection measures of environmental factor water, and proper waste management measures and hazardous substances, ensures the protection of the environmental factor soil / subsoil.

III.7.10.4. Environment factor fauna and flora

According to *Preliminary study of impact for intermediate dry spent fuel storage facility- IDSFS* conducted by ICIM Bucharest in 2001, during the execution of IDSFS objective, environmental impact is reduced and time limited. His diminution is possible with a judicious site organization, especially in terms of fuel supply of equipment and vehicles, proper waste management, maintenance in good working condition of machinery and equipment, use of advanced equipment in terms of pollutant generation and noise, etc.

Compliance project in terms of technical execution solutions, of quality materials, and proper equip of the objective in order to avoid the risk of adverse environmental effects.

During operation the main measures that can be taken to minimize the impact of storage modules on the environment are:

- structural integrity of the storage modules
- biological protection
- implement a high quality confining system
- sufficiently large distance from the storage place towards the limit of the exclusion area.

III.7.10.5. Social and economic cumulative impact

IDSFS extension is a measure of appropriate management of waste generated by nuclear systems - radioactive spent fuel.

Radiation protection of operational staff and population are provided for IDSFS extension in accordance with principles and general requirements applicable to all nuclear installations.

Storage area is located at a sufficient distance inside the exclusion zone of the Cernavodă site, ensuring the maintenance of dose for the population below the limit value for both normal operation and for accident conditions. Storage area is equipped with an adequate fencing to prevent unauthorized access of the public in the plant.

Since design stage, IDSFS is designed so that radiation exposure should be kept as low as reasonably achievable (respecting the ALARA principle). Thus are foreseen the following protection measures against radiation from IDSFS:

- radiation shielding (gamma and neutrons) to reduce exposure of personnel during normal operation of IDSFS
- organization of circulation paths and control the access in the area
- fuel containment
- minimizing the need for remediation through the use of appropriate materials and systems
- radiation monitoring.

Shielding against gamma radiation and neutrons of the operating personnel is achieved through constructive and operating measures, namely:

- design the walls and floor of the storage modules (both MACSTOR 200 and MACSTOR 400) as well as the final shield plug, so as to reduce the radiation dose rate to acceptable limits;
- providing a labyrinth of concrete to the storage modules (both MACSTOR 200 and MACSTOR 400) so as to prevent primary or secondary irradiation outside it. Labyrinth ensure nominal thickness of monolithic concrete wall in any direction
- providing a protective ring of plumbum (both MACSTOR 200 and MACSTOR 400) to ensure operator shielding located on the module during module loading operations
- ensuring a minimum distance between operator and storage enclosure under filling, during which it is discovered
- filling technology as a whole

During module charging, in order to prevent the spread of potential contamination, they were provided a series of measures:

- execution of the spent fuel transfer to IDSFS only during the day and in good weather conditions;
- verification, after each load, of the contact area between the transfer flask and the storage cylinder;
- decontamination according to plant procedures;
- isolation of the drainage systems from the storage platform.

Fuel containment is ensured by technological barriers (welded storage basket and module storage enclosure) that are designed to isolate the radioactive material to the environment.

In cases of accidental contamination, will apply, as appropriate, plant procedures for "rubber area" or "rubber change area".

Operating personnel access to IDSFS is controlled, made through Security Building, ensuring access limiting to the IDSFS site.

Access on the MACSTOR modules is made on an acces ladder located on the small side modules, not to interfere with inlet / outlet of the cooling air.

III.7.10.6. Measures to avoid, reduce or improve the impact on landscape

No measures are required to avoid, reduce or improve impact on landscape because the project is placed in the enclosure of Cernavodă NPP, where the overall landscape is industrial, on the site being present dispersion baskets, production halls and head offices of the Cernavodă NPP (offices, workshops and laboratories type ground and first floor), etc.

III.7.10.7. Measures to avoid, reduce or improve the impact on historical and cultural patrimony

No measures are required to avoid, reduce or improve the impact on the historical and cultural patrimony, because the project is located inside the Cernavodă NPP.

Moreover, around each nuclear unit are set:

- an exclusion area with a 1 km radius – in which no other activities than those carried out in the NPP are allowed,
- a low population area - with a radius starting from 1 up to 2 km from the nuclear objective

thus considering existing restrictions, the new integrated project may not have an impact on the historical and cultural patrimony, in terms of operation at the designed parameters.

III.7.10.8. Measures to reduce noises and vibrations

If during operation phase, it is found local situations of exceeding noise and vibration levels, as a result of specific investigations, will act through specific reducing measures:

- reduce noise levels and vibration sources
- noise screenings
- anti-vibration treatments
- receiver decreases of noise and vibration levels by using personal protective equipment by workers.

III.7.10.9. Measures to reduce impact due to waste generated during operation

Measures that should be considered to reduce impacts associated with waste production, generated during operation are:

- Implementation of the existing and already operational system in Cernavodă NPP in the treatment, classification and tracking of waste and optimizing processes procedures, potential waste generator.
- Non-radioactive industrial and household waste management according to approved procedures in Cernavodă NPP, of the Environmental permit and legislation in force.
- Continuous monitoring of waste management and their managing.

Regarding weak radioactive waste management from IDSFS operation, we can make the following clarifications:

- **Radioactive liquid waste** – at IDSFS are generated potentially radioactive liquid wastes that are managed within the power plant's systems;
- **Radioactive gaseous waste** – in case of occurrence of radioactive exhausts, only in the case of events such as:

  a) breaking of a sheath of a fuel element - the presence of confinement barriers (basket and storage enclosure) prevents a possible release of radioactive products, if the defective fuel item is already stored in the module.

  b) releases from the basket – the tightness is assured constructively by welding, and containment is provided by the other barrier (storage cylinder). Consequently, the likelihood of gaseous recesses is very low, the storage unit being assured towards the environment through these engineering barriers:
  - storage basket;
  - storage cylinder.
- **Radioactive solid waste** – radioactive solid waste resulting from the process of preparing the transfer container for his location on the auto – transporter, and after an eventual decontamination of the transfer container or of the storage module, are collected in a type A container. For transportation of the waste container back to Unit 1 or Unit 2, will comply with the specific procedure. Treating this waste is identical to other weak active solid waste treatment resulting from operation of the plant.

III.7.11. Transboundary nature of the impact

Regarding the IDSFS expansion, MACSTOR modules (both MACSTOR 200 and MACSTOR 400) are themselves buildings designed to hold in safe conditions, radiation from the spent fuel, the storage representing a measure of proper waste management generated by nuclear systems.

Storage area is located at a sufficient distance inside the exclusion zone of the Cernavodă site, ensuring the maintenance of dose for the population below the limit for both normal operation and for accident conditions. Storage area is equipped with an adequate fencing to prevent unauthorized access of public in the facility.

Given the long distance of over 36 km from the border, from the storage area to the border in normal operating conditions, there is no danger of a transboundary impact.

Because there are no contaminated air emissions during IDSFS operation, we conclude that there is no impact on the environment that can be analysed / calculated for transboundary impacts.

IV. Sources of pollutants and facilities for retention, disposal and dispersion of pollutants in the environment

IV.1. Water quality protection

IV.1.1. Source of pollutants for waters, discharge location or emissary

Under normal operation of IDSFS no pollutant emissions that affect surface waters and groundwater are produced.

During fuel transfer operations no liquid waste are produced.

On the IDSFS platform, the only possible sources of pollution are rainwaters, that can be radioactively contaminated or not.

The main sources of wastewater generated during the construction phase are:

- construction activity: oil accidental leaks from vehicles transporting materials
- uncontrolled disposal of construction waste - inert
- domestic waste and wastewater from personnel
- rainwater fallen on working platforms of the site organization

Roads and platforms inside IDSFS are designed so that through considered slopes, water from rain to be properly evacuated to ditches and sewers related to IDSFS platform. The remaining land of the IDSFS site is arranged so as to solve drainage from rainfall, with drainage slopes toward adjacent roads.

The rainwater network (meteoric), corresponding to IDSFS site, consists of collecting sewers from tubes, Dn (nominal diameter) 500 mm, made of polyester reinforced with fiberglass (PAFS), on which are located PAFS manholes. Sewers are located underground, beneath the depth of frost.

Rainwater channels, for each row of modules, is discharging by gravity the waters collected in the rainwater sewer ditch located at the base of the IDSFS embankment platform.

In the collector pit was installed a level indicator, and the alarm of the maximum level of water from the pit is transmitted in the Main Control Room (MCR).

Instrumentation and control system is performing the role of signalling in MCR of the high level in rainwater pits associated to modules from 8 to 30, located on the 2, 3 and 4 rows. In total will be required a total number of 22 signals. Also, the instrumentation and control system also performs the function of measuring temperature in various locations of the module no. 10, MACSTOR 400 type.

Waters from rain on the peripherally embankment of the IDSFS platform will be taken also by concrete ditch, that will ultimately have a total length of approximately 655.00 m, from which 350.00 m is already completed, and discharged into a manhole located outside the enclosure of IDSFS, in the immediate vicinity.

Collector pit along with the ditch can collect and retain the maximum amount of water, resulting from 24 hours of rain with return period of 5 years, from the relevant platform of modules that are placed between. This protection measure provides a sufficient time for verification of water thus retained and discharge accordingly without allowing possibly contaminated water spreading.

During a storage campaign of irradiated fuel, the valve from the valve pit for the module being loaded is in closed position, in order to retain water from rainfall from related platform.

From the collecting pit water samples are taken to check possible radioactive contamination.

If the water collected, resulting in rainfall from the platform **is radioactively contaminated (in case of not fitting in the CNCAN limits), it is transported to the radioactive wastes system from Unit 1.**

If this water is not radioactive contaminated, the valves from the valve pit opens, **and the water collected is gravitational discharged in the sewage collector from rainfall from IDSFS platform.**

To prevent seepage from ditches and pit of collected water possibly radioactively contaminated, they are protected waterproof.

Between storage campaigns, the valve is on open position, only after confirmation of the lack of contamination of platform.

Waters coming from rainfall on the perimeter embankment of the arranged platform will be discharged by gravity, in Cismelei Valley.

For quality control and water levels in groundwater on the IDSFS relevant platform, four (4) drilled wells (piezometric wells) were placed. Drillings are made of high density polyethylene (HDPE) pipe, PE80, being composed of a protective column with Dext 400 x 22.8 mm and a filtering column with Dext 110 x 6.3 mm and have a depth of approx. 14.00 m.

IV.1.2. Provided stations and treatment or pre-treatment facilities of waste water

There is no wastewater treatment plant in Cernavodă NPP site.

If case of IDSFS, if the water collected from rainfall from the platform is radioactive contaminated, is loaded into trucks and transported to the Radioactive Liquid Waste System.

If rainwater from platform IDSFS is not contaminated radioactive, valve from the valve pit opens, and the water collected is discharged by gravity in the sewerage collector from rainfall.

Water from rainfall on the peripherally embankment slope of the platform, will be evacuated by gravity into Cismelei Valley.

IV.2. Air protection

IV.2.1. Air pollution sources, pollutants

During construction of MACSTOR modules and platforms, roads related to IDSFS

During construction, emission sources of air pollutants of the specific studied project are sources on the ground, open (those that involve handling construction materials and soil management) and mobile (machinery and truck traffic - emissions of pollutants and noise). All these source categories are unguided, being considered as surface sources.

A large proportion of these works include operations that constitute on dust emission sources.

It's about handling operations related to earth, ballast materials and cement / asphalt and other materials.

These are:

- digs, including:
  - excavating and collecting sand and ballast, in piles;
  - loading soil into dumpers;
- fillers, including processes such as:
  - discharging the material (sand, ballast) from dumpers;
  - scattering material;
  - compacting the material;
- infrastructure - additional work.

Dust emissions in the atmosphere often vary substantially from day to day, depending on the level of activity, types of operations and weather.

An additional source of dust is represented by wind erosion, a phenomenon that accompanies the construction works. The phenomenon occurs due to the existence, for a certain period of time, of uncovered land surfaces exposed to wind action.

Along with these sources of air pollution, in the works area there is a second category of sources, namely machinery with which work is carried out: bulldozers,

transportation systems.

The machines, regardless of their type, works with Diesel engines, the exhaust gases discharged into the atmosphere containing the entire complex pollutant specific to internal burning of diesel: nitrogen oxides (NOx), volatile organic compounds non-methane (VOCnm), methane (CH_4), carbon oxides (CO, CO_2), ammonia (NH_3), particles of heavy metals (Cd, Cu, Cr, Ni, Se, Zn), aromatic hydrocarbons (PAH), sulphur dioxide (SO_2).

Particles from exhaust gases from machinery fall, mostly, in the category of respirable particles.

Particles with diameters ≤ 15 μm are found in the atmosphere as particles in suspension. Those with larger diameters are deposited on the ground quickly.

During IDSFS operation

During normal operations in IDSFS of spent fuel transfer are generated gaseous emissions produced by running of the car motor towing the transfer trailer that are issued free into the atmosphere by forced ventilation.

Radioactive contamination sources in normal operation conditions are described in **Chapter IV.4. Radiation protection.**

IV.2.2. Systems for retention and dispersion of pollutants in the atmosphere

Regarding the extension of IDSFS, the MACSTOR modules themselves represent buildings designed to hold in safe conditions radiations from spent fuel.

IV.3. Protection against noise and vibrations

IV.3.1. Sources of noise and vibrations

On the Cernavodă NPP platform the main sources of noise are associated to activities carried out on its site and enclosure road transport.

During construction

Regarding the expansion of IDSFS, noise sources are the ones represented by specific activities for the project achievement.

Construction machines produce noise. Noise level is variable, around up to 90 db (A), higher values being at excavators, bulldozers, pavers, graders and vole. For machinery used in construction, the associated acoustic powers are: bulldozer - approx. 80 to 115dB (A); Wolla Chargers - approx. 80-112dB (A); excavators - approx. 80-117dB (A); compactors - cca.105dB (A); dumpers - approx. 80 to 107dB (A).

The equivalent noise level in transport is determined by the volume of site traffic, vehicle flow patterns, weather conditions, etc.

Dumper trucks serving the site can generate noise levels equivalent to the reference period of 24 hours, approx. 50 dB (A).

STAS no. 10009 - 88 (Urban Acoustics) - Table. 3 - admits a noise level between 60 db (A) - for Category IV streets and 75- 85 db (A) - for Category I roads.

Both for workers and staff from Cernavodă NPP platform, noise from these machines could be disturbing.

During operation

Regarding the expansion of IDSFS, noise sources are represented by the gantry crane operation and by the auto – transporter of the spent fuel.

IV.3.2. Works and endowments for protection against noise and vibration

The project location inside the Cernavodă NPP, industrial area, with restrictions regarding the placement of dwellings, or the banning of their distances below 1000 m from the nuclear units (exclusion zone) makes the noise impact to be insignificant and not affect population.

Given the location in the industrial area sound pressure levels, the equivalent continuous A-weighted, will be lower than allowable limit of 65 dB (A) according to STAS 10009-88.

Noise sources on the territory of the plant are located, mostly at distances of less than 20 m from the boundary of the premises (the fence which borders the territory of the plant). Noise forecasted levels are lower least 3 dB (A) from the limit of 65 dB (A) required by law.

During construction

Reduce risks from exposure to noise must be based on general principles of prevention provided by national legislation transposing the Directive 89/391 / EEC, considering in particular the following:

- choosing of appropriate work equipment, to issue, taking into account the nature of activity, the lowest noise level possible;
- design and layout of workplaces and work stations;
- informing and training employees on the proper use of work equipment in order to reduce to minimum the exposure to noise
- technical means for reducing aerial noise, such as screens, enclosures, sound-absorbent coverings and also structural noise reducing by damping or isolation;
- organization of work so as to reduce noise by limiting the duration and intensity of exposure by establishing sufficient rest breaks during working hours;
- machines will be equipped with silencers, noise collectors, speakers and silencers for fans;

Additional to sound level, construction machines with their large masses, are sources of vibration during their travels or by carried out activity. Thus, the second source of noise and vibration in site is represented by traffic of vehicles. For land

transport, concrete, ballast, etc. heavy vehicles will be used with bigger load of several tons.

Construction functions do not produce disturbing noises.

During operation

Regarding the gantry crane and spent fuel auto – transporter, special arrangements / protections are not required.

The distance to the inhabited area is over 1 km, so there will be no noise problems for the population.

Taking into account foundation quality, the level of vibrations transmitted will be very limited, as a result there is no potential environmental pollution through vibration.

IV.4. Radiation protection

The beneficiary already has a Radiation Protection Regulations and subsequent procedures applicable in production activities, which provide actions and measures to ensure protection from radiation. Regulation is reviewed periodically, actions and procedures being tested through simulation exercises.

IV.4.1. Radiation sources

Source of radiation to IDSFS consists of spent fuel bundles from Units 1 and 2 of Cernavodă NPP, stored on cylindrical modules enclosures of type MACSTOR.

Cernavodă IDSFS is characterized by a high degree of integrity of confinement barriers of radioactive materials provided by using two containment barriers: fuel basket and storage cylinder.

The Cernavodă NPP fuel bundle is made up of 37 fuel elements containing Zircaloy-clad UO2 pellets. Every year, new spent fuel bundles from the reactor may be added to those that are already in the Spent Fuel Bay (SFB); the number of irradiated fuel bundles depends on the capacity factor of the plant. After a sufficient cooling period, the fuel bundles that have been stored in the SFB will be able to be transferred to the IDSFS.

The mass of uranium (reference value) is for the designs of the previous CANDU 6 irradiated fuel dry storage facilities. The value may vary depending on the plant and fuel manufacturer. The actual mass of uranium within the Cernavodă fuel bundles is approximately 18.9 - 19.3 kg, which is the reference value.

The reference value for bundles that are freshly removed from the CANDU reactor. The degree of burnup of the fuel bundles can be higher than the average value, but not exceed 12,000 MWday/tU

The reliability of CANDU fuel bundles is excellent; over time, less than 0.1% of them experienced leaks (non-leaktight sheaths) in at least one of the 37 elements. The presence of a non-leaktight element (with a defective sheath) in a bundle does not normally affect the mechanical integrity of the bundle. For every 6,000 bundles consumed, a maximum of five defective bundles can be discharged from the reactor per year. These bundles are easily detected during irradiation in the active area, or during transfer into the Reception Bay, and are visually inspected to confirm their mechanical integrity. These bundles may then be prepared for dry storage, following special approved procedures.

In general, bundles that lose their mechanical integrity are separated from intact bundles and handled separately. The dry storage system includes tools for the separate handling of defective fuel elements, to prepare them for dry storage, if applicable. The decision to store mechanically-defective fuel elements must be taken by the plant management.

Structural Characteristics of the Spent Fuel Bundle

The CANDU 6 fuel bundle used in the Cernavodă NPP consists of 37 fuel elements arranged in three rings of 18, 12 and 6 elements, respectively, around a central element. Each fuel element contains natural uranium in the form of 30 cylindrical pellets of sintered uranium dioxide (UO2). The inner surface of the sheath is coated with a thin layer of graphite (CANLUB), to reduce pellet/sheath interaction. The pellets are clad in a sheath made of zirconium alloy (Zircaloy-4), which is closed at both end with end caps. The caps are welded to provide:

- A seal for the contents of the element;
- The actual end of the fuel element, so that it can be assembled to the end plates;
- The interface with the fuel handling system.

The separation required between the fuel bundle and the fuel channel in the reactor core is maintained by means of bearing pads brazed onto the fuel elements. The metal used for brazing is beryllium. These pads also enable handling of the fuel bundle during the dry storage process.

The collected data confirms the reference values set by AECL.

Residual Heat of Reference Spent Fuel Bundles

In the next table is presented the residual heat (decay heat) values for actinides and fission products for nine different cooling periods within a 0–100 year range, estimated for the CANDU reference fuel.

Residual Heat as a Function of Cooling Time

Cooling Period (years)	Residual Heat of Actinides (W/bundle)	Residual Heat of Fission Products (W/bundle)	Total Residual Heat (W/bundle)
0	1,810	23,700	25,500
6	0,44	5,64	6,08
8	0,47	4,44	4,91
10	0,50	3,95	4,45
15	0,56	3,34	3,90
20	0,60	2,94	3,54
30	0,66	2,30	2,96
50	0,71	1,43	2,14
100	0,70	0,44	1,14

IV.4.2. Works and endowments for protection against radiation

The Intermediate Dry Spent Fuel Storage Facility (IDSFS) from Cernavodă is designed so that radiation doses on-site and off-site to comply with the principle of ALARA throughout the preparation, transfer and storage of spent fuel.

Design of biological protection, access control, radiological monitoring design of ventilation systems and waste management must ensure radiological protection required for personnel and for population. The project must limit the effective doses of radiation so that the administrative and legal limits will be respected for occupational exposure, the dose constraint for the population of 50 μSv/year, and also the base principles of radioprotection: justification, optimization and limitation of individual doses.

Storage area is located at a sufficient distance inside the exclusion zone of the Cernavodă site, ensuring the maintenance of dose for the population below the limit for both normal operation and for accident conditions. Storage area is equipped with an adequate fencing to prevent unauthorized access of public in the facility.

In the following are the main requirements that must be met to ensure radiation protection.

Space and equipment layout

Storage modules are placed in network to simplify loading operations and to minimize dose of radiation collected by operators.

The network module is sufficiently compact to minimize the radiological area size.

Previous project experience

The experience accumulated from previous projects was actually transferred to the Cernavodă IDSFS, which is a replica of the fuel preparation area designed

for Point Lepreau and of storage modules from Gentilly 2. These storage facilities have registered during operation very low values of radiation doses for the professionally exposed personnel.

The IDSFS benefits from the design, operational experience and dose-reducing measures implemented at these facilities during their design, construction and use. These designs have also benefited from previous experience accumulated by AECL following the dry storage of spent fuel from 4 other decommissioned facilities.

The Cernavodă IDSFS also benefits from the results of the research and development programs carried out at the AECL Whiteshell laboratories.

Storage modules proposed for Cernavodă benefited from improved shielding, resulting from the operation of the storage modules from Gentilly 2. Improving consisted in providing axial shielding tiles on the outside of the air intake openings to reduce the local dose rate in their right, below value of 25 μ Sv / h for fuel cooled for 6 years in SFB.

For the Cernavodă IDSFS, the ALARA elements of the radiation protection program focus on:

1. Protection of workers by means of a conservative design, appropriately tested equipment and simple fuel preparation methods.
2. Appropriate radiological protection of workers using area and personnel monitoring equipment.
3. Training of personnel involved in the operation of the IDSFS, in accordance with their duties, with an emphasis on work quality, radiological protection, management of abnormal events and recovery following design basis accidents.
4. Planning work for areas where radioactivity is present.
5. Minimising exposure time.
6. Maintaining a safe distance from equipment containing spent fuel and maximizing the control of equipment, such as carrying out loading operations at the SWS and storage module from a remote location.
7. Adequate shielding of gamma and neutron radiation at the SWS, transfer flask and storage module.
8. Decontamination of equipment and areas in accordance with the decontamination procedures.
9. Providing adequate ventilation of work areas and minimising the spread of contamination.

The way in which the ALARA objectives and trends for the IDSFS activities are established is described in the documentation regarding the ALARA program for the Cernavodă NPP.

Providing protection against radiation

The Cernavodă IDSFS is characterised by a high degree of integrity of the containment barriers for radioactive materials, ensured by the use of two containment barriers: the spent fuel storage basket and the storage cylinder.

The fuel basket is made of stainless steel, operates in a non-pressurized state and is stored in a dry air atmosphere. The internal structures of the basket are not subject to corrosion, since the fuel has been dried before the basket is sealed and the air inside the basket is dry.

The storage cylinder is a carbon steel structure designed to resist degradation. This is fully protected against corrosion by applying a corrosion-resistant zinc coating during manufacture.

Also, the storage cylinder is also protected from rain by the concrete storage module and because it is heated inside, the corrosion rate due to ambient surface is reduced.

Tests have shown that, for a working period of 50 years, corrosion of the storage cylinder would be below the acceptable limit (1.6 mm for a cylinder wall thickness of 9.5 mm) even if it was not protected

The ventilation and drainage lines of the storage cylinder are also protected against corrosion using pipes coated with a layer resistant to severe corrosion, in the vicinity of the storage cylinder, and stainless steel pipes in the external section of the lines.

Design dose rate and values measured for the IDSFS equipment and structures

Equipment and Structures	Design Dose Rate	Values Measured (γ)	
SWS	25 μSv/h	Maximum 5 μSv/h	
Transfer flask	25 μSv/h	Maximum 48 μSv/h (in the campaigns from 2014 – 2015 of spent fuel transfer to IDSFS, the gamma design dose rate at the transfer flask contact was exceeded for a number of 5 baskets: 0943, 0966, 0945, 0946, 0891, all 5 baskets being transferred in 2014)	
Storage Module	25 μSv/h	Exterior walls of the MACSTOR module 21 μSv/h and 33μSv/h on the vents	Permanent sealing plug after shielding < maximum 22 μSv/h
Fence	2,5μSv/h	< 0.5 μSv/h	

Storage module is shielded on the side with a concrete wall, minimum thickness 96.5 cm. At the top of the module, the concrete screen is 107 cm thick, and the thickened parts of the air intake and exhaust holes, concrete thickness is 225 cm (over 50% of the front surface of the module).

Due to low level of CANDU fuel combustion and relatively high content of lightweight elements in normal concrete, neutrons are fully shielded by concrete

Regarding the nuclear zoning at IDSFS, the modules is considered zone II, since there is a little possibility of contamination during certain

manoeuvres. When opening a cylinder containing spent fuel basket, the zone II becomes temporarily Zone I.

In normal operation only sealed sources will be handled. It was provided an Access Building for access to the deposit. A portable contamination monitor of staff is available in the Access Building, to detect accidental contamination.

To prevent the possible spread of contamination were provided a series of measures:

- execution of the spent fuel transfer to IDSFS only during the day and in good weather conditions;
- verification, after each load, of the contact area between the transfer flask and the storage cylinder;
- decontamination according to plant procedures;
- isolation of the drainage systems from the storage platform.

In cases of accidental contamination, will apply, as appropriate, plant procedures for "rubber area" or "rubber change area".

During storage operations, there are transitional periods very short (less than a minute at each loading operation) in which the storage cylinder plug is lifted and moved laterally to allow installation of transfer flask over that cylinder, for storing a fuel basket (plug is moved backwards and reinstalled on the cylinder after storage). In these short periods, the transient radiation dose rate near the module exceeds the normal value of project. In this case, backscattering contribution due to ambient air (effect "sky shine") is more important than the contribution of direct radiation through the shielding concrete.

IV.5. Soil and subsoil protection

IV.5.1. Sources of pollution for soil, subsoil and groundwater

During construction

Pollution sources of the soil, under the construction phase are:

- construction technologies;
- earthmoving and transport machinery;
- human activity.

Construction technologies

Execution of expansion works, are the main types of activities with direct impact on soil and subsoil.

A disorderly execution of works can lead to loss of materials and pollutants (e.g. loss of fuel and oil from construction and transport equipment) which can migrate into the soil.

Soil deposits can be trained by rain water and wind. As a result of rainfall, surface outflow washes and train fractions of material or masses of earth.

Handling and placing into work construction materials (concrete, aggregates etc.) determine specific emissions for each type of material and each construction operation, emissions that can be deposited on soil and can be trained by rainwater.

Earthmoving and transport machinery

Working mode, the age of the equipment and their technical condition are elements liable to cause soil and subsoil pollution during construction.

The main pollutants are diesel and burned oils.

These may come to affect the quality of the soil and subsoil by:

- accidental losses of materials, fuels, oils from machinery involved in the construction works;
- equipment repairs, conducting exchanges of oil in undeveloped areas;
- diesel or burnt oil storage in storages or unsuitable containers.

Heavy traffic, specific to construction period, determine various emission of pollutants into the atmosphere (NOx, CO, SOx - characteristic to diesel - particulate matter, etc.). Also, there will be friction and wear particles results (of runway, tire). The atmosphere is also washed by rain so that, air pollutants are transferred to other environmental factors (surface water and groundwater, soil, etc.).

Human activity

The activity of employees who perform construction work is in turn generating pollutants impacting the soil, because:

- produces domestic waste that can be stored in inappropriate places and trained by water and can affect soil and subsoil;
- careless handling of construction materials and storing them in places where they can be trained in soil and subsoil;

The intensity of the dust impact on soil depends on many factors including: proximity to major sources producing dust, dominant wind direction.

Dust pollution has no lasting negative effect on the soil.

The impact that construction activity may have on the soil and subsoil will have a limited time period.

After taking all measures to reduce the impact will be recorded however the residual impact in case of soil surfaces permanently occupied by buildings (permanent change of destination).

During operation

Sources of soil, subsoil and groundwater pollution are represented by waters coming through rainfall on site facility and waters from washing platform (which may contain including accidental leaks from auto-transporters of spent fuel baskets) if they are not are taken up by concrete ditches and spouts, or in the event

of network integrity problems of takeover of these waters that can lead to accidental leaks in the soil / subsoil.

IV.5.2. Works and endowments for soil and subsoil protection

Regarding on the collection of rainwater from the IDSFS site that can pollute the soil / subsoil and groundwater, constructive measures of the reception system of these waters provide safe meteoric water takeover, without the possibility of soil / subsoil pollution according to the following specifications.

Collector pit along with the ditch are able to collect and confine the maximum volume of water, resulted in 24 hours of rain, with return period of 5 years, from the platform related to both modules between which are placed. This protection measure provides a sufficient time for verification of water thus retained and discharge accordingly without allowing possibly contaminated water spreading.

During a storage campaign of irradiated fuel, the valve from the valve pit for the module being loaded is in closed position, in order to retain water from rainfall from related platform.

From the collecting pit water samples are taken to check possible radioactive contamination.

If the water collected, resulting in rainfall from the platform **is radioactively contaminated, it is loaded into trucks and transported to the NPP, where is taken by the Liquid Radioactive Waste System.**

If this water is not radioactive contaminated, the valves from the valve pit opens, **and the water collected is gravitational discharged in the sewage collector from rainfall from IDSFS platform.**

To prevent seepage from ditches and pit of collected water possibly radioactively contaminated, they are protected waterproof.

Between storage campaigns, the valve is on open position, only after confirmation of the lack of contamination of platform.

For quality control and water levels in groundwater on the IDSFS relevant platform, four (4) drilled wells (piezometric wells) were placed. Drillings are made of high density polyethylene (HDPE) pipe, PE80, being composed of a protective column with Dext 400 x 22.8 mm and a filtering column with Dext 110 x 6.3 mm and have a depth of approx. 14.00 m.

IV.6. Protection of terrestrial and aquatic ecosystems

IV.6.1. Identification of sensitive areas that may be affected by the project

Intermediar Dry Spent Fuel Storage Facility (IDSFS) is located in an industrial area (Cernavodă NPP platform), at a distance of over 1.8 km from the nearest protected area designated for protection of species and habitats of high conservation value.

Placing the objects near the U1 and U2 Units reduce risks arising from transport of material with potential of radiological contamination (spent fuel) to other locations located outside the Cernavodă NPP.

IV.6.2. Works, endowments and measures for the protection of biodiversity, natural monuments and protected areas

Since the normal functioning of IDSFS do not lead to discharges of radioactive or non-radioactive in the air, water or ground level, it can be appreciated that, that objective will not affect terrestrial and aquatic ecosystems in the studied area (Technical documentation for obtaining the environmental permit for the operation of IDSFS, CITON, 2003)

It is not anticipated an increased levels of gamma radioactivity as a result of the proposed extension for IDSFS objective.

The inlet and outlet air which is equipped with storage module MACSTOR are covered with grates to prevent entry of birds and mammals. Exterior protective fence that prevents the entry of large terrestrial vertebrates in the storage and 4m from security fence (Technical documentation for obtaining the environmental permit for the operation of IDSFS, CITON, 2003).

IV.7. Protection of human settlements and other public interest objectives

IV.7.1. Identifying public interest objectives, the distance from human settlements and from historical and architectural monuments, and other areas over which a system of restriction is established, traditional interest areas etc.

Around each nuclear unit there are set up:

- an exclusion area with a radius of 1 km – in which no other activities than those carried out in the NPP are allowed
- an area with low population – with a radius starting from 1 up to 2 km from the nuclear unit.

The nearest localities in the influence area of Cernavodă NPP site are:

- Cernavodă city with a population of 16.143 inhabitants accounted in 2011 – situated at approx.1.6 km NW from Cernavodă NPP platform
- Stefan cel Mare village with a population of approx.573 inhabitants in 2002 – situated at approx.2km SE from Cernavodă NPP.

The localities Seimeni (approx. 2.4 km), Dunarea (approx. 8.5 km), Capidava (approx. 15 km) and Topalu (approx. 22 km) are downstream of the discharge of cooling water from Cernavodă NPP into the Danube.

After consulting the General Urban Plan of Cernavodă, the Mapserver for national cultural heritage managed by National Heritage Institute – Department of Research, Record of Mobile Cultural Heritage, Intangible and Digital Bucharest, as well as Law No. 5/2000 on the approval of the National Spatial Plan - Section III - protected areas, it was found that Cernavodă NPP site is located in an area with concentration in the territory of built heritage of national cultural value – the municipality of Cernavodă, Mircea Voda and Topalu communes.

The closest are the archeologic sites from Axiopolis – approx. 2.6 km to WSW, Dealu Viforului medieval settlement – approx. 3.6 km WSW and Valul de piatra from Cernavodă – approx. 2.7 km WSW, and "Engineer Anghel Saligny" Bridge – approx. 3 km WNW from the project.

Given the location of the Project inside Cernavodă NPP site, it can be estimated that the IDSFS expansion will not have an impact on localities and historical and cultural heritage of the area.

IV.7.2. Works, endowments and measures for the protection of human settlements and protected objectives and/or of public interest

No measures are required to avoid, reduce or improve the impact on protected objectives and / or public interest because the project is located inside the enclosure of Cernavodă NPP.

Moreover, around each nuclear unit are imposed exclusion zone and zone with low population for which are imposed restrictions on the conduct of activities, so the project cannot have an impact on protected objects and / or public interest, in terms of operation at designed parameters.

Systems and measures for the prevention and control of emissions into the atmosphere and aquatic systems, respectively waste and hazardous substances management planned for the project, will be integrated into the environmental management system of Cernavodă NPP, thus ensuring conditions and requirements duly authorized for the protection of human settlements and other protected and/or public interest objectives in the area.

During normal operation of the IDSFS, the only exposure pathway for an individual who lives on the boundary of the exclusion zone of the Cernavodă NPP site is external irradiation.

The public is not possible to ingest or inhale radioactive substances unless these substances reach into the environment. The proposed storage method is characterized by the absence of any leaks of radioactive material into the environment during normal operation of the facility

Radiation dose rate considering all the ways of scattering, near the storage modules and until limit of exclusion zone of Cernavodă site, were calculated using the MCNP-4b code. The results are presented in the following table.

Gamma dose rate at various distances from storage facility

Distance (m)	Dose rate (µSv/h)
20	2,22
30	1,40
40	1,02
50	$7,85 \cdot 10^{-1}$
100	$1,20 \cdot 10^{-1}$
200	$1,80 \cdot 10^{-2}$
300	$5,00 \cdot 10^{-3}$
400	$2,00 \cdot 10^{-3}$
500	$1,08 \cdot 10^{-3}$

600	$4{,}40 \cdot 10^{-4}$
700	$1{,}76 \cdot 10^{-4}$
800	$7{,}43 \cdot 10^{-5}$
900	$3.24 \cdot 10^{-5}$

For distances less than 50 m from the storage models were estimated dose rates along the four directions, the maximum values are presented in the table (W direction). At greater distances dose rate values are generally independent of direction (at a given distance) and therefore average was calculated of different directions for a given radius.

The average gamma dose integrated measured using environmental thermoluminescent dosimeters placed in the 12 monitoring locations of the protective fence of IDSFS, in 2004-2014 period was 0.084μSv / h (for background locations, placed at 25 km, the average gamma integrated dose was 0.0999 μSv / h for ADB-01 - Topalu and 0.1062 μSv / h for ADB-02 Deleni).

Analysing the results are found the following:

a) Values of dose rate at the boundary site are several orders of magnitude lower than natural background radiation and therefore can not be measured. Also, these values are much lower than the limit enforced for the Cernavodă IDSFS by CNCAN (50 μSv / year).

b) At distances greater than 250 m from the storage platform is possible permanent standing of people, without exceeding the dose limit imposed by CNCAN for Cernavodă IDSFS (50 μSv / year).

Therefore, it is expected that the real values of the dose rate at various distances from the Cernavodă IDSFS will be lower than the estimated values.

To confirm this argument, dose rate measurements were carried out at the boundary of the Cernavodă IDSFS fence after loading of the first module; also, measurements will be carried out periodically during the fuel storage program. Depending on the measurement results, the necessary measures will be taken with regard to the occupancy periods less than 250 m away from the IDSFS.

Starting from 2003, the IDSFS facility has been included in the radioactivity monitoring program for the Cernavodă NPP environment. The average value of the gamma dose rate, measured at the 12 points where environmental thermoluminescent dosimeters are located, was lower than 0.1 μSv/h during the period 2003-2014, value comparable to background values measured at distances greater than 25 km.

IV.8. Management of waste generated on the site

IV.8.1. Types and quantities of any kind of generated waste

During construction

The main types and categories of waste that may result in the construction phase are commercial wastes similar to those that result from construction works for usual industrial objectives, and wastes similar to municipal:

- Construction material waste
  - concrete (17 01 01)
  - mixtures of concrete, bricks, tiles and ceramic materials, other than those specified in 17 01 06 (17 01 07)
  - iron and steel (17 04 05)
  - metallic mixtures (17 04 07)
- wood (17 02 01)
- plastic (17 02 03)
- soil and stones containing dangerous substances (17 05 03*)
- soil and stones other than those mentioned in 17 05 03* (17 05 04)
- dredging spoil containing dangerous substances (17 05 05)
- insulating materials other than those specified in 17 06 01 (insulation materials containing asbestos) and 17 06 03 - other insulation materials consisting of or containing dangerous substances (17 06 04)
- used oils:
  - mineral-based non-chlorinated engine, gear and lubricating oils (13 02 05*)
  - other engine, gear and lubricating oils (13 02 08*)
- end-of-life tyres (16 01 03)
- lead batteries (16 06 01*)
- absorbents, filter materials (including oil filters not otherwise specified), wiping cloths, protective clothing contaminated by dangerous substances (15 02 02*)
- absorbents, filter materials, wiping cloths and protective clothing other than those mentioned in 15 02 02 (15 02 03)
- packaging waste:
  - paper and cardboard packaging (15 01 01)
  - plastic packaging (15 01 02)
  - wooden packaging (15 01 03)
  - composite packaging (15 01 05)
  - packaging containing residues of or contaminated by dangerous substances (15 01 10*)
- reusable / recyclable wastes: paper and cardboard wastes (20 01 01 - from administrative activities, office), glass wastes (20 01 02), plastics (20 01 39), metals (20 01 40) for which is recommended separate collection and storage,

in suitable containers, specially designed and following to be delivered to authorized companies, for recovery.

- mixed municipal wastes (20 03 01), generated from personnel activity

No execution activities after which will result wastes that would represent a potential danger to the population and environment are made.

Subject to the proceedings of Cernavodă NPP at this stage will not generate radioactive waste or with potential of radiological contamination.

During operation

The object itself, IDSFS, represents the solution for radioactive waste management from the operation of Units 1 and 2 of Cernavodă NPP through intermediate storage of this waste.

Following the operation of IDSFS, about radioactive waste, we can make the following clarifications:

- **Liquid radioactive waste** - at IDSFS can be generated potentially radioactive liquid wastes (coming from the decontamination by the wash of the transfer container, trailer) that are managed within the power plant's systems.
- **Gaseous radioactive waste** - Radioactive exhausts may only occur in the case of events such as:

  a) breaking of a sheath of a fuel element

  If the defective fuel item is already stored in the module, the presence of confinement barriers (basket and storage enclosure) prevents a possible release of radioactive products.

  b) releases from the basket

  The basket is welded and tightness is assured; so far, there were not detected releases from the basket at operational CANDU objectives. However, containment is provided by the other barrier (storage cylinder). Consequently, the likelihood of gaseous releases is very low, the storage unit being assured towards the environment through these engineering barriers:

  - Storage basket;
  - Storage cylinder.
- **Solid radioactive waste** - During storage, for the annual monitoring of storage cylinder is used a filter for retaining particles and one with active charcoal to retain iodine, for each storage cylinder. These filters, which are only a few cm^3 of waste / enclosure / year, will not normally be contaminated. Considering the source of sampling, they are considered weak-active waste and are treated in accordance with NPP procedures.

  Also in the category of solid weak-active waste goes also materials used in case of an eventual decontamination of the transfer flask or storage module.

Operational experience gained on all AECL deposits type IDSFS from CANDU 6 power plants in recent decades, and at IDSFS Cernavodă in the thirteen years of operation, confirms that waste produced during activities of handling irradiated fuel are in small amounts and does not significantly affect the general amount of waste produced by the NPP.

For example, analysis of samples taken from the entry into operation of the first module, to the end of 2014 from all cylinders in storage modules 1 ÷5 and of the 7 cylinders of module 6 (filled in 2014campaign) indicated that no radionuclide of fission and activation products have been observed in the air from the storage cylinders.

IV.8.2. Waste management

During construction

In order to ensure a proper management for waste management during construction works, in the site organization will be respected the legal provisions regarding effective waste management, and also the following:

- Cernavodă NPP procedures
- special procedures for the project
- prevention and / or reduction measures of accidental leaks
- waste management procedures resulting from construction - assembly activities
- periodic maintenance activities of machinery and vehicles
- proper handling and storage of fuels and materials.

Relevant legal provisions comply with the requirements of Law 211/2011 on the regime of wastes and the special and subsequent legislation applicable to wastes categories and to operations with wastes.

All the necessary measures will be taken for the collection and storage in appropriate conditions of non-radioactive industrial waste generated during the construction period and to ensure that the operations of collection, transport, disposal or recovery to be achieved by specialized and authorized companies.

For taking over the recyclable construction wastes and processing them, and for disposal of non-recyclable wastes in landfills of inert wastes or hazardous wastes, the provider will contract specialized and authorized companies.

The provider of construction / assembly works will be required to make separate collection of all wastes generated, depending on the nature of the materials and the possibilities of reuse / recovery, and also depending on the contamination degree with hazardous substances, or not, so the following wastes categories will be collected:

- recyclable wastes / non-recyclable wastes
- non-hazardous wastes / hazardous wastes.

The proper wastes management responsibility is according to law in force.

Construction wastes will be managed according to specific legal provisions, avoiding temporary storage in spaces from the site organization.

Temporary storage of wastes generated during construction / assembly stage and their disposal shall be made according to the internal procedures of NPP Cernavodă and the applicable law, only in sites specially arranged for this purpose.

During operation

Following the operation of IDSFS, about weak radioactive waste, we can make the following clarifications:

- **Liquid radioactive waste** – are managed within the power plant's systems.
- **Gaseous radioactive waste** – in case of radioactive exhausts, only in the case of events such as:

  a) breaking of a sheath of a fuel element - the presence of confinement barriers (basket and storage enclosure) prevents a possible release of radioactive products, if the defective fuel item is already stored in the module

  b) releases from the basket - tightness is assured during manufacturing by welding and containment is provided by the other barrier (storage cylinder). Consequently, the likelihood of gaseous releases is very low, the storage unit being assured towards the environment through these engineering barriers:
  - Storage basket;
  - Storage cylinder.
- **Solid radioactive waste** - solid radioactive waste arising in the process of preparing the transfer flask for its location of the auto – transporter and after an eventual decontamination of the transfer flask or storage module, is collected in a flask type A. Waste flask transport back to Unit 1 or Unit 2, will comply with specific procedure. Treating this waste is identical to the active poor treatment of other solid waste resulting from operation of the plant.

Solid Radioactive Waste Temporary Storage (DIDR) is designed for limited period storing of low and intermediate level solid waste preconditioned (separated and compacted) resulting from normal operation or accident situations Cernavodă NPP. The storage, located inside the fence physical protection of the plant site, provides storage of solid waste, with the exception of used ionic resins, reactivity bars and spent fuel.

The Intermediate Storage takes continually waste produced on the Cernavodă NPP site, so that, after a period of storage in which the radiation dose is considerably reduced by disintegration, they are retrieved and transferred to **the Final Storage of Low and Medium Active Waste (FSLMAW).**

Analysis of necessary space to accommodate additional storage capacity determined for the units U1, U2, U3 and U4, two operation cycles, assuming completion of Final Geologic Deposit in 2060.

Regarding the spent fuel storage from Unit1 and Unit 2 of NPP in IDSFS, in order to definitive storage of high active waste, constituted mostly of spent nuclear fuel (considered radioactive waste, in Romania), Romania is considering the construction of a **Geological deposit** of great depth, until 2060.

Underlying this election state that, internationally, after 30 years of research, has sufficiently demonstrated that geological storage is currently the safer option and more durable in terms management of high activity waste on long-term and on nuclear spent fuel.

On the assumption that the Geological deposit will be completed in 2060, and considering the pace of production of the spent fuel, during the two life cycles of U1, U2, eventually U3 and U4, it can be seen that some of the spent fuel stored in IDSFS can be transferred to the Final Geological Deposit.

IV.9. Management of dangerous substances and chemical mixtures

IV.9.1. Dangerous substances and chemical mixtures used and / or produced

Substances in this category used during construction works are likely paints, fuel used for means of transportation / equipment, oxygen and acetylene for welding.

During IDSFS operation, toxic and dangerous substances will not be used.

IV.9.2. How to manage dangerous chemical substances and preparations and provide protection conditions for environmental factors and human health

In the event of such substances, they should be stored in special places, with the rules in force.

According to Cernavodă NPP procedures, chemical products are kept in manufacturer packaging, with procedural requirements that, both on command and on reception and periodical inspections, to pursue integrity and tightness of packaging, correct labelling with information on the correct name of the product, trademarks and name of manufacturer, date of manufacture, expiration date, data strictly necessary to avoid chemical hazards, of first aid, removal of residual products and, where applicable restrictions on use of the product.

Use of chemicals, especially those who are toxic and hazardous, is made with equipment and facilities on work safety according to applicable labour. Personnel who handles, store, transport and use chemical substances is trained for such activities as required by law and the specific tasks described in the Job Description.

Chemical products used in various stages will be held in temporary premises approved under the internal procedure for allocating these facilities for contractors (Operating Manuals: Handling and storage of chemicals, code 03410-OM-SM-1-22, Chemical products management code, OM94000). The diversity and quantity

approved for these products will be required to limit of use of time-limited and reduced as time.

Considering that will not be used toxic and hazardous substances on IDSFS site during operating, measures to their management will not be necessary.

IV.10. Sources of pollutants in case of accidents / incidents (including nuclear)

a) The intermediate dry storage modules are designed to operate safely both during normal operation and in the event of postulated events, generated by natural phenomena, human activities outer to the objective, random failures of equipment and also human errors.

These credible events (frequency of occurrence is higher than 10^{-6} / year), which could have consequences for the personnel, population and environment are called Project Base Events (PBE).

Next are briefly presented a series of events in the category of PBE and their consequences. This analysis is the subject of specialized studies on nuclear security, Preliminary Report of Nuclear Security - 79D-01320-RPS-04, rev. 5, August 2015 proving that Cernavodă IDSFS is safe in the conditions of the postulated PBE set.

Given that the extension of IDSFS site is made in similar conditions, within the extended site, according to the specifications from this Memorandum, and the MACSTOR 400 modules differ from the MACSTOR 200 modules through their double capacity to storage the dry spent fuel and the corresponding increase of the module's size, using the same construction materials and the same design and construction principles, it is estimated that there is no modification on the conclusions of the Preliminary Report of Nuclear Security - 79D-01320-RPS-04, rev. 5, August 2015.

The doses received by operators and stable population in the PBE conditions were estimated to values well below the permitted limits, consequently, the impact on personnel, public and external environment is negligible.

Events caused by natural phenomena

Natural phenomena that could affect the MACSTOR storage modules from the IDSFS site are:

- severe weather phenomena (strong winds, lightning, tornadoes, including projectiles caused by tornadoes)
- floods
- earthquakes
- fires.

According to the Preliminary Report of Nuclear Security - 79D-01320-RPS-04, rev. 5, August 2015, Chapter 8. ACCIDENT ANALYSES, pages 8-10: „*severe*

weather phenomena have such small frequencies of production that they can be considered negligible for the Cernavodă IDSFS site"

The storage modules from Cernavodă IDSFS project are protected against these weather phenomena, because through the reference project they were designed to withstand much more severe phenomena than those that might occur at Cernavodă.

Regarding **storms and tornadoes**, the project value of wind resistance of the storage modules is significantly higher than the maximum pressure exerted by the wind characteristic to Cernavodă site.

In these circumstances it is estimated that environmental factors will not be disturbed by the operation of project as a result of the occurrence of such phenomena.

Regarding the lightnings it can be mentioned that the height of the IDSFS deposit in relation to the surrounding buildings is very small, so the chance of being struck by lightning is reduced. However, if in the modules area should get lightnings in the area, their energy would be dissipated by earthing and lightning protection systems, the storage modules being protected in this regard. Thus, lightnings will be captured by beams with lightning protection role installed on parapets, and the induced currents will be directed to earth through grounding wires properly dimensioned.

In these circumstances it is estimated that environmental factors will not be disturbed by the operation of project as a result of the occurrence of such phenomena.

Regarding the **floods,** the following mentions can be made:

- During re-evaluation of the security margin, it was rechecked and confirmed the protection of Cernavodă NPP site to floods, including the IDSFS site
- Reported to the Baltic Sea level, the flood level taken as project basis for Cernavodă NPP was considered of 14.13 MMB with the probability of being achieved once every 10,000 years. IDSFS was designed to this flood by placing the storage platform at the elevation of 16,00 mdMB and of the storage module's foundation at 16,00 mdMB. The inlet openings of air inside the modules are approx. 1 m from the module's base, **therefore the Project Base Flood will not have implications on the security of IDSFS.**
- Floods due to natural freshets or breaking upstream dams do not reach the level where IDSFS is situated.

In these circumstances it is estimated that environmental factors will not be disturbed by the operation of project as a result of the occurrence of such phenomena.

Earthquakes

IDSFS project foresees measures to avoid and / or limit the negative effects of an earthquake on the objective, and also on the environment (storage structures and handling equipment are seismic qualified)

Storage modules structure is DBE qualified - Earthquake Base Project. Within the Preliminary Report of Nuclear Security - 79D-01320-RPS-04, rev. 5, August 2015, was analyzed and confirmed the adaptability of the reference projects (for the storage module) to the specific conditions of DBE level earthquake at Cernavodă.

Also, the assessment of the design seismic margin realized after the Fukushima accident, as a part of "stress tests" proved that the objective can withstand an earthquake corresponding to a horizontal acceleration of 0.4g on the ground level, without impacting the structural integrity or the cooling of the stored dry spent fuel.

In these circumstances it is estimated that environmental factors will not be disturbed by the operation of project as a result of the occurrence of such earthquake.

Explosions / exterior fires / fires from natural sources

For the storage modules were analyzed effects of explosions and fires that may occur in the vicinity of the IDSFS site (discharges of toxic substances do not affect the security of the storage modules).

- Explosions

In the analysis was used the concept of dominant sources - sources with the largest quantities of explosives in TNT equivalent, located at the smallest distances to the IDSFS site.

The dominant explosion source for the IDSFS site is the Fuel Station "Meridian Benz Motor Oil" S.R.L., situated about 1,8 km from the storage.

By extension of IDSFS site, the distance to the Fuel Station "Meridian Benz Motor Oil" S.R.L. of teh new MACSTOR modules increases slightly.

According to the calculations of the Preliminary impact study for the Intermediate Dry Spent Fuel Storage facility – IDSFS results that the biggest explosion at a stationary source from the area does not affect the integrity of storage modules, so the environmental factors cannot be affected by the operation of the project.

- Fires from methane gas and oil products pipelines

All pipelines in the IDSFS influence area are at greater distances than the minimum safety distance between oil transporting and methane gas pipelines and nuclear facilities.

Thus, in accordance with the Preliminary Impact Study for the Intermediary Dry Spent Fuel Storage – IDSFS it can be concluded that the economic activities in the area (including oil transporting and methane gas pipelines) does not affect the

safety of the Intermediary Dry Spent Fuel Storage, so no pollution sources exist from the extension of the IDSFS and building of the MACSTOR 400 modules.

Fuel deposits from the enclosure

MACSTOR modules are designed so that the structural strength and the modules themselves not to be influenced by fires that may occur in the fuel house of the NPP so there is no environmental factor air contamination danger.

The fire does not endanger the building integrity, so environmental factors cannot be affected.

- Fires from natural sources

The storage – IDSFS extended is placed in an area at distance from forests or other combustible vegetal clusters, so that potential fires of them will have no consequences on the extended IDSFS.

b) Events with a frequency of occurrence less than 10^{-6}/year, whose consequences may be more severe, are called **severe accidents or accidents that exceed the project limits.** In this category are included next events:

- Failure of Unit 1 (Unit 2) turbine and the impact of IDSFS with projectiles generated by the damaged turbine;
- IDSFS impact (random) with a small plane or a line plane (commercial);
- Strong storms (tornadoes)
- Portal crane collapse.

Turbine generated projectiles

The turbine (body or blades) of Unit 1 or Unit 2 may damage, generating projectiles that can be thrown at long distances.

The preferential propagation direction of projectiles is perpendicular on the turbine shaft, in a fairly narrow angle.

Due to the distance and angles towards Unit 1 and Unit 2 from Cernavodă, the impact probability of the IDSFS storage modules with projectiles generated by those units' turbines is extremely low. This is also valid for Unit 3 and 4.

Meanwhile, the machine room and service building related to Cernavodă units are equipped with thick concrete walls that block near the source, the turbine blades or other parts of it.

Also, since the storage modules are designed to withstand a possible impact with projectiles of various types, radioactive releases from the module are unlikely.

Impact with heavy of light planes

MACSTOR storage module structure is compact and robust, with significant reserves of strength with large safety margin against design loads. These features lead to limit possible damage induced by severe postulated accidents. Due to dry storage of the fuel after cooling it for 6 years and due to the protective barriers, the

release of volatile radionuclides is only possible by heating the fuel stored at a temperature above 600ºC.

Following the analysis of site conditions (distances from transport routes, sources of explosions, weather conditions, etc.) and structural characteristics of the module, the only result of severe accidents postulated for Cernavodă IDSFS that can present radiological consequences is a plane crash over the storage module (aviation impact), attended by fuel burning from the aircraft tanks. In the collision the fuel containment barriers will be destroyed and the fuel will be exposed to the high temperatures produced by the fire.

After the specialized analysis that is the subject to Chapter 8.5.7. Radiologic consequences of severe accidents defined in IDSFS Cernavodă from the Preliminary Report of nuclear security - 79D-01320-RPS-04, rev. 5, August 2015 resulted:

From the analysis of radiological consequence assessment of the plane impact at Cernavodă IDSFS results the following:

- approx. 97% from the effective dose radiation is due to Ru^{-106} and Pu aerosols inhalation;
- in the most conservative extreme case, when the plane impact is followed by the release of the whole volatile inventory (at temperatures that occur during fire type „pool fire”) from a storage module are found:
  - the maximum dose, from 20 km, exceed generic interventions established in the emergency plan on the Cernavodă NPP site, code RD-01364-RP8, approved by CNCAN (50 mSv for evacuation and 10 mSv for sheltering); we mention that these values, representing maximum radiation values evaluated of the dose radiation, are theoretical
  - dose values with a 99,9% probability exceed, for a 20 km distance, generic interventions levels established in the emergency plan on the Cernavodă NPP site, code RD-01364-RP8, approved by CNCAN (50 mSv for evacuation and 10 mSv for sheltering);
  - the medium dose values do not reach the generic intervention levels established in the emergency plan on the Cernavodă NPP site, code RD-01364-RP8, approved by CNCAN (50 mSv for evacuation and 10 mSv for sheltering)

Regarding small planes, light, such as those for agricultural fertilizer spreading, the impact consequences are smaller than those previously evaluated.

It is very important to note that **The emergency site plan of Cernavodă NPP was developed also for all postulated events from IDSFS, including the „Plane crash over IDSFS” event. The Plan and the emergency procedures include emergency measures and actions that are applicable for IDSFS objective.**

Strong storms (tornadoes) that are not included in Project Base Events

On the Cernavodă site, are unlikely F5 level storms (on the Fujita scale), but the reference project (the Gentilly 2 storage module) was designed for CANDU sites considered the consequences of strong storms and projectiles generated by F5 level tornadoes. The storage modules were designed to resist to strong storm loads.

The tension analyses of the storage modules include, also, the qualification to projectiles generated by these storms. The effect of the event consists in the production of a hollow in concrete at the projectile impact place. The Repair is common in construction works.

Therefore, even if this event would occur, there would be no radiological consequences on staff and population, including the valid conclusion in the situation of IDSFS expansion and MACSTOR 400 module use.

Portal crane collapse

The portal crane is provided with anti-derailment clips that prevent accidental derailment and a possible overturning during seismic events.

According to the Preliminary Report of nuclear safety - 79D-01320-RPS-04, rev. 5, August 2015, the impact of the portal crane collapse over the module is smaller than the one produced by external explosions, tornadoes generated projectiles, etc.

Therefore, even if this event would occur, there would be no radiological consequences on staff and population, including the valid conclusion in the situation of IDSFS expansion and MACSTOR 400 module use.

V. Provisions for environmental monitoring. Endowments and measures provided for the control of pollutant emissions in the environment

Monitoring environmental radioactivity

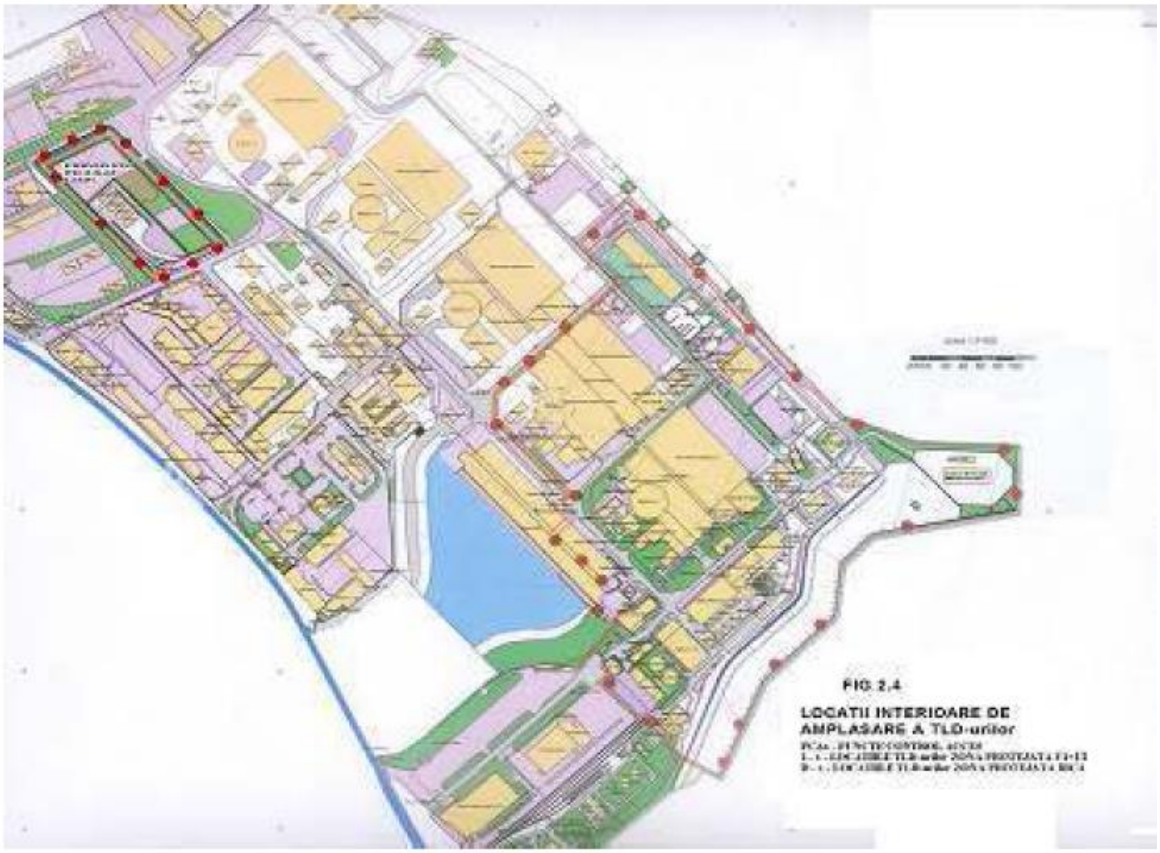
The routine monitoring program of the environment on Cernavodă NPP is designed to meet the following goals in normal operating conditions of the power plant:

- an accurate assessment of doses for a member from the critical group by determining the growth of radioactivity level in food chains specific to the area, due to power plant operation;
- a fair assessment, based on environmental measurements, of the effectiveness of sources control, control and monitoring of effluents;
- an estimation of doses in the event of a major discharge of radioactivity

The routine monitoring program of the environment on Cernavodă NPP was elaborated and approved in 1995 - RD-01364-RP7. On September 2005, was approved by CNCAN the revision of this program that was transformed in SI-01365-RP15.

For surveillance on IDSFS, the monitoring program of environmental radioactivity foresees the measurement of gamma dose in 12 points (on the protection fence are located 12 environmental TLDs that are verified quarterly). Monthly are measured the filters for particle, iodine, trapping retainers for tritium and carbon-14. Were established sampling points for infiltration water from observation wells and soil.

Gaseous and liquid radioactive effluents produced at IDSFS are monitored in accordance with the requirements of SI-01365-RP006.



The current location of TLDs, including on IDSFS site

Regarding IDSFS radiation monitoring, the radiation monitoring activities for the IDSFS are an integrated part of the radiation protection program of the Cernavodă NPP, which has been extended to include spent fuel preparation and storage operations.

All these activities fall under the responsibility of the Radiation Protection Department of the Cernavodă NPP.

The Radiation protection programs of Cernavodă NPP are designed to comply with the following requirements:

- The individual doses for nuclear energy worker shall be assessed by monitoring external doses (using personal dosimetry equipment) and internal contamination (by monitoring the working areas and/or carrying out laboratory testing of biological samples).

- Monitor working areas by measuring the dose rate, the concentration of radioactive aerosols and the contamination of surfaces, equipment and machinery using portable instruments and/or by taking samples and analysing them in a laboratory.
- Air sampling from the storage module, to allow checking the integrity of the storage basket containment barrier.
- The storage platform - equipped with a water drainage system with the possibility of taking samples from the drained water.
- The storage area - equipped with devices that enable the gamma radiation dose in the storage modules to be measured.
- Use of portable monitoring equipment, and also personal dosimeters, which are appropriate for the type of radiation and the right measurement range to cover the predicted radiation levels. Means must be ensured for the calibration and functional inspection of the monitoring equipment and dosimeters
- The IDSFS areas are grouped into zones (nuclear zoning), depending on their probability of contamination, and respectively, level of irradiation. The spreading of radioactive contamination must be avoided.
- Environmental monitoring - via a program established during operation, integrated in the existing environmental monitoring program at the Cernavodă NPP.

Thus, radiation monitoring system provides the following functions:

- monitoring radioactive discharges (liquid and gaseous effluents)
- environment surveillance
- data registration.

M*onitoring radioactive liquid and gaseous effluents*

In the storage area are ensured:

- Periodic sampling and analysis of representative samples of water from the pit provided at the water drainage system on the site;
- Periodic sampling of air samples from storage cylinders and laboratory analysis, to verify the integrity of containment barriers. A sampling pump with filters for retaining iodine, aerosols and tritium is available for connecting to the nozzle provided in the storage modules

Environment surveillance

Environmental monitoring activities currently performed at IDSFS are integrated into existing environmental monitoring program at the NPP.

Environmental monitoring program includes all activities necessary for the determination of levels of radioactivity in the environment and their impact on the environment and human health, due to normal operation of Cernavodă IDSFS.

Currently, are ensured:

- measuring gamma radiation doses in 12 points of the perimeter fence of the storage with environmental dosimeters with thermoluminescent detectors
- periodic sampling and analysis of samples from the underground water (sampling points are located on NPP site)
- sampling and analysis of infiltration water from the four drilling wells located on IDSFS platform - and maintaining them functional
- periodic air sampling on particulate filter, iodine trap (activated charcoal filter), tritiated water trap and *C14 trap* - air sampling station is an endowment of IDSFS
- sampling of surface water from the rainwater collector pit and from Cismelei Valley channel
- sampling of water from the peripheral ditch around each pair of storage modules.

Sampling frequencies, types of analysis and detection limits required are detailed in the latest revision of the document SI-01365-RP15 - Environmental Radioactivity Monitoring Program for the Cernavodă NPP.

Data registration

The information resulting from dosimetric measurements are recorded and stored as required in Radiological Safety Norms, registration activity being integrated in similar work of the plant.

VI. Justification of project framing, as appropriate, under the provisions of other national regulations that transpose community legislation (SEVESO, COV, LCP, Water Framework Directive, Air Framework Directive, Waste Framework Directive, etc.)

The project of site extension of the Intermediate Dry Spent Fuel Storage Facility and continuing to build the MACSTOR 400 type modules, are not subject of:

• ***Law no. 278 of October 24, 2013*** *on industrial emissions* - transpose into national law the provisions of ***Directive 2010/75 / EU*** of the European Parliament and of the Council of 24 November 2010 on industrial emissions - IED (Integrated Pollution Prevention and Control). By this law are revoked:

- GD No. 699/2003 establishing certain measures on the limitation of volatile organic compounds emissions due to the use of organic solvents in certain activities and installations (transposing the Directive 1999/13/EC)
- GD No. 440/2010 concerning the establishment of measures to limit air emissions of certain pollutants from large combustion plants (transposing the Directive 2001/80/EC)

- EGO No 152/2005 concerning integrated pollution prevention and control (that transposes Directive 2008/1/EC - IPPC)

The new Directive 2010/75 / EU covers the regulatory area seven European Directives, gathering so in a single legislative instrument, clear and coherent, a set of common rules for the authorization and control of industrial plants, aimed to reduce industrial emissions across the European Union in particular through better application of Best Available Techniques, namely these directives (only 3 from 7, as requested by chapter):

- Council Directive 1999/13/EC of 11 March 1999 on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain activities and installations **(VOC)**
- Directive 2001/80/EC on the limitation of emissions of certain pollutants into the air from large combustion plants **(LCP)**
- Directive 2008/1/CE concerning integrated pollution prevention and control (**IPPC**)

Regarding the control of major accident risks involving dangerous substances, the following clarifications are made: Law 59 of April 11th, 2016 on control of major accident risks involving dangerous substances, regulates the measures to prevent major accidents involving dangerous substances, and also to limit their consequences on human health and the environment, to ensure a high level of protection on the entire national territory, in a consistent and effective manner. Law 59/2016 transposes the provisions of Directive 2012/18 / EU (Seveso III Directive) of the European Parliament and of the Council of July 4th, 2012 on the control of major accident hazards involving dangerous substances, amending and subsequently repealing Council Directive 96/82 / EC.

Law 59/2016 do not apply to hazards induced by ionizing radiation coming from radioactive materials (acc. to Art. 2, paragraph 2, letter b).

It is noted that on site is a fire station, related to Units 1 and 2 endowed with adequate equipment for rapid intervention in case of fire, with permanent program organized on shifts, **which serves all buildings and systems from Cernavodă NPP site**

Emergency intervention exercises that include sequences of intervention in case of fire are periodically organized, as provided by internal procedures and regulations.

From the point of view of Law No. 104/2011 on ambient air quality, as amended and supplemented by Government Decision no. 336/2015, transposing **Directive 2008/50/EC on ambient air quality** and cleaner air for Europe, it is estimated that expansion of IDSFS with building MACSTOR 400 modules, will not affect air quality in the area in terms of pollutants regulated by this Directive.

Water Law No. 107/2006 with subsequent amendments transposes the **Water Framework Directive 2000/60/EC** which aims sustainable development –the harmonization of socio- economic system development in relation to the supportability of the aquatic environment.

Currently, water management for Units U1 and U2 is licensed by the Water Management Authorisation No. 305/17.12.2013, issued by the "Romanian Waters" National Administration.

Cernavodă NPP has the Water Management Authorisation No. 267 from 11.11.2013 for Cernavodă Intermediate Dry Spent Fuel Storage (I.D.S.F.S), and for extension of IDSFS it is about to be issued a new Water Management Authorisation.

Non-radioactive industrial waste management will be in accordance with approved procedures, the Environmental Authorisation of Cernavodă NPP and the norms in force, complying with Law No. 211/2011 on waste regime - which transposes Directive 2008/98/EC on waste, GD No. 856/2002 regarding waste management records and for approval of waste list, including hazardous waste, as amended and supplemented, and the specific legislation for certain categories of waste (Government Decision no. 235/2007 on the management of waste oils, Emergency Ordinance no. 5/2015 on electrical and electronic equipment waste, etc.) and GD. 1061/2008 on transportation of hazardous and non-hazardous waste on the territory of Romania.

Periodical reports on non-radioactive industrial waste management will be included in the regular reports submitted by the Environmental Management Group of Cernavodă NPP for the entire branch, even since the initial stages of the project implementation.

The management of the radioactive waste generated will be similar with the management of the ones generated from the activities at U1 and U2. Management activities are adequately documented and reported on monthly basis to the environmental authorities and to CNCAN. During construction and installation, neither radioactive nor potential radiological contaminating waste is generated. Chapter IV.8.2 describes management of waste, including radioactive ones during operation.

VII. Site organization works

VII.1. Description of site organization works

Access ways used in the site organization will be the access routes approved, inside Cernavodă NPP site. As it was mentioned above, access to IDSFS is made through the existing connection of road from DJ223C on the secondary concreted road, inside Cernavodă NPP site, that passes in front of IDSFS. Access to the storage area is controlled at the Access Building and it respects the operating procedures of the plant.

Necessary utilities on site - will be made by connection to existing utilities from the NPP Cernavodă Platform**,** as follows:

- **The electricity** will be provided within Cernavodă NPP own network
- **The rest of utilities needed during the construction will be provided by the constructors, according to the conditions imposed by the contracts concluded with them.**

Tools, devices, equipment, machinery and means estimated to be needed within the site organization are typical to a site organization, being represented by:

- Trucks / transportation means adequate for raw materials and materials supply, respectively for construction waste disposal or for moving machinery and equipment
- Concrete mixer trucks
- Bulldozers, excavators, mobile cranes, pneumatic hammers, welding equipment (electric arc and oxyacetylene), shovels, metal scaffolds etc.

Works schedule for extension of IDSFS is structured to accommodate both the times for design, obtaining permits and authorizations and those for the actual construction in a manner that avoids any situations where Cernavodă NPP would experience difficulties in operating due to lack of storage space.

Scheduling of investment (Investment / Construction + Assembly)

	Investment			Construction + Assembly		
Activity	**Start date**	**Finish date**	**Months No.**	**Start date**	**Finish date**	**Months No.**
Module 8 type MACSTOR200	**3/6/2015**	**15/1/2017**	20	15/4/2016	15/12/2016	8
Module 9 type MACSTOR200	**3/6/2015**	**31/8/2017**	26	01/12/2016	31/7/2017	8
Module 10 type MACSTOR400	**1/3/2017**	**28/9/2018**	18	01/8/2017	29/8/2018	13
Module 11 type MACSTOR400	**29/6/2018**	**9/3/2020**	21	7/12/2018	6/2/2020	14
Module 12 type MACSTOR400	**9/12/2019**	**17/8/2021**	20	18/5/2020	16/7/2021	14
Module 13 type MACSTOR400	**18/5/2021**	**25/1/2023**	20	26/10/2021	26/12/2022	14
Module 14 type MACSTOR400	**26/10/2022**	**4/7/2024**	21	5/4/2023	4/6/2024	14
Module 15 type MACSTOR400	**4/4/2024**	**16/1/2026**	21	12/9/2024	17/12/2025	15
Module 16 type MACSTOR400	**17/10/2025**	**12/7/2027**	21	27/3/2026	10/6/2027	15

Module 17 type MACSTOR400	**12/4/2027**	**19/12/2028**	20	27/2/2029	29/4/2030	14
Module 18 type MACSTOR400	**19/9/2028**	**29/5/2030**	20	27/2/2029	29/4/2030	14
Module 19 type MACSTOR400	**27/2/2030**	**6/11/2031**	21	7/8/2030	7/10/2031	14
Module 20 type MACSTOR400	**7/8/2031**	**15/4/2033**	20	15/1/2032	16/3/2033	14
Module 21 type MACSTOR400	**14/1/2033**	**25/9/2034**	20	24/6/2033	24/8/2034	14
Module 22 type MACSTOR400	**26/6/2034**	**4/3/2036**	21	4/12/2034	1/2/2036	14
Module 23 type MACSTOR400	**4/12/2035**	**12/8/2037**	20	13/5/2036	13/7/2037	14
Module 24 type MACSTOR400	**13/5/2037**	**3/2/2039**	21	21/10/2037	4/1/2039	15
Module 25 type MACSTOR400	**4/11/2038**	**13/7/2040**	20	14/4/2039	13/6/2040	14
Module 26 type MACSTOR400	**13/4/2040**	**23/12/2041**	20	21/9/2040	21/11/2041	14
Module 27 type MACSTOR400	**23/9/2041**	**2/6/2043**	21	3/3/2042	1/5/2043	14
Module 28 type MACSTOR400	**3/3/2043**	**9/11/2044**	20	11/8/2043	10/10/2044	14
Module 29 type MACSTOR400	**10/8/2044**	**19/4/2046**	20	18/1/2045	20/3/2046	14
Module 30 type MACSTOR400	**18/1/2046**	**27/9/2047**	20	28/6/2046	28/8/2047	14
TOTAL	**3/6/2015**	**27/9/2047**	380			***312***

Organization of spaces necessary for temporary storage of materials, specific measures for preservation and to avoid degradation during storage - it will comply with Cernavodă NPP procedures for the approval of temporary storage spaces for equipment and materials, depending on the quantity, hazards, etc.

Space for the construction site will have a premise approved for storing tools and working devices strictly necessary for works in progress. Chemical products used in different stages will be held in temporary spaces approved under the internal procedure for allocating these facilities for contractors (Operating manuals: Handling and storage of chemicals, code 03410-OM-SM-1-22, Chemicals management, code OM94000). Diversity and the amount approved for these products will be at the necessary limit for the use on limited duration and reduced in time.

Specific measures for health and safety in work involve signing and implementation of a Convention on Occupational Safety, as part of service contracts commitments with prospective contractors – by these conventions will be established the obligations of the parties regarding specific trainings of staff, requirements on ensuring individual and collective protection equipment, risks sheets associated to activities performed and responsibilities in the field assumed by the parties.

The provider's staff that will perform the activities within the construction site organization, inside the premises of Cernavodă NPP, will benefit on the same requirements on health and safety in work as those applicable to the beneficiary's

own staff, requirements provided by NPP procedures specific to the work actually performed (Operating manual: Safety in work, code OM03410).

Access to locker rooms, drinking water, toilets - as previously mentioned in the utilities chapter, the provider's staff will have access to facilities such as: toilets, drinking water, and locker rooms in the designated areas inside protected premises of Cernavodă NPP dedicated to providers.

Allocation and use of these spaces shall be in accordance with the internal procedure of Cernavodă NPP.

VII.2. Site organization location

Site organization will be realized on the project sites, respecting the requirements of Cernavodă NPP on access control of people and means of transport.

VII.3. Description of environmental impact of the site organization works

Rigor of internal procedures of Cernavodă NPP which is required to the service providers in addition to the specific norms for this kind of activities will make the environmental impact during this period to be reduced.

Water

The impact on the environmental factor water can manifest also as a result of noncompliance to the working procedures specific for construction-assembly works and measures presented in Chapter VII.5.

Given that, during construction works, the staff for the site organization will use bottled potable water, and in technological purposes (sprinkling roads and concrete structures) water transported by tankers through the care of the builders, given the inexistence of technological wastewater, it is estimated a reduced impact on the environmental factor water during the site organization and execution of works

Air

During execution of works in the construction site, the activities have impact on the quality of the atmosphere in working areas and on their adjacent areas.

During the execution of construction works, the environmental factor air will be influenced by traffic of machines and transportations means from the site, that work with diesel. They will emit during operation SOx, CO, NOx, particles and hydrocarbons.

Geographical, administrative and topographic arrangement, and dominant wind direction have a favourable contribution to mitigating the impact of combustion gases emissions over the affected areas.

These machines can operate in several batches on site, grouped in a working position (but working alternately), so dispersed in time, the works being carried out by a graphic that takes into account many factors.

Areas of air pollution with particulates / dust are relatively limited in extent, in the vicinity of working points and transport routes.

In order to analyse pollutant emissions into the atmosphere from the area where the works are taking place, following elements are important:

- categories of works to be executed
- quantities of materials (soil, ballast, concrete / asphalt) handled on works categories
- intensity of works
- number of kilometres travelled and vehicle speed
- duration of the works / operation time of the source
- manufacturing technology of engines
- engine power
- fuel consumption per unit of power
- equipment capacity
- age of engines / machines

An important aspect is that all construction materials will be manufactured off-site, and they will be delivered in the construction zone in the strictly necessary quantities and within the planned stages, thereby avoiding a too long disposal of materials stocks on site and the overloading of construction site with materials.

Given the above and the fact that all activities associated with the construction phase will take place:

- mostly at ground level or at low heights
- into a space shielded from other objects and industrial buildings

it is estimated that within the inhabited areas closest to the perimeter of Cernavodă NPP, the values of air pollutants concentrations, regulated by Law no. 104/2011 on ambient air quality, will not be affected as a result of the activities of construction / assembly.

Therefore, it is estimated that the impact will be strictly local, limited in time and low level.

Regarding the radioactive emissions by disrupting and exposing of land surfaces, as a result of IDSFS operation, doesn’t result artificial radionuclides gamma emitters.

Soil/Subsoil

In the process of building / assembly made on the site organization, a physical impact on soil / subsoil occurs, consisting of earthworks to be carried out (excavation, levelling, compacting) for infrastructure and related networks.

The impact on soil / subsoil can be produced also as a result of possible occurrence of accidental leakages of lubricants or fuel, due to operation of equipment and means of transportation used within the site organization or due to repairing in inadequate conditions.

Also a form of impact on soil / subsoil specific to this period is the change in quality of soil / subsoil under the influence of pollutants present in the air, given its exposure during construction/assembly works.

If works execution technologies are respected, and the connection utilities are made correctly (presented in this Memorandum), the environmental factor soil / subsoil will not be affected by pollution.

Biodiversity

Regarding the impact on biodiversity resulting from activities within the site organization it should be noted that these activities will take place within Cernavodă NPP, where there are no natural or semi-natural habitats or flora species of conservation interest. Fauna is represented by species adapted to human presence and long term anthropogenic impact, so the impact on them is not significant.

Wastes

Wastes resulting during construction period will not be radioactively contaminated, so there will be no outstanding issues of environmental impact in terms of compliance with the proper measures of their management.

The majority of construction wastes will be inert ones, therefore, under the management in accordance with legal requirements and application of measures to minimize / eliminate, will have a relatively low impact on environment.

Impact associated with construction waste manifests as follows:

- visual impact – it dissipates throughout general construction site assembley
- possible impact if temporary construction wastes storage will not be done directly in special containers or if it is not possible the containerization
- impact due to the disposal of wastes from the site, by producing pollutants due to their transportation (noise, dust), energy consumption, equipment depreciation
- impact from consumption of some resources - wastes resulting from materials where were embedded raw materials and energy

Probability of occurrence of these forms of impact is significant.

The possibility of restoring normal environmental conditions is great if the waste management measures are respected according to law in force.

Due to the location of the project within the perimeter of Cernavodă NPP platform, and due to the strict requirements of Cernavodă NPP imposed to contractors regarding the compliance with the procedures of Cernavodă NPP and the applicable legislation for wastes management, it is not estimated an impact on population and/or protected areas associated with the generation and transport of waste.

Noise

Through used equipment and developed activities, the construction site represents a typical noise source of industrial nature.

Noise can affect both the personnel engaged in construction/assembly activities and the Cernavodă NPP staff that work near the site organization.

Given that the site organizations will be located on the industrial site of Cernavodă NPP, the premises limit where the noise levels are appreciated is considered to be the limit (fence) of Cernavodă NPP platform.

In terms of restrictions on noise, STAS 10009/88, page 3 Table 2.2 provides for the industrial site the limit of 65 dB (A) for $L_{pAeq,T}$ - A weighted equivalent sound pressure level.

For the noise at work place, according to Government Decision no. 493 / 12.04.2006 on the minimum requirements on safety and health in work, regarding the exposure of workers to the risks arising from noise, are specified both the descriptor physical parameters, the allowable limits, and the appropriate recommendations.

For the application of Government Decision no. 493 of 2006, as amended and supplemented, the exposure limit values from which is started the action of the employer on safety and health protection of workers in relation to daily exposure levels to noise and peak sound pressure are fixed as follows, according to Art. 5:

- limit values of exposure L(EX, 8h) = 87 dB(A), respectively p(peak) = 200 Pa
- higher exposures values from which starts the action L(EX, 8h) = 85 dB(A), respectively p(peak) = 140 Pa;
- lower exposure limit values from which starts the action L(EX, 8h) = 80 dB(A), respectively p(peak) = 112 Pa

During all phases of the project will be identified areas where the exposure levels can exceed the minimum threshold that starts the action.

It is estimated that during construction / assembly stage the **noise levels generated will fall within the maximum allowable limit of 65 dB (A)** required by STAS 10009-88 for industrial area, starting from the distance of 30 m from the site.

VII.4. Pollution sources and installations for retention, disposal and dispersion of pollutants in the environment during site organisation

Water

Sources of pollutants to the environmental factor water from the site organization are:

- possible accidental spills of lubricants or fuel that may result due to the operation of machines and other means of transport used within the site organization
- any discharge of untreated wastewater into surface waters, soil or groundwater
- rainwater washing of the intermediate storages of bulk building materials if they are not stored properly, this way they can pollute both water and soil / subsoil
- washing machines and transport means within the site organization in areas that are not especially arranged for such activities - can produce water contaminated with petroleum-related substances, like fuel and oils
- particles in suspension, including those with heavy metals content, and also materials resulting from construction works (from digging, levelling, filling, etc.) that can be driven by rainwater, polluting both water and soil / subsoil

Air

Sources of pollutants for the environmental factor air, from site organization during construction / assembly stage, framed under Order from Environment and Forests Minister no. 3299/2012 for approval of the methodology for development and reporting of the air pollutants emissions inventories for air pollutants – NFR encodings (nomenclature for reporting) correlated with those from guide EMEP/EEA 2009, are listed in the following table:

Description of the source/activities category	Framing according to EMEP / EEA 2009 methodology	Main pollutants emitted into the atmosphere
Land preparation - conducting excavations (scraping, excavation) on the surfaces where the access roads, foundations, structures will be constructed - making fillings, levelling, compaction, etc. - transfer and temporary storage of land, respectively of wastes Realization of construction and assembly activities - supply and temporary storage of construction materials and some equipment / machinery - realization of foundations and	***code NFR 2.A.7.b*** Construction and demolition	Total suspended particles TSP Suspended particles – PM_{10} fraction

superstructure - concrete casting, respectively assembly – holing, welding joints, fittings etc. for machineries, equipment, pipes, ducts - temporary storage and loading of construction and installation wastes		
Combustion of fuels in vehicle engines (trucks, concrete mixers) - transportation of materials inside the premises of Cernavodă NPP platform	***code NFR 1.A.3.b*** – Road transport – source category *code NFR 1.A.3.b.iii – Heavy-duty vehicles*	Exhaust gases – NO_2, SO_2, CO, nmVOC Polycyclic aromatic hydrocarbons (PAHs) Particles
Fuel combustion engines that equip non-road mobile sources (on-site operation of mobile machines and equipment)	***code NFR 1.A.4*** – Other mobile sources, source category code *1.A.2.f.ii – Mobile equipment and machinery in manufacturing industry and construction*	Exhaust gases Particles containing metals (Cd, Cu, Cr, Ni, Se, Zn) VOCs
Wind erosion from disturbed land surfaces and earth piles	***code NFR 7.A*** – Other sources	Total suspended particles (TSP) and fractions
Resuspension of particles by surface entrainment due to vehicle traffic	***code NFR 7.A*** – Other sources	Total suspended particles (TSP) and fractions

The emission sources of air pollutants specific to the studied project are **sources on the ground, open** (those that involve handling construction materials and soil management) and **mobile** (machinery and truck traffic - emissions of pollutants and noise). All these categories of sources during construction / assembly stage are **unguided,** being considered **surface, linear sources**.

The main pollutant to be emitted into the atmosphere during execution will be represented by the total suspended particles - especially TSP and PM10 fraction.

A significant proportion of the works include operations that represent source of dust emission. These are operations related to land handling, ballast materials and cement / asphalt and other materials. These are:

- excavations, including:
  - • excavation and collection of sand and ballast in piles
  - • loading the soil into dump trucks
- fillings including processes such as:
  - • discharging material (sand, ballast) of the dump trucks
  - • scattering material
  - • material compaction
- infrastructure - additional works

Dust releases in the atmosphere often vary substantially from day to day, depending on the level of activity, type of operation and weather conditions.

An additional dust source is represented by wind erosion, a phenomenon that accompanies the construction works. The phenomena occur due to the existence, for a certain period of time, of the uncovered land surfaces exposed to wind action.

Along with these sources of air pollution, in the area where works will be made, there is a second category of sources, namely machinery used to do the works, such as: bulldozers, transportation systems, excavators, concrete mixers, etc.

The machines, regardless of their type, work with diesel engines, the exhaust gases discharged into the atmosphere containing the entire complex of pollutants specific to internal burning of diesel: nitrogen oxides (NOx), non-methane volatile organic compounds (NMVOCs), methane (CH4), carbon oxides (CO, CO2), ammonia (NH3), particles of heavy metals (Cd, Cu, Cr, Ni, Se, Zn), polycyclic aromatic hydrocarbons (PAH), sulphur dioxide (SO2).

Particles from exhaust gases from machinery are mostly framed within the category of breathable particles.

Particles with diameters ≤ 15 μm are found in the atmosphere as particles in suspension. The larger diameters are deposited on the ground quickly.

During construction works, by disrupting and exposing the land surfaces, a source of radiological pollution can be considered the particles emitted into the atmosphere through the tritium content from soil.

Soil/Subsoil

Possible sources of pollution of the environmental factor soil / subsoil during construction works, some of them being similar to those for the environmental factor water, may be:

- possible accidental spills of lubricants or fuel that may result due to the operation of machines and other means of transport used within the site organization or due to repairs in improper conditions
- rainwater washing of the intermediate storages of bulk building materials if they are not stored properly, this way they can pollute both soil / subsoil and water
- washing machines and transport means within the site organization in areas that are not especially arranged for such activities - can produce water contaminated with petroleum-related substances, like fuel and oils
- particles in suspension, including those with heavy metals content, and also materials resulting from construction works (from digging, levelling, filling, etc.) that can be driven by rainwater, polluting both soil / subsoil and water
- improper storage of wastes generated during the construction period, both the domestic wastes from staff who will serve the construction activities and the technological ones
- the embankment works themselves by stripping and disturbing the soil layers

Wastes

During the construction / assembly period will be generated only wastes of construction materials and wastes similar to municipal ones.

If the procedures of Cernavodă NPP are respected, during this stage will not be generated radioactive wastes or wastes with potential radiological contamination.

Wastes resulting during the execution period of the project will be mainly from the following categories:

- Construction material waste
  - concrete (17 01 01)
  - mixtures of concrete, bricks, tiles and ceramic materials, other than those specified in 17 01 06 (17 01 07)
  - iron and steel (17 04 05)
  - metallic mixtures (17 04 07)
- wood (17 02 01)
- plastic (17 02 03)
- soil and stones containing dangerous substances (17 05 03*)
- soil and stones other than those mentioned in 17 05 03* (17 05 04)
- dredging spoil containing dangerous substances (17 05 05)
- insulating materials other than those specified in 17 06 01 (insulation materials containing asbestos) and 17 06 03 - other insulation materials consisting of or containing dangerous substances (17 06 04)
- used oils:
  - mineral-based non-chlorinated engine, gear and lubricating oils (13 02 05*)
  - other engine, gear and lubricating oils (13 02 08*)
- end-of-life tyres (16 01 03)
- lead batteries (16 06 01*)
- absorbents, filter materials (including oil filters not otherwise specified), wiping cloths, protective clothing contaminated by dangerous substances (15 02 02*)
- absorbents, filter materials, wiping cloths and protective clothing other than those mentioned in 15 02 02 (15 02 03)
- packaging waste:
  - paper and cardboard packaging (15 01 01)
  - plastic packaging (15 01 02)
  - wooden packaging (15 01 03)
  - composite packaging (15 01 05)
  - packaging containing residues of or contaminated by dangerous substances (15 01 10*)

- reusable / recyclable wastes: paper and cardboard wastes (20 01 01 - from administrative activities, office), glass wastes (20 01 02), plastics (20 01 39), metals (20 01 40) for which is recommended separate collection and storage, in suitable containers, specially designed and following to be delivered to authorized companies, for recovery.
- mixed municipal wastes (20 03 01), generated from personnel activity

Noise

During the construction / assembly stage, the noise sources are generated by:

- heavy vehicles traffic: dump trucks, concrete mixers, trailers for the transport of heavy machinery on site, aggregates, various components. The noise from heavy traffic will include both the engine noise and the noise produced by their tires running on the access roads to the sites.
- operating machinery: bulldozers, excavators, compactors, loaders, needed to prepare the ground - equipment according to norms and procedures for making nuclear constructions. The noise from these machines will include the noise generated by the engines of such machines, noise generated during excavation work, and the noise from the protection alarms of these machines.
- operating machinery on site, loading / unloading excess soil operations - all these will be accompanied by specific noise emissions.
- noise from various tools / equipment (welding, cutting, etc.)

VII.5. Facilities and measures foreseen for controlling emissions of pollutants into the environment

Water

Appropriate management of site organization and the construction works itself will cancel any possibility of generating negative effects on the quality of environmental factor water.

Specific measures to reduce the impact on the environmental factor water are listed as follows:

- machinery and transport means will be regularly checked in order to avoid the possibility to appear accidental spills as a result of their malfunction
- it is forbidden to discharge waste waters resulting during construction in natural spaces (surface water, soil)
- storing materials within the site organization must provide security of the deposits, proper and efficiency handling, all these in order to avoid accidental losses and pollution
- washing the machinery and transport means will be done exclusively in areas specially designated for such operations

- machinery and transport means will be used only on the access routes established under the project, avoiding unpaved surfaces
- the operations of oil changing for transport means will only be made in specially arranged places, by qualified personnel, with full recovery of waste oil, which will be handed over to economic operators authorized to perform activities of collection, recovery and / or elimination of waste oils, in accordance with Directive 75/439/EEC on the disposal of waste oils, amended by Directive 87/101/EEC, which was transposed into national legislation by Govern Decision no. 235/2007 (on the management of waste oils)
- working program must avoid overloading the site organization with materials and too long storage of material stocks on site
- to avoid any inconvenience, activities that produce a lot of dust will be reduced during periods of strong winds, and if it is not possible then measures will be taken in order to limit dust emissions generated by wind erosion, by spraying
- construction company will maintain the access ways free, clean, in order to prevent the occurrence of accidents
- staff of the site organization will use only the existing toilets of Cernavodă NPP, according to project
- will be strictly respected the execution technology presented in project, taking measures to prevent and combat accidental pollutions
- If in the next phases of the project occur technical design changes that require changing the solutions approved, the beneficiary will require modifying approval of the competent authorities.

Air

Measures for particles emissions are operational type measures specific to this kind of source.

During the execution of construction works, to avoid particles dispersion in the atmosphere, will be taken measures to reduce the amount of dust, and the construction materials must be stored in specially arranged places and out of the wind action.

Works will be executed with mechanical and manual means, the storage of materials being made in specially designated areas.

Also, to limit air pollution with dust during transportation, the materials will be transported under conditions that ensure this by spraying the material, its coverage, the use of dump trucks / containers appropriate to the type of material transported, etc.

Bulk construction materials will be manipulated in a manner which minimizes the level of particles that can be driven by atmospheric currents.

Loading / unloading of transport means activities generating dust will be avoided in windy periods.

During storage, the soil deposits will be sprinkled to prevent environmental pollution of air with sediments.

The roads will be permanently maintained by spraying with water to reduce dust.

It is estimated that the practice of collecting and preserving excavated soil in containers / closed bags for subsequent refills and arrangements of the construction, can contribute to additional cut of particles emissions in the air, at the construction site stage. This measure can be considered.

Similarly, the containerization and coverage of potential bulk wastes prevent the particles emissions from these sources, and selective waste collection on the site where they are generated helps reduce the associated emissions of any additional segregation activity.

Transport means and machinery will only use the routes foreseen in the project, arranged areas, avoiding unpaved surfaces, so as to minimize as much as possible the retraining of particles in the air.

Using machinery with smooth surfaces and slightly rounded prevents dust accumulation and allow more advanced cleaning. Keeping clean by removing dust from machinery and vehicles should be a daily practice (sprinkler, suction, pads). It is recommended that during break activities, the machinery and vehicles that can retain dust, to be covered, closed or moved - within the perimeter authorized by Cernavodă NPP – to prevent dust accumulation.

Particles emissions will be reduced by washing / cleaning by vacuuming of the concreted / paved surfaces, respectively by spraying the unpaved or disrupted surfaces. It is mentioned that at Cernavodă NPP is implemented a program of cleaning of roads inside the site premises and there is a procedure for keeping the contractors machinery and equipment.

Periodic checks will be performed, under the relevant legislation, for machinery and transport means involved in the construction works, for them to be in good technical condition and not give off noxious above the permissible limits.

After the periodic checks regarding the carbon monoxide levels and concentrations of emissions in the exhaust gases, if exceeding of the admitted indicators occur (exceeding the limits approved by technical books of equipment), those will be stopped and will only be operational again after remedy of possible malfunctions.

For reducing exhaust gases emissions it is recommend the use of modern machinery and equipment, that meet the EURO standards on the construction of new engines, respectively on the systems for controlling emissions, considering the worldwide trend of making engines with low fuel consumption on the power unit and restrictive emissions control.

The works of site organization must be properly designed and executed, with modern facilities that reduce the emission of pollutants in air, water and soil. Their

concentration on the site is beneficial, decreasing the impact areas and favouring a controlled and correct operation.

It is important that during the activity breaks the engines of machinery and transport means to be stopped, avoiding their unjustified operation, or unjustified manoeuvres.

Judicious organizing of construction activities, in compliance with the planned program and its update, as appropriate, depending on specific situations arising, will allow streamlining the traffic and avoiding overcrowding of vehicles and machinery within the organization site.

Also, compliance with provisions imposed by laws for fuel quality contributes to the reduction of exhaust gases:

- According to *Govern Decision no. 928 of September 12th, 2012 (*updated*) on establishing the conditions for insertion in the market of gasoline and diesel and introducing a mechanism to monitor and reduce greenhouse gas emissions*, the content in sulphur and lead in fuels are:
  - It is allowed a maximum sulphur content of 10 mg/kg for diesel, as well as respecting the other technical specifications in Appendix 2
  - It is allowed a maximum lead content of 0,005 g Pb/l, respectively maximum sulphur content of 10 mg S/kg for gasoline, as well as respecting the other technical specifications in Appendix 1
- *Govern Decision no. 829/2010 amending and supplementing Government Decision no. 1844/2005 on promoting the use of biofuels and other renewable fuels for transport*, the economic operators can enter the market only mixtures of biofuels and conventional fuels - mineral oil derivatives, as follows:
  - Starting with January 1st, 2011, diesel with a minimum content of 5% of biofuel by volume
  - Starting with January 1st, 2013, diesel with a minimum content of 7% of biofuel by volume

Given the above measures, it is not expected to be necessary facilities for emission control within the site organization.

The contractor personnel training regarding the possibilities to deal with the activities and access within the construction site perimeter, following weather forecasts to avoid construction activities in adverse conditions will help prevent / reduce the risks of accidents and pollution during construction / assembly stage.

Soil/Subsoil

Specific measures to reduce the impact on the environmental factor Soil/Subsoil are listed as follows:

- machinery and transport means will be regularly checked in order to avoid the possibly to appear accidental spills as a result of their malfunction

- it is forbidden to discharge waste waters resulting during construction in natural spaces (surface water, soil)
- storing materials within the site organization must provide security of the deposits, proper and efficiency handling, all these in order to avoid accidental losses and pollution
- washing the machinery and transport means will be done exclusively in areas specially designated for such operations
- machinery and transport means will be used only on the access routes established under the project, avoiding unpaved surfaces
- the operations of oil changing for transport means will only be made in specially arranged places, by qualified personnel, with full recovery of waste oil, which will be handed over to economic operators authorized to perform activities of collection, recovery and / or elimination of waste oils, in accordance with Directive 75/439/EEC on the disposal of waste oils, amended by Directive 87/101/EEC, which was transposed into national legislation by Govern Decision no. 235/2007 (on the management of waste oils)
- repairs of machinery / transport means serving the site organization will be made in specially arranged places with concrete platforms (within the site organization perimeter or externally - to specialized units)
- it is prohibited placing temporary storage of fuels and lubricants in non-designated areas where losses may occur on the ground
- construction company will maintain the access ways free, clean, in order to prevent the occurrence of accidents
- for evacuation from the construction site of the materials and wastes, construction companies are forced to use only means of transport provided with protection against their spreading on the traffic routes
- ensuring the soil protection within the site organization perimeter, through concrete platforms and specially designated parking spaces
- soil excavations will result after the completion of foundations, which can be reused in fillings, and the rest - that can not be used - will be transported and stored in locations determined by Cernavodă NPP together with Cernavodă City Hall
- will strictly be respected the execution technology proposed in the project, taking measures to prevent and combat accidental pollutions
- will be foreseen all the constructive and supervision measures for safe operation of Cernavodă NPP facilities

Wastes

In order to ensure a proper management for waste management during construction works, in the site organization will be respected the legal provisions regarding effective waste management, and also the following:

- Cernavodă NPP procedures
- special procedures for the project
- prevention and / or reduction measures of accidental leaks
- waste management procedures resulting from construction - assembly activities
- periodic maintenance activities of machinery and vehicles
- proper handling and storage of fuels and materials.

Relevant legal provisions comply with the requirements of Law 211/2011 on the regime of wastes and the special and subsequent legislation applicable to wastes categories and to operations with wastes.

All the necessary measures will be taken for the collection and storage in appropriate conditions of non-radioactive industrial waste generated during the construction period and to ensure that the operations of collection, transport, disposal or recovery to be achieved by specialized and authorized companies.

For taking over the recyclable construction wastes and processing them, and for disposal of non-recyclable wastes in landfills of inert wastes or hazardous wastes, the provider will contract specialized and authorized companies.

The provider of construction / assembly works will be required to make separate collection of all wastes generated, depending on the nature of the materials and the possibilities of reuse / recovery, and also depending on the contamination degree with hazardous substances, or not, so the following wastes categories will be collected:

- recyclable wastes / non-recyclable wastes
- non-hazardous wastes / hazardous wastes.

The proper wastes management responsibility is according to law in force.

Construction materials containing asbestos will not be used and therefore will not be generated construction wastes - Insulation materials and building materials containing asbestos coded 17 06 (according to *Govern Decision No. 856/2002 on waste management records and for approval of the list containing the wastes, including hazardous wastes*, with subsequent amendments).

Machinery, equipment and vehicles used during construction / assembly stages will be provided through contract services, their maintenance and repair being exclusively the contractor's obligation and will be performed at specialized units used by him, off-site.

Construction wastes will be managed according to specific legal provisions, avoiding temporary storage in spaces from the site organization.

Temporary storage of wastes generated during construction / assembly stage and their disposal shall be made according to the internal procedures of NPP Cernavodă and the applicable law, only in sites specially arranged for this purpose.

Below are presented the main types of wastes that can be generated during construction / assembly stage (including the status of waste: solid, liquid, semisolid) and management options - possibly recovered and / or possibly to dispose:

Waste name	**Waste code according to GD 856/2002**	**Physical state Solid-S Liquid-L Semisolid-SS**	**Management options**	
			Possibly recovered	**Possibly to dispose**
concrete	17 01 01	S	X	
mixtures of concrete, bricks, tiles and ceramic materials, other than those specified in 17 01 06	17 01 07	S	X	
iron and steel	17 04 05	S	X	
metallic mixtures	17 04 07	S	X	
wood	17 02 01	S	X	
plastic	17 02 03	S	X	
soil and stones containing dangerous substances	17 05 03*	S		X
soil and stones other than those mentioned in 17 05 03*	17 05 04	S	X	X
dredging spoil containing dangerous substances	17 05 05	S	X	X
insulating materials other than those specified in 17 06 01 (insulation materials containing asbestos) and 17 06 03 - other insulation materials consisting of or containing dangerous substances	17 06 04	S		X
used oils from the next categories: • mineral-based non-chlorinated engine, gear and lubricating oils • other engine, gear and lubricating oils	13 02 05* 13 02 08*	L	X	X
end-of-life tyres	16 01 03	S	X	
lead batteries	16 06 01*	S	X	
absorbents, filter materials (including oil filters not otherwise specified), wiping cloths, protective clothing contaminated by dangerous substances	15 02 02*	S		X
absorbents, filter materials, wiping cloths and protective clothing other than those mentioned in 15 02 02	15 02 03	S	X	X

Waste name	Waste code according to GD 856/2002	Physical state Solid-S Liquid-L Semisolid-SS	Management options	
			Possibly recovered	Possibly to dispose
paper and cardboard packaging	15 01 01	S	X	
plastic packaging	15 01 02	S	X	
wooden packaging	15 01 03	S	X	
composite packaging	15 01 05	S	X	X
packaging containing residues of or contaminated by dangerous substances	15 01 10*	S		X
paper and cardboard wastes	20 01 01	S	X	
glass wastes	20 01 02	S	X	
plastics	20 01 39	S	X	
metals	20 01 40	S	X	
mixed municipal wastes generated from personnel activity	20 03 01	S		X

Wastes marked with * are hazardous wastes that have one or more hazardous properties listed in Appendix no. 4 - Properties of wastes which render them hazardous from Law 211/2011 on wastes regime.

Noise

Protection measures against noise especially aim specially the staff engaged in construction / assembly activities that may be affected by noise if excesses of the maximum permissible levels, under the laws and regulations in force, are recorded. Therefore, if any excesses of the exposure limit values are recorded according to Govern Decision no. 493/2006, as amended and supplemented, the employer action will be started regarding safety and health protection of staff in relation to the daily noise and sound pressure exposure levels, will be identified the noise sources or the activities that generate such levels of noise and will be proposed measures to reduce noise levels:

- at source
- on the route between source and receiver (worker)
- ultimately, individual protective measures
- combined measures of the above

Measures to avoid breaching noise levels at the site organization include activities related to the proper management of construction/assembly works and the quality of the works, namely:

- staging the work so as to avoid performing two or more works with different character on the same time, in order to prevent the accumulation of several noise sources and work organization so as to reduce noise by limiting the duration and intensity of personal exposure by setting sufficient rest breaks during working hours

- work quality that should meet the quality requirements so as to limit the need for unplanned repairs or interventions that may produce a negative effect by generating noise etc.
- informing and training employees on the proper use of working equipment in order to reduce the minimum exposure to noise
- machinery will have to be equipped with noise absorbers, noise catchers, speakers and dampers for fans.

VIII. Works for the restoration of the site upon the completion of the investment, in case of accidents and/or when the activity stops, as far as such information are available

VIII.1. Works for the restoration of the site upon the completion of the investment, in case of accidents and/or when the activity stops

a) Upon completion of construction / assembly works of the investment are not necessary special recovery site / ecological reconstruction works, given that its site is located in an industrial area, inside the Cernavodă NPP.

During construction and normal operation of the project objectives will not affect local flora and fauna, and are therefore no ecological reconstruction works are needed.

b) In case of accidents

In terms of preparation, planning and intervention in cases of accidental pollution, it is stated that Cernavodă NPP has a master plan at the level of the nuclear object, which is endorsed and approved by the relevant organism and will be revised and expanded to include the analysed project. Within it will be provided inclusively measures to restore the site.

Of course, the site restoration works will depend on the type of accident and the degree of pollution / contamination, which will be established following a study.

c) Upon closure, site restoration work is a part of the documentation for decommissioning and will comply with the legislation in force for nuclear objectives / installations.

Restoration and greening of the land cleared of technological tasks will be subject to a **rehabilitation project** that will take into account the results of a assessing study of the degree of pollution / contamination.

This study will indicate and include details of the decontamination and restoration of land quality measures until his return to a state as close to the initial one, signalled in the study “Initial Security Analysis on IDSFS” (79D-01364-AIS-

01, 2001) based in which was obtained the Authorization for location of IDSFS with 27 modules.

VIII.2. Aspects related to prevention and response in case of accidental pollution

Protection of population and of the operating personnel, both during normal operation and **in the event of an accident at the technological unit**, represents the main safety objective which is envisaged even from the outset of the design of a nuclear facility.

According to the documentation provided by the beneficiary, were analyzed the following types of abnormal events that can occur during the charge of a MACSTOR module, and the measures that are taken in these circumstances:

- Loss of the Containment Integrity of the Basket during Dry Storage - This event can be detected during storage cylinder monitoring, through the presence of contaminants in the recirculated air. Since the storage cylinder is designed as a secondary containment barrier, there will be no release of radioactive material to the external environment. This event will be resolved by isolating the defective basket and repairing it. To identify the defective basket, the baskets will be transferred to a new cylinder and then checked, one by one, by measuring potential releases inside the cylinder during air recirculation. The defective basket will be isolated or repaired.
- Loss of the Containment Integrity of the Cylinder during Dry Storage - This event must be resolved, to remedy the potential loss of the second fuel containment barrier. A leaking cylinder can be detected due to the presence of humidity during storage cylinder monitoring. When a defective cylinder is detected, the accessible welds of the cylinder cover are inspected to detect the source of the leak, and the welds are covered over, if applicable. If the defective cylinder cannot be repaired, then it will be emptied and the baskets will be transferred to another cylinder; the defective storage cylinder will be sealed and abandoned. The occurrence of this event can be avoided by reducing the corrosion rate, by the application of zinc protective coatings during the manufacturing stage (both on the inner and outer surface of each cylinder), as well as by inspecting and repairing any possible damage to these surfaces due to construction activities.
- Detecting Activity Inside a Storage Cylinder - Monitoring of the atmosphere inside a storage cylinder may reveal the presence of radioactivity.
- The source for this radioactivity could be contamination from the surface of the storage baskets, and it is preferable that this contamination remain contained within the storage cylinder. If the loss of basket containment integrity is suspected, then the basket will be identified and returned to the shielded work station for inspection and re-welding. All retrieval operations

will be carried out in accordance with approved procedures that will specify the way in which the contamination will be controlled.

- Seismic Event - The MACSTOR modules are seismically qualified and a seismic event will have no effect on the module's structural, cooling or shielding capabilities as its structure will not be affected. Following a seismic event, the modules are inspected for any sign of damage. A random verification of a number of storage cylinders can also be made to verify the storage cylinder confinement properties have been maintained.
- Air Flow Blockage of MACSTOR modules Air Circuit Elements - The confinement function to prevent release of volatile radionuclides stored in the MACSTOR module is maintained by the fuel element, by the fuel basket and the storage cylinder. Those are respectively made from Zircaloy, stainless steel and galvanized carbon steel and would not be affected by the small temperature increases generated by credible obstructions to the air flow in the air circuit. There are thus no credible natural events that can obstruct the airflow cooling to the MACSTOR 400 that would result in a radiological hazard or a release of volatile radionuclides.
- Fuel Basket Drop - The transfer flask hoist, chain and grapple form a system that is used to load the fuel baskets into the storage cylinder of the MACSTOR module. This forms a normal reliability lifting device that cannot be claimed to maintain control of the load for all credible conditions. The drop of a fuel basket into the storage cylinder would be a low probability event but has to be considered as a credible event. The fuel basket is a rugged structure that is expected to maintain its structural integrity following its drop from the transfer flask down into the storage cylinder. Specifically, the fuel basket will not deform sufficiently to seize into the storage cylinder, to deform the lifting ring and will maintain the integrity of the welds connecting the central post to the base plate. The storage cylinder is also designed to minimise its deformation and to maintain its bottom plate attached to the vertical section of the storage cylinder body. Following the event, the transfer flask hoist is repaired and the fuel basket retrieved out of the storage cylinder. Following such an event, the storage cylinder is no longer used for storage, as verification of the containment or mechanical integrity of its bottom section is not practical. The drop of a fuel basket can generate large stresses in the module's upper deck. The storage cylinder absorbs significant impact energy by its elastic and plastic deformation. The upper deck is provided with sufficient reinforcing bars to accommodate the resulting dynamic loads. The upper deck of the module may however be subject to some local damage that would be repaired, principally by injecting grout in the upper deck.
- Transfer Flask Drop - The transfer flask is manoeuvred over the module at a height that is less than the maximum allowable transfer flask handling

height. The upper deck is provided with sufficient reinforcing bars to accommodate those dynamic loads. From the event, the upper deck of the module may however be subject to some local damage at the point of impact that would be repaired, principally by injecting grout in the upper deck. An analysis of the radiation doses received by the general population if the flask falls at the storage module shows that the period of exposure must be limited for people who, for various reasons, are present at the storage facility fence. Due to the increased span of the MACSTOR module, a detailed verification of the effects of a transfer flask drop at a number of locations on the module was made. The analysis concluded that some local and repairable damages would occur solely at the specific location of impact and that the event would not result in failure of reinforcing bars, would not result in unacceptable stresses in the module structure and would not result in internal scabbing of concrete.

- Collision from Land Vehicles, such as the transfer flask transporter - The only heavy land vehicle (security vehicles are assumed to be lighter) that comes near loaded MACSTOR modules is the transfer flask transporter. Its speed is kept below 10 km per hour, in areas near the loaded modules, to ensure manoeuvrability and control, so as to prevent collisions. Should a collision of the transfer flask transporter occur with the MACSTOR module, the impact of the vehicle at a nominal speed of up to 15 km per hour has been analysed to be benign and would not topple over the module nor affect its general shielding properties. Should a collision occur, any damage to the concrete would be repaired following the event.

VIII.3. Aspects related to the facility shutdown / decommissioning / demolition

The term "decommissioning" used in the nuclear industry refers to the technical and administrative actions necessary to take place at the end of life of a nuclear facility to achieve the level of liberation, partial or total, under control of the Regulatory Authority.

Nuclear decommissioning has as main objectives the protection of personnel, population and environment against radiological and non-radiological hazards resulting from the decommissioning of the facility, and also limiting the potential impacts on future generations.

The envisaged actions involve, among others, decontamination, disassembling / dismantling and removal of radioactive materials, of components, structures and waste.

These activities are carried out in order to achieve a systematic and progressive reduction of radiological hazards and also are based on planning and initial assessment to ensure nuclear safety during decommissioning operations.

In some cases, the nuclear objective subject to decommissioning will remain under the control of the Regulatory Authority, as it may be part of a complex of nuclear facilities still in operation.

Decommissioning activities specific to IDSFS

In case of IDSFS decommissioning, the main activity consists in removing fuel from storage modules. This implies the existence in the country or abroad of a final deposit for irradiated fuel.

- *Decommissioning of equipment and structures used in the preparation and transfer of spent fuel*

Regarding the equipment used in the preparation and transfer of spent fuel, such as Shielded Work Station (SWS) and transfer flask, they will be decontaminated and stored for reuse for other purposes or off-site IDSFS storage. Decommissioning of the SFB building extension will take place similar to other parts of CSAN decommissioning and will be part of the general plan for decommissioning of the nuclear power.

- *Decommissioning of storage modules*

The main activities of the decommissioning plan for storage modules are next:

- Removing Storage Baskets
- Checking absence of contamination in storage cylinders and modules surface
- Checking radioactivity of active materials compared to the maximum permissible limits for each isotope
- Reuse or demolition of modules, resulting materials being stored as industrial wastes
- Decommissioning of the storage area
- Land restoration

The simplicity of the decommissioning program is because the carbon steel from which storage cylinder are made, reinforcement from the module concrete and concrete itself don't have the radioactivity level so they have to be considered weakly active waste. This was verified by activation calculation. The only materials that should be stored as weak active waste could be textiles used for cleaning possible contamination from the bottom of storage cylinders. Consequently, the main activity of the decommissioning program of storage modules consists of checking that there is no radioactive material that should be disposed as radioactive waste.

The activities mentioned before are detailed below:

- *Removing storage baskets*

Removal of the fuel from the storage module is the main activity of decommissioning. Removal of baskets from the module is performed, in reverse order, loading operations. At the storage, the storage basket will be loaded directly

in the transfer flask. Due to higher weight of the transfer flask, will be necessary a higher capacity gantry crane, with a platform and a charging door of the transfer flask. The time required to remove baskets from storage depends on transfer and storage systems capacity, and also on the amount of fuel that need to be handled. Emptying the entire deposit could take several years. Demolition activities of storage modules will begin only after removing all of the fuel stored

- *Checking absence of contamination in storage cylinders and modules surface*

After removing fuel, storage cylinders internal cavities will be checked in terms of superficial contamination and, if necessary, will be decontaminated. Following these operations, it may be produced small amounts of contaminated fabric and liquids, which will then be stored in a national or international final storage.

- *Checking absence of activation products in storage structures*

Due to relatively low degree of CANDU fuel combustion, relatively few neutrons are produced on irradiated fuel bundle. Emitted neutrons will enable some elements from the carbon steel from which are made the storage cylinders and concrete reinforcement; in a negligible measure, concrete will be activated. Production of neutrons in the irradiated fuel slowly decreases over time. The half-time of activation products is relatively short, the activation products of interest reaching equilibrium activity after several half-times. Producing new activation products stops after removing the fuel from storage cylinders thereby activated element radioactivity decreases rapidly. Most likely, modules demolition will be made after the end of the unloading and lifting program of nuclear storage zoning. In practice, removing all fuel from storage modules can take months or years.

In the following table are presented for 3 periods, the percentage of the maximum concentration permitted for main activation products of carbon steel.

As shown in „*79D-35370-220-000-2001, AECL Internal Memo from K.Tsang to R.R.Beaudoin, Cernavodă Dry Fuel Storage Module – Activation of steeland concrete following dry storage”*, concrete activation is insignificant.

From the table we can see that Co-60 activity in carbon steel is initially 40 times lower than the allowed limit. Concrete activation is due primarily to Ca-45, which is negligible (0.1 Bq / g after one month) and decreases rapidly with a half-time of 165 days.

Disintegration of main activation products from carbon steel after 50 years of dry storage and typical disintegration periods

	Fe-55 (half time 949 days)	Co-60 (half time 5,3 years) in carbon steel	Co-60 (half time 5,3 years) in stainless steel
Maximum allowable concentration (CMP)	1000 Bq/gram	10 Bq/gram	10 Bq/gram
Relationship between activity and CMP after one month	0,23%	2,4%	7,4%
Relationship between activity and CMP after one year	0,19%	2,1%	6,5%
Relationship between activity and CMP after four years	0,08%	1,4%	4,4%

Because of very low activity, all materials from the storage module will be stored as non-nuclear industrial waste. Consequently, after decommissioning are not expected large quantities of radioactive waste that requires disposal as such.

Activation levels of storage modules will be checked. During this work, concrete samples will be taken (by drilling inside concrete module wall), from reinforcement bars in concrete and samples (by cutting) from the storage cylinders material. If tests will indicate activity values lower than those defining weakly active waste, it will proceed to storage modules demolition.

- *Reuse or demolition storage modules*

After being emptied of fuel, the storage module may be used to store less radioactive materials. The beneficiary must first consider what alternative uses can give to these modules; if is not found another use, demolition will move to the module.

Operations of emptying the storage modules may take some time. The beneficiary has the option of waiting before demolition begins, until all modules of the deposit will be emptied, decontaminated and checked in terms of materials acceptance as uncontaminated. This strategy will reduce overall radiation dose received by personnel and will facilitate development of activities on the IDSFS storage platform.

Demolition of storage modules will be made using standard equipment and methods for such activities. After the release of the CNCAN licensing regime, materials resulting from these activities will be recycled or disposed as industrial waste. Materials that do not meet the requirements for releasing under the authorization regime will be stored as radioactive waste.

- *Decommissioning of the storage area*

Decommissioning of the storage area requires a minimum of activity (after removal of fuel in advance), which consists of removal of lifting equipment, demolition of the access building and fences, if applicable. These components are uncontaminated and will be recycled or handled as industrial waste.

- *Land restoration*

After decommissioning of the storage modules and other equipment in the storage area, the land can be used for other industrial purposes, in which may be useful the reuse of solid foundations built for the storage modules. Alternatively, the land can be left as it is or restored for other purposes.

Decommissioning plan of IDSFS

Because IDSFS is located in Cernavodă NPP site, **the storage decommissioning was addressed in the Preliminary Decommissioning Plan (PDP) of U1 and U2**, developed by Canadian company Kinectrics in the document "SNN Cernavodă NPP Units 1 & 2 Preliminary Decommissioning Plan" code K-414716-00001-R03. Also IDSFS decommissioning costs have been estimated in the report of Kinectrics Company: "SNN Cernavodă NPP Units 1 & 2 Decommissioning Costing Report" code K-414716-00003-R01.

Under the leadership of Kinectrics at PDP development of U1 and U2 Cernavodă NPP, the following companies have participated:

- CANDESCO Corporation, Canadian company, a subsidiary of Kinectrics, whose staff has compiled similar PDPs for Canadian nuclear power plants in Pickering, Bruce and Darlington.
- DECOM s.a., Slovak company that has developed a specialized computing code called OMEGA that run on PC, being dedicated to decommissioning projects of nuclear power plants.
- MATE-FIN, Romanian company with experience in nuclear waste processing and has participated in data collection from U1 and U2, required as input for computing OMEGA program. Is also worth mentioning that MATE-FIN provides to NPP consultancy and services regarding the processing of radioactive waste of low and medium low activity, shaping the decommissioning strategy, cost estimates for decommissioning and for optimizing and developing PDPs, and also Cost Report (CR) was used OMEGA design software.

OMEGA program meets specifications of IAEA, OECD / NEA and the EU regarding the approach of costs, and their structure, expressed in the document "International Structure for Decommissioning Costing (ISDC) of Nuclear Installations" NEA no. 7088 / OECD 2012.

According to the legislation in force, Preliminary Decommissioning Plan and Cost Report were submitted to the Nuclear Agency for Radioactive Waste (NARW) and agreed with the Approval no. Cernavodă NPP / 02 from 22.11.2013.

Preliminary Decommissioning Plan content

Preliminary Decommissioning Plan includes the following*:*

- a description of the installations that will be decommissioned: U1, U2, Unit 0, DIDR and IDSFS
- a presentation of the decommissioning strategy that will be used
- planning of decommissioning activities
- a description of the administrative structure that will be created for the management of decommissioning activities
- an overview of roles and responsibilities for decommissioning activities
- a description of activities to be carried out as part of the decommissioning
- an estimation inventory of radioactive waste that will be generated during decommissioning
- an estimation of decommissioning costs; this section is a summary of the Costs Report mentioned above
- a preliminary assessment of radiological and conventional hazards associated with decommissioning activities
- a preliminary assessment of the impact of decommissioning activities on the environment
- quality management system applicable to decommissioning
- a description of updating requirements of the documentation associated with decommissioning activity

Removing baskets from IDSFS and their containerisation for final storage

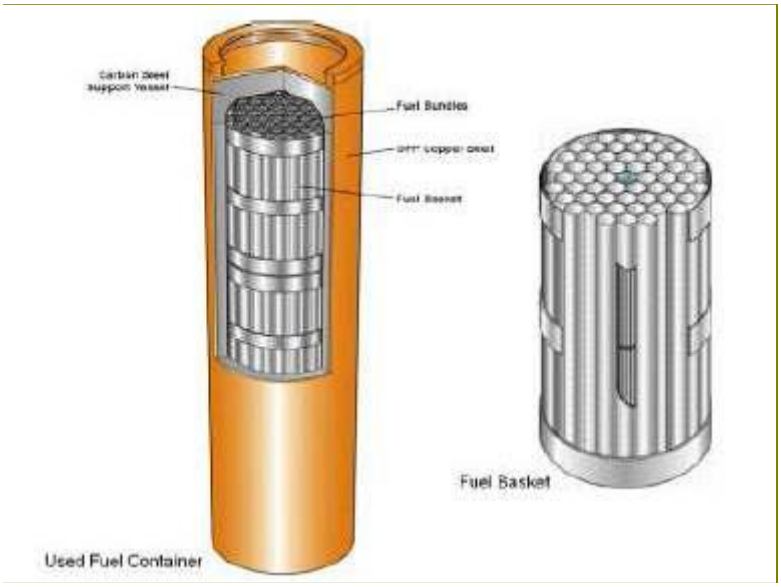
IDSFS specific decommissioning activities, including removing storage baskets from the IDSFS modules cylinders are presented above. Thus, at IDSFS decommissioning, removing baskets with 60 bundles of spent fuel from the IDSFS modules cylinders will be performed, in reverse order, loading operations. After being taken out from the module, the spent fuel storage basket will be loaded in the transfer flask and transported in the packing plant, where fuel will be recovered and packed for final storage. According to PDP, for the packing plant of spent fuel, is intended to use the solution developed by the Canadian government agency, Nuclear Waste Management Organization (NWMO), except that in Canada this station will be built at the Deep Geological Repository - DGR, and in Romania will be build on the Cernavodă site, near IDSFS.

In the packing plant, spent fuel will be recovered from the basket containing 60 bundles and will be transferred to a different kind of basket, where will be loaded 120 bundles, arranged in two layers of 60 bundles each. Spent fuel baskets

will be loaded into containers for final storing, three in each container. The container containing 360 bundles of spent fuel, after being welded and inspected, will be transported to the final deposit.

In the image below is presented the conceptual design of the container and the spent fuel storage basket developed by NWMO. NWMO solution for the packing plant is in an early stage of development. Estimated date for completion of the project and the preliminary report of nuclear safety of the spent fuel packing plant (UFPP - Used Fuel Packing Plant), and the final container of spent fuel storage (UFC - Used Fuel Container) is 2024.

In conclusion, packing activities transport and final storage of spent fuel from IDSFS will be detailed on the following revisions of the Preliminary Decommissioning Plan and of the Cost Report.



IDSFS Decommissioning Plan update

According to art.7 from NSN-15 Norms, IDSFS Decommissioning Plan must be updated and submitted to CNCAN every 5 years.

VIII.4. Ways to restore the original state / rehabilitation for future use of the land

Restoration and greening of the land cleared of technological charges will be subject to a rehabilitation project that will take into account the results of an assessment study of the extent of pollution / contamination.

This study will indicate and include details of the decontamination and restoration of land quality measures down to his return to a state as close to the initial one, mentioned in the study "Initial Security Analysis on IDSFS" (79D-01364-AIS-01, 2001) based in which was obtained the Authorization for location of IDSFS with 27 modules.

Although the project has provided protection of soil and subsoil on the site, by concrete platforms where installations / modules will be placed, it is possible that the action of returning the land to a state as close to the initial one to generate waste, some of them might be classified as hazardous waste, due to a radioactive contamination - probably of low intensity, either due to hazardous substances pollution.

Actions of reconfiguration and rehabilitation of occupied land shall be executed according to a schedule that will take into account the operations of decommissioning on the entire nuclear site and the final destination of the site after consultations with local administration.

After decommissioning of the storage modules and other equipment in the storage area, the land can be used for other industrial purposes, which may be useful in reusing solid foundations built for the storage modules.

At choice, the land can be left as it is or restored for other purposes.

IX. Annexes - Drawings

1. Framing Plan of the objective and Layout Plan, with the use of surface planning

Physical forms of the project (plans, buildings, other structures, construction materials, etc.)

Plans about project site limits, inclusive any land surface requested to be used temporarily (Layout and site plans)

2. Flow – scheme for:

- technological process and activities phases, with depollution facilities.

3. Other drawings, required by the public authority for environment protection.

X. For projects for which in the initial assessment stage the competent environmental protection agency decided the need to start the appropriate assessment procedure, the memorandum is completed with:

a) a brief description of the project and distance from the protected area of community interest, and geographical coordinates (Stereo 70) of the project site. These coordinates will be presented in vector form in digital georeferenced form, in national Stereo 1970 projection system or a table in electronic format containing the outline coordinates (X, Y) in national Stereo 1970 projection system

Location and technical data:

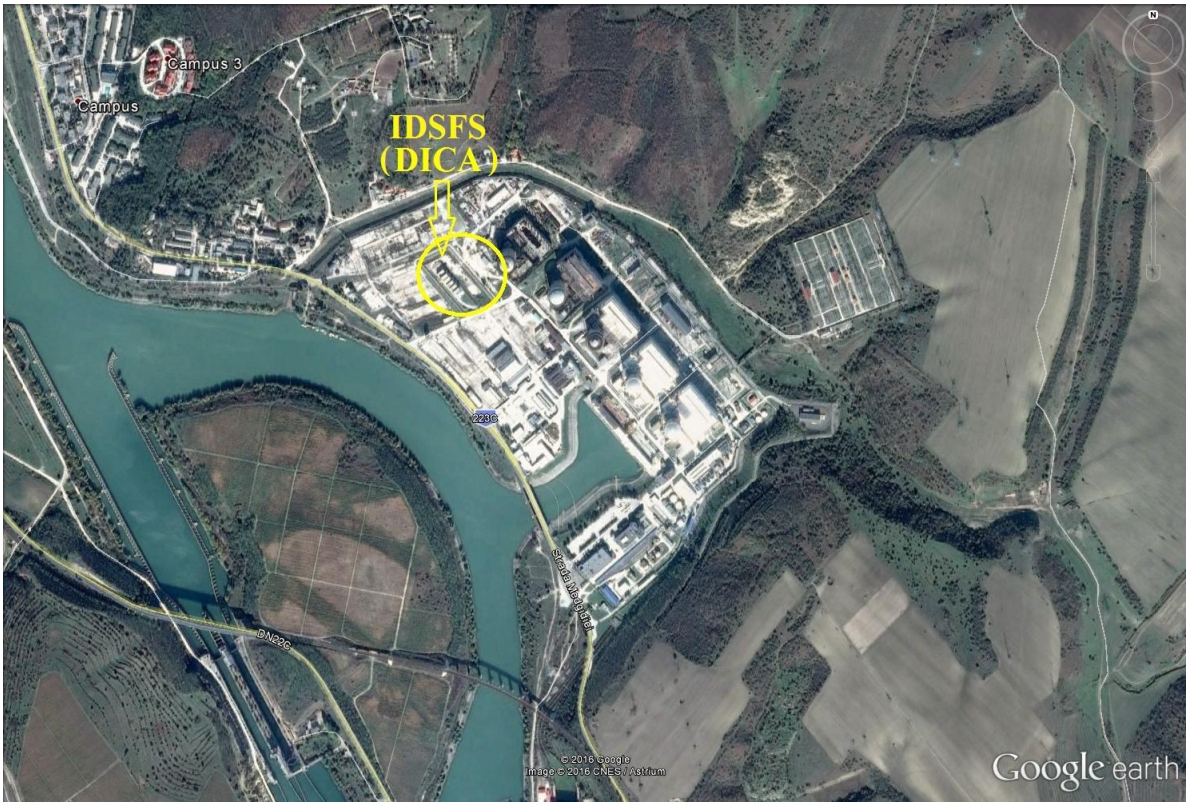
Through the project „Site extension of the Intermediate Dry Spent Fuel Storage facility and continuing to build the MACSTOR 400 type modules" is proposed to extend the radioactive wastes resulting from the operation of Cernavodă NPP storage.

Extension of IDSFS has the purpose to increase the spent fuel storage capacity in perspective of prolongation of U1 and U 2 operation period with another operating cycle of 30 years.

By implementing the IDSFS extension project, the following objectives are pursued:

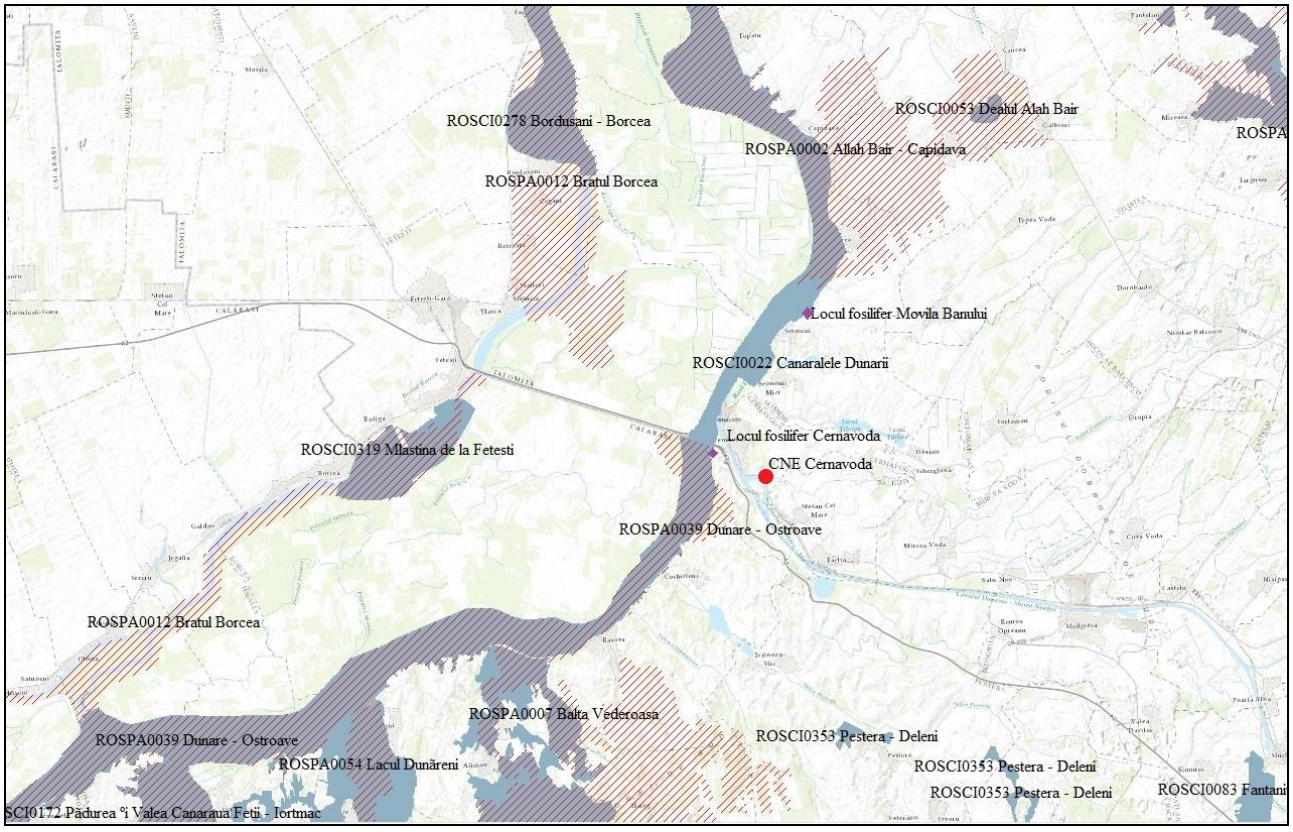
- Extension of IDSFS site with the fourth module row (compared to the 3 foreseen in the original project) of interim storage of spent fuel (increase of surface to approx. 31.000 m^2)
- Building 21 MACSTOR 400 modules starting with module no. 10 from second row
- Increasing the number of spent fuel bundles that can be stored in MACSTOR modules, from 324000 to 612000 spent fuel bundles

The site of Intermediary Dry Spent Fuel Storage (IDSFS) is located within the Cernavodă NPP platform.



Location of the Intermediary Dry Spent Fuel Storage (IDSFS)

The analysed objective is located on Cernavodă NPP platform, outside natural protected areas of national and community interest.



Location of Cernavodă NPP towards natural protected areas of national and community interest

b) Name and code of the natural protected area of community interest

The analysed objective does not overlap with natural protected areas of community interest.

Natural protected areas of community interest in the vicinity of analysed project are:

1. ROSPA0039 Dunăre - Ostroave
2. ROSCI0022 Canaralele Dunării
3. ROSPA0012 Bratul Borcea
4. ROSPA0002 Allah Bair - Capidava
5. ROSPA0001 Aliman - Adamclisi
6. ROSCI0353 Peștera - Deleni

c) Presence and herds / surfaces covered with species and habitats of community interest in the project area

Flora, vegetation and habitats

In the area on Cernavodă NPP, on the site of IDSFS there are no plant species or habitats of community interest listed in Government Emergency Ordinance (G.E.O.) no. 57/2007 with subsequent amendments. The vegetation from the sites of the two objectives is represented mostly by ornamental and ruderal species that do not form vegetal associations with high conservation value.

In the exclusion area of Cernavodă NPP (on 1 km radius) are mainly present semi-natural habitats such as forestry plantations and grasslands, and also strongly anthropogenic habitats, such as agro-ecosystems. Among the steppe species, grass species are found, such as: *Stipa capillata*, *Botriochloa ischaemum*, *Poa bulbosa* and *Festuca valesiaca.* Overgrazing, agricultural practices and planting invasive alien woody species (*Robinia pseudoacacia*, *Gleditsia triacanthos* si *Amorpha fruticosa*) near Cernavodă NPP, have led in time to the degradation of natural habitats, and ruderal species show a very high ratio in the structure of local phytocoenoses.

Habitat types present in the exclusion zone (1 km)

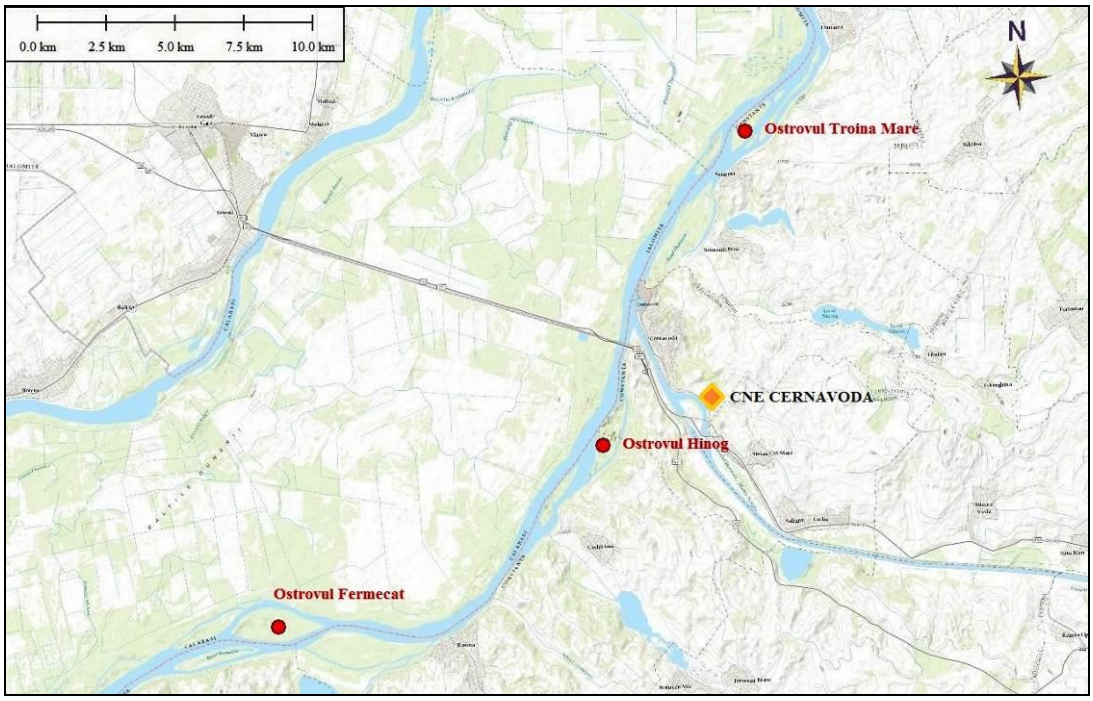

Habitat types present in the exclusion zone (1 km)

Having as defining elements the confluence of the Danube river and the Danube-Black Sea Canal, and also the valleys Carasu, Tibrin and Silistea converging towards the Danube, the relief of analysed area (a radius of 15 km) is very varied, the landscape alternating from floodplain to steep canaries, agricultural lands sprinkled with ravines formed by draining torrents, hills and valleys covered by steppe grasslands, scrubs and forest plantations.

Silistea Valley

Between the two nearby protected areas of community importance, namely the ROSCI0022 Canaralele Dunării and ROSCI0353 Pestera Deleni only the first one protects plant species and habitats of community interest. As part of our approach, a special attention has been paid to vegetation of isles for which there were proposals to declare certain mixed natural reservations (Petrescu M., 2007): Ostrovul Hinog Reservation (located between km 308-302 on the Danube, next to Cochirleni town), Ostroavele Seica-Fermecat Reservation (located on the Danube between km 330-318) and Ostroavele Troina Mare-Balaban Reservation (situated between km 296-274, near Seimeni village, on the Danube). All these isles are part

of the natural protected area of community importance ROSCI0022 Canaralele Dunării.



Location of mentioned isles
Map source: World Topo Map (by Esri)

Ostrovul Hinog Reservation includes the mentioned isle and the smaller adjacent isles including Ostrovul Mic (Ostrovul Cochirleni) and the Valu Lui Traian promontory. The complexity of the landscape is highlighted by the ease which the isles can be observed from the rocky promontory with steppe vegetation (Petrescu, 2007).

Ostrovul Hinog seen from Valu lui Traian promontory

The combination of the forest, steppe and wetlands habitats constitute the strong point of Ostroavele Seica-Fermecat Reservation, comprising Muzait Hill, Carasan Forest and the isles: Seica, Marinaru, Ceacaru-Uzunada and Fermecat (Petrescu, 2007).

The only location in the area where there is an island with rocky substrate and specific vegetation is Ostrovul Podul de Piatra (Stone Bridge Isle), that is a part of Ostroavele Troina Mare – Balaban Reservation. At the mentioned isle are added the isles: Fasolele, Balaban, Troina Mare, Țării and Boascicul Mare.

The vegetation of the isles is a meadow specific vegetation, with rare open areas populated by steppe species. Very good state of preservation is due precisely to their isolation.

Within Ostrovul Hinog Reservation are present the vegetal associations: *Stipetum capillatae* (Hueck 1931) Krausch 1961, *Botriochloetum ischaemum* (Kist. 1937) Pop 1977, *Pruno spinosae - Crataegetum* Soo (1927) 1931, *Salicetum albae* Issler 1924, *Populetum nigro-albae* Slavnic 1952 which enlighten the Natura 2000 habitats: **62 C0* Ponto-Sarmatic steppes**, **40 C0* Ponto-Sarmatic deciduous thickets** and **92 A0 *Salix alba* and *Populus alba* galleries.**

Within Seica-Fermecat Reservation is observed the presence of associations: *Stipetum capillatae* (Hueck 1931) Krausch 1961, *Botriochloetum ischaemum* (Kist. 1937) Pop 1977, *Populetum nigro-albae* Slavnic 1952, *Populetum albae* (Br. - Bl. 1931) Borza 1937, *Salicetum albae* Issler 1924 si *Fraxino – Ulmetum* Oberdorfer 1953 that represent the Natura 2000 habitats: **62 C0* Ponto-Sarmatic steppes**, **92 A0 *Salix alba* and *Populus alba* galleries and 91 F0 Riparian mixed forests of**

***Quercus robur, Ulmus laevis, Fraxinus excelsior* or *Fraxinus angustifolia*, along the great rivers (*Ulmenion minoris*).**

Within Ostroavele Troina Mare – Balaban Reservation are present the vegetal association: *Populetum nigro-albae* Slavnic 1952 *Salicetum albae* Issler 1924 si *Fraxino – Ulmetum* Oberdorfer 1953 that represent the Natura 2000 habitats: **92 A0 *Salix alba* and *Populus alba* galleries** and **91 F0 Riparian mixed forests of *Quercus robur, Ulmus laevis, Fraxinus excelsior* or *Fraxinus angustifolia*, along the great rivers (*Ulmenion minoris*).**

It should be noted that the plant species of Community importance mentioned in the Standard Form of ROSCI0022 Canaralele Dunării: *Moehringia jankae* and *Campanula romanica* were not identified on surfaces covered by the studied area.

The other protected areas, located on a radius of 15 km, show a good state of conservation, despite uncontrolled grazing that take place in these areas.

Along the roads and on the edges of agricultural crops, a series of ruderal species (specific to areas where a major human impact manifests) and segetal species (weeds of agricultural crops) were installed.

We can say about secondary steppe grasslands without protection regime (outside the natural protected areas), which are practically destroyed by overgrazing, that the characteristic species are currently the nitrophos ones, the ones without feeding value and thistles. Here can also be framed the scrubs identified, these areas being currently used as pasture.

Grazing within the former quarry Tibrinu

Among freshwater aquatic habitats listed in the Standard Form of ROSCI0022 Canaralele Dunării, in the studied area (on a radius of 15 km from Cernavodă NPP) are found only on these Natura 2000 habitats: in the area of floodplain is present the habitat **3270 Rivers with muddy banks with**

***Chenopodion rubri* and *Bidention* vegetation**, and in the area with stagnant water has been identified the habitat **3150 Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition* - type vegetation**.

Fauna

Within Cernavodă NPP perimeter were not identified invertebrate species of conservation interest, listed in the Annexes of G.E.O. no. 57/2007 with subsequent amendments.

Among the six protected areas that overlap partially with the analysed surface, only in the standard form of ROSCI0022 Canaralele Dunării is mentioned the presence of an invertebrate species of conservative value at European level, namely *Anisus vorticulus* gastropod. On the territory of the other protected areas taken into consideration, it is not mentioned the presence of invertebrate species that may require special conservation measures.

Regarding vertebrate species we mention that on the sites of the Intermediary Dry Spent Fuel Storage (IDSFS) no habitat favourable for shelter and reproduction (nests, burrows) is present for the protected species of Community Interest (Annex 3 and 4 to G.E.O. no. 57/2007).

Amongst the vertebrates, the *Aves* class is best represented in the area, followed by *Mammalia* class. On the site can be found anthropophilic, common species, characteristic to residential or industrial areas.

But analysing the standard forms of protected areas from the perimeter considered it appears that in the area a large number of species listed in Annexes of G.E.O. no. 57/2007 are present. Basically, in the studied area can be observed representatives of all vertebrates classes:

Pisces Class

Only one Natura 2000 site hosts fish species of Community interest, namely ROSCI0022 Canaralele Dunării. So on the taxonomic list of this natural protected area can be found the species: *Alosa immaculata*, *Gobio albipinnatus*, *Gymnocephalus schraetzer*, *Misgurnus fossilis*, *Pelecus cultratus*, *Rhodeus sericeus amarus*, *Zingel streber*, *Zingel zingel*, *Aspius aspius*, *Gobio kessleri*, *Alosa tanaica*, *Gymnocephalus baloni*, *Cobitis taenia*, *Eudontomyzon mariae* and *Sabanejewia aurata*. The last two species have a pretty precarious conservation status, the population of these species being very small and in continuous decline. Aquatic environment where these species have their life cycle is most susceptible to potential pollution episodes with radioactively contaminated water, or to episodes of excessive thermal pollution, but, from data provided by Cernavodă NPP, the Intermediary Dry Spent Fuel Storage (IDSFS) project is designed to prevent pollution with radioactive substances of water and land environment.

From all the specific observations, onsite, results no impact of the installations already in service (U1 + U2) on the ichtyofauna or the associated benthic invertebrate fauna.

Amphibia Class

Amphibian fauna from protected areas located within the considered perimeter circumscribed to radius of 15 km, comprises only two priority species for conservation, namely *Triturus dobrogicus* and *Bombina bombina.* These species are found in the standard form of protected area ROSCI 0022 Canaralele Dunării, being also found all over the floodplain of the Lower Danube, especially in the breeding season (spring months).

Given the biology and ecology of the species *Bombina bombina*, it can reproduce during the entire warm season because the adult individuals of this species are present in water bodies starting from spring until late autumn.

Moreover, larvae and juveniles of species *Triturus dobrogicus* and *Bombina bombina* present on Annex 3 of G.E.O. no. 57/2007, can be found in temporary and permanent swamps throughout the area considered.

Even if they are not mentioned on the standard forms of the protected areas from the analyzed territory, another species can also be found in the studied area, such as speices of *Pelobates* genus: *Pelobates fuscus* and *Pelobates syriacus,* European tree frog (*Hyla arborea*), Common green toad (*Bufo - Epidalea - viridis*), Marsh frog (*Rana - Pelophylax - ridibunda*) and the hybrid *Rana - Pelophylax - kl. esculenta.*

Bufo - Epidalea – viridis

pontă of *Bufo - Epidalea - viridis*

Pelobates syriacus

Hyla arborea

Except for the waterfrogs (*Pelophylax sp.*), the amphibian species listed above are among those that require strict protection (Annex 4A - Species of Community interest - animal and plant species that require strict protection).

Rana - Pelophylax - ridibunda

Given the sensitivity to moisture factor of amphibians, these species are characteristic for wet areas, because their breathing is made not only in the lungs (for adults) and gills (for larvae), but also through the skin. The typical life cycle of amphibians in the studied area involve an aquatic life phase for breeding, followed by terrestrial or amphibious life. Therefore, amphibian species are likely to suffer in case of pollution accidents with contaminated water, but also in case of accumulation of radioactive elements from terrestrial sources.

Reptilia Class

Among the conservation interest reptiles, in the standard forms of natural protected areas of SCI type (Community Importance Site) that overlap with the studied area, only two species can be found, namely *Emys orbicularis* and *Testudo graeca*. These species can also be found in close proximity of Cernavodă NPP, but also on the whole territory considered (except for *Testudo graeca* species that can only be found in the dobrogean area of the analysed perimeter).

Elaphe sauromates

Testudo graeca


Lacerta agilis


Lacerta trilineata

Studies conducted in the analysed area highlighted also the presence of some ophidian species such as: *Elaphe sauromates, Natrix tessellata, Coluber (Dolichophis) caspius, Coronella austriaca, Natrix natrix* and even *Eryx jaculus* considered extinct previously to 2015 both from Dobrogea fauna and Romania fauna. In the studied area were also identified during the last four years lizard species such as: *Lacerta viridis, Lacerta trilineata, Lacerta agilis, Podarcis taurica* and *Podarcis muralis*, with a sigle exception *Natrix natrix,* all these taxons are amongst the species of Community interest under Annex 3 and Annex 4 of G.E.O. no. 57/2007.

Aves

As indicated at the beginning of this chapter, birds are represented in a large number of species throughout the analysed area. Of these, a number of 62 species are listed on Appendix 3 and Appendix 4 of Government Emergency Ordinance no. 57/2007 and they are: *Accipiter brevipes, Acrocephalus melanopogon, Alcedo atthis, Anthus campestris, Aquila heliaca, Aquila pomarina, Ardea purpurea, Ardeola ralloides, Aythya nyroca, Botaurus stellaris, Branta ruficollis, Bubo bubo, Burhinus oedicnemus, Buteo rufinus, Calandrella brachydactyla, Caprimulgus europaeus, Chlidonias hybridus, Chlidonias niger, Ciconia ciconia, Ciconia nigra, Circaetus gallicus, Circus aeruginosus, Circus cyaneus, Circus macrourus, Circus pygargus, Coracias garrulus, Dendrocopos medius, Dendrocopos syriacus, Dryocopus martius, Egretta garzetta, Emberiza hortulana, Falco cherrug, Falco vespertinus, Ficedula albicollis, Ficedula parva, Haliaeetus albicilla, Hieraaetus pennatus, Himantopus himantopus, Ixobrychus minutus, Lanius collurio, Lanius minor, Larus minutus, Lullula arborea, Melanocorypha calandra, Milvus migrans, Nycticorax nycticorax, Oenanthe pleschanka, Pandion haliaetus, Pelecanus crispus, Pelecanus onocrotalus, Pernis apivorus, Phalacrocorax pygmeus, Picus canus, Platalea leucorodia, Plegadis falcinellus, Porzana parva, Recurvirostra avosetta, Sterna albifrons, Sterna hirundo, Sylvia nisoria, Tadorna ferruginea* and *Tringa glareola*.

In addition to these species, standard forms of protected areas ROSPA0039 Dunare – Ostroave, ROSPA0012 Bratul Borcea, ROSPA0002 Allah Bair -

Capidava, ROSPA0001 Aliman – Adamclisi mention also an important number of species that have either regular migration over those site's surfaces, or they are wintering or nesting in those areas. These species are: *Anas platyrhynchos, Accipiter nisus, Acrocephalus arundinaceus, Acrocephalus schoenobaenus, Acrocephalus scirpaceus, Alauda arvensis, Anas querquedula, Anser albifrons, Anthus trivialis, Ardea cinerea, Asio otus, Aythya ferina, Buteo buteo, Carduelis cannabina, Carduelis carduelis, Carduelis chloris, Carduelis spinus, Chlidonias leucopterus, Coccothraustes coccothraustes, Columba oenas, Columba palumbus,, Coturnix coturnix, Cuculus canorus, Delichon urbica, Falco subbuteo, Falco tinnunculus, Fringilla coelebs, Galerida cristata, Hippolais icterina, Hirundo rustica, Lanius excubitor, Lanius senator, Larus cachinnans, Larus ridibundus, Locustella luscinioides, Luscinia megarhynchos, Merops apiaster, Miliaria calandra, Motacilla alba, Motacilla flava, Muscicapa striata, Oenanthe isabellina, Oenanthe oenanthe, Oriolus oriolus, Otus scops, Phalacrocorax carbo, Phoenicurus ochruros, Podiceps cristatus, Remiz pendulinus, Riparia riparia, Saxicola rubetra, Saxicola torquata, Streptopelia turtur, Sturnus vulgaris, Sylvia atricapilla, Sylvia borin, Sylvia communis, Turdus iliacus, Turdus merula, Turdus philomelos, Turdus pilaris, Turdus viscivorus* and *Upupa epops.*

As illustrated in both taxonomic lists inserted above, we can meet in the studied area, bird species of all major ecological groups (insectivores, granivores, ichthyophagous, day raptors and night raptors).

On the studied site it can be found synanthropic bird species, adapted to anthropogenic impact and human presence. Among these, we mention the following species, which can also be breeding in the platform area of Cernavodă NPP: *Passer domesticus, Passer montanus, Streptopelia decaocto, Columba livia domestica, Pica pica, Sturnus vulgaris, Hirundo rustica* and *Delichon urbica.*

Within Cernavodă NPP premises were not found aquatic bird species, most of the time they were seen in passage or during winter in the distribution canal or on the canal for evacuation of cooling water from Seimeni where they temporary shelter. The temporary presence of these species in the area of distribution basin and along the discharge canal is possible because of the thermal peculiarities of waters that are freezing harder during winter.

Aquatic bird species prefer the natural and semi-natural habitats from the isles and from Danube meadow or the lakes from south-west of Dobrogea.

Day raptor birds can be seen transiting in high flight the Cernavodă NPP platform.

Species characteristic to steppe, to areas with bushes or agroecosystems do not enter inside NPP premises because they prefer open plain habitats.

Mammalia Class

From the analysis of standard forms of natural protected areas of Community Importance (SCIs) that overlap with the studied territory, it appears that these sites host mammal species of Community interest (ROSCI0022

Canaralele Dunarii and ROSCI0353 Pestera Deleni). Thus, these species are otter (*Lutra Lutra*), Romanian hamster (*Mesocricetus newtoni*) and ground squirrel (*Spermophilus citellus*).

In terms of specific richness, mammal fauna of the area under study is much richer than reflected by standard forms of the two protected areas of community interest mentioned above. Thus, field studies have identified in the area presence of *Canis aureus* (golden jackal), *Vulpes vulpes* (red fox), *Meles meles* (European badger), *Vormela peregusna* (marbled polecat - a species that usually accompanies populations of ground squirrel wich they prey), *Mustela eversmanni* (steppe polecat) and even *Martes foina* (stone marten).

Erinaceus concolor (southern white-breasted hedgehog)

Also, among small mammals in the area have been identified species of insectivorous as *Crocidura suaveolens* (lesser white-toothed shrew), *Talpa europaea* (European mole) and *Erinaceus concolor* (southern white-breasted hedgehog) and rodents as *Spalax leucodon* (lesser mole-rat), *Ondatra zibethicus* (muskrat) *Apodemus agrarius (striped field mouse)*, *Microtus arvalis* (common vole*)*, *Mus spicilegus (*steppe mouse*)*, *Mus musculus (*house mouse*)* and *Rattus norvegicus* (brown rat).

We can not exclude the potential presence of the species in the study area of *Mustela lutrola* (European mink), as well as the possible presence (especially in winter) of the grey wolf (*Canis lupus*).

Inside the Cernavodă NPP enclosure is possible the presence of rodent species, unimportant conservative. Larger mammals are unable to penetrate inside the NPP enclosure, due to its fencing with a protection fence.

d) The justification if the proposed project is not directly connected with or is not necessary for conservation management of protected natural areas of community interest

Currently there are no approved Management Plans of protected natural areas targeted by the project.

We mention that for protected natural areas of community interest ROSCI0022 Canaralele Dunarii, ROSPA0039 Dunare – Ostroave, ROSPA0002 Allah Bair – Capidava in the custody of RNP Romsilva – Constanta Forest Direction, The Management Plan was approved by Monister Order 1252/30.06.2016.

For the other Natura 2000 sites from the project area: ROSPA0001 Aliman-Adamclisi, ROSPA0012 Bratul Borcea and ROSCI0353 Pestera – Deleni, there are no Managemnt Plans approved.

The proposed project does not have direct connection with or it is not necessary for the conservation management of protected natural area of community interest.

e) Assess of the potential impact of the project on species and habitats in the protected area of community interest

During the achievement of the objective will not be affected species and habitats with high conservative values because these two objectives are located on the platform Cernavodă NPP. In the NPP perimeter the habitat is an exclusively anthropogenic one, plant species being represented predominantly by herbaceous and woody ornamental species and ruderal species with wide distribution in such deep anthropogenic habitats.

Direct impact on short term is generated by the noise outcome from the building site activities and dust emissions due to construction materials transport and construction works itself.

Given that on the analysed site were not identified habitat of conservative value and fauna species identified are mostly antropofile, adapted to current conditions of human impact, we consider that the direct impact on the site biodiversity will be an insignificant one, both within short term, and also on medium and long term.

Noise can be a disturbing factor for the local avifauna, but considering that the area is not a favourable habitat for shelter, feeding and reproduction of bird species, impact will be insignificant and limited to the level of the analyzed site.

In the Cernavodă NPP area were observed, nesting only few synanthropic birds common, without be classified as endangered or rare species. These species are sedentary (such as sparrows and starlings) or summer visitors (such as swallows and martins). In case of these species there is the possibility of disturbance as result of intensifying anthropogenic activities on sites throughout the construction and installation period. The impact on nesting species inside the Cernavodă NPP enclosure will be insignificant because birds are organisms moving actively and can leave affected areas by the works stipulated by the project, orienting themselves to similar habitats in the vicinity of locations that offer better conditions for feeding, resting and reproduction.

Noise impact on surrounding areas (inclusively natural protected areas) will be insignificant, because construction works are not extensive and the long distance to the nearest protected area (about 1,8 km to ROSPA0039 Dunarea - Ostroave) reduce the possibility of a negative impact on important areas for resting and breeding of avifauna.

Indirect impact (short, medium and long term) can occur by changing the quality of other environmental factors: water, air, soil, subsoil. Implementation of measures to reduce the impact of these environmental factors will exclude the emergence of a potential indirect impact.

During operation of the objective

The Intermediate Dry Spent Fuel Storage Facility (IDSFS) is designed for temporary storage purposes for a minimum period of 50 years, of the nuclear fuel coming from the operation of U1 and U2. IDSFS extension aims to increase the storage capacity of nuclear spent fuel.

The operation of IDSFS will not have a direct impact (short, medium and long term) on the local flora and fauna, due to their constructive peculiarities of the MACSTOR modules type system which provide operation in conditions of nuclear safety for both operating personnel and population, as well as for environment by:

- providing fuel containment barriers against ambient environment (outside fuel sheath);
- removal of residual heat of stored fuel by natural air convection;
- ensuring the storage area against external events (natural and human induced);
- ensuring appropriate biological protection

Under normal operation will not be produced polluting emissions that affect surface waters and groundwater, leading to minimization of potential indirect impact on aquatic organisms.

Because of the solution reached of dry storage of spent fuel, will not be generated solid radioactive waste and / or liquids that could lead to contamination of flora and fauna inside the Cernavodă NPP and vicinity (including natural protected areas).

f) Other information provided in the Methodological Guide for appropriate assessment.

We mention that this memorandum was developed according to the framework content of the Presentation Memorandum in Annex. 5 of ORDER no. 135 of 2010 ***on approving the Application Methodology of environmental impact assessment for public and private projects.***

Chapter X contains elements of Appropriate Assessment based in a great measure on data and information provided by the beneficiary and also from scientific bibliographic sources.

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